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RESEARCH

Head Coach Gender and Player Performance in NCAA Softball

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Abstract

In some industry segments, more than 70% of leadership positions are held by men. This can often lead to the suggestion that men are more successful in leadership roles, particularly in areas where women are viewed to have no practical experience. Unfortunately, it is often difficult to find women and men in leadership positions where performance of the leader can be objectively evaluated, which can make it likewise difficult to establish if the gender identity of a leader makes a measurable difference. While men's sports are an example of an industry dominated by gendered thinking in leadership, as women are assumed to be worse candidates for coaching positions due to a lack of familiarity with playing men's sports, there is an exception to this general trend in women's sports. In women's sports, both women and men work as coaches, often in equivalent roles and positions. Consequently, we can scientifically evaluate if the gender of the coach impacts the outcomes we observe. In this article, we specifically consider the sport of college softball, where we note a more equal breakdown in coaching by gender than most other sports. The evidence from college softball indicates the gender of the coach does not impact outcomes. Specifically, we find the gender of the head coach does not appear to alter the performance of individual hitters and thus a team's offensive production. Such findings challenge the gender stereotypes we see in coaching and leadership hiring.

Keywords Head Coach · Gender · Player Performance · NCAA Softball

In 1950, the labor force participation rate for women was only approximately 33%.[1] Paid employment outside of the home was predominantly an activity for men. By the end of the 20th century, however, the labor force participation rate for women was 60%. Both women and men had become active participants in the paid labor force.

Despite this increased participation by women, many inequalities clearly remain. As Lennon (2013) documents, women only occupy 20–25% of all leadership positions across a variety of the top industry segments (i.e., technology, business, law, education). This underrepresentation of women in leadership roles has been attributed to gender discrimination and unequal opportunities for advancement (Koenig et al., 2011). In general, previous research focused on this stark discrepancy in leadership representation has attributed the discrimination and unequal opportunities to the presence of gender stereotypes that limit a woman's ability to advance in an organization and thrive in a leadership position when one appears (Badura et al. 2018; Begeny et al. 2020; Darvin et al. 2018; Pullen and Vachhani 2021).

This poses a natural question, then: are women preferred less than men for general leadership roles, or would women be preferred if discrimination due to gendered stereotype thinking could be eliminated? Heilman (2012) noted that there are two distinct forms of gendered stereotype thinking. The first is descriptive, defined as stereotypes about how men and women are alike. Descriptive stereotypes will lead one to conclude that a woman can only succeed as a leader if she adopts the characteristics and mannerisms seen with male leaders (Heilman 2012; Manzi and Heilman 2021). The second set of stereotypes are prescriptive, and these are defined as stereotypes about what women and men should

[1] Data on the labor force participation rate can be found at the St. Louis Federal Reserve's website: https://fred.stlouisfed.org/series/LNS11300002.

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be like. [2] In these stereotypes, women are penalized when they do not act as people think women should act.

Thus, women in leadership positions often face what Janet Holmes refers to as "the tightrope of impressions management".[3] If a woman behaves as a man stereotypically behaves in a leadership position, she is penalized for not acting like a woman. On the other hand, if a woman follows the stereotypes of how women are perceived to behave, she is penalized for not acting like a male leader. In sum, both descriptive and prescriptive gender stereotypes (i.e., both sides of the tightrope) can impede the ability of a woman to advance into a leadership position and maintain and succeed once she arrives (Badura et al. 2018; Begeny et al. 2020; Pullen and Vachhani 2021).

Unfortunately, examining leadership stereotypes is difficult in many industry settings. In addition, in many industry settings, it is highly difficult to objectively test the impact a leader has on the outcomes observed and the performance of their subordinates. Thus, attempts at debunking the discriminatory stereotyping women face are limited and serves to further institutionalize the notion that women are not inherently equipped to be successful leaders (Manzi and Heilman, 2021; Walker et al., 2017). However, if these stereotypes are indeed true, this would suggest it is not only harder for women to succeed in leadership positions, but that they are somehow presumed to maintain skillsets that would equate to less success in these roles. In contrast, men would instead be inherently equipped to perform better as leaders regardless of the context of the leadership role (Badura et al. 2018; Begeny et al. 2020).

Most researchers think of leadership in the context of boardrooms and business management exclusively, though, which can be limiting. Would we expect the same results to hold true in more specialized fields, particularly fields where women might instead have a perceived subject matter advantage over men?

Athletics provides just such a case study. Nowhere is this gendered thinking on greater display than in the area of men's sports leadership, specifically coaching. Women are rarely if ever considered for coaching positions at the highest levels of collegiate and professional men's sports due to the perception that playing experience is required in order to coach. There is however an exception to this issue of examining leadership performance and success: the women's sports industry (Darvin et al. 2018; Wicker et al. 2019). In women's sports, both men and women are found in leadership positions (i.e., the head coach role) at substantial numbers (Darvin & Lubke, 2021). As a result, the women's sports industry can be used to examine the impact both women and men have on the organizations they lead in a setting where the organizational circumstances and expected outcomes are roughly the same for all coaches (Darvin et al. 2018; Wicker et al. 2019). Further, we can focus on a women's sport that few if any men play at a significant college or professional level: softball.[4] If gendered stereotypes for leadership are true, men should perform better as coaches for women's softball despite not having played the game they are coaching. If playing a sport is required to be a successful coach of that sport, then women should perform better as coaches for women's softball.

The organization of our inquiry will be as follows. We begin with a discussion of leadership in sports that will review the impact coaches have on performance, as well as the prevalence of women leading in college softball, the sport of choice for our analysis. From there we will move on to our empirical study of this topic. This begins with the measurement of hitter performance in college softball. With measure in hand, we will then build and estimate an empirical model to evaluate how the gender of the coach impacts player performance. A discussion of this model's estimation will then conclude the paper.

Gendered Sport Representation

In 1971, an estimated 3.7 million boys played high school sports in the United States. At the same time, only 300,000 girls played high school sports (Acosta & Carpenter, 2014). These proportions fed the long-standing stereotype that boys were simply more interested in sports than girls (Staurowsky et al. 2022).

