

Age at peak soccer performance among world-class women soccer players

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Research Article

Keywords: football, team, sport, career, females

Posted Date: October 14th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11340778/v1>

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Additional Declarations: The authors declare no competing interests.

Abstract

In soccer, understanding the age of peak soccer performance is essential for career development, managing squads, and evaluating players. Despite numerous studies on peak performance age in men's soccer, little research has focused exclusively on elite women players. In our study, we thus aimed to determine the peak performance age of world-class women's soccer players by analyzing their ages at nomination for any of six major international individual (i.e. FIFA, UEFA, Ballon d'Or, BBC, FIFPRO, and The Guardian's 100 best female football players) awards and selections from 2001 to 2023. Overall, 1,066 nominations were examined, and players' ages at first, last, and average nominations were analyzed. Chi-square analyses, ANOVAs, and correlation analyses were used to assess differences across playing positions and temporal trends. The results indicated an overall average peak performance age of 26.8 years, with significant positional differences. Forwards peaked their performances earliest, at 25.3 years, followed by midfielders at 26.6 years, defenders at 27.7 years, and goalkeepers at 29.3 years. Those results suggest that women's peak soccer performance age aligns closely with men's but is older than previously reported for women's. No clear trend of rising peak performance age was observed over time. Altogether, our findings contribute valuable insights to career development and player longevity in elite women's soccer.

Introduction

Peak soccer performance refers to the integrated expression of physical, technical, tactical, and psychological capacities within the specific demands of the soccer game. Different from general physiological peak performance, which might occur earlier, peak soccer performance depends on accumulated experience, tactical understanding, coordination, and contextual factors that influence how players perform (Dendir, 2016). Understanding when soccer players typically reach this peak provides crucial insight into designing the performance development and career trajectories in elite soccer (e.g. Cote et al., 2009).

Players, coaches, clubs, and federations continuously make decisions based on assumptions regarding how performance develops across the soccer career. Reliable estimates of peak soccer performance age may therefore inform so-called talent development, training planning, performance forecasting, and career management (Cote et al., 2009; Allen & Hopkins, 2015; Tanaka & Toussaint, 2023). In professional soccer, knowledge of age-related performance patterns may also guide recruitment strategies, contract decisions, player valuation, and squad construction. Clubs must continuously assess both players' current performance levels and their future performance potential when making such decisions (Dendir, 2016; Franck & Nüesch, 2010; Kuper & Szymanski, 2018; Poli et al., 2021a).

Research examining the career trajectories of elite athletes has expanded considerably, particularly in relation to male athletes (e.g. Barraclough, et al., 2025). Studies of men's soccer have consistently reported an average age of peak performance between 25 and 30 years, depending on how it is measured. For example, Kalén et al. (2019) argued that peak soccer performance age was 26.5 years

based on the average age at participation in the UEFA Champions League. Dendir (2016), by comparison, calculated the peak age of men soccer players to be between 25 and 27 years, depending on average total playing time, score on WhoScored.com, and playing position, based on the average age of players in the top four leagues in Europe. More recently, Sal-De-Rellán Guerra et al. (2023) found that the average age of men players participating in the FIFA World Cup between 1998 and 2018 was 26 years. Using nominations for major international player-of-the-year awards as a proxy for the age of peak soccer performance, Oterhals et al. (2021) reported an average peak age just under 27 years (range = 26–30 years), depending on playing position. By position, studies on men soccer players have identified the highest peak soccer performance age among defending players, including goalkeepers and defenders, and the youngest among attacking players (Kalen et al., 2019; Dendir 2016; Sal-De-Rellán Guerra et al., 2023; Oterhals et al., 2021).

