Short Communication

Comparison of anthropometrics and physical performance in professional baseball pitchers

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Objectives: Previous investigations have shown that differences exist between positional groups within a team, which has led to more specific methods of training to enhance performance for that positional group during competition. The purpose of this investigation was to examine anthropometric and physical performance measures between these two classifications of baseball pitchers.

Design and Methods: Twenty professional pitchers completed a battery of test including anthropometrics, body composition, vertical jump, sprint cycling, and shuttle run. All testing was performed during the preseason prior to the start of competition. Independent sample t-tests were performed on each variable between starters and relievers.

Results: Significant differences were seen between starters and relievers in height ($p < 0.05$). No other variables showed statistically significant differences, though moderate effect sizes were present for sprint cycling and shuttle run times.

Conclusion: Findings of this investigation lend support to training pitchers in a similar manner as no differences were seen been groups based on physical performance and anthropometric.

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Key words: Positional differences ■ Anaerobic power ■ Baseball training

INTRODUCTION

Recently, several studies have been conducted investigating anthropometric, physical and physiological profiles of athletes to better gain insight to differences between playing positions and levels of competition in rugby,[1-3] soccer,[4,5] and baseball[6,7]. Previous investigations into positional differences between backs and forwards in rugby have shown differences to measures of anthropometrics, strength, and speed across both playing position and levels of competition.[2,8] Similarly investigations have been conducted in differences of level of competition in professional baseball (major and minor leagues) with differences present in vertical jump performance, body mass (BM) and height.[6] Additionally, the effect of age was investigated on similar measures of anthropometry and physical performance with differences seen across age groups in professional baseball players.[7] Specifically, differences were seen in the vertical jump height, anthropometrics, and anaerobic capacity (300 yd shuttle). While this has led to greater understanding of the professional baseball players, there was no analysis performed across playing positions.

Baseball players can be divided into a two positional groups having pitchers and position players. Inside of the pitchers group there are two further classifications of starters and relievers. While both of these groups perform the same task on the field, in that they attempt to throw a ball with both velocity and accuracy, the demands during the game are slightly different. Starters have the goal of throwing as many innings in a single game as possible, thus the total number of pitches thrown in a game can approach and at in some cases exceed 100.[9] In contrast, a reliever is tasked with throwing during more situational aspects of the game and at the professional level typically will pitch between 1 to 3 innings with pitch totals between 15 and 20 per inning.[9] It has been proposed that training methods used with pitchers should be similar between starters and relievers because the task that each group while in competition is identical.[9] While this makes logical sense, comparisons have not been made between position groups in baseball the same way that they have been in other sports, which has allowed for more position specific training in sports such as soccer and rugby. Thus, it was the goal of this investigation to compare anthropometric and physical performance measures of starters and relievers in professional baseball.

METHODS

Twenty professional baseball pitchers were recruited and participated in this investigation. All pitchers had at least one season of professional experience (2.64 ± 1.77 years) regardless of being a starter or reliever. Pitchers were grouped based on their current role as starter (n = 7) or reliever (n = 13) at the time of data collection. All players belonged to one professional organization (Rookie ball through AAA). Participants had at least one season of professional pitching experience (2.64 ± 1.77 years). All assessments took place as part of the

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organizational physical and performance testing battery during spring training. Informed consent approved from the University Institutional Review Board was obtained.

Anthropometric Measures

Anthropometric measures included height, body mass, and body fat percentage. Height was measured to the nearest 0.1 cm. Body mass was measured to the nearest 0.1 kg. Body density was determined by using the Jackson-Pollock 3 site skinfold equation (Equation #1).[10] This was then used in the SIRI equation for body fat percentage. All skinfold measurements were taken by one investigator.[11] The average of two measurements was taken at each site (chest, abdomen and thigh).

$$\text{Body Density} = 1.10938 - (0.0008267 \times \text{Sum of Skinfolds}) + (0.0000016 \times \text{Square of the Sum of Skinfolds}) - (0.0002574 \times \text{age})$$