If that stereotype were true, however, the events of 1972 would not have changed sports participation rates. In 1972, President Richard Nixon signed the following statement into law:

> *No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance.*

This law, known colloquially as Title IX, prohibited institutions that receive federal funding from discriminating on the

[2] See both Heilman (2012) and Manzi and Heilman (2021).

[3] This is a phrase coined by Janet Holmes, author of *Gendered Talk*, cited by Cameron (2007, p. 141). It was also noted in Cordelia Fine's book *Delusions of Gender*.

[4] The authors acknowledge that many male softball coaches do have experience playing collegiate or professional baseball, which may be seen as equivalent to experience in softball. However, we note that playing professional women's softball is not considered substitute experience in coaching professional baseball, for example, and so we apply the same logic here and in further detail in our methodology discussion.

basis of gender (Stevenson, 2014). Although the statement does not mention sports explicitly, after Title IX passed into law, high schools and universities were no longer permitted to provide athletic opportunities to men that were not available to women (Staurowsky et al. 2022; Stevenson 2014).

As Zimbalist (2001) notes, by 1978 there were 2.1 million girls playing high school sports. In other words, participation in girls' athletics increased about 700%. Zimbalist notes a similar story at the college level as well. In 1971, fewer than 32,000 women played college sports. By 1977 there were more than 64,000 women participating in college athletics (Zimbalist, 2001).

According to the NCAA (2022), today women comprise 47% of all student-athletes. While this demonstrates a significant and substantial move toward participation equity, this may not be entirely consistent with Title IX. One of the primary interpretations of Title IX is that opportunity should match student population. Women comprise more than 50% of college students in the United States, but they are decidedly less than 50% of athletes. Nevertheless, substantial progress has been made.[5]

That is, substantial progress has been made in participation for collegiate athletics. Although women have made considerable gains with respect to athletic overall opportunities, the same cannot be said for sports leadership positions.

Gendered Sport Leadership

In terms of leader and employee representation, the sport industry has endured as one of the most male prominent segments of society (Fink 2016; Lapchick et al. 2020). Previous literature has established a variety of obstacles and barriers that exist due to the low proportion of women employees in this industry, including gender stereotyping and discrimination (Burton, 2015; Fink 2016; Forsyth et al. 2019; LaVoi, 2016). More specifically, the masculine nature of the sport industry is ripe for both descriptive and prescriptive gender stereotypes regarding how women should behave and act in the setting (Burton, 2015).

The outcomes of such gendered stereotypes result in much lower proportions of women leaders in widely varying occupations throughout the industry. For example, in terms of the athletic director position, women only account for roughly 25% of all collegiate athletic director roles regardless of governing body or level of play (Lapchick et al. 2020). Specific to sport coaching, women as head coaches, the most prominent leadership-level role of sport coaching, only account for roughly 40% of all head coach positions for collegiate women's teams and less than 1% of men's college teams (Darvin 2020; Lapchick et al. 2020). The underrepresentation of women as head coaches has been attributed to the same traditional gender stereotypes that women face in obtaining leadership positions across industry segments (Fink 2016).

Specific to this gendered representation, when Title IX was passed in 1972, roughly 90% of women's college teams were coached by women (Hruby 2021). Across the next 50 years, while the number of women playing college sports continued to increase, the proportion of coaching opportunities that went to men also increased (Darvin and Sagas 2017). According to the NCAA (2022), 58.7% of head coaches in women's college sports were men. At the same time, only 5.8% of head coaching jobs in men's collegiate sports went to women (NCAA, 2022).[6] Consequently – just as Zimbalist observed in broader leadership roles across industries – men hold about 75% of all head coaching positions in college sports. In 2019, 88% of athletic directors in Division I college athletics were men (Hruby 2021). As LaVoi argues (Hruby 2021):

> One of the theories that we often use is what social scientists call homologous reproduction. It basically means that people like to hire people like themselves. It's very similar to affinity bias, in which we warm up to people like ourselves. We like to surround ourselves with people who are like us because it affirms our identities – and that's true for athletic directors, too.

Elsesser (2019) offered a similar explanation for this pattern:

> The truth is men dominate coaching for the same reason that they run most of our Fortune 500 companies and our country. When we think of leaders, we tend to think of men. We want someone to lead our team, our company or our country, then our experience and unconscious bias makes us gravitate toward men.

This pattern suggests that somewhere, women are being discriminated against in the hiring process.[7] However, there is

[5] This progress has not come at the expense of opportunities for men. The (2022) also reports that since 2002, men have gained 73,000 participation opportunities, while women have only added 67,000 such opportunities.

[6] In major men's professional sports, the picture is even more bleak. The major men's sports leagues in North America are the National Football League, National Basketball Association, Major League Baseball, and the National Hockey League. In none of these leagues has a woman ever served as a head coach. And Kim Ng – the general manager of the Miami Marlins in MLB since 2020 – is the only woman to serve in that position in any of these leagues.

[7] Previous literature has established a variety of obstacles and barriers that exist due to the low proportion of women employees in this industry, including gender stereotyping (Burton, 2015; Forsyth et al. 2019; LaVoi, 2016). More specifically, the masculine nature of the

another explanation. The market – both in sports and outside of sports – may indicate men are simply better leaders than women.

Outside of sports, it can be difficult to say if the market is correct in this assumption. In women's sports, however, we have an opportunity to test the hypothesis. Both men and women coach women's sports. If men truly are better coaches, we should see male coaches performing better than female coaches. This would indicate that even in an arena where women have more direct experience (women's sports), the natural leadership advantages of being male support hiring a male coach over a female coach.

