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State Population Influences Athletic Performance Combine Test Scores in High School-Aged American Football Players

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ABSTRACT

International Journal of Exercise Science 12(6): 256-262, 2019. This study compared athletic performance differences among high school American football combine participants originating from states of different population sizes. High school-aged American football players (n=7,214) who had participated in athletic performance combines between March 2015 and January 2016 were included in this analysis. Data included combine date and location, school state of origin, football position, class, height, weight, 10-, 20-, and 40-yd dash times, pro-agility, L-cone drill, vertical jump, broad jump, and power push-up. Participants were separated into high- (state population>10,000,000; HIGH; n=2,804), mid- (state population=5,000,000-9,999,999; MID; n=2,911), or low-population (state population<5,000,000; LOW; n=1,499) state of origin. Data were allometrically scaled to account for differences in body mass across high school grade levels and American football positions. All statistical analyses were performed on the allometrically scaled data. LOW athletes performed better than HIGH athletes in the 20-yd dash (p≤0.01). LOW athletes performed better than HIGH and MID in the 40-yd dash, pro-agility, broad jump, and power push-up (p<0.01). LOW and HIGH athletes performed better than MID in the L-cone and vertical jump (p<0.01). When considering population size, athletes originating from LOW states may demonstrate higher levels of athletic performance in football combine events hypothetically due to more opportunities for sports participation and playing time, leading to greater athletic development. Youth and high school coaches in MID and HIGH states might consider providing more opportunities for playing and individualized coaching to encourage long-term athletic development.

KEY WORDS: Sports testing, region size, speed, agility, power

INTRODUCTION

Current literature suggests that athletes from low population regions have a greater presence among professional sports organizations compared to athletes from high population regions (8). MacDonald et al. (8) examined the representation of National Football League (NFL) athletes from high population cities (> 500,000) and low population cities (< 500,000). The authors determined that athletes from low population cities were over-represented, while athletes from high population cities were under-represented. In support of their findings, several previous authors have demonstrated similar results among other professional sports

organizations (2, 3, 9). Côté et al. (3) determined that, across various professional sports organizations (National Hockey League, National Basketball Association, Major League Baseball, and Professional Golfers Association) a greater proportion of athletes originated from low population cities (< 500,000). Baker and Logan (2) found that hockey players from Untied States and Canadian regions with a population > 1,000,000 had a lower chance of being drafted for the National Hockey League than hockey players from regions with a population < 1,000,000. Furthermore, MacDonald et al. (9) noted that, among the Women's United States Soccer Association, players born in cities < 1,000,000 were over-represented, while in the Ladies Professional Golf Association, players born in cities of < 250,000 were over-represented.

Côté et al. (3) and MacDonald et al. (8, 9) hypothesized that professional athletes originating from smaller regions may receive more playing time and sports participation opportunities as children. Greater playing time and sports participation may aid in long-term athletic development, increasing the likelihood of future success in sport. In support, Kytta (6) reported that children from smaller cities (defined as "rural environment") do indeed have more opportunities for playing time and sports participation. Furthermore, Martindale et al. (10) suggested that low population regions allow for more individualized attention from coaches, giving athletes more opportunity for talent development. Therefore, the reason low population regions (i.e., cities < 1,000,000) have greater representation among professional sports may be due to greater opportunities for athletic development through more playing time, sports participation, individualized coaching, and improved athletic performance. However, we are not aware of any previous research that has examined athletic performance attributes from regions with different population sizes, only athlete representation at the professional level.

A popular method of assessing athletic performance is through scouting or recruiting combines. The most publically visible combine example is the NFL scouting combine (11). Such combines utilize various assessments to measure athletic performance such as the vertical jump (VJ) and broad jump (BJ) to assess power, the pro-agility (PA) and L-cone (LC) drills to assess agility, and the 10-, 20-, and 40-yard dashes to assess linear speed and acceleration (4, 7). High school American football combines, such as the Under Armour and Army All-American Combines (1, 14), are much like the NFL scouting combine and are becoming popular to assess potential collegiate American football recruits across the United States. Performing these high school combines in regions throughout the United States provides an opportunity for high school American football players to participate, allowing collegiate scouts and coaches to assess players from nearly every state. Assessing athletic performance differences among players from states of different population sizes may address the research question about athletic performance that parallels simple representation in professional sports. Therefore, the purpose of this study was to assess athletic performance differences among high school American football combine participants who originated from high state population > 10,000,000), mid (state population = 5,000,000-9,999,999), and low (population states state population < 5,000,000).

