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The Relationship Between Physical Characteristics and Playing Time in NCAA Division Three Baseball Players

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ABSTRACT

This investigation sought to investigate whether age, anthropometric characteristics, and athleticism of NCAA D3 collegiate baseball players have an influence on the amount of playing time they receive. Over the two weeks prior to the start of the team's championship season, 144 participants from three universities in the Great Lakes region of the Midwestern United States completed an assessment protocol consisting of standing and seated height, wingspan, weight, body composition, grip strength, countermovement vertical jumps on force plates, and 20yd sprints. Upon conclusion of their season, their yearend participation statistics were evaluated to determine whether they should be considered a starter or a backup. Independent samples t-tests were then performed to determine if statistically significant differences in performance were observed on the assessment protocols by starters and backups. Significance levels were set at $p < 0.05$. Overall, starters (21.5 ± 1.3years) were older than backups (20.3 ± 1.1), and performed better on all of the metrics related to performance on countermovement vertical jump. Starting pitchers were older and produced higher peak concentric power (5074 ± 708W) than their backups (4779 ± 584W). Starting hitters were also older than backups, in addition to being better than the backups on assessments of grip strength (109.4 ± 16.2KG versus 101.0 ± 20.1KG), and several metrics derived from the countermovement jumps. These results could be used by coaches in the talent evaluation and identification process to determine who is more likely to be a successful player.

Keywords: Baseball, Countermovement jump, Sprint, Grip strength, Anthropometry.

INTRODUCTION

Talent identification in professional and collegiate baseball is considered one of the most important aspects of building and sustaining winning baseball organizations. Excelling at talent identification is so important that National Collegiate Athletic Association (NCAA) Division 1 (D1) programs typically have a dedicated "recruiting coordinator" on their staff while Major League Baseball (MLB) organizations have entire departments, often in excess of 15 employees, dedicated to scouting[5]. These recruiting coordinators, scouts, and coaches are tasked with identifying the most talented amateur baseball players available to join their organization based on the playing skill, athletic characteristics, and other traits of the prospects[16]. Ho et al[7] demonstrated how specific combinations of movement abilities, anthropometric characteristics, functional vision, and decision-making ability have a relationship with position played in amateur baseball players. This research highlights how many different areas contribute to performance in baseball players, which creates significant challenges for coaches

and scouts responsible for talent identification. Also contributing to this challenge is that the current body of research dedicated to the relationship between physical characteristics of amateur baseball players and their impact on playing status or success is limited. This leaves baseball coaches to be mainly reliant on subjective evaluations when identifying talent, and leaves strength and conditioning coaches with little to no direct data to compare the athleticism of their players to. The lack of information can partly be attributed to the fact that MLB only began holding a scouting combine to measure anthropometric and athleticism characteristics of its amateur prospects in 2021, and they have not made that data publicly available for analysis. Data from the National Football League (NFL), National Basketball Association (NBA), and National Hockey League (NHL) annual scouting combines are publicly available. This data is often utilized in research exploring the relationship between a player's physical characteristics and abilities to their on-field performance, and draft status[19]. The availability of data like this from NFL, NBA, and NHL players allows sport and strength and conditioning coaches working in amateur football, basketball, and hockey to provide their athletes with objective benchmarks for their physical performance while going through the evaluation process.

While research directly measuring the physical characteristics of collegiate baseball players is limited, there has been useful research published that strength and conditioning coaches could apply to the assessment and programming of baseball players. While assessing athletes from a different sport, prior studies found starting football players at the NCAA Division Three level performed significantly better than their backups on measures of speed (40yd sprint), agility (pro shuttle), vertical jump height, 1RM bench press, and were significantly older[16]. Hoffman et al[8] studied the anthropometric and athletic characteristics of professional baseball players in MLB and at four different affiliated minor league levels. They found significant differences between the players at various levels in body composition (lower at the two lowest levels of competition), fat free mass (higher at the three highest levels of competition), grip strength (higher at the two highest levels of competition), sprinting speed (fastest at the Major League level), lower body power (highest at Major League level), and age (significantly older the higher up the level). In addition to better identifying future players, being able to objectively evaluate their current players may help coaches to put their most competitive lineup on the field. However, none of the current available literature directly evaluates the relationship between how a division three collegiate baseball player's physical characteristics and age impacts their ability to gain playing time.