Before this can be tested, we must first define what coaches are being asked to accomplish to determine "better" performance. This is not hard to define when examined from the perspective of a team's owner/operator. Whenever a team fires a coach and hires a new one, even if the team intends to rebuild, it is implicitly making the following statement: "A different coach would get more wins for this team." While coaching changes may not be made purely on the basis of player productivity (for example, a belief that a new coach would be stronger at recruiting may factor in), the statement does indicate that at the very least a current coach has not been productive with the players they have. There is an underlying assumption that coaches have some basic ability to alter the productivity of the athletes they lead, which can be seen in players' decisions to play for a particular coach rather than a particular school or program. Much of the basis of player recruitment is in the argument, "I am the coach who can take your playing to the next level."

Bum Phillips put the argument this way in discussing the coaching skills of NFL legend Don Shula:[8]

> *"Don Shula can take his'n and beat your'n. Or he can take your'n and beat his'n."*

Given this view of coaching, if men are being hired over women, it must be the case that men are better at getting improved performance from the athletes they lead. If that were not the case, all else being equal, why prefer men? Or put another way, why not prefer women, even in arenas where women are not traditionally found?

Coaching College Softball

To address this question, we will consider the sport of college softball. This is an interesting sport for men to coach. Unlike sports like basketball, volleyball, soccer, or lacrosse, men do not typically play in dedicated fastpitch softball competitions. There is a men's fastpitch team who competes for the USA in international competitions,[9] but unlike the opportunities available for women, fastpitch softball is not offered to men at the collegiate level, and there has been little effort to create a professional men's fastpitch league. Consequently, men without experience playing the game themselves are being hired to lead women's fastpitch softball teams. Even though arguments can be made that the rules of men's baseball and women's softball demonstrate clear similarities, this similarity does not translate to the collegiate experience. As noted across the literature evaluating Title IX funding in college sports (e.g., Shaw 1995; Yanus & Karen, 2016; Druckman et al. 2018), women's sports are significantly underfunded relative to men's sports. Because of this, recruiting, playing facilities, and even player experience varies significantly as well. Playing collegiate baseball may give some insight into playing collegiate softball, but they are clearly not direct equivalents.

This issue of equivalency is often raised in the opposite direction when women are not considered for coaching positions in football or baseball, sports traditionally offered almost exclusively to men. Since women are thus often excluded from both sports, organizations argue women are not qualified to lead those teams. If this is true, though, certainly a similar argument must apply to men with respect to fastpitch softball. In practice, however, athletic directors have often looked past this issue to still hire men – who again, have never truly played the same game they are coaching – to lead these teams of women.

NCAA Softball Data

For this study, we employ an extensive set of individual player data scraped from the NCAA softball statistics website. We have collected data on NCAA Division-I softball teams from 2012 to 2022. For concision, we will consider a "season" to be a single team over a single year, so these years provide a sample of 2,662 team/season observations, or 2,662 "seasons."

After further review, we verified 2,627 of these observations as seasons where a single person coached the team for the entire season. In this sample, there are 1,775 seasons where the team was solely coached by a woman, and 852

sport industry is ripe for both descriptive and prescriptive gender stereotypes regarding how women should behave and act in the setting (Burton, 2015). The outcomes of such gendered stereotypes result in a much lower proportion of women leaders in varying occupations throughout the industry.

[8] This quote is taken from Anderson (1992). As noted in Berri and Schmidt (2010), it is possible that Phillips borrowed the quote from someone else since it has been attributed to other coaches and said about other coaches.

[9] https://www.teamusa.org/usa-softball/team-usa/history/mens-fastpitch.

seasons where a team was solely coached by a man. In other words, 68% of the time a team was coached by a woman compared to 32% coached by a man.

The data set includes 595 total coaches, where a coach may have coached across multiple seasons and/or teams (though always completing a full season with a given team). Of these 595 coaches, 391 were women, and 204 were men. In other words, 66% of the coaches in the data sample are female. Subsequently, that means from 2012 to 2022, there are approximately 200 cases where a Division I athletic department hired a person to coach their softball team who has little to no experience playing fastpitch softball. If experience does truly matter to coaching, even 34% of coaching positions going to men would be unexpected if not disastrous for their programs.

Of course, if men are naturally superior leaders, this decision might be justified. Looking at the win-loss records of the teams, though, this story seems to lack support. Across the data sample, teams coached by women played 91,908 games and won 49.5% of the time.[10] Teams coached by men played 43,698 games and won 50.8% of the time. This appears to indicate there is not much difference between men and women in terms of team records.[11]

Although coaches are often evaluated in terms of their team's win-loss records, such records are not necessarily about the coach. Players on the field win or lose games. As noted, one key function of the coach is to find a way to get those players to play better. That is, a coach with great players they never impact is not as good a coach as a coach with relatively poor players who manages to elicit some improvement from those athletes. The former coach would likely have a better record. But it is the latter coach that is better at coaching.

Given this, our approach to evaluating coaching performance is similar to the approach used in studies of coaching in basketball and baseball.[12] We will begin with a measure of player performance. More specifically, we will focus on the productivity of hitters in softball.[13] After measuring the performance of these players, we then construct a model designed to evaluate if the gender of the coach systematically alters the performance of softball players. Again, the story told in many places is that men are better at coaching, and in fact, they are so much better at coaching that gender trumps experience. If that is true, then having a man as a coach should systematically lead to improvements in hitter performance. If instead experience wins overall, having a woman as a coach should instead lead to improvements in hitter performance.

Table 1 Summary Statistics for Model of Player Performance in College Softball Hitters with a minimum of 50 plate appearances in consecutive seasons Years: 2012 to 2022 Observations: 11,148

Dependent/Independent Variables	label	Mean	Standard Deviation	Minimum	Maximum
Player Performance Measures					
Batting Average	batavg	0.277	0.065	0.042	0.522
Isolated Power	isopower	1.481	0.298	1.000	4.000
Eye	eye	0.111	0.050	0.000	0.423
On-Base Percentage	obp	0.356	0.070	0.098	0.669
Slugging Percentage	slg	0.413	0.137	0.042	1.212
Runs Created per 100 plate appearances	rcpa100	10.147	6.643	-13.569	39.918
Wins Created per game	wcpergame	0.022	0.013	-0.023	0.079
Explanatory Variables					
Dummy Variable, woman coach	dwcoach	0.67	0.47	0.000	1.000
Dummy Variable, men coach	----------	0.32	0.47	0.000	1.000
Dummy Variable, New Coach	newcoach	0.15	0.35	0.000	1.000
Class	classid	2.90	0.83	1.000	7.000
Games Played	gp	47.80	8.84	14.00	70.00
Games Played, Lag	laggp	45.94	9.44	13.00	70.00
Difference in Games Played	difgp	1.86	9.58	-43.00	45.00

[10] It is possible for a softball game to end in a tie. So winning percentage is calculated as (wins + 0.5*ties)/ games.