METHODS

Participants
High school-aged American football players (n = 7,214) in their freshman (n = 1,122), sophomore (n = 2,411), junior (n = 3,621), or senior (n = 60) years who had participated in an American football recruiting combine hosted by Zybek Sports between March 2015 and January 2016 were included in this comparison. The de-identified database provided by Zybek Sports included: combine date and location, school state of origin, football position, class, height (HT, cm), weight (WT, kg), 10-, 20-, and 40-yd dash times (s), pro-agility (PA, s), L-cone drill (LC, s), vertical jump (VJ, cm), broad jump (BJ, cm), and power push-up (PPU scores, N). Based on reported schools in the United States (U.S.), participants were separated into high (state population > 10,000,000; HIGH; n = 2,804; HT = 178±7 cm; WT = 85±18 kg), mid (state population = 5,000,000-9,999,999; MID; n = 2,911; HT = 178±7 cm; WT = 86±19 kg), or low (state population < 5,000,000; LOW; n = 1,499; HT = 179±7 cm; WT = 88±21 kg) population states of origin similar to previous literature (8). The University of Nebraska-Lincoln Institutional Review Board (IRB) determined that IRB approval was unnecessary because the de-identified high school data provided by Zybek Sports with a transfer agreement did not constitute human subject research (official letter from the IRB, February 26th, 2016). A cross-sectional design was used to analyze performance differences among high school American football players originating from different states of origin across the U.S. Athletes were categorized based on self-reported state of origin: HIGH, MID, or LOW population states. States considered HIGH population (n = 7) were California, Texas, New York, Florida, Illinois, Pennsylvania, and Ohio. States considered MID population (n = 15) were Michigan, Georgia, North Carolina, New Jersey, Virginia, Washington, Massachusetts, Indiana, Arizona, Tennessee, Missouri, Maryland, Wisconsin, Minnesota, and Colorado. States considered LOW population (n = 25) were Alabama, South Carolina, Louisiana, Kentucky, Oregon, Oklahoma, Connecticut, Iowa, Mississippi, Arkansas, Kansas, Utah, Nevada, New Mexico, West Virginia, Nebraska, Hawaii, Maine, New Hampshire, Rhode Island, Delaware, South Dakota, Alaska, Washington DC, and Wyoming.

Protocol
Previous studies have provided detailed descriptions of the combine measurement methods (4, 12, 13). In short, the 10-, 20-, and 40-yd dashes, as well as the PA and LC tests were measured in seconds (s) using digital laser beam actuated timing gates (Zybek Sports, Fully Automated Timing systems, Broomfield, CO). The 10-, 20-, and 40-yd dashes measure linear speed, while the PA and LC tests measure bi- and multi-directional agility, respectively. The VJ was measured as the difference between standing reach and jump height with a standard testing device (Zybek Sports, Power Jump, Broomfield, CO), which is a measure of vertical power. The BJ was measured as the distance from the starting line to the athlete's closest heel at their landing position, which is a measure of both vertical and horizontal power. The PPU consisted of a single explosive push-up performed on a force plate and is a measure of upper body power. The best score for each test was used as the representative score. Since the data consisted of high school freshmen, sophomores, juniors, and seniors, and all American football

positions, all data were allometrically scaled for WT prior to analysis, based on previous studies (5, 15) to control for differences in body mass among maturity levels and American football positions. Not all measurements were available for each player on each variable, but sample sizes for each variable are presented in Table 1.

Statistical Analysis
Nine separate one-way factorial ANOVAs with population category as the independent variable (HIGH vs. MID vs. LOW) were conducted for the following dependent variables: HT, 10-yd, 20-yd, 40-yd, PA, LC, VJ, BJ, and PPU. Each dependent variable was allometrically scaled for WT prior to analysis. The allometric scaling procedure involved the following equation:

$$a = \frac{T}{m^b}$$

where a = allometric-scaled performance measure, T = absolute performance measure, m = WT, and b = allometric parameter (5, 15). Additionally, to demonstrate an equal sample representation of each population category (HIGH, MID, or LOW), ratios of athletes to total state population were calculated. An additional one-way ANOVA (HIGH vs. MID vs. LOW) was used to compare the means of sample:population ratios. All statistical analyses were performed using SPSS version 24 (IBM, Inc., Chicago, IL). Allometric scaling and sample:population ratio calculations were performed in Microsoft Excel 2016. An alpha of $p \leq 0.05$ was considered statistically significant for all comparisons.

RESULTS

Athletes in LOW regions performed better than those in HIGH regions in the 20-yd dash ($p < 0.01$) (Table 1). Additionally, LOW performed better than both HIGH and MID in the 40-yd, PA, BJ, and PPU ($p < 0.01$), whereas LOW and HIGH performed better than MID in the LC and VJ ($p < 0.01$) (Table 1). There were no differences among sample:population ratios ($p > 0.05$).