The purpose of this study was to determine whether there are significant differences between the age, physical characteristics (e.g., anthropometrics), and athleticism (e.g., strength, speed, etc.) of starting and backup baseball players at the NCAA Division Three level. Based on the results of previous literature, we hypothesized that the starting players would have significantly better performance on several of the assessments of athleticism including lower body power (peak concentric power especially), sprinting speed, and grip strength. Additionally, we hypothesized that starters would have greater height, wingspan to height ratio, and fat free mass compared to the backups. Finally, this investigation also examined whether age was predictive of playing time. We hypothesized that the starters will be significantly older than the backups, regardless of position.

METHODS

Experimental Approach to the Problem

This study involved the participants completing a short demographic survey (date of birth, class, primary position), assessments of athleticism (20yd sprint, vertical jump, grip strength) and anthropometric characteristics (standing height, seated height, wingspan, weight, body fat percentage), and the collection of statistics relevant to the participants playing time during a single competitive season. The survey was completed digitally prior to the participants arriving for their assessments. The assessments were completed during a single session in a gymnasium on the team's respective campuses, immediately prior to a practice within two weeks of their first regular season game of the 2022 season. Following their season, players were classified by playing status (starter or backup) based on the amount they played during the season. Playing status was determined using modified versions of existing NCAA criteria[14]. The NCAA's standards for qualifying as a hitter on their statistical leaderboards are 3.0 plate appearances per game and playing in 75% of the team's games for hitters, while pitchers must average at least one inning pitched per team game played[14]. For the purposes of this study, starters were considered any

hitter who averaged at least 2.0 plate appearances per game and played in 75% of the team's games. Regarding pitchers, any pitcher who had a minimum of one inning pitched per game played by their team or appeared as a pitcher in at least 25% of the team games played was considered a starter. For clarity, this means they do not have to be the first pitcher to appear in a game to achieve starter status in this study, rather, the emphasis is on how frequently they are used relative to other pitchers. This was done to encapsulate both starting pitchers who pitch less frequently but for longer durations, as well as relief pitchers who pitch more frequently but for shorter durations. The qualifying standards were expanded slightly by the researchers from the NCAA recommendations to increase the sample size of the players who qualify as starters, with a specific focus on increasing the number of relief pitchers who are prominently used to meet qualifying standards. Performance characteristics were compared directly between starters and backups as whole, as well as split into position groups (hitter or pitcher) to look for position specific differences. Their age, physical and anthropometric characteristics were then analyzed to determine if there was a relationship to playing status.

Subjects

Players (N = 144) from three, Division Three college baseball teams located in the greater Cleveland, Ohio area completed a brief questionnaire and participated in single laboratory assessment visit. Participants in the study were students at these universities who are healthy members of the university's baseball team. The average age of the participants was 20.7±1.3years and all were male. Prior to completing the assessments, the participants were sent a google form that collected background information (e.g. primary position, age, year in school, etc) relevant to the study. All procedures were approved by Kent State University's Institutional Review Board (protocol #12).

Procedures

Participants were asked to refrain from moderate-to-strenuous resistance training and conditioning in the 48 hours prior to the assessment period. The assessment protocol consisted of measurements of each player's anthropometric characteristics and athleticism. Participants received instruction on how to properly complete each assessment immediately prior to performing them. All participants performed the assessments in the same order. Station one was anthropometric assessments, station two was the dynamic warm up, station three was countermovement vertical jump and grip strength, and the final station was the 20yd sprint. The testers were a combination of Certified Strength and Conditioning Specialists (CSCS) through the National Strength and Conditioning Association (NSCA), and undergraduate research assistants majoring in exercise science. All were trained by the primary investigator and completed CITI training prior to assisting in the study. The testing parameters all met the testing recommendations of the NSCA[13].