[11] We do note this is a statistically significant difference at the 0.05 level when using a simple two-sample proportion test. However, this is not surprising given the size of the samples, and it ignores any controlling factors such as the strength of a particular program or the opponents a team faced.

[12] As we will note, our model builds on previous work by Berri et al. (2009), Bradbury (2017), Darvin et al. (2018), Croft et al. (2023), and Stowkowski, et al. (working paper).

[13] Most studies in looking at baseball have only examined the performance of hitters. Though we again point out softball and baseball are not perfect substitutes, we do borrow the measurement mechanic here as an attempt to provide a player performance metric already well-studied in the literature. As noted in Bradbury (2007), a pitcher's performance is dependent to some extent on the defensive players around them. This is much less true for hitters.

We report the overall summary statistics of the measurement variables in our data in Table 1. The statistics used here are further defined when used in the modeling in the following sections, for those unfamiliar with terms such as "batting average" or "on-base percentage." (We would also note that although we have included both "men coach" and "women coach" dummy variables in Table 1, only one dummy variable for the gender of the coach is included in the empirical modeling: a women coach or not a women coach. It is separated here to more clearly demonstrate the differences between male and female coaches only. The two separate variables exist in the data set to account for situations where teams do not have a single gendered coach, which does happen in approximately 1% of situations as seen in the table below as the difference in means between the male coach and female coach dummy variables. Examples of this rare situation would be a nongendered coach, a female/male coaching team, etc.)

Measuring the Performance of Hitters

In 2000, Lawrence Kahn offered the following justification for why economists should study sports:

> There is no research setting other than sports where we know the name, face, and life history of every production worker and supervisor in the industry.

This extensive data on worker productivity allows economists to examine a host of issues. Before such studies can commence, though, researchers must decide how productivity should be measured.

For hitters in baseball and softball, the choices to evaluate productivity are varied and may seem endless. In 1872, H.A. Dobson introduced batting average.[14] Batting average is simply a batter's hits divided by the batter's at-bats. Of course, not all hits are equal, and hitters will also score runs with actions besides hits. Thus, Dobson's simple measure has been recently discounted as the best measure of an overall hitter's value.

Approximately 100 years after Dobson introduced batting average, an economist began using the statistics tracked for hitters in baseball to study the economic value of workers. Gerald Scully's (1974) classic study compared the wages and marginal revenue product of Major League Baseball batters. To measure the productivity of a hitter, Scully employed slugging percentage, which is calculated as follows:

Slugging Percentage = Total Bases /At-Bats (1).

where Total Bases = Singles + 2*Doubles + 3*Triples + 4*Home Runs.

This measure does assign different values to different hits and as such makes a significant improvement over batting average. Across the next thirty years, slugging percentage was employed in a host of studies.[15] But slugging percentage – like batting average – also ignores many things a hitter can do to alter the outcome of a game.

More recently, researchers have put additional effort into capturing more of what hitters do to impact their team's offense. For example, Hakes and Sauer (2006) employed both slugging and on-base percentage, where the latter is calculated as follows:

On-Base Percentage = [Hits + Walks + Hit by Pitch] /.

[At Bats + Walks + Hit by Pitch + Sacrifice Flies] (2).

As noted in Holmes et al. (2018), whereas on-base percentage explains 79% of the variation in runs scored, and slugging percentage explains 82%, on-base percentage plus slugging average (or OPS) explains 91% of the variation in runs scored.[16] So, slugging percentage and on-base percentage together capture much of what a hitter does to impact a team's offense.

Holmes et al. (2018) argued that one could also explain 92% of the variation in runs scored[17] with three different

[14] Schwartz (2004, p. 11).

[15] A number of studies in the sports economics literature have used slugging percentage as a measure of performance. A brief list would include Sommers and Quinton [1982], Raimondo [1983], Bruggink and Rose [1990], Hill [1985], Durland and Sommers [1991], Sommers [1993], Krautmann and Oppenheimer [1994], Krautmann [1999], Krautmann, Gustafson, and Hadley [2000], Maxcy, Fort, and Krautmann [2002], Krautmann and Oppenheimer [2002] and Goff, McCormick, and Tollison [2002]. Sommers [1993] also employed a player's batting average. Slugging percentage has not been the only measure of productivity chosen. Medoff [1976], Hill and Spellman [1983], and MacDonald and Reynolds [1994] measured a hitter's productivity with runs scored. Such a choice ignores the impact a player's hitting has upon the scoring of teammates. Sommers [1990] utilized a player's batting average, or simply hits divided by at-bats. Batting average ignores the quality of a player's hits and is generally considered inferior to slugging average. Finally, Zimbalist [1992a, Zimbalist 1992b>] utilized slugging percentage with a player's on-base percentage in the construction of a summary statistic he labeled PROD.

[16] Holmes et al. (2018) regressed runs scored on a variety of measures for hitters using Major League Baseball team data from 1969 to 2016. We repeated the same exercise with our data from NCAA softball. Using 2,656 Division-I team observations from 2012 to 2022, we found that batting average explained 78% of the variation in a team's runs scored. The explanatory power of on-base percentage, slugging percentage, and OPS were 0.86, 0.83, and 0.90 respectively.

