Predictors of Fielding Performance in Professional Baseball Players

Gerald T. Mangine, Jay R. Hoffman, Jose Vazquez, Napoleon Pichardo, Maren S. Fragala, and Jeffrey R. Stout

The ultimate zone-rating extrapolation (UZR/150) rates fielding performance by runs saved or cost within a zone of responsibility in comparison with the league average (150 games) for a position. Spring-training anthropometric and performance measures have been previously related to hitting performance; however, their relationships with fielding performance measures are unknown. **Purpose:** To examine the relationship between anthropometric and performance measurements on fielding performance in professional baseball players.

**Methods:** Body mass, lean body mass (LBM), grip strength, 10-yd sprint, proagility, and vertical-jump mean (VJMP) and peak power (VJPP) were collected during spring training over the course of 5 seasons (2007–2011) for professional corner infielders (CI; n = 17, fielding opportunities = 420.7 ± 307.1), middle infielders (MI; n = 14, fielding opportunities = 497.3 ± 259.1), and outfielders (OF; n = 16, fielding opportunities = 227.9 ± 70.9). The relationships between these data and regular-season (100-opportunity minimum) fielding statistics were examined using Pearson correlation coefficients, while stepwise regression identified the single best predictor of UZR/150. **Results:** Significant correlations \((P < .05)\) were observed between UZR/150 and body mass \((r = .364)\), LBM \((r = .396)\), VJPP \((r = .397)\), and VJMP \((r = .405)\). Of these variables, stepwise regression indicated VJMP \((R = .405, \text{SEE} = 14.441, P = .005)\) as the single best predictor for all players, although the addition of proagility performance strengthened \((R = .496, \text{SEE} = 13.865, P = .002)\) predictive ability by 8.3%. The best predictor for UZR/150 was body mass for CI \((R = .519, \text{SEE} = 15.364, P = .033)\) and MI \((R = .672, \text{SEE} = 12.331, P = .009)\), while proagility time was the best predictor for OF \((R = .514, \text{SEE} = 8.850, P = .042)\). **Conclusions:** Spring-training measurements of VJMP and proagility time may predict the defensive run value of a player over the course of a professional baseball season.

**Keywords:** power, agility, ultimate zone rating, fielding percentage, range factor

Fielding performance, although statistically difficult to assess, is considered a significant factor in the outcome of a professional baseball game, accounting for approximately one-fifth of total wins during a major-league season.\(^1,2\) Over the course of an entire major-league baseball season (162 nine-inning games), a minimum of 4374 outs must be made. Two commonly accepted methods of measuring fielding performance are fielding percentage (FPCT) and range factor (RF),\(^3\) which are based on the percentage of outs per fielding opportunity and average outs made per inning played, respectively. However, these statistics are largely based on the number of defensive chances a team or specific player will face, which are not guaranteed. Several circumstantial variables such as defensive position, pitching performance, batter performance, defensive skill of one’s teammates, defensive strategy, player substitutions, injuries, and extra innings will all affect the number of fielding opportunities a baseball player will experience, as well as the requisite skill to successfully make the out. As a result, sabermetrics were developed to provide an objective statistical analysis of in-game activity for baseball.\(^4\) Several sabermetric statistics have been developed to equate players across position and quantify their value either in terms of runs or wins.\(^1-3,5-11\) Recently, the ultimate zone rating (UZR) sabermetric was developed to more accurately define fielding performance by calculating the number of runs a player saved (or cost) his team through fielding in comparison with his respective position’s league average for the season.\(^5,6,10-12\) This measure accounts for the trajectory, velocity, and the 2-dimensional location of the batted ball within a predefined zone of fielding responsibility while also correcting for situational factors such as the number of outs, the handedness of the batter, the ballpark being play in, base-runner configuration, the pitcher’s ground-ball-to-fly-ball ratio, and “ball-hogging” teammates.\(^5\) Although its major limitation is in the discretion used in creating the zones of responsibility,\(^11\) the UZR is believed to be a more comprehensive measure than FPCT or RF for describing the impact of an individual fielder.