Anthropometric Assessments

Participants began by having their standing height, seated height, and wingspan measured. Height, seated height, and wingspan were measured in centimeters using the ISAK compatible version of the Zybek Athlete Measurement Station (ZAMS). The ZAMS was used by Leutzinger et al[11] in their research on the anthropometric and athletic characteristics of high school football players. Measurements of the participants standing height, seated height, and wingspan were used to calculate relative anthropometric metrics for each participant. This includes wingspan to standing height ratio, leg length (standing height minus seated height), trunk to leg length ratio, and percentage of leg length to standing height. After completing their height and wingspan measurements, participants had their weight and body fat percentage measured. Weight and body composition were assessed for all participants using bioelectrical impedance via the Omron HBF-514C. This model was found to be a reliable and valid measuring tool for assessing body composition of college age men by Vasold et al[20] using a BodPod as the criterion (r = .942). Weight in kilograms and body fat percentage were directly recorded, then used to calculate kilograms of fat mass and fat free mass.

Assessments of Athleticism

Upon completion of the anthropometric assessments, participants performed a dynamic warm up designed to maximize their performance on the subsequent assessments of athleticism. The first phase included slower dynamic movements done for 15 yards (e.g. walking lunges), while the second phase consisted of faster dynamic movements for 20yds (e.g. shuffling), before culminating with two, 20yd maximal sprints. No

static stretching was performed. Upon conclusion of the dynamic warm up, participants competed 3 non-consecutive countermovement vertical jumps on Pasco force plates (model PS-2142) sampling at 1000Hz. Participants kept their hands on their hips throughout the entirety of the jump assessments and were verbally cued by the tester when to perform each jump. This model of force plate has shown to be both highly reliable and valid compared to the gold standard criterion (Kistler force plates) when performing vertical jumps (r=0.989, 0.997, 0.996)[15]. The software used to run each test, as well as store and analyze the data, was the ForceDecks software by Vald Performance, version 2.0.7954 (Brisbane, QLD, Australia). The specific metrics used for analysis were flight time to contraction time ratio, peak concentric power output, peak concentric power output relative to body weight, and jump height in centimeters. These metrics were chosen due to their ability to evaluate different aspects of explosive lower body power such as speed of movement, height of jump, as well as both overall and relative power output[3,10].

After the jump test, participants performed an isometric grip strength test. Both hands were measured using a Jamar Handgrip Dynamometer with the subjects elbow next to their side and flexed at a 90-degree angle. They alternated between performing two maximal intensity three second trials on their left and right side. The force output of their best trial on each hand was recorded in kilograms, then totaled for analysis[1]. Lastly, the SmartSpeed Prop Timing Gate System by Vald Performance was used to measure 20-yard sprint time. The 20yd distance was chosen because it was the longest sprint distance that could be performed safely inside the gymnasiums that the testing took place in. No split times were recorded. Participants performed one warm up run at 90% of full speed, then two timed runs. They were instructed to assume a staggered stance start position with both feet and shoulders pointing in the direction they were running, and the toe of their lead leg immediately behind the start line. This position was chosen because it was familiar to all of the participants from their team workouts. The fastest of the two trials was used for analysis.

Statistical Analysis

All analyses were performed on SPSS for Windows (version 28.0). Descriptive statistics (mean ± SD) for all variables were calculated. The participants were then split by playing status (starter or backup) as discussed in the methods section, and independent samples t-tests were performed assessing differences in all dependent variables (e.g., anthropometrics, athleticism, playing status). Significance levels were set at $p < 0.05$. The analyses comparing the variables of starters and backups was first performed on the participants as a whole, then again with them split into groups based on their primary position as either a pitcher or hitter. Hitter included all players whose primary position was catcher, first base, second base, shortstop, third base, left field, centerfield, right field, or utility player.

RESULTS

There was a total of 144 participants who completed a portion of the study protocol. Ten participants did not state their age, meaning 134 ages were recorded in total. Three participants completed the anthropometric screen but were not medically cleared to perform the vertical jump and 20yd sprint assessments. One additional participant was not medically cleared to do the 20yd sprint but was allowed to perform the vertical jump. Therefore, other than reporting age, a total of 140 participants performed the entire assessment protocol, with 144 performing all anthropometric and grip strength assessments. All participants were included for each assessment they completed. Descriptive statistics for this population can be found in Table 1.