[17] We repeated the same exercise with our data from NCAA softball. Using 2,656 Division-I team observations from 2012 to 2022, we found that batting average, isolated power, and eye explained 91% of the variation in a team's runs scored.

variables.[18] The first of these is batting average. [19] Beyond this measure, these authors also employed isolated power and eye. These are calculated as follows:

Isolated Power = Total Bases / Hits (3).

Eye = (Walks + Hit-by-Pitches)/Plate Appearances (4).

Each of the aforementioned measures is relatively simple to calculate and – by themselves – incomplete. Blass (1992) offered an approach that was both more sophisticated and more complete. More specifically, Blass estimates a regression – similar to the following[20] – that incorporates nearly everything a hitter does to impact a team's runs scored per game:

Runs Scored per Game = $b_0 + b_1$*1B + b_2*2B + b_3*3B + b_4*HR + b_5*BB + b_6*HBP + b_7*SB + b_8*CS + b_9*SF + b_{10}*DP + b_{11}*SO + b_{12}*GO + b_{13}*FO + e_t (5).

where.

1B = Singles per game 2B = Doubles per game.

3B = Triples per game HR = Home Runs per game.

BB = Walks per game HBP = Hit by pitch.

SB = Stolen bases per game CS = Caught stealing per game.

SF = Sacrifice flies per game DP = Double plays per game.

SO = Strike outs per game GO = Grounded out per game.

FO = Fly outs per game.

This model was estimated with team observations from Division-I NCAA softball from 2012 to 2022.[21] The results of this estimation are reported in the following table 2.

Table 2 Modeling Runs Score per Game in College Softball Division I Team Data from 2012 to 2022 Dependent Variable: Runs Scored per Game

Independent Variables	Coefficients/Standard Error
1B	0.546***
	[0.00981]
2B	0.912***
	[0.0244]
3B	1.376***
	[0.0678]
HR	1.446***
	[0.0207]
BB	0.388***
	[0.0101]
HBP	0.392***
	[0.0242]
SB	0.211***
	[0.0148]
CS	-0.410***
	[0.0579]
SF	0.846***
	[0.0751]
DP	-0.483***
	[0.0564]
SO	-0.194***
	[0.00871]
GO	-0.156***
	[0.00892]
FO	-0.218***
	[0.00825]
Constant	1.422***
	[0.143]
Observations	2,656
R-squared	0.945

Standard errors in brackets

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The results are highly consistent with Blass' (1992) conclusions for Major League Baseball hitters decades ago. The model explains 94.5% of the variation in runs scored (a mark that is better than observed in any other approach taken). The model also demonstrated some important lessons about understanding softball play. For example, a single in softball appears to be worth an average of 0.55 runs scored. A naïve approach to evaluating hitters and productivity would lead to an assumption that a double should be worth twice that amount, but – just as Blass reported – it is worth slightly less. Likewise, a home run is also not worth four times the value of a single despite being worth four bases rather than the one base of a single.

Turning to the other variables, similar patterns exist with outs in that not all outs are created equal. An out from being caught stealing is significantly more damaging than an out achieved by a hitter at the plate. The reported results indicates that a baserunner in softball has to be successful on 66% of stolen base attempts just to break even on this activity.

From this model we can estimate how many runs each hitter created. Holmes et al. (2018) notes that this model can also be employed to estimate how many wins each hitter produces.

We first estimate the relationship between a team's winning percentage and both that team's runs scored per game and their opponent's runs scored per game. The results of this simple model are presented in Table 3.

[18] Holmes et al. (2018) argued that batting average, isolated power, and eye are better measures of performance because they are relatively independent of each other. In contrast, there is a high correlation between slugging percentage and on-base percentage.

[19] Holmes et al. (2018) notes that batting average – by itself – explains 66% of the variation in runs scored.

[20] Blass's (1992) work built upon the work of Thorn and Palmer (1984). Blass's regression also differed somewhat from ours. For example, Blass does not specficy how a player makes an out, and he also combines caught stealing and double plays into one variable.

[21] This data came from the NCAA. The NCAA does not report complete data for softball prior to 2012.

Table 3 Modeling Team Winning Percentage in College Softball Division I Team Data from 2012 to 2022 Dependent Variable: Team Winning Percentage

Independent Variables	Coefficients/ Standard Error
Runs per game	0.073***
	[0.001]
Opponent's runs per game	-0.073
	[0.001]
Constant	0.499***
	[0.001]
Observations	2,660
R-squared	0.831

Standard errors in brackets

*** p < 0.01, ** p < 0.05, * p < 0.1

Note: reported coefficients are constrained so the coefficient on runs per game equals – in absolute terms – the coefficient on opponent's runs per game

All variables in the above regression are per-game measures. Therefore, these results indicate that each additional run per game increases a team's winning percentage (in decimal form) by 0.073, on average.

Given this measure of runs created, a natural follow-up would be to simply multiply the value of runs in terms of wins by our measure of each player's runs created. But as Holmes et al. (2018) notes, that is not exactly correct. Pitchers also produce wins. However, pitching only directly impacts the opponent's runs scored. As long as a pitcher allows the opponent to score, their impact on wins – according to the above model – will always be negative. In other words, the above model indicates that only hitters have a (direct) positive impact on team wins.

Obviously, this cannot be the full specification. Consequently, Holmes et al. (2018) propose a two-step approach, which can be easily illustrated by examining the productivity of Jocelyn Alo in 2022. The raw numbers for Alo are impressive. She finished her career at Oklahoma in 2022 as the all-time leader in career home runs. In 2022, she led all players in home runs, slugging percentage, on-base percentage, and OPS. Her 90.2 runs created also led all of Division-I softball. For this impressive performance, she was the clear first overall pick in the very first draft of the Women's Professional Fastpitch league.

Clearly Alo was well above the average player. But how many wins was she worth to Oklahoma? The answer begins by ascertaining how many runs an average player would produce if they were given the same opportunities at the plate as the player we are examining. For example, the 51,504 hitter observations in our data set[22] produced 409,754.8 runs in 4,181,073 plate appearances. Therefore, per plate appearance the average softball hitter produced 0.098 runs. Alo had 226 plate appearances in 2022. An average player – producing 0.098 runs per plate appearance – would have created 22.2 runs given Alo's opportunities.