Table 1. Means and (standard deviations) for all raw performance variables among high school American football players.

	10-yd (s)	20-yd (s)	40-yd (s)	PA (s)	LC (s)	VJ (cm)	BJ (cm)	PPU (N)
HIGH	1.9±0.2	3.1±0.2	5.3±0.4	4.6±0.3	7.9±0.6†	64±11	246±27	273±92
	n = 2710	n = 2227	n = 2737	n = 2706	n = 2620	n = 2693	n = 2745	n = 2769
MID	1.9±0.2	3.1±0.2	5.3±0.4	4.6±0.3	8.0±0.6	63±10	245±28	274±88
	n = 2827	n = 2813	n = 2870	n = 2879	n = 2336	n = 2870	n = 2864	n = 2876
LOW	1.9±0.2	3.1±0.2*	5.3±0.4*†	4.6±0.3*†	7.9±0.6†	64±11†	249±28*†	295±96*†
	n = 1438	n = 1358	n = 1470	n = 1470	n = 1388	n = 1468	n = 1457	n = 1472

* = better performance than HIGH when allometrically scaled for WT, † = better performance than MID when allometrically scaled for WT

DISCUSSION

The primary findings of the present study indicate that high school American football players from LOW population states exhibit better athletic performance outcomes than athletes from MID and HIGH population states in most of the traditional performance combine assessments. In contrast, players from HIGH population states may have a slight advantage over MID in agility and power measurements. MacDonald et al. (8) demonstrated that, among NFL players, there is a high representation of athletes born in smaller cities (< 500,000), while players born in larger cities (> 500,000) were under-represented. Similar results have also been reported in other professional sports such as golf, soccer, baseball, basketball, and hockey (2, 3, 9). However, these previous studies have only examined athlete representation from different population categories, rather than performance outcomes. The unique contribution of the present study is the comparison of athletic performance scores among states of HIGH, MID, and LOW populations, not just demographic representations. Overall, our results extend those of previous studies and support the notion that athletes originating from lower populated regions may exhibit advantages in reaching an elite skill level.

Several hypotheses exist regarding elite athlete representation from lower population regions (3, 8, 9), including greater opportunities for sport participation, more on-field playing time, and more individualized training. For example, Côté et al. (3) suggested that elite-level players born in smaller cities may have greater quantity of playing time, due to a smaller number of youth athletes engaging in sport. This hypothesis is supported by Kytta (6) who reported that children in smaller cities tend to have more opportunities for sport participation. This increased playing time may influence a young athlete's training age, giving athletes from smaller regions a greater training age than those from more populated regions.

Additionally, MacDonald et al. (8) suggested that athletes from smaller regions tend to sample more sports at a younger age, allowing greater overall playing time and greater exposure to sports of various biomechanical and metabolic properties. This exposure to multiple sports may allow a greater transfer of skills across sports. Martindale et al. (10) supported this hypothesis by providing a framework for the proper development of young athletic talent, including exposure to different types of sports, giving children the freedom to choose the sport they prefer, while developing various motor skills.

From a practical perspective, a school from a HIGH state will likely have a greater number of athletes playing individual sports than a comparable school from a LOW state. For example, from a HIGH state, will likely be more athletes participating on a given athletic team compared to a LOW state (8). This discrepancy in the number of players may provide greater opportunities for on-field experience among athletes from the LOW school, thus further improving athletic ability and experience level (8). As suggested by MacDonald et al. (8), this increased on-field experience may lead to greater self-efficacy, providing a more positive experience with American football compared to HIGH states. However, examining the influence of playing time on psychological performance was outside the scope of this study.

Collectively, these previous studies suggest that the more intimate settings of a smaller town may provide opportunities for more individualized training with lower coach:athlete ratios. Lower ratios may allow coaches to spend more time focusing on individual athletes, which may influence the long-term athletic development of youth athletes. As stated by Martindale et al. (10), positive reinforcement in sport, which can be practically given by a coach, is an important factor in developing talent from an early age. Therefore, ensuring that youth athletes have more individualized attention from a coach may aid in improving talent.

Understanding the differences in athletic performance among high school American football players from different state population categories may high school American football coaches in ensuring there is a proper coach:athlete ratio to maximize athlete exposure and opportunities at the high school level. Additionally, HIGH and MID populated states may want to explore methods of exposing young athletes to multiple sports, more on-field playing time, and more intimate practice and training settings. Suggestions may include increasing the number of coaches working with HIGH and MID teams, which may aid in allowing athletes more individualized attention. In addition, allowing more on-field playing opportunities, perhaps at skill-specific levels, may improve the athletic ability of a collective group of athletes as an entire team, rather than only the "best" players getting on-field playing time.

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