Descriptive statistics by position are listed in Table 2. Some positions were grouped together based on similar positional requirements and the likelihood that players switch back and forth between the two positions. Specifically, first basemen and third basemen were grouped as corner infielders (INF-COR), shortstops and second basemen as middle infielders (INF-MID), while left and right fielders appear as corner outfielders (OF-COR). Pitchers (PIT), catchers (CAT), and centerfielders (CF) were left to be evaluated in their individual position groups due to the unique nature of these positions and the decreased likelihood that players playing these positions will play other positions. Lastly, utility players (UTI) were defined as those who regularly play several positions that cannot be grouped together easily (e.g., a player who rotates between playing left field, third base, and second base).

Age and performance on the assessment protocol between starters and backups was then compared. First, all participants were analyzed together

Table 1. Descriptive Statistics – All Participants

Category	N	Mean ± SD
Age	134	20.7±1.3
Anthropometric Assessments		
Height – Standing (CM)	144	180.2±6.5
Height – Seated (CM)	144	93.8±3.2
Leg Length (CM)	144	86.4±4.7
% Leg Length of Standing Height	144	47.9±1.3
Trunk: Leg Ratio	144	1.09±0.06
Wingspan (CM)	144	183.5±6.9
Wingspan: Height Ratio	144	1.02±0.02
Weight (KG)	144	86.2±10.2
Body Fat %	144	20.6±5.0
Fat Free Mass (KG)	144	68.2±6.6
Fat Mass (KG)	144	18.0±6.0
Athleticism and Strength Assessments		
Grip Strength (KG)	144	102.7±17.1
Force Plate Countermovement Jump:		
Flight Time: Contraction Time	141	0.71±0.11
Peak Concentric Power (W)	141	4835±666
Peak Concentric Power Relative (W/KG)	141	56.1±6.0
Jump Height (CM)	141	42.4±6.1
20 Yard Sprint (S)	140	2.95±0.14

without being split by position group (Table 3). No statistically significant differences were observed related to the anthropometric characteristics of the starters and backups. This includes standing height (t = 0.62, p = 0.268, d = 0.11), seated height (t = 0.32, p = 0.375, d = 0.03), leg length (t = 1.109, p = 0.135, d = 0.20), trunk to leg length ratio (t = 1.424, p = 0.078, d = 0.18), leg length percentage of total height (t =1.38, p =0.170, d = 0.23), wingspan (t = 0.575, p = 0.283, d = 0.10), wingspan to height ratio (t = 0.068, p = 0.473, d = 0.02), weight (t = 0.707, p = 0.240, d = 0.13), body fat percentage (t = 0.033, p = 0.487, d = 0.02), fat free mass (t = 0.996, p = 0.161, d = 0.19), and fat mass (t = 0.116, p = 0.454, d = 0.02). However, there were differences between these groups in age and several different assessments related to athleticism. First, the age of the starters (21.5 ± 1.3years) was significantly greater than the backups (20.3 ± 1.1years, t = 4.3, p <0.001, d = 1.14). Next, starters performed better on all of the metrics derived from the vertical jump assessment with force plates. Flight time to contraction time ratio was significantly better (t = 2.1, p = 0.018, d = 0.38) for starters (0.73 ± 0.12) than for backups (0.70 ± 0.10). Peak concentric lower body power was significantly greater (t = 2.2, p = 0.014, d = 0.41) for starters (5009 ± 610W) than backups (4748 ± 679W). Peak concentric power relative to body weight was significantly better (t = 2.2, p = 0.014, d = 0.40) for starters (57.7 ± 6.4W/KG) than backups (55.3 ± 5.7W/KG). Also, starters (44.2 ±6.9cm) outperformed backups (41.7 ± 5.6cm) on jump height (t = 2.2, p = 0.014, d = 0.40). Lastly, while not statistically significant, there was a trend towards significance (t =1.53, p = 0.064, d = 0.28) on the 20yard sprint test between starters (2.92 ± 0.15S) and backups (2.96 ± 0.14S).

Independent samples t tests were also performed to investigate the differences between playing status for hitters (n=80) and pitchers (n=63) separately. Hitters consist of all the non-pitching positions. The results of the analysis on hitters can be viewed in their entirety in Table 4. There was a comparable outcome to the analysis of the population as a whole. Starting hitters (21.5±1.2 years) were significantly older (t = 4.3, p = <0.001, d = 1.07) than the backups (20.3 ± 1.1 years). Starting hitters (109.4 ± 16.2KG) also significantly (t = 1.9, p = 0.034, d = 0.44) outperformed backups (101.0 ± 20.1KG) on the grip strength assessment. Three of the vertical jump metrics displayed statistically significant differences based on playing status, all in favor of the starting hitters. Flight time to contraction time ratio was greater (t = 2.1, p = 0.021, d = 0.49) in starters (0.74 ± 0.10) than backups (0.69 ± 0.09).

