A COMPARISON OF THE NATIONAL BASKETBALL ASSOCIATION'S ANNUAL NATIONAL BASKETBALL ASSOCIATION DRAFT COMBINE 2001 TO 2018

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The current study investigated whether athlete performances in the National Basketball Association's (NBA) Draft Combine are changing over time. The current study was conducted with data from the 2001 (n = 78) and 2018 NBA Draft Combine (n = 69) for ten combine assessments (data from NBA.com). Results indicated that athletes from 2018 had a lower body weight ($p < 0.05$) and body fat percentage ($p < 0.001$) and exhibited better performance in lane agility time ($p < 0.05$), maximum vertical jump ($p < 0.05$), and three-quarter court sprint ($p < 0.001$), but decreased performance in 185 lb. bench press ($p < 0.05$). No significant differences were found between years for height, standing reach, wingspan, and standing vertical jump. The reported differences are notable given that multiple years of NBA Draft Combine data have previously been pooled and used to predict NBA success.

KEYWORDS: performance, assessment, elite.

INTRODUCTION: Basketball is a multifaceted sport that requires a distinct combination of physical attributes to be successful at an elite level. These attributes include anaerobic and aerobic capacity, speed and agility, and strength and power (Dawes, Marshall, & Spiteri, 2016). The game of basketball is played at a multitude of levels from youth leagues to highly-skilled professionals at the elite level, which is represented by the league known as the National Basketball Association (NBA). The NBA was founded in 1946 and started with only eleven teams, while the modern era of the NBA started in the mid-1960's as most rule changes were firmly in place by this time, with the exception of the eventual introduction of the three-point line (Chatterjee & Yilmaz, 1999).

Assessment of physical fitness is widely used for evaluation of an athlete's abilities and their potential for success in competitive sports (Teramoto, Cross, Rieger, Maak, & Willick, 2018). Along with the NBA, other professional sports leagues such as the National Hockey League and National Football League host an annual event known as a draft combine to evaluate prospective players for their respective sport's upcoming draft. Specifically, the NBA Draft Combine (NBA Combine) includes anthropometric assessments as well as a series of skill assessments, which evaluate the athlete's speed, agility, strength, and power (Teramoto et al., 2018; Kannan, Kolovich, Lawrence, & Rafiqi, 2018).

The identification of athletes who are likely to contribute to a team's success is important. Past research has closely examined the ability of NBA Combine results to predict an athlete's future contributions at the professional level. Various studies have focused on how well NBA Combine results can predict an athlete's playing time in the NBA (Hoffman, Tenenbaum, Maresh, & Kraemer, 1996; Gonzalez et al., 2013), while others have investigated the ability of the Combine results to predict an athlete's future NBA performance in traditional statistical categories such as points per game and blocks per game (McGill, Andersen, & Horne, 2012). Previous literature has also explored the usefulness of the NBA Combine results in their ability to predict injury rates and injury resilience in the NBA (Mehran et al., 2016).

One aspect that past research has overlooked is if athlete performances in the NBA Combine have changed over time. This may have critical implications; if relative athlete strengths are changing, so too could the relationships between these predictors and a player's NBA success. Thus, the purpose of the current study was to compare all athlete combine entries from 2001 to all entries from 2018 to see if there were differences across ten NBA Combine assessments: lane

agility time, three-quarter court sprint, standing vertical leap, maximum vertical leap, 185 lb. (83.9 kg) bench press repetitions, and five anthropometric assessments.

METHODS: Subjects of the current study were basketball players who participated in the NBA Combine in either 2001 (n = 78) or 2018 (n = 69). Participation in the NBA Combine is invite only and all selections are made by NBA executives. All data were publicly available online and were obtained from NBA.com (https://stats.nba.com/draft/combine/). Therefore, the current study was exempt from requiring consent of participants. Approval for this study was granted by the Human Subjects Institutional Review Board of Northern Michigan University, Marquette, Michigan, USA (IRB# HS19-1005). Participation in all tests was not required, so data were recorded for all tests that each individual chose to take part in. The procedures for all NBA Combine assessments are described in detail in Teramoto et al. (2018), while a brief overview is provided below.