Again, Alo produced 90.2 runs. This mark was 68.1 runs beyond what an average hitter would have accomplished. As shown above, these additional runs translate directly to an outsized increase in wins for Oklahoma purely based on Alo's presence in the lineup.

Modeling the Impact of Coaching

As demonstrated in the previous section, the productivity of hitters in softball can be measured with batting average, slugging percentage, on-base percentage, OPS, isolated power, eye, runs created, and wins produced. Due to the nature of softball, this productivity should not be unduly impacted by the hitter's teammates, at least not relative to the theoretical impact of the hitter's coach. Thus, our primary focus is the impact to this productivity due to the hitter's coach. (We note that better teammates may raise a player's ability as well, though this can be difficult to quantify. Nevertheless, we will extend our analysis to attempt to take this into account as a later robustness and completeness check.)

This work builds on past studies looking at how coaches and managers impact player performance in sports. For example, in a study similar to this study of softball, Bradbury (2017) looked at how managers in baseball impacted a hitter's performance in Major League Baseball.[23] Beyond this work, we also note three studies that looked at player performance in different basketball leagues. Coaching in the NBA was explored by Berri et al. (2009), while Croft et al. (2023) looked at how coaching impacted performance of players in men's college basketball.

The paper that most closely follows our study of gender and coaching is Darvin et al. (2018). This paper examined how the gender of the coach impacted performance in both the WNBA and women's college basketball. In both cases, gender of the coach did not impact the performance of women in basketball.

This earlier work inspires the model detailed in Eq. (6). Our dependent variable, Perf, will be the seven measures of performance detailed earlier.

$\text{Perf} = \gamma_0 + \gamma_1\ \text{GENDER} + \gamma_4\ \text{NewCoach} + \gamma_3 \text{Class} + \gamma_4\ \text{DifGP} + \gamma_5\ \text{LagPerf} + \varepsilon$ (6).

Our list of independent variables in Eq. (6) begins with a dummy variable equal to one if the head coach was a

[22] Again, we are looking at Division I softball teams from 2012 to 2022.

[23] Bradbury's (2017) work looked at how a player's OPS was explained by a hitter's past performance, age, and a dummy variable for a player's manager. The model we employ is similar to this earlier work.

woman. As Table 1 shows, 67% of the players in the sample had a woman as head coach. This is especially relevant to our analysis, as the central question in the model concerns the impact of the gender of the coach on player performance.

We acknowledge, however, that other factors may also play a significant role. Beyond the gender of the coach, the model also includes whether or not a player is playing for a new coach. Presumably a new coach will have a different impact than an established coach. We would also expect a player to improve as they progress through college, hence the inclusion of the class a player is in (i.e., second year, third year, etc.). Progress could be derailed, though, by injuries, which we seek to capture by noting differences in games played (i.e., games played this season minus games played the previous season). This also leads to questions of intangible individual player characteristics, such as motivation or work ethic.

Thus, the final factor we consider is a player's performance the previous season (denoted as lagPerf, where each Performance measure would have a particular lag, e.g., lagPref for batting average would be the lagged batting average). This allows for comparison to measure improvement against the same player, presumably with the same motivation and other personal characteristics. Again, if gender of the coach matters, then player performance should be systematically different from lagged performance depending on whether or not the coach is a woman or a man. As a further robustness check, we also interact the gender variable with the lagged performance variable, under the assumption that bigger gains could be observed due to coaching gender. If so, this would also provide evidence that gender contributes to a change in performance.

Estimation Results and Discussion

The parameters of the model are estimated via a fixed effects model with robust standard errors. The fixed effects here are the conference each player played in. These were employed to control for the level of competition the player faced.

We estimate the model with each of the seven performance variables reported above. In each case, we find that lagged performance and changes in games played matter. Class – or year in school – matters with respect to eye and on-base percentage. This suggests hitters do learn as their college careers proceed and consequently get better at discerning good pitches from bad pitches.

This improvement, though, seems independent of the gender of the coach. Regardless of how we measure performance, the gender of the coach does not appear statistically significant. Notably, the interaction term between each performance measure and the gender of the coach also appears insignificant for all performance measures (Table 4). [24]

Once again, outside of softball, men are consistently the preferred leader, particularly in athletic organizations. Given that men typically do not play fastpitch softball, it seems odd for programs to still choose men as leaders in this environment if player experience truly does make one a better coach. However, since we note no discernible difference in player performance due to coach's gender, it may be that teams should be indifferent to both gender and playing experience, in which case their decision will be based on external factors.[25]

For this reason, we re-estimate the model by including program expenditures. The data in this case is more limited, but it provides a valuable proxy for many of the otherwise difficult to quantify measures of the quality of a program.[26] Due to the disruption of the COVID-19 pandemic, we only consider program expense for years up to 2019. This should give all schools accurate representation, since some programs were better able to weather the canceled seasons and low attendance of the pandemic.

Table 5 shows the results of this re-run analysis, this time including program expense (adjusted for real values for equal comparison across years and programs) as a variable to control for the quality of the program and its ability to attract top talent:

As Table 5 shows, expense is clearly significant, but again, the effects of the gender variables remain insignificant. The quality of the program does not appear to materially affect the relationships (or lack thereof) between the gender of a coach and the impact to player performance.[27]

[24] For readers interested in seeing how these results do not change when the insignificant interaction term is not included, please see Table A in Appendix A.

[25] We note this result should hold true regardless of gender and sport. Although we focus on the expansion of coaching to women's roles in men's sports, the same could be said in reverse: men should be equally represented in leadership for women's sports. However, we also note this does not appear to be the same problem in women's sports as it is in men's sports currently.

[26] This procedure follows the reasoning outlined in Von Allmen (2013), among others. Because the quality of an athletics program is difficult to measure objectively, the funds for the program can be used to provide a quantifiable measure instead. A better funded program will be able to attract and recruit better players; it will have better playing facilities; it will provide players with more "perks" and updated equipment; etc.