Table 2. Normative Data by Position (Mean+SD)

Category	Catchers (n=11)	INF-COR (n=20)	INF-MID (n=17)	OF-COR (n=18)	OF-CF (n=9)	Pitchers (n=64)	Utility (n=5)
Age	20.8±1.2	20.5±1.2	20.3±1.6	20.8±1.2	20.7±1.3	20.7±1.2	21.5±0.6
Anthropometric Assessments							
Height – Standing (CM)	179.0±7.1	180.6±3.7	174.9±5.7	178.4±4.4	178.00±7.7	182.7±6.5	178.6±9.5
Height – Seated (CM)	92.9±3.0	93.6±2.1	92.4±2.9	93.9±3.1	92.2±3.1	94.8±3.4	92.4±3.3
Leg Length (CM)	86.1±5.1	87.0±3.4	82.5±4.0	84.5±2.5	85.8±5.5	87.9±4.4	86.2±7.5
% Leg Length of Standing Height	48.0±1.3	48.2±1.2	47.2±1.2	47.4±1.0	48.1±1.4	48.1±1.3	48.2±2.0
Trunk: Leg Length Ratio	1.08±0.06	1.08±0.05	1.12±0.05	1.11±0.04	1.08±0.06	1.08±0.06	1.08±0.08
Wingspan (CM)	181.1±5.3	184.6±4.0	177.4±5.0	181.7±4.9	180.1±9.4	186.4±7.0	181.5±8.0
Wingspan: Height Ratio	1.01±0.02	1.02±0.02	1.01±0.02	1.02±0.02	1.01±0.03	1.02±0.02	1.02±0.01
Weight (KG)	88.7±9.5	92.0±10.0	78.4±8.0	84.4±8.6	81.9±8.1	87.4±10.3	83.3±9.8
Body Fat %	21.8±3.5	22.5±6.1	19.5±4.5	19.9±4.9	16.9±4.7	20.8±4.9	19.6±6.2
Fat Free Mass (KG)	69.1±5.5	70.9±5.2	62.9±5.1	67.4±5.8	68.2±9.2	68.9±6.5	66.9±9.0
Fat Mass (KG)	19.5±4.8	21.1±7.7	15.5±4.7	17.0±5.4	13.7±3.5	18.5±5.8	16.4±5.6
Athleticism and Strength Assessments							
Grip Strength (KG)	110.4±13.1	99.4±26.8	100.7±15.6	106.8±16.9	103.9±21.1	101.3±14.0	104.9±9.5
Flight Time: Contraction Time†	0.71±0.09	0.68±0.07	0.70±0.08	0.72±0.13	0.78±0.11	0.71±0.11	0.65±0.07
Peak Concentric Power (W)†	5044±638	5077±599	4413±613	4771±745	4886±335	4879±638	4480±1100
Peak Concentric Power Relative (W/KG)†	57.0±6.8	55.6±5.4	56.1±6.0	56.1±6.8	60.0±4.8	55.8±5.8	53.2±7.9
Jump Height (CM)†	43.9±6.9	41.7±4.8	40.9±5.3	42.4±7.1	47.0±3.6	42.7±6.4	37.3±5.8
20 Yard Sprint (S)	2.98±0.15	2.98±0.17	2.93±0.12	2.88±0.11	2.83±0.11	2.97±0.13	2.97±0.20

†Measured via countermovement vertical jump on force plates

Peak concentric power relative to bodyweight was also significantly better (t = 1.9, p = 0.028, d = 0.46) in starters (58.3 ± 5.8W/KG) than backups (55.4 ± 6.2W/KG). Finally, the jump height of starting hitters (44.5 ± 5.6cm) compared to that of backup hitters (16.3 ± 6.1cm) was significantly higher (t = 2.1, p = 0.022, d = 0.49).