Research on women's soccer has been considerably more limited, which continues to constrain the development of sport-specific knowledge and the identification of pathway differences across levels of expertise (Peters et al., 2022). The few studies that have examined the age of peak soccer performance in women have also typically used the average age of participants in major tournaments as a proxy for age of peak soccer performance. In the 2012 Olympic Games, the average age of participating women soccer players was 25.1 years, with minor variations across playing positions and with the best performers slightly older (Barreira, 2016). Longo et al. (2016) also analyzed the 2012 Olympic Games but with a sample restricted to only the highest-performing players who reached the semifinals. In particular, they identified the average age of semifinalists to be 2.4 years older (i.e. 27.5 years) than the average age of all participants reported by Barreira et al. (2016). In another study, Barreira et al. (2021) identified the increasing average age of women soccer players who participated in the Olympic Games in the period from 1996 to 2016—namely, from 25.0 to 26.2 years. Also, that year, Poli et al. (2021_b) identified a steadily increasing average age, from 24.3 to 25.3 years, among elite women soccer players across 10 professional leagues between 2017 and 2021. For women, average age during participation in major soccer tournaments seems to range from 24.3 (Poli et al., 2021_b) to 26.2 years (Barreira et al., 2021) and to be even older— 27.5 years—when only participants at the highest performance level are included (Longo et al., 2016). Similar to the results from men's soccer, defending players seem to be the oldest at their peak (Barreira et al. 2021).

In Oterhals et al.'s (2021) study, the average age at which men soccer players were nominated for awards for the last time in their careers was close to 28 years, ranging from 27.4 years among midfielders to 30.4 years among goalkeepers. Those authors also analyzed a separate sample that included only players who had already retired, with the rationale that it is impossible to know a player's peak soccer performance age until the player has retired and can no longer alter the peak. True, in their sample of retired soccer players, peak performance age was somewhat older than in the overall sample. Similar analyses have not been found in studies on women soccer players.

Despite obvious sex-based differences in performance due to physiology (Allen & Hopkins, 2015; Cheuvront et al., 2005; Pedersen et al., 2019; Thibault et al., 2010), the age-related decline in

physiological function does not seem to differ much between men and women (Lepers & Stapley, 2016). In turn, there is no reason to believe that physiological factors influence the age of peak soccer performance in soccer players differently based on sex. As mentioned earlier, top soccer performance can be maintained long after physiological factors have begun to decline, likely because they can be compensated for by superior technical and/or tactical skills (Rey et al., 2022).

However, maintaining a soccer career at the highest level may be influenced by factors beyond physiology. In women's soccer, challenges related to pregnancy and childbirth (Culvin & Bowes, 2021), combining education and/or work with soccer and low salaries (Andersson & Barker-Ruchti, 2019) may affect career trajectories. However, the professionalization of women's soccer has increased considerably in recent years through improved maternity policies (FIFPRO, 2020), better financial conditions (Geekie, 2024; Pascoe et al. 2022). Furthermore, organizational structures have been strengthened through greater investment, commercial growth, and dedicated strategies for women's soccer (FIFA 2022; FIFA, 2023). Consequently, the opportunities and constraints influencing long-term career development in women's soccer differ from those historically observed in men's soccer, and the extent to which these biological, social, and structural conditions influence the age of peak soccer performance differently in women and men remains unclear.

The present study does not concern any of the above mentioned biological, psychological, or structural factors in particular. Rather, our concern is the extent to which findings from men's soccer can be generalized to women players. While some results may be transferable across sexes, variables such as the peak performance age are formed by the interrelationship between the biological, psychological, and structural factors, which in turn influence men and women differently. Thus, it is important to study women soccer players on their own terms, and to decide if it is legitimate to conclude about women soccer players based on studies of men soccer players.

The literature on the peak age of soccer players has with a few notable exceptions (mentioned above) been very scarce on women players, due to the lack of good data. Oterhals et al. (2021) introduced a novel proxy for peak soccer performance age based on the average age at which players are nominated for major individual awards. Until recently, lack of data has prevented the use of the same approach on women players. More recently, however, the data pool has increased considerably due to the establishment of new awards, and more players being nominated for each award.