Strength, Speed, & Agility assessments: The three-quarter court sprint is a maximum effort sprint in which athletes begin at the baseline of the court and run to the opposite free throw line as fast as possible (Teramoto et al., 2018). The score is recorded as the time it takes to cover the three-quarter court distance, in seconds. The standing vertical jump measures an athlete's ability to jump vertically with no running start. For this assessment, the Vertec device (Sports Imports, Inc.; Columbus, OH, USA) is set to the appropriate height based on the athlete's standing reach (Teramoto et al., 2018). Next, the athlete starts with both feet flat on the floor, jumps vertically as high as possible and taps the Vertec device. The score is recorded as the difference between the standing reach height and jump reach height, in inches (Teramoto et al., 2018). The maximum vertical leap measures an athlete's ability to jump vertically with a running start. For this assessment, the athlete can choose to take off with one or two feet as well as how many steps they take as long as their approach distance is less than 4.6 meters (Teramoto et al., 2018). The athlete is instructed to approach the Vertec device using a running start, jump vertically as high as possible, and tap the Vertec device (Teramoto et al., 2018). The score is recorded as the jump reach height where the Vertec was tapped, in inches. The 185 lb. bench press repetitions assessment measures an athlete's upper body muscular endurance (Teramoto et al., 2018). During this assessment, the athlete performs 185 lb. bench press for as many repetitions as possible. The score is recorded as the total number of completed repetitions (Teramoto et al., 2018). The lane agility assessment measures an athlete's lateral quickness and ability to change direction (Teramoto et al., 2018). For this test, the athlete circumnavigates the space inside the free throw line (the lane) performing forward and backward sprints on the long sides and side shuffling on the short sides (Teramoto et al., 2018). The athlete completes two laps, one clockwise and one counterclockwise, as fast as possible in order to reach test completion. The score is recorded as the time it takes to complete both laps, in seconds (Teramoto et al., 2018).

Anthropometric Assessments: Body fat percentage is an anthropometric assessment in which the athlete's skinfold thickness of the pectoral, abdomen, and quadriceps locations are measured using a skinfold caliper (Teramoto et al., 2018). The score is recorded as a percentage. Height without shoes is an anthropometric assessment in which an athlete's height is measured using a physician scale, while the athlete is not wearing shoes (Teramoto et al., 2018). The score is recorded in feet and inches. Standing reach is an anthropometric assessment in which the athlete's reach is measured using a measuring tape, while the athlete is standing and reaching straight up (Teramoto et al., 2018). The score is recorded in feet and inches. Weight is an anthropometric assessment in which an athlete's body mass is measured in pounds using a physician scale (Teramoto et al., 2018). Wingspan is an anthropometric assessment in which the tip of the left hand to the tip of the right hand is measured using a measuring tape, while the athlete stretches their arms horizontally as far as possible (Teramoto et al., 2018). The score is recorded in feet and inches.

Statistical analyses were completed with IBM SPSS (version 24). Accuracy of data transfer was ensured through a precise cross-reference during data entry. All tests with scores recorded in feet and inches were converted to total inches. Ten separate Independent T-Tests were performed to compare group mean values for combine assessments between years to determine statistical significance. Cohen's *d* was calculated as the difference between means divided by the pooled standard deviation and was reported as a measure of effect size. Interpretations were based on the scale for effect size classification of Hopkins (2000): < 0.04 = trivial, 0.041-0.249 = small, 0.25-0.549 = medium, 0.55-0.799 = large, and >0.8 = very large. The alpha level was set at $p < 0.05$.

RESULTS: Values for mean and standard deviation for each of the dependent variables are shown in Table 1**.** All assumptions of independence and normality were met, while appropriate adjustments were made for violations of homogeneity of variance. As noted in Table 1, results indicate that athletes from the 2018 NBA Combine demonstrated better performance in lane agility time ($p < 0.05$), maximum vertical jump ($p < 0.05$), and three-quarter court sprint ($p < 0.001$), but decreased performance in 185 lb. bench press ($p < 0.05$), and a reduction in weight ($p < 0.05$) and body fat percentage ($p < 0.001$). There were no significant differences between years for height without shoes, standing reach, wingspan, and standing vertical jump ($p > 0.05$).