Few statistically significant differences were observed when the pitchers were compared across playing status (Table 5). Age was significantly (t =3.4, p = 0.001, d = 0.91) higher in starters (21.4 ± 1.3 years) than in backups (20.3 ± 1.0 years). The only physical attribute that displayed a statistically significant difference between the two groups was peak concentric power (t =1.7, p =0.04, d = 0.47), which saw starters (5074 ± 708W) outperform backups (4779 ± 584W). While none of the other assessments analyzed displayed statistical significance, there were two anthropometric assessments that trended toward significance. First of these was body fat percentage, which saw starting pitchers (22.1 ± 4.7%) have a higher (t = 1.5, p = 0.068, d = 0.40) percent body fat than the backups (20.2 ± 4.9%). Second was kilograms of fat mass, in which starters (20.1 ± 6.1KG) had higher totals (t = 1.5, p = 0.066, d = 0.41) than backups (17.7 ± 5.6).

Of note, individual position groups of hitters (e.g., catchers, inf-mid, etc.) were not separately analyzed for differences based on playing status. The researchers determined that the sample sizes, especially when split into starters and backups, were too small to be compared by position for hitters.

DISCUSSION

To our knowledge, this study was the first to explore the relationship between age, anthropometric

Table 3. Comparison of Starters and Backups – All Players

Category	Starters			Backups			*P*
	N	Mean	SD	N	Mean	SD	
Age	44	21.5	1.3	90	20.3	1.1	<0.001*
Height - Standing (CM)	47	180.7	5.9	97	180.0	6.8	0.268
Height - Seated (CM)	47	93.7	2.9	97	93.9	3.3	0.375
Leg Length (CM)	47	87.0	4.4	97	86.1	4.7	0.135
Trunk: Leg Length Ratio	47	1.08	0.05	97	1.09	0.06	0.078
% Leg Length of Standing Height	47	48.1	1.3	97	47.8	1.3	0.170
Wingspan (CM)	47	184.0	6.3	97	183.3	7.2	0.283
Wingspan: Height Ratio	47	1.01	0.02	97	1.02	0.02	0.473
Weight (KG)	47	87.1	9.6	97	85.8	10.5	0.240
Body Fat %	47	20.5	4.7	97	20.6	5.2	0.487
Fat Free Mass (KG)	47	69.0	6.1	97	67.8	6.57	0.161
Fat Mass (KG)	47	18.1	5.5	97	18.0	6.21	0.454
Grip Strength (KG)	47	105.0	15.6	97	101.5	17.8	0.123
Flight Time: Contraction Time†	47	0.73	0.12	94	0.70	0.10	0.018*
Peak Concentric Power (W)†	47	5009	610	94	4748	679	0.014*
Peak Concentric Power Relative (W/KG)†	47	57.7	6.4	94	55.3	5.7	0.014*
Jump Height (CM)†	47	44.2	6.9	94	41.7	5.6	0.014*
20 Yard Sprint (S)	47	2.92	0.15	93	2.96	0.14	0.064

**Denotes a significant difference at p ≤0.05, †Measured via countermovement vertical jump on force plates*

Table 4. Comparison of Starting and Backup Hitters

Category	Starters			Backups			*P*
	N	Mean	SD	N	Mean	SD	
Age	23	21.5	1.2	52	20.3	1.1	<0.001*
Height - Standing (CM)	26	178.7	6.3	54	178.0	5.8	0.334
Height - Seated (CM)	26	93.03	2.8	54	93.1	2.8	0.454
Leg Length (CM)	26	85.6	4.5	54	84.9	4.4	0.257
Trunk: Leg Length Ratio	26	1.09	0.05	54	1.10	0.06	0.230
% Leg Length of Standing Height	26	47.9	1.2	54	47.7	1.3	0.4710
Wingspan (CM)	26	182.0	5.8	54	180.8	6.1	0.204
Wingspan: Height Ratio	26	1.02	0.02	54	1.02	0.02	0.280
Weight (KG)	26	85.2	8.1	54	85.2	10.9	0.500
Body Fat %	26	19.3	4.3	54	20.9	5.5	0.097
Fat Free Mass (KG)	26	68.7	6.6	54	67.1	6.6	0.147
Fat Mass (KG)	26	16.5	4.5	54	18.2	6.7	0.128
Grip Strength (KG)	26	109.4	16.2	54	101.0	20.1	0.034*
Flight Time: Contraction Time†	26	0.74	0.10	53	0.69	0.09	0.021*
Peak Concentric Power (W)†	26	4957	527	53	4723	748	0.079
Peak Concentric Power Relative (W/KG)†	26	58.3	5.8	53	55.4	6.2	0.028*
Jump Height (CM)†	26	17.5	2.2	53	16.3	2.4	0.022*
20 Yard Sprint (S)	26	2.90	0.13	53	2.94	0.15	0.097