Understanding gender differences, or similarities, in the age of peak soccer performance can give an indication of whether biological and structural factors shape performance trajectories differently for men and women players. Thus, we used the age at nomination for major international individual women's soccer awards as a proxy for women's peak soccer performance age in a bid to identify women soccer players' average age at individual peak soccer performance.

Methods

Player sample and procedure

The data in our study represented women soccer players nominated for major awards each year from 2001 to 2023, as well as the annual ranking of the 100 best players by The Guardian in cooperation with the website the Offside Rule (see details below). In fact, we included every major award that we were able to identify. We added the Guardian/ Offside Rule list of the best 100 players because the nomination procedure was similar to the procedure in the remainder of the awards, in asking present and former top players and coaches to nominate players. It can be argued that, the only population that affords comparison of the peak performance age is the absolute top performers because it extends the whole world with the best players migrating towards the best clubs regardless of geography. Thus, it can be viewed as one population, and also one common market.

All nominations, not merely the winners, for the various player-of-the-year awards from 2001 to 2022 were included (N = 1,066), including multiple nominations during the same players' careers but only one nomination per year. In cases when a player was nominated for more than one award the same year, only one was included in the dataset. Nominations from 2001–2013 are based on one award, and analyses from the latest years 2013–2023 are based on multiple awards.

Thus, the sample included the age of any player who ranked among the world's best players in a certain year, a feat that would most certainly be recognized as a career peak. Nomination lists for player of the year awards, including nominees for positional awards, were obtained: 198 nominations for Best FIFA Women's Player¹, 72 nominees for FIFPRO's Women's World 11², 48 for UEFA's Women's Player of the Year³, 102 for France Football's Ballon d'Or Féminin⁴, and 11 for the BBC's Women's Footballer of the Year⁵. Last, the 635 nominees on the annual ranking of the 100 best players by The Guardian⁶ and the Offside Rule⁷ from 2016 to 2022 were included as well.

Our study was based on publicly available, non-sensitive data from the mentioned websites, and can be accessed through weblinks in footnotes 1–7. Thus, ethics approval was not required per applicable institutional and national guidelines and regulations.

Major individual women's soccer awards

FIFA introduced the FIFA Women's World Player of the Year in 2001, which in 2016 was replaced by the Best FIFA Women's Player and has been presented annually. The FIFA awards are judged on sport performance as well as general conduct on and off the pitch. The votes are decided by media representatives, national team coaches, and national team captains. From 2016, public votes have counted for 25% of the overall vote.

UEFA's Best Women's Player in Europe Award has been awarded to the best European female footballer since 2013. Beginning in 2017, the award became known as the UEFA Women's Player of the Year Award. The 10 nominations for the award are made by coaches and journalists.

The Ballon d'Or Féminin, first awarded in 2018, is presented by the French football magazine France Football. The shortlist is created by the magazine's editorial team and voted for by a panel of international journalists. Fifteen players are shortlisted every year.

The BBC's Women's Footballer of the Year, established in 2015, is an award given to the best woman soccer player of the year. Every year, four finalists are shortlisted by a panel of experts, including coaches, players, administrators and journalists, and the winner is decided by fan voting.

FIFPRO Women's World 11 was launched in 2016 by the FIFPRO (i.e. Fédération Internationale des Associations de Footballeurs Professionnels), the worldwide representative organization for 66,000 professional footballers that comprises 72 national players' associations. Each year, every member of FIFPRO (i.e. all professional men's and women's footballers) is invited to assemble the best women's team of the year (i.e. one goalkeeper, four defenders, three midfielders, and three forwards), thereby making it the only global player award decided exclusively by footballers. We used all 11–55 players shortlisted each year, except from 2018, when there was no award. In the years 2016, 2017, 2019, and 2020, the 55 players most voted for were included in our dataset. For the years 2021 and 2022, however, only the 11 players awarded were available and included in our dataset.