Mangine, Hoffman, Fragala, and Stout are with the Inst of Exercise Physiology and Wellness, University of Central Florida, Orlando, FL. Vazquez and Pichardo are with the Texas Rangers Baseball Club, Arlington, TX.
Before a competitive season, several anthropometric and performance measurements are collected to evaluate amateur and minor- and major-league professional baseball players. Significant associations between these measures and hitting performance have been demonstrated; however, whether these physical performance measures can predict fielding performance has not been established. It is believed that proficiency in 4 largely independent skills—sure-handedness (ability to avoid error), range, positioning, and throwing—define defensive capability. Although increased lower-body power, grip strength, and throwing distance have each been associated with increased throwing velocity, whether they translate to better fielding performance is not known. The need for a strong throw may depend on specific actions during a game. For instance, if the athlete is able to reach a ball in a difficult place on the field, his ability to throw out the runner may depend on his arm strength, but it was the initial ability to reach and field the ball that was key. For this task, speed and agility are valued assets in baseball players, particularly in centerfielders and middle infielders, as they appear to improve their range. Nevertheless, neither has been associated with greater FPCT, RF, or any other sabermetric statistic. Therefore, the purpose of this investigation was to identify the anthropometric and physiological variables that may predict fielding performance across defensive positions.

Methods

Subjects

Data from 22 professional baseball players from the Texas Rangers professional baseball organization during the 2007–2011 seasons were examined. To be considered for inclusion, all examined players totaled a minimum of 100 opportunities (ie, putouts, assists, and errors) per season to make a defensive play within their defensive category. The order of testing began with anthropometric measures in the same season, comparisons were made for both categories in relation to spring-training data for that season. Consequently, data from 11 players occurred over multiple seasons (1 season, n = 11; 2 seasons, n = 3; 3 seasons, n = 4; 4 seasons, n = 2; 5 seasons, n = 2). Of the players tracked for multiple seasons, 1 player qualified for 2 different defensive categories within a season twice, while another’s defensive category changed between seasons. Three defensive categories of positions, based on similar positional demands, were used for analysis.

Anthropometric Measures

Anthropometric assessments included height, body mass, and body-fat percentage. Body mass was measured to the nearest 0.1 kg, while height was measured to the nearest 0.1 in and converted to meters. All body-composition measures were performed by the same strength coach using the standardized procedures previously described for collecting skinfold measurement from the chest, abdomen, and thigh and previously published formulas for calculating body density and body-fat percentage.

Isometric Handgrip Testing

Isometric grip strength was assessed with a Jamar handgrip dynamometer (Sammons Preston, Bolingbrook, IL, USA). All measurements were assessed with the player’s dominant and nondominant hands. Isometric handgrip assessments were performed as previously described. Briefly, players began seated with their back straight, arm resting on the arm rest, elbow at 90°, and were instructed to remain motionless while performing a maximal-effort attempt. The best score from 2 maximal-effort attempts was recorded in kilograms as maximal grip strength.
Vertical-Jump and Anaerobic-Power Measures

Countermovement vertical-jump height was measured using a Vertec jump trainer (Sports Imports, Columbus, OH, USA). Before testing, each athlete’s standing vertical-reach height was determined. Vertical-jump height was calculated by subtracting the standing reach height from the jump height. Each player performed 3 attempts, of which the highest vertical-jump height achieved was recorded. The Harman formula was used to estimate both vertical-jump peak power (VJPP) and vertical-jump mean power (VJMP) outputs.

Speed and Agility Assessments

All speed and agility assessments were timed by the same strength coach using standardized procedures. Speed was determined by a timed 10-yard (9-m) sprint. Sprint times were measured using an infrared testing device (Speed Trap II, Brower Timing Systems, Draper, UT, USA) and performed on an Astroturf field. Timing began on the player’s movement out of a 2-point (base-running) stance. The best of 3 attempts was recorded as the player’s fastest time.