**Denotes a significant difference at p ≤0.05, †Measured via countermovement vertical jump on force plates*

Table 5. Comparison of Starting and Backup Pitchers

Category	Starters			Backups			*P*
	N	Mean	SD	N	Mean	SD	
Age	21	21.4	1.3	38	20.3	1.0	0.001*
Height - Standing (CM)	21	183.2	4.4	43	182.4	7.3	0.319
Height - Seated (CM)	21	94.6	2.9	43	94.9	3.7	0.362
Leg Length (CM)	21	88.6	3.7	43	87.5	4.7	0.166
Trunk: Leg Length Ratio	21	1.07	0.06	43	1.09	0.05	0.098
% Leg Length of Standing Height	21	48.4	1.4	43	47.9	1.2	0.212
Wingspan (CM)	21	186.5	6.2	43	186.4	7.4	0.486
Wingspan: Height Ratio	21	1.02	0.03	43	1.02	0.02	0.256
Weight (KG)	21	89.4	10.9	43	86.5	10.0	0.151
Body Fat %	21	22.1	4.7	43	20.2	4.9	0.068
Fat Free Mass (KG)	21	69.3	6.7	43	68.8	6.5	0.381
Fat Mass (KG)	21	20.1	6.1	43	17.7	5.6	0.066
Grip Strength (KG)	21	99.7	13.2	43	102.1	14.5	0.257
Flight Time: Contraction Time†	21	0.73	0.14	41	0.70	0.10	0.174
Peak Concentric Power (W)†	21	5074	708	41	4779	584	0.043*
Peak Concentric Power Relative (W/KG)†	21	57.0	7.1	41	55.2	5.0	0.125
Jump Height (CM)†	21	43.7	8.1	41	42.2	5.1	0.153
20 Yard Sprint (S)	21	2.95	0.16	40	2.98	0.12	0.194

**Denotes a significant difference at p ≤0.05, †Measured via countermovement vertical jump on force plates*

characteristics, athleticism, and the ability of these factors to predict playing time in collegiate baseball players at the NCAA Division Three level. This study provides some of the first normative data by playing position for this level, which is outlined in Table 2. This study also sought to determine if differences existed between the anthropometric and athletic characteristics of starting and backup Division Three college baseball players. We hypothesized that the starting players would outperform the backups in the measurements of lower body power, sprinting speed, grip strength, and fat free mass. These findings support prior research demonstrating lower body power, sprinting speed, and fat free mass all were predictive of level of play in professional baseball players, with better performance on the test indicative of a higher level of competition achieved[6]. When all players were analyzed together this hypothesis was accurate in some, but not all, areas measured. All of the data analyzed from the force plate jumps measuring lower body power showed that the starting players significantly outperformed the backups. Additionally, the sprinting speed of the starters was better than the backups at a level that trended towards, but fell short of, statistical significance. However, grip strength and fat free mass were not different between starters and backups, meaning our hypothesis was incorrect for these characteristics. This was also true for the other anthropometric measurements including height, wingspan, seated height, leg length, weight, percent body fat and fat mass.