Every year since 2016, the website the Offside Rule has ranked the 100 best female footballers in the world, and from 2018 onwards, its team has collaborated with the British newspaper The Guardian. The list is decided by a jury consisting of leading coaches, former players, and journalists from the women's game and, in 2023, had 112 members (The Guardian, 2024). With 100 players nominated each year, the award contributed more to the total average in our study than the remainder of awards (i.e. 11–55 players). Arguably, including as many as 100 players per year will somewhat deflate the performance level compared with other awards. However, players on The Guardian's list are also arguably performing at the highest level and are at least as representative of peak performance than those included in any previous study. All told, our study included the largest dataset of world-class women soccer players, which enabled a comparison of peak age with women performing in individual sports and with men soccer players as well.

From each player's nomination, age at nomination was calculated and used in the calculation of an average age at nomination for all players. Additionally, the average age at players' first nomination was calculated as well as the average age at their last nomination. For first nomination and last nomination each player, was represented with a single value ($N = 355$) because a player cannot be nominated for the first time more than once, and this also applies to their last nomination.

In accordance with Oterhals et al. (2011) each player's peak soccer performance age was determined according to several different operationalizations, including average age at nomination across all years that a player had been nominated and the average age at which a player was nominated for the first time. Different operationalizations of the proxy are interesting and relevant for different reasons.

The age at first nomination reflects the age at which players first attain world-class performance and may provide insights into talent development pathways and the accumulation of sport-specific expertise. The average age at nomination represents the typical age at which players perform at the highest level and facilitates comparisons with age-related performance patterns observed across sports. Finally, the age at last nomination reflects the age at which players, on average, cease to be recognized among the world's elite performers, thereby providing an indication of performance longevity at the highest level.

A timeline of the players' average age at nomination was also established, from FIFA Women's World Player of the Year 2001 through major awards for the 2023 season.

This method allowed recording each player's career peak(s) similar to Oterhals et al.'s (2021) method, except that we did not include data on retired players which, at that point in time, were to scarce for analysis since not enough players had retired.

Statistical analysis

Kolmogorov–Smirnov (KS) tests, histograms, and Q–Q plots, applied to examine normality assumptions of the variables' statistical distributions, indicated a normal distribution (KS test = .025, $p = .123$). The distribution of nominations according to playing position was analyzed using chi-square goodness-of-fit tests (χ^2), with observed frequencies of nominations in each playing position compared against an even distribution (i.e., 25% of total nominations in each of the four playing positions). Potential position-related differences in age at nomination were examined using one-way analyses of variance (ANOVAs) with partial eta squared (η^2p) as the indicator of effect size, interpreted as small effect (i.e. .01), medium effect (i.e. .06), and large effect (i.e. 0.14) (Ziv & Lidor, 2011; Korhonen, 2009). Position-related differences were further examined with Bonferroni- corrected post hoc analysis with Cohen's d applied as a measure of effect size, in which .2, .5, and .8 were considered to be small, moderate, and large, respectively (Ziv & Lidor, 2011; Gorzi et al., 2022). Pearson product-moment correlations were used to examine the relation between the year of nomination and average age of nomination at various time points. Predictive Analytics Software (PASW, IBM, United States; previously SPSS) version 29.0.1.0 was used for all statistical procedures, with $p < .05$ as the criterion for statistical significance.

Results

Total sample of nominated players

In the overall sample of 1,066 nominations, 8.0% were goalkeepers, 18.9% were defenders, 31.9% were midfielders, and 41.3% were forwards. The distribution of nominations for each playing positions differed significantly from an even distribution ($\chi^2 = 272$, $df = 3$, $p < .001$), with defenders being underrepresented relative to the number of defending positions and forwards being somewhat overrepresented. The age at nomination was normally distributed for the overall sample of nominations (see Fig. 1), and the mean age of players in the overall sample was 26.81 years ($SD = 4.04$). The mean

age of player's first nomination was 25.27 (SD = 3.84), and the mean age of player's last nomination was 27.74 (SD = 4.10).

