CHANGES IN 800 METER PERSONAL RECORDS FOR COMPETITIVE FEMALE RUNNERS FROM HIGH SCHOOL TO COLLEGE

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To advance understanding of improvements in running performance, changes in personal records (PR) from high school to college were compared. It was hypothesized that females competing in the 800m in college would improve PR times from high school to college, improvements would be different between athletic conferences, and modern statistical methods could differentiate trends in the relationship between high school and college PR. Data from female athletes competing in the 800m from three different athletic conferences (n=73) were gathered from published race results and 79.4% improved by at least 1s with no significant differences between conferences. A positive relationship exists between high school and college PRs. Knowledge of changes in running performance provides context when interpreting an individual's improvements in running biomechanics over time.

KEYWORDS: athletics, track and field, improvement in performance, running

INTRODUCTION: Performance results reported on competition websites can assist coaches and athletes with documenting improvements in an athlete's performance and provide context when interpreting the impact of improved running biomechanics. Tracking an individual's personal record (PR) over time can provide meaningful insight into how changes in movement mechanics and injury prevention interventions implemented in training plans contribute to performance outcomes. Race performances provide valuable metadata about athlete experience when coaches, athletes, and medical trainers have limited time to study and assess training outcomes. Track and field performance data provides evidence to evaluate training programs designed by coaches (Brusa, 2018).

Previous authors have analysed performance data to provide an idea of how many races athletes typically participate in before reaching a season PR (Johns et al., 2019). Knowing answers to questions about training can help coaches plan. Additionally, knowing expected levels of improvement from high school to college provides insight as to the likelihood of individual's qualifying for top tier competitions (e.g. National Collegiate Athletic Association Division I) (Brusa, 2018). Providing this insight can also help coaches, sports medicine and sports scientists work together to design and implement personalized training programs that effectively support improvements in human performance, reduce risk of injury, and advance fundamental science using biomechanics (McNitt-Gray et al., 2015; Waters et al., 2019).

To advance our understanding of improvements in running performance by competitive female athletes in a middle distance event (800m), changes in personal records from high school to college were compared using published race results. Our aim was to determine if competitive female runners a) get faster in the 800m when they transition from high school to college, b) the margin of improvement in an individual's PR performance is different between athletic conferences, and c) if the relationship between high school and college PR was consistent using modern statistical methods. We hypothesized runners will improve their 800m PR times when they run in college, conference will have a significant impact on the margin of improvement, and improvement in PR times will be greater for athletes with slower PR times in high school.

METHODS: Data for female athletes competing in the 800m in three different athletic conferences were gathered from published race results. Three Division I (DI) conferences within the National Collegiate Athletic Association (NCAA) were selected to illustrate the value of considering competition levels in the analysis. Pac-12 and Big Ten were considered to be

larger DI conferences while the Patriot League was considered a smaller DI conference based on the size of the undergraduate student population and team performances at the NCAA championship level (*Data USA*, n.d.; "Which Are the NCAA's Best Conferences?," 2015).
There were 84 athletes that competed in their respective 2019 conference championship 800m race at the end of the outdoor season in the results published for the Pac-12, Big Ten, Patriot League Conferences (*TFRRS*, 2021). For this athlete population, high school and college PR were scraped from publicly available data, but only (n=73) athletes were included in the final analysis (Table 1) because high school or college PR information was not found (*MileSplit United States*, 2021). PR times were converted to seconds for statistical analysis but compiled descriptive results are reported in a standard format for use by track and field coaches (min:s) (Table 1). The PR difference for an individual was calculated (Eqn 1) as well as percent change in PR from high school to college (Eqn 2).