$$\text{Body Fat \%} = (4.95/\text{DB}) - 4.50$$

Countermovement Vertical Jump

Countermovement vertical jumps (CMJ) were performed using a wooden dowel (1.0 kg) placed across the shoulders in a high bar squat position. Participants performed a general warm up routine prior to all testing. Once the warm-up was completed, one set of three jumps at a self-selected foot position and to a self-selected countermovement depth were performed. Participants were instructed to jump as explosively as possible to achieve a maximal height while maintaining contact between the dowel and the upper back. This allowed for the assumption that the dowel and the participant were one system. A minimum of 15 seconds rest was given between CMJ attempts. CMJ performance was assessed with the use of a linear position transducer (LPT) (GymawareTM; Kinetic Performance Technology, Canberra Australia) which was attached to the right end of the wooden dowel. The LPT transmitted information to a handheld device via Bluetooth communication. The displacement data is time stamped at a 1000 Hz then down sampled to 50Hz for analysis. Velocity is then calculated as the change in displacement over the change in time. Acceleration data is then calculated as the change in velocity over the change in time. Accelerations are then used to calculate force with the mass of the system (body mass and the dowel) multiplied by the acceleration.[12] Power is then calculated as the force multiplied by the velocity. Variables of interest in the CMJ included, peak power (CMJPP), mean power (CMJMP), normalized peak power (CMJPP/kg), normalized mean power (CMJMP/kg). The mean values of the three jumps was used in the analysis. Reliability of similar methods and population have previously been reported.[13]

30 Second Sprint Cycling Test

All cycle testing was performed on an air-braked cycle ergometer (Wattbike Pro, Nottingham, UK). Each participant performed a warm up that consisted of cycling at a self-selected pace for three minutes, followed by a 60 second rest period. Participants were instructed to remain seated during the duration of the test. Elapsed time was available for participant from the digital screen attached to the cycle ergometer and were required to perform the greatest amount of work possible during that time period. Verbal encouragement was provided throughout the duration of the test. Peak (CyclePP) and mean (CycleMP) power, normalized peak (CyclePP/kg) and mean (CycleMP/kg) power and fatigue factor (CycleFatigue) were used in the analysis. The fatigue factor is calculated as a decline in power from the highest to the lowest 5s average block which is represented as a percentage.

Anaerobic Endurance

A 274.32-meter (300-yd) shuttle test was performed to determine anaerobic endurance. The subject sprinted 22.86-meter (25 yards) yards to a mark they touched with their foot and sprinted back to the starting line. This was repeated 6 times consecutively without stopping (covering 300 yards in total). The timer began at first movement out of a 2-point stance and finished after the completion of the final 22.86-meter sprint. All times were recorded using a handheld digital stopwatch.

Statistical Analysis

SPSS 24 (SPSS Inc, IBM, Chicago, IL) was used for all statistical analyses. Independent sample t-tests were used to compare means between groups. Levene's test for equality of variances was used to assess homogeneity of variance between groups. Significance was set a $p < 0.05$ for all analysis. Effect sizes are presented as Cohen's *d* and interpreted using the criteria of trivial (0.0-0.2), small (0.2-0.6), moderate (0.6-1.2), large (1.2-2.0), very large (2.0) and nearly perfect (4.0 or greater).[14]

RESULTS

Means and standard deviations are reported for all variables (Table 1). Significant differences between groups were observed for height ($t_{(26)} = 3.473$, $p = 0.002$, $d = 1.07$) with starters being taller than relievers (Table 1). No other differences were observed between the groups. Though not statistically significant moderate effect sizes were seen between groups for body fat percentage ($d = 0.70$), CyclePP ($d = 0.84$), CycleFatigue ($d = 0.67$), and shuttle time ($d = 0.67$) (Table 1).

DISCUSSION

The primary findings of this investigation were that starters and relievers in professional baseball are similar in both anthropometrics and physical performance measures. This is important in determining training methods used with both classifications of pitchers. The present investigation found moderate effects of several performance measures that could potentially help in determining the positional profiles.

Results from the present investigation show no statistical significant differences between starters and reliever at the professional level outside of height. Though differences are present in the number of pitches and innings during a game, the biomechanics, physiology and goal of throwing with both velocity and accuracy are the same for both groups of pitch-