Average peak performance age by playing position

The mean age at nomination, as shown in Table 1, varied across playing positions. A one-way ANOVA indicated significant differences, $F(1, 3) = 19.52$, $\eta^2p = .05$ [95% CI (0.03, 0.08)] across playing positions ($p < .001$). Additional post hoc analysis with Bonferroni correction indeed confirmed that age at nomination differed significantly between most positions, $d \geq .24$ [95% CI (0.07, 0.41)], $p < .01$, except between midfielders and forwards, $d = 0.15$ [95% CI (- 0.32, 0.03)], $p = .65$.

Age at first performance peak by playing position

The mean age at first nomination (see Table 1) also varied across playing positions. A one-way ANOVA indicated significant differences, $F(1, 3) = 6.59$, $\eta^2p = .05$ [95% CI (0.01, 0.10)], $p < .001$. Further post hoc analysis with Bonferroni correction indicated that age at nomination differed significantly only between goalkeepers and forwards, $d \geq .73$ [95% CI (0.35, 1.10)], $p < .001$, and between defenders and forwards, $d \geq .38$ [95% CI (0.09, 0.66)], $p < .01$.

Age at last performance peak by playing position

One-way ANOVA indicated significant differences, $F(1, 3) = 4.63$, $\eta^2p = .04$ [95% CI (0.005, 0.08)], $p < .01$, between playing positions for mean age at last nomination (see Table 1). Post hoc analysis with Bonferroni correction indicated that age at last nomination differed significantly only between goalkeepers and forwards, $d \geq .56$ [95% CI (0.20, 0.93)], $p < .01$, and between midfielders and forwards, $d \geq 0.36$ [95% CI (0.11, 0.62)], $p < .01$.

Table 1
Descriptive statistics for age at nomination across playing positions for the overall sample

Position	<i>n</i> (% of total)	Average age <i>Mean (SD)</i>	First nomination <i>Mean (SD)</i>	Last nomination <i>Mean (SD)</i>
Goalkeepers	85 (8.0)	29.06 (3.85) ^a	27.09 (3.84) ^d	29.22 (4.5) ^f
Defenders	201 (18.9)	26.83 (3.64) ^b	25.71 (3.60) ^e	27.79 (3.63)
Midfielders	340 (31.9)	27.40 (4.02)	25.63 (3.66)	28.35 (4.09) ^g
Forwards	440 (41.3)	25.91 (4.02) ^c	24.29 (3.87)	26.87 (4.07)
Total	1066 (100)	26.81 (4.04)	25.27 (3.84)	27.74 (4.10)

Note. Superscript letters indicate significant pairwise differences based on Bonferroni-corrected post hoc comparisons. ^aGoalkeepers older than all other positions ($p < .01$), ^bDefenders and midfielders did not differ from each other but were older than forwards ($p < .05$), ^cForwards were significantly younger than goalkeepers and defenders ($p < .05$), ^dGoalkeepers were significantly older than forwards ($p < .001$), ^eDefenders were older than forwards ($p < .01$), ^fGoalkeepers were significantly older than forwards ($p < .01$), ^gMidfielders were significantly older than forwards ($p < .01$).

Variations of the peak performance age between 2001–2023

As depicted in Fig. 2, the mean age at nomination for each year fluctuated from 2001 to 2023. Following an initial mean age at nomination of 28.4 years in 2001, it dropped to 25.74 years in 2004 before increasing to peak at 28.76 years in 2014. Thereafter, it again dropped to 26.12 years at nomination in 2017 followed by an increase in 2021 at 27.46 years. In 2022 and 2023, mean age at nomination slightly decreased. On the whole, no significant relationship was found between year of nomination and average age at nomination from 2001 to 2023 ($r = .11$, $p = .63$).

Discussion

As an operationalized proxy for peak soccer performance age, the average age of women soccer players when nominated for world's best player awards was 26.8 years in the overall sample with all nominations included. The average age was 25.3 years when nominated for such awards for the first time and 27.7 years when nominated for the last time. Positional differences were apparent: forwards peaked at approximately 26 years, defenders and midfielders peaked at 27-27.5 years, and goalkeepers at over 29, about three years later than forwards. Many decisions regarding players' careers are based on the ability to predict career trajectories (Côté et al., 2009, Allen & Hopkins, 2015; Tanaka & Toussaint, 2023). These require precise knowledge about age-related performance patterns, which have been lacking in the female population due to methodological shortcomings mentioned above. Our results thus add specific knowledge about women soccer players' peak performance age that can inform decision making instead of relying on findings from male populations.