[Equation 1] $PR\ Difference\ [s] = HS\ PR\ [s] - College\ PR\ [s]$

[Equation 2] $PR\ Change\ [\%] = \frac{(HS\ PR\ [s] - College\ PR\ [s])}{HS\ PR\ [s]} * 100$

Statistical analysis was done in R Studio (Version 3.6.1) using a robust multiple comparisons approach with a 2x2 between by within design with conference as an independent factor and competition level as a dependent variable (*R: A Language and Environment for Statistical Computing.*, 2019; Wilcox, 2017). The multiple comparison technique utilized a percentile bootstrap method with 20% trimmed means to assess main effects due to conference, competition level, and interactions. A running interval smoother was used to provide more information about the relationship between high school and college PR for athletes at different levels. This method provides advantages over classic linear regression by accounting for heteroscedasticity and non-normality while providing the 25th and 75th percentiles for college PR for each high school PR. Outliers due to high school PRs (n=3) shown in Figure 3 were removed using the MAD-median rule.

RESULTS: PR times for the 800m were found to be significantly different ($p < 0.001$*) between high school and college (Tab 1, Fig 1). 58 of 73 athletes (79.4%) improved by over 1s (second) from high school to college. The trimmed mean for an individual's PR difference was 4.4s from high school to college (Tab 1).

Table 1: Summary of overall findings. Trimmed mean (20%) and Winsorized variance with 20% trimming indicated in parentheses. Overall indicates data combined across all 3 conferences.

Conference	Sample (n)	HS (min:s)	College (min:s)	PR Difference (s)	PR Change (%)
Big Ten	24	2:11.1 (9.9)	2:07.4 (4.2)	3.9 (9.0)	4.5 (4.7)
Pac-12	23	2:13.6 (10.0)	2:07.5 (2.6)	6.1 (8.9)	2.9 (5.2)
Patriot League	26	2:17.7 (9.6)	2:14.2 (5.2)	3.6 (7.4)	2.6 (3.5)
Overall	73	2:14.2 (11.7)	2:09.4 (8.7)	4.4 (8.2)	3.3 (4.1)

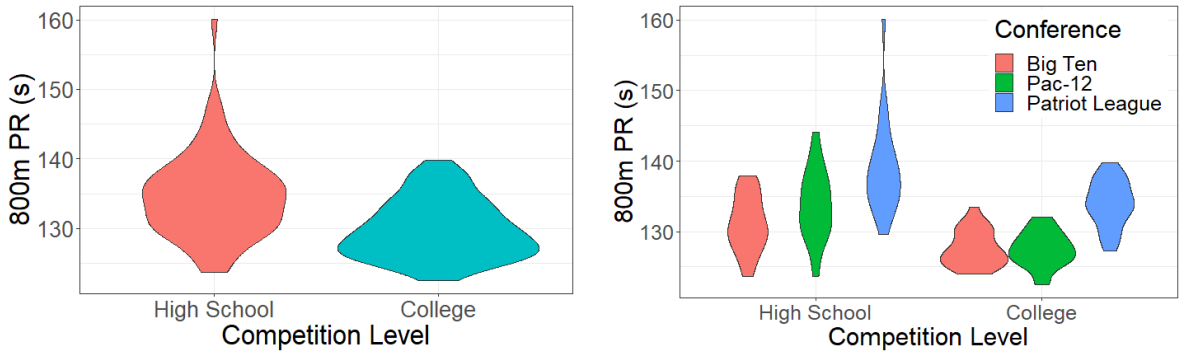

Figure 1: (Left) Distribution of 800 m PRs in high school and college (Right) by conference.

No significant interactions between PR improvements in 800m times were observed between conference and competition level using the multiple comparisons technique. These results indicate college conference did not have a significant effect on PR improvements from high school to college (p= 0.060, p = 0.088, p = 0.956). The results of the running interval smoother indicated that there was a direct relationship between high school and college PRs for these athletes (Fig 3). However, the data was heteroscedastic (different variability) so the 25th and 75th percentile were further apart for slower PRs (Fig 3).