Table 1. Mean ± SD for all variables for all subjects across 2001-2002 and 2018-2019 NBA combines.

Combine Test	2001-2002 (mean ± SD)	2018-2019 (mean ± SD)	*p*	Diff	d
Body fat percentage (%)	8.83 ± 3.53 (n = 76)	6.62 ± 2.07 (n = 69)	<0.001**	2.21	0.79
Height without shoes (inches)	78.33 ± 3.99 (n = 78)	77.22 ± 3.20 (n = 69)	0.064	1.11	0.31
Standing reach (inches)	103.79 ± 5.26 (n = 78)	102.95 ± 4.98 (n = 69)	0.324	0.84	0.16
Weight (lbs)	220.00 ± 31.46 (n = 78)	210.35 ± 23.74 (n = 69)	0.036*	9.65	0.35
Wingspan (inches)	83.12 ± 4.16 (n = 78)	82.51 ± 4.02 (n = 69)	0.376	0.61	0.15
Lane agility time (sec)	11.63 ± 0.66 (n = 76)	11.34 ± 0.56 (n = 56)	0.010*	0.29	0.48
Three-quarter court sprint (sec)	3.28 ± 0.17 (n = 77)	3.20 ± 0.09 (n = 56)	<0.001**	0.08	0.62
Standing vertical jump (inches)	29.35 ± 3.63 (n = 77)	29.47 ± 2.58 (n = 56)	0.820	-0.12	-0.04
Maximum vertical jump (inches)	34.17 ± 4.14 (n = 77)	35.98 ± 3.33 (n = 56)	0.008*	-1.81	-0.48
185 lb. Bench press (# reps)	10.36 ± 5.71 (n = 77)	7.92 ± 4.87 (n = 53)	0.012*	2.44	0.46

* represents a statistically significant finding at the $p < 0.05$ level
** represents a statistically significant finding at the $p < 0.001$ level
Note: p is p-value; Diff is Difference; d is Cohen's d

DISCUSSION: Published literature investigating changes in professional sport combines is sparse. The current study's findings are in agreement with one similar study by Fitzgerald & Jensen (2018), who noted changes in athlete performance over time in the National Football League Combine. These findings are also in agreement with the previously mentioned study (Fitzgerald & Jensen, 2018) in regards to the direction of change, in that athletes from more recent combines are generally demonstrating improved performance, when compared to earlier years. Both the current study and Fitzgerald & Jensen (2018) report significant increases in vertical jump and their respective speed assessments, which may be indicative of modern use of innovative speed and power training methods or possibly even an increased demand of athletes with exceptionally versatile skill sets and abilities.

When considering strength assessments, Fitzgerald & Jensen (2018) reported no significant changes while the current study reported a significant decrease in 185 lb. bench press, which may be explained by the accompanying significant reduction in body weight. This pairing of reductions may reflect a change in the profile of an elite collegiate basketball player, where speed, agility, and jumping ability take precedence over size and strength. Past research has analyzed NBA Combine performance using multiple years and indicated that NBA Combine results from

assessments such as maximum vertical jump and lane agility may predict an athlete's NBA steal percentage or playing time (Hoffman et al., 1996; Huyvaert, Teramoto, Reiger, & Cross, 2015). However, knowing that athlete performance at the NBA Combine is changing over time illustrates the importance of understanding how combine assessment results may be more or less indicative of NBA success for different years.

CONCLUSION: The purpose of the current study was to compare all combine entries from 2001 to all entries from 2018 to see if there were differences across ten NBA Combine assessments. Results indicated that athletes from the 2018 NBA Combine demonstrated better performance in lane agility time ($p < 0.05$), maximum vertical jump ($p < 0.05$), and three-quarter court sprint ($p < 0.001$), but decreased performance in 185 lb. bench press ($p < 0.05$), and a reduction in weight ($p < 0.05$) and body fat percentage ($p < 0.001$). No significant differences ($p > 0.05$) were found between years for height without shoes, standing reach, standing vertical jump, and wingspan. The current study demonstrates that it may be important to consider these findings when evaluating relationships between variables that are used to predict future NBA performance.

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