[27] We again note here that our goal is not to create a model to explain each performance metric but rather to demonstrate gender of the coach does not affect the relationships that exist. While it is highly likely some unobserved variables would contribute to models with higher explanatory power, these variables are also likely to be innumerable and prohibitively difficult to quantify, as well as being outside the scope of our argument.

Table 4 Estimating player performance measures Dependent variable listed at the top of each column

	batavg	isopower	eye	obp
Independent Variables	**Coefficient/ Standard Error**	**Coefficient/ Standard Error**	**Coefficient/ Standard Error**	**Coefficient/ Standard Error**
dwcoach	**-0.0110**	**-0.000573**	**-0.00163**	**-0.00813**
	[0.00673]	**[0.0289]**	**[0.00249]**	**[0.00905]**
dwcoach*lagPerf	**0.0351**	**-4.69e-05**	**0.00331**	**0.0175**
	[0.0233]	**[0.0200]**	**[0.0292]**	**[0.0273]**
newcoach	-0.00302	-0.00187	-0.00136	-0.00345
	[0.00213]	[0.00859]	[0.00123]	[0.00219]
classid	0.00131*	-0.00305	0.00149***	0.00216***
	[0.000706]	[0.00275]	[0.000394]	[0.000704]
difgp	0.00101***	0.00176***	3.93e-05	0.000916***
	[6.50e-05]	[0.000241]	[3.84e-05]	[5.95e-05]
lagPerf	0.463***	0.605***	0.539***	0.493***
	[0.0188]	[0.0188]	[0.0249]	[0.0234]
Constant	0.140***	0.603***	0.0495***	0.177***
	[0.00361]	[0.0207]	[0.00244]	[0.00740]
Observations	11,148	11,148	11,148	11,148
Number of confid	35	35	35	35
R-squared	0.245	0.357	0.279	0.258
	slg	rcpa100	wchpergame	
Independent Variables	**Coefficient/ Standard Error**	**Coefficient/ Standard Error**	**Coefficient/ Standard Error**	
dwcoach	**-0.0128**	**-0.320**	**-0.000643**	
	[0.00863]	**[0.211]**	**[0.000447]**	
dwcoach*lagPerf	**0.0286**	**0.0153**	**0.0149**	
	[0.0228]	**[0.0219]**	**[0.0218]**	
newcoach	-0.00473	-0.234	-0.000458	
	[0.00405]	[0.198]	[0.000379]	
classid	0.000489	0.0868	0.000159	
	[0.00114]	[0.0580]	[0.000109]	
difgp	0.00201***	0.0994***	0.000189***	
	[0.000135]	[0.00580]	[1.10e-05]	
lagPerf	0.564***	0.560***	0.560***	
	[0.0184]	[0.0197]	[0.0195]	
Constant	0.183***	4.517***	0.00982***	
	[0.00648]	[0.217]	[0.000439]	
Observations	11,148	11,148	11,148	
Number of confid	35	35	35	
R-squared	0.326	0.319	0.319	

Robust standard errors in brackets

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

where confid references the conference where the player played

Concluding Observations

There is extensive literature indicating women in leadership positions face more obstacles than men. Hence, it would not be surprising to find some evidence that men – who appear to be faced with the easier task in leadership positions – would perform better overall in leadership roles, regardless of particular experience. However, that is not the evidence we find in exploring college softball data. The evidence of our empirical modeling shows no difference in how women and men perform with respect to changing the productivity of the hitters they lead.

Such a result is consistent with the work of Darvin et al. that found women and men are equally skilled at coaching basketball. Such results appear to be contrary to the arguments presented in both the world of sports and beyond. Men are overwhelmingly the preferred choice when people are hiring for leadership positions. This pattern suggests that many people simply perceive men are better leaders than women.

Obviously, this suggests that qualified women are being passed over for management and coaching positions in areas where they could be considered equally. It also has another, more concerning implication. As Nicole LaVoi observed, the tendency for people to prefer male leaders to women has a negative impact on young girls and women (Hruby 2021): "I think the effect in general – that we know from the literature – is that same-sex, same-identity role models matter. 100% of young men get a male coaching role model. A majority of young women don't."

Table 5 Estimating player performance measures with expense Dependent variable listed at the top of each column

	batavg	isopower	eye	obp
Independent Variables	**Coefficient/ Standard Error**	**Coefficient/ Standard Error**	**Coefficient/ Standard Error**	**Coefficient/ Standard Error**
dwcoach	**-0.00679**	**0.0267**	**-0.000929**	**-0.00266**
	[0.00701]	**[0.0288]**	**[0.00294]**	**[0.00985]**
dwcoach*lagPerf	**0.0246**	**-0.0189**	**-0.00211**	**0.00585**
	[0.0252]	[0.0200]	[0.00134]	[0.0291]
newcoach	-0.00120	-0.00387	0.00134***	-0.00248
	[0.00214]	[0.00928]	[0.000479]	[0.00224]
classid	0.000487	-0.00278	1.28e-05	0.00134
	[0.000804]	[0.00319]	[4.12e-05]	[0.000819]
difgp	0.00108***	0.00183***	-0.000929	0.000973***
	[7.32e-05]	[0.000260]	[0.00294]	[6.96e-05]
lagPerf	0.475***	0.617***	0.547***	0.503***
	[0.0214]	[0.0193]	[0.0289]	[0.0259]
realexpense	1.11e-08***	1.65e-08*	4.98e-09***	1.27e-08***
	[3.11e-09]	[9.35e-09]	[1.65e-09]	[2.96e-09]
Constant	0.134***	0.569***	0.0437***	0.163***
	[0.00509]	[0.0307]	[0.00361]	[0.00794]
Observations	9,310	9,310	9,310	9,310
Number of confid	34	34	34	34
R-squared	0.254	0.356	0.282	0.264
	slg	rcpa100	wchpergame	
Independent Variables	**Coefficient/ Standard Error**	**Coefficient/ Standard Error**	**Coefficient/ Standard Error**	
dwcoach	**-0.00676**	**-0.112**	**-0.000219**	
	[0.00743]	**[0.190]**	**[0.000403]**	
dwcoach*lagPerf	**0.0184**	**0.00502**	**0.00472**	
	[0.0195]	**[0.0203]**	**[0.0201]**	
newcoach	-0.00299	-0.122	-0.000249	
	[0.00394]	[0.192]	[0.000366]	
classid	-0.000360	0.0394	6.93e-05	
	[0.00141]	[0.0718]	[0.000136]	
difgp	0.00213***	0.105***	0.000200***	
	[0.000136]	[0.00625]	[1.20e-05]	
lagPerf	0.568***	0.569***	0.569***	
	[0.0173]	[0.0199]	[0.0196]	
realexpense	1.96e-08***	9.91e-07***	1.89e-09***	
	[6.52e-09]	[2.89e-07]	[5.53e-10]	
Constant	0.165***	3.569***	0.00799***	
	[0.00855]	[0.307]	[0.000595]	
Observations	9,310	9,310	9,310	
Number of confid	34	34	34	
R-squared	0.328	0.323	0.323	