Agility was determined by the proagility test. The protocol was conducted as previously described. Three lines with 5 yd (4.5 m) between consecutive lines were marked on the field. The player straddled the middle line and sprinted to one line (4.5 m away) and touched the line. He then changed direction and sprinted to the far opposite line (9 m away), touched the line with the same hand used to touch the first line, reversed direction, and returned to the starting point, sprinting through the finish line. Agility times were measured using a handheld stopwatch with the time beginning at the athlete’s initial movement and stopping as the athlete crossed the finish line. Each subject performed 3 maximal attempts, and the fastest time was recorded.

Fielding Performance

Fielding performance was determined from published statistics of regular-season Major League Baseball play. To objectively compare fielding performance, while accounting for situational variability among defensive positions (with the exception of catcher and pitcher), the UZR was used. This sabermetric statistic is determined by dividing the field of play into 64 zones of responsibility. Credits and debits are given for plays successfully made or not made within a player’s zone, with bonuses given to plays made outside of one’s responsibility. These plays are compared with the league average out rate in each zone, and the difference is summed over all the remaining 64 zones, weighted by run expectancies and adjusted for factors such as ball speed. The final result is the season total number of runs saved (positive) or cost (negative) by the specific fielder. The year-to-year reliability of UZR has been reported to be $r = .444$. For players logging an entire season at a single position, this statistic is ideal in quantifying fielding performance. However, the current sample included players who logged multiple innings and fielding opportunities at several positions during their respective seasons. For these players, the UZR extrapolation was the most appropriate statistic to be used for comparison, as it multiplies the UZR by a factor of the average number of balls in play a fielder at that position would observe over 150 games. In addition, traditional measures of fielding performance were used for comparison. For these, the relationships between UZR/150 and FPC, the total number of outs (assists + putouts) divided by the total number of defensive chances (putouts + assists + errors) and RF, the total number of outs (assists + putouts) per 9 innings played were examined.

Statistical Analysis

All data are reported as mean ± SD. Comparisons between defensive categorizations for spring-training performance data and regular-season defensive statistics were performed using 1-way analysis of variance (ANOVA). If a significant $F$ ratio was observed, then follow-up Tukey post hoc analyses were used to determine difference between groups. Pearson product–moment correlations were used to examine the relationships between performance data and defensive statistics (FPC, RF, UZR, and UZR/150) for all players and by defensive category. The contribution of each variable was then evaluated using a stepwise-regression analysis. A criterion alpha level of $P \leq .05$ was used to determine statistical significance. Statistical software (PASW v. 20.0, SPSS Inc, Chicago, IL) was used for all analyses.

Results

Significant differences in anthropometric, performance, and defensive statistics were seen between defensive categories. Table 1 highlights the differences in fielding requirements among fielding positions for all players and for individual defensive categorizations.

The extrapolation of UZR over 150 (UZR/150) games produced different predictors of performance. Pearson correlation coefficients indicated significant relationships between UZR/150 and body mass, lean body mass (LBM), VJPP, and VJMP. Of these variables, stepwise regression indicated VJMP $(R = .405, \text{SEE} = 14.441, P = .005)$ to be the single best predictor for all players, although the addition of proagility performance strengthened $(R = .496, \text{SEE} = 13.865, P = .002)$ predictive ability by 8.3%. By itself, proagility was not significantly correlated, although a trend toward an inverse relationship $(r = -.287, P = .051)$ was observed. However, these relationships varied among defensive categories: Body mass, LBM, and VJMP remained significantly
related to UZR/150 in CI, while body mass and LBM were the only significant variables for MI; a trend toward VJMP ($r = .507$, $P = .064$) was also observed. For both CI and MI, body mass was the single best predictor ($CI, R = .519$, $SEE = 15.364$, $P = .033$; $MI, R = .672$, $SEE = 12.331$, $P = .009$). A significant inverse relationship was observed between UZR/150 and proagility time for OF. Stepwise regression also revealed proagility time to be the single best predictor ($R = .514$, $SEE = 8.850$, $P = .042$) for UZR/150 in OF. Table 2 provides selected bivariate relationships between UZR/150 and the examined variables.