Table 1 Comparison of anthropometrics and physical performance measures

	Starters	Relievers	*p*	*d*
Height (cm)	192.31 ± 5.23	188.16 ± 1.63	0.015	1.07
Body Mass (kg)	92.86 ± 14.00	95.52 ± 4.45	0.539	0.03
Body Fat (%)	9.72 ± 2.26	11.64 ± 3.17	0.175	0.70
Cycle Peak Power (W)	1243.57 ± 186.04	1401.62 ± 191.34	0.092	0.84
Cycle Mean Power (W)	794.43 ± 123.41	829.08 ± 73.46	0.438	0.34
Cycle Fatigue (%)	61.29 ± 3.30	65.08 ± 7.23	0.209	0.67
Cycle PP/kg (W/kg)	14.36 ± 3.14	14.67 ± 1.85	0.783	0.12
Cycle MP/kg (W/kg)	8.90 ± 1.05	8.68 ± 0.68	0.578	0.25
CMJ Peak Power (W)	6184.04 ± 1508.16	6745.94 ± 1888.19	0.507	0.33
CMJ Mean Power (W)	3734.70 ± 803.93	3759.35 ± 479.76	0.942	0.04
CMJ PP/kg (W/kg)	65.99 ± 8.92	70.41 ± 17.61	0.545	0.32
CMJ MP/kg(W/kg)	40.00 ± 5.09	39.40 ± 4.92	0.799	0.12
Shuttle (s)	57.57 ± 2.07	56.38 ± 1.39	0.142	0.67

PP/kg = Peak power/kilogram; MP/kg = Mean Power/kilogram; cmJ = countermovement jump

ers. Thus, it is expected that outputs from a variety of testing measures would be similar between the two groups. Previous investigations into professional baseball players anthropometric and physical performance profiles have been across levels of competition and age making direct comparisons with analyzing positional differences. Additionally, these investigations used either position players[6] or combination of both pitchers and position players.[7] The present investigation found similar measures of anthropometry and vertical jump performance between the present study and previous investigations with baseball athletes.[6,7] This is important as the previous investigations included several different organizations, thus the results of this study maybe generalizable to the professional level within the United States, though only 1 of 32 organizations were assessed.

The findings of this study support the recommendations made by Coleman[9] in that training of baseball pitchers should be similar regardless of position, with a reduction in the volume during the competitive season due to the variability in rest between game appearances. Though not statistically significant, moderate effect sizes were seen between position groups for several performance measures. Findings such as this could potentially be important in determining the positional fits as relievers had higher peak power in both the vertical jump and cycling, with a greater drop off in terms of cycling fatigue index. A greater absolute power and higher fatigue index shows that these individuals could potentially be better suited to roles in which a shorter duration (1-3 innings) is typical. These findings are however in contrast to the result of Gillet et al.[15] in which no differences where seen in anaerobic threshold between starters and relievers during a graded submaximal exercise test. Additionally, it was shown that on-field performance appears to be impacted by cardiorespiratory fitness amongst starting pitches with significant differences seen between high and low performing VO2max groups.[15] While limited, the data in the present study may provide support to starting pitchers having a higher anaerobic thresholds and greater VO2max as lower cycling fatigue index was seen in the starters group. Limitations in these direct comparison are primarily driven by modality differences in cycling and treadmill running. Additionally, only anaerobic measures were assessed in the present study, while Gillet et al[15] only assessed aerobic fitness, which can lead to the differences between studies.

Future investigations in this area with larger samples and across multiple levels would be of interest. Though a moderate effect size (d = 0.67) was seen in the shuttle, the nature of conditioning for baseball pitchers regardless of position is to be anaerobic. Due to the short-duration, maximal intensity movements of pitching, it has been suggested that conditioning programs be centered around interval and sprint training with short rest intervals to mimic the heart rate responses seen during competition.[16] Thus, both the starters and relievers should have similar anaerobic capacities that are seen in the present study. Performing the shuttle test at different points during the season to examine if a decline in performance would be present compared to preseason should be considered in future investigations. It should also be noted as a limitation that shuttle times were conducted using hand held timers, which induces a level of variability to the measurement. This assessment was included as a part of the present investigation as an additional measurement that was seen in previous literature involving a similar population. It is important to also note the time of the year in which these test where performed. As training during the offseason has been suggested to be similar for all pitchers, differences in all testing would not be a result of training volume that may exist at different points throughout the competitive season.

The results of this study are confined to professional level pitchers, as differences between may exist between starter and relievers at different levels of competition. Additionally, it should be noted that other aspects of performance including psychological, age, and experience could factor into the talent identification and selection of pitchers into being a starter or reliever. Future investigations should examine positional differences in anthropometrics and physical performance at other levels of competition in pitchers as well as position players using large samples (entire organization) or across multiple organizations. These findings could potential be used in talent identification and better training methods for the profile of an individual position.

CONCLUSION

In the present study no statistical significant differences were seen between starters and relievers pitchers in during a battery of performance tests involving both lower body power output and physiological measures. These results suggest that professional level pitchers regardless of position should be trained in a similar manner to enhance performance.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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