These results were somewhat different when the participants were split into groups of hitters and pitchers and compared based on playing status. When analyzing the hitter data, starters significantly outperformed backups on grip strength and three out of four of the metrics related to lower body power (flight time to contraction time ratio, peak power relative to weight, and jump height), but there was no difference in terms of sprinting speed, fat free mass, or any other anthropometric measurements. Starting pitchers achieved significantly higher peak concentric power on the force plate vertical jumps than backups did, but they did not have any other measurement of athleticism or stature that was different from their backups. These finding support those of Sakurai et al[18] who demonstrated a significant correlation (r=0.68) between fastball velocity and CMJ peak power in Division One collegiate pitchers. Collectively, these findings demonstrate how increasing lower body power outputs will likely lead to pitchers throwing harder, which could in turn could lead to more playing time. In regard to body composition data, there was a trend towards significantly greater total fat mass, and higher body fat percentage in starting pitchers

compared to backups. These findings on pitchers are a particularly interesting outcome. The ability to produce higher amounts of peak concentric power on the countermovement jump is largely related to the jumper's total weight, as opposed to how high, or fast, they jump[10]. This, coupled with starters having greater average amounts of fat mass and percent body fat, may suggest that higher body fat levels will not negatively impact a pitcher's ability to receive playing time, if they have powerful legs.

These findings share similarities with Hoffman et al8, who demonstrated that greater lower body power outputs and better sprinting speed made professional baseball hitters more likely to play at higher levels of competition and have better offensive production in games. Our results were also comparable to those by Stuempfle et al who found 40yd sprint speed and vertical jump height to be superior in starting Division Three football players than backups[17]. Magrini et al demonstrated that vertical jump height, and movement speed on jumps were superior for starters compared to backups in collegiate soccer players[12]. Black and Roundy et al also determined starting Division One football players at several different positions had higher vertical jump height than backups[2]. However, to the researcher's knowledge, this study is the first to specifically examine the relationship between physical characteristics as a predictor of playing time in Division Three baseball players. Given the previously mentioned lack of publicly available normative data on the athleticism of collegiate and professional baseball players, this study could be very useful to strength coaches when designing workouts. Additionally, a novel area of our investigation was the use of force plates to analyze lower body performance in the countermovement vertical jump as opposed to the previously mentioned studies, which all used vertical jump analysis via a Vertec or a linear position transducer. The use of force plates allows for more aspects of lower body performance to be evaluated than jump height and/or speed[10]. This study demonstrated that using force plates in athlete assessment, as opposed to vertical jump height alone, may give coaches more detailed information on their players that show a wider variety of physical characteristics.

The second aim of this study was to determine whether age has a statistically significant relationship with playing status. We hypothesized that the starters would be significantly older than the backups, regardless of position. This hypothesis was supported by our results. Starters were older than the backups when analyzed collectively and when split into hitters and pitchers. These findings support those previously performed on Division Three football players and Division One soccer players that starters are significantly older than backups in collegiate sports teams[9,17]. These findings also can be interpreted to be in line with those by Hoffman et al who demonstrated that professional baseball players are significantly older at higher levels of competition[8]. One can infer from these findings that a Division Three collegiate baseball player's accrued knowledge and playing experience may impact their chances of becoming a starter to a degree equivalent to the way their physical characteristics do. Our investigation appears to be the first to directly measure the relationship between age and playing status on Division Three baseball players.

In conclusion, our data suggests that age is a significant predictor of playing status in NCAA Division Three baseball players. Specifically, regardless of position, older players are likely to be starters while younger players are likely to be backups. Additionally, several physical characteristics are related to playing status as well, particularly when analyzing hitters and pitchers separately. Hitters that qualified as starters displayed significantly better ability to express power in the lower body, and better upper body strength than their backups. Pitchers who expressed greater maximum power outputs in their lower body were more likely to receive more playing time. Outcomes from the current study also suggest, possibly counter-intuitively, that having higher levels fat mass may be beneficial to the amount of playing time a pitcher receives. In addition to increasing the variety of assessments performed, future research should perform comparable investigations with larger samples sizes at the NCAA Division One and Division Two levels to determine if similar outcomes are observed in players who receive collegiate scholarships. Ideally, these future studies could also include the measurement of physical characteristics like agility and lower body strength that the researchers did not have the time to perform in this investigation. Also, additional research exploring how on field performance, and not just playing time, is impacted by these physical characteristics would be of use. This would further aid collegiate coaches in their recruiting efforts and strength and conditioning coaches in individualizing their exercise prescription.

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CONFLICTS OF INTEREST

All authors declare no financial conflicts of interest with this study.

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ETHICAL APPROVAL

Ethics for this study were approved in line with University's ethics procedure. All procedures were approved by Kent State University's Institutional Review Board (protocol #12).

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