For all players, height appears to be the single most predictive variable for FPCT ($R = .296$, $SEE = 0.012$, $P = .043$), although inverse relationships with age ($R = .512$, $SEE = 0.016$, $P = .035$) and maximal grip strength ($R = .527$, $SEE = 0.242$, $P = .036$) were the best predictors for CI and OF, respectively. The predictive ability of any single variable for RF varied among defensive categories. For all players, percent body fat ($R = .313$, $SEE = 2.441$, $P = .032$) best predicted RF, although the addition of age ($R = .469$, $SEE = 2.296$, $P = .004$) strengthened predictive ability by 12.2%. However, neither was predictive of RF when players were categorized by defensive position. For CI, an inverse relationship with age appeared to best predict RF ($R = .544$, $SEE = 2.556$, $P = .024$), while no relationship was observed for MI. For OF, 10- yd sprint showed an inverse relationship with RF and was its best predictor ($R = .527$, $SEE = 0.242$, $P = .036$). In addition, a relationship between FPCT or RF and UZR/150 was not observed. Table 3 provides selected bivariate relationships between FPCT, RF, and the examined variables.

### Discussion

Fielding performance is considered to have a significant effect on the outcome of a professional baseball game.\(^1,2\) The results of this study suggest that fielding performance over an entire season of professional baseball may be predicted by anthropometric and physical-performance measurements typically obtained during spring training. Although variability existed between individual defensive positions, mean lower-body power, followed by agility, was the best predictor of defensive-player value for all positions, while the best predictor of traditional fielding measurements varied by position. Previous research has examined the relationship between these measurements and offensive statistics\(^16\) and the coach’s perception of fielding performance,\(^15\) but this study is the first to relate them to actual defensive statistics of performance in professional baseball players.

The results of the current study suggest that VJMP and proagility time are the best predictors of a fielder’s ability to routinely make outs of baseballs hit in play. Power is essential any time one needs to accelerate to a specific location,\(^26\) as a fielder does to catch or field a ball. It has also been reported to influence throwing velocity,\(^13,27\) which may determine whether a ball reaches its intended target in time to make an out. Furthermore, the ability to complete these tasks outside of the average zone of responsibility is rewarded in the UZR/150 scoring format.\(^5,6,10,11\) Our data indicate that those with greater VJMP are able to expand the range in which they make plays. Previous research in college baseball players did not find a significant relationship between measurements.
of power and fielding performance. However, the methods used to examine power (medicine-ball throw and standing broad jump) did not account for body mass or distinguish between peak and mean power, which are necessary to make comparisons between individuals of varying size. It is interesting that the researchers observed a significant difference between the highest- and lowest-rated fielders and their throwing ability, which has been reported to be related to lower-body power.

Proagility performance was the best predictor of “runs saved.” The current investigation measured power by converting countermovement vertical-jump performance with a previously published formula, providing an approximation of concentric power. Although concentric power and fielding performance. However, the methods used to examine power (medicine-ball throw and standing broad jump) did not account for body mass or distinguish between peak and mean power, which are necessary to make comparisons between individuals of varying size. It is interesting that the researchers observed a significant difference between the highest- and lowest-rated fielders and their throwing ability, which has been reported to be related to lower-body power.

Proagility performance was the best predictor of “runs saved.” The current investigation measured power by converting countermovement vertical-jump performance with a previously published formula, providing an approximation of concentric power. Although concentric power...
Predicting Baseball Fielding Performance