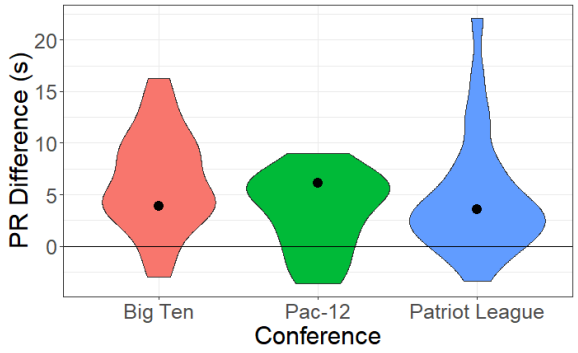

Figure 2: Distribution of PR differences from high school to college in the 800m. Black line indicates no improvement from HS to college. Black dots indicate 20% trimmed mean of PR differences included in Table 1.

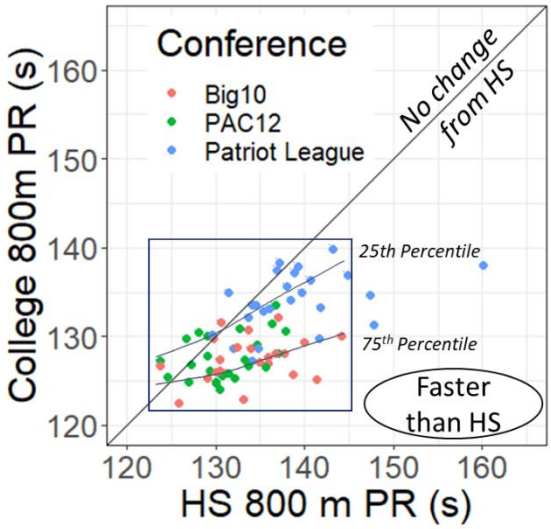

Figure 3: Relationship between HS PR times and College PR times for the 800 for individuals competing in different conferences in college (Big Ten, Pac-12, Patriot League). Black diagonal line indicates no improvement in PR times for the 800m. 25th and 75th percentiles produced using a running interval smoother. Blue box indicates boundaries for excluding slower HS outliers.

DISCUSSION: The aim of this work was to provide a framework for evaluating a specific athlete population's performance over time using published results data. In this exemplar study, our aim was to determine if this set of female NCAA DI runners improved their 800m personal best from high school to college, evaluate if athletic conference differentiated the margin of improvement, and relate high school and college PRs. From this work, we found that female athletes in these conferences improved their PRs from high school to college in the 800 meters by around 4.4s (Tab 1). Additionally, we did not find sufficient evidence to support the hypothesis that athletic conference influences PR difference between high school and college. This result was in spite of the Patriot League being a smaller DI conference with athletes that generally had slower 800m PRs in high school than the other two conferences studied. Using

modern statistical techniques, faster athletes in high school had a smaller range of college PRs than athletes who had slower high school times. This type of analysis provides advantages over classic linear regression models because it can show how relationships change for different levels of athletes (Fig 3).

A limitation of this study is that only athletes who competed in the 800m conference championship were included rather than every member of a college team. The data is biased because athletes participating in a conference championship are often the fastest members of their teams so results across all college DI female runners might differ from this analysis. Only 800 meter DI female athletes were included in this dataset but similar methods can be used to evaluate changes in performance from high school to college for other distances or field events, male athletes, and other conference levels (DII, DIII, international). Additionally, a PR is just a snapshot of that athlete's performance and development. Relating a PR in high school and to a PR in college does not tell us why that athlete improved or did not improve between those observations. Still, this approach is a useful framework for providing insights on how athletes develop over time using readily available performance data.

Gaining insights as to variability in performance improvements between athletes may help assess progress over time and personalize/evaluate training plans for individual athletes within training groups. Performance metrics are also a useful first step to engage with coaches and athletes who have a deeply vested interest in developing evidence-based practices. This route may also serve to open up conversations about ways that biomechanics and science can help athletes improve and achieve their goals. Additionally, it may be a useful tool to help coaches evaluate their practice plans for effectiveness and help athletes make informed decisions about transitioning to colleges. For biomechanists, it can help put biomechanical data in context by understanding performance changes over time.

CONCLUSION: This work provides a framework for evaluating a specific athlete population's performance over time using published results as a strategy to better understand changes and translate science into practice.

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