Robust standard errors in brackets

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

where confid references the conference where the player played

While this is true of role models outside the coaching world, we do know when young people, and particularly young athletes, fail to see people like them in certain roles, they tend to conclude such roles are closed to them. Hence, the failure to consider and hire women in general has implications beyond the organizations doing the hiring. This is especially obvious in sports organizations, where many young women grow up with predominantly male professional sports leagues as their exposure to the world of professional sports and coaching opportunities. It is not that young women do not see female role models in their coaches but rather that seeing women as only qualified to coach female sports will hurt aspirations young women may have outside women's sports. For example, seeing no female coaches or female referees in professional male sports will lead women to assume those roles are not available to them because of their gender. Young men do not find coaching women's sports closed to them, since they can see evidence of role models in male coaches even in women's sports. This seems to suggest a history of playing a given sport should neither qualify nor disqualify someone from consideration to coach that sport.

It is important to note in closing that this work does have limitations. Although we would argue that improving the play of players is a primary job of coaches, it is not the only job. Coaches in college also are charged with the task of recruiting talent and serving in other roles beyond improving current players. For example, this work does not take into account a coach's role in athletics fundraising. These roles could provide important context to choosing a bigger-name male coach over a lesser-known female coach (though this would again naturally lead to a larger discussion on the opportunities given to males in sports to achieve that greater renown). Further, we would also note that many unobserved variables could contribute to player performance, some of which are likely also impossible to measure.

Where the function of a coach is in improving quantifiable player performance, however, our results show no difference in how men and women demonstrate impact. While extrapolating to the wider business world is beyond the scope of this single study, it does pose a question for men's sports at both the collegiate and professional levels: do women truly deserve to be discounted on the basis of gender and lack of perceived experience?

Appendix A: Performance Results without Lagged Interactions

Table A Estimating our player performance measures. Dependent variable listed at the top of each column. No lag interaction term included in estimated model

	batavg	isopower	eye	obp
Independent Variables	**Coefficient/ Standard Error**	**Coefficient/ Standard Error**	**Coefficient/ Standard Error**	**Coefficient/ Standard Error**
dwcoach	**-0.00143**	**-0.000641**	**-0.00128**	**-0.00198**
	[0.00147]	**[0.00494]**	**[0.00121]**	**[0.00163]**
newcoach	-0.00303	-0.00187	-0.00136	-0.00346
	[0.00211]	[0.00856]	[0.00123]	[0.00218]
classid	0.00131*	-0.00305	0.00149***	0.00216***
	[0.000707]	[0.00276]	[0.000394]	[0.000705]
difgp	0.00101***	0.00176***	3.94e-05	0.000916***
	[6.44e-05]	[0.000241]	[3.82e-05]	[5.93e-05]
lagbatavg	0.486***			
	[0.0108]			
lagisopower		0.605***		
		[0.0123]		
lageye			0.541***	
			[0.0113]	
lagobp				0.504***
				[0.0117]
Constant	0.140***	0.603***	0.0492***	0.173***
	[0.00361]	[0.0207]	[0.00164]	[0.00417]
Observations	11,148	11,148	11,148	11,148
Number of confid	35	35	35	35
R-squared	0.245	0.357	0.279	0.258

Table A Estimating our player performance measures. Dependent variable listed at the top of each column. No lag interaction term included in estimated model

	slg	rcpa100	wchpergame
Independent Variables	**Coefficient/ Standard Error**	**Coefficient/ Standard Error**	**Coefficient/ Standard Error**
dwcoach	**-0.00132**	**-0.173**	**-0.000328**
	[0.00274]	**[0.144]**	**[0.000276]**
newcoach	-0.00478	-0.235	-0.000459
	[0.00403]	[0.198]	[0.000379]
classid	0.000512	0.0874	0.000160
	[0.00115]	[0.0584]	[0.000110]
difgp	0.00201***	0.0993***	0.000189***
	[0.000135]	[0.00577]	[1.10e-05]
lagslg	0.583***		
	[0.0123]		
lagrcpa100		0.570***	
		[0.0114]	
lagwcpergame			0.570***
			[0.0114]
Constant	0.175***	4.417***	0.00961***
	[0.00604]	[0.219]	[0.000425]
Observations	11,148	11,148	11,148
Number of confid	35	35	35
R-squared	0.326	0.319	0.319

Robust standard

errors in brackets

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

where confid references the conference where the player played

.

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which was done based on available official Athletics photographs and noted gender on team websites.

Declarations

Competing interests The authors have no competing interests in the submission or production of this manuscript. The authors are full-time research faculty at their respective institutions and do not receive financial or other personal compensation for this work.

Ethics approval and consent to participate Not Applicable. No direct subject interaction was involved in this research study, and no ethical concerns apply to the use of the data and methods in the subjects of this research study. Data was collected from the public records at the NCAA website, and no subject experimentation was performed in the course of this study.

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