Our sample's peak soccer performance age was up to two years older than previously found in the 2012 Olympic Games players (Longo et al., 2016; Barreira, 2016) and about a year older than found in the 2016 average (Barreira et al., 2021). Besides, our results are in accordance with Barreira et al., (2021) who found that the highest average age of women players participating in the Olympic Games was among goalkeepers and somewhat younger among midfielders and youngest among forwards. Goalkeepers likely peak at an older age because they benefit greatly from tactical experience, and their running capacity contributes less significantly to their overall soccer performance (Ziv & Lidor, 2011). At the same time, physical requirements in general and specifically explosive sprint performance are crucial for the overall soccer performance in forwards, which explains why their peak soccer performance age is much earlier. Forwards are likely more vulnerable than the remaining positions to age-related decline in the properties of physical sprints, for men beginning at 20–25 years of age (Korhonen, 2009), hence the early peak performance age among sprinters (Gorzi et al., 2022; Haugen et al., 2018). Women, however, reach their peak sprinting performance 0.8 years later than men (Haugen et al., 2018). Still the same argument applies to why women forwards peak earlier than midfielders and defenders.

Notably, studies assessing the peak soccer performance age of women (Longo et al., 2016; Barreira, 2016; Barreira et al., 2021) have included the average age of participants in Olympic tournaments as a proxy for age at peak performance, which would not necessarily indicate an individual career peak, neither would it indicate performance at the highest level for individual players. Barreira (2016) found that the average age of participating players in women's soccer in the 2012 Olympic games was 25.1 years. On average, the teams that reached the quarterfinals were older than the teams that did not (Barreira, 2016). The positive relationship between performance and age corresponds to the findings of Longo et al. (2016), who also analyzed the 2012 Olympic Games, albeit with the sample restricted to only the ones that reached the semifinals. Longo et al., (2016) identified the average age of semifinalists to be 2.4 years older (i.e. 27.5 years) than the average age of all participants reported by Barreira (2016). The reason why the peak soccer performance age in our sample was older, may be that the samples included players representing different levels of performance. Unlike Barreira (2016) and Longo et al.'s (2016) samples, our sample included soccer players who, in a certain year, were considered to rank among the world's best players, a feat that would most certainly be recognized as a soccer career peak. In the Olympics, entire soccer teams qualify, not individual players who only have to be good enough to be selected for their country's squad. In our sample, players had been nominated on lists of the world's best women soccer players in that particular year based on their individual performance. The average level of performance of soccer players in our study was arguably higher insofar as they represented the (up to 100) best women players on the planet each year; in the Olympics, however, as many as 256 soccer players are included in the squads, and many better players do not participate in the Olympics whatsoever because their teams did not qualify.

Among studies on men, both Dendir (2016), who included individual players' playing time and match performance in calculating individual career peak ages, and Oterhals et al. (2021), who used nominations for individual awards as a proxy, applied the same methodology as we did in that they identified players' individual career peaks. Thus, their results can be reasonably compared with ours.

The peak soccer performance age among women world-class soccer players that we found was very similar to the age reported by Oterhals et al. (2021) for the corresponding group of men. Hence, physiological factors do not appear to influence the age of peak soccer performance differently between world-class men and women players. This may be due to the recent rapid development in women's soccer, including the already mentioned improved maternity policies (FIFPRO, 2020), better financial conditions (Geekie, 2024; Pascoe et al. 2022), and dedicated strategies for women's soccer (FIFA 2022, FIFA (2023)).

However, between the present and Oterhals et al. (2021) study there are notable variations in peak soccer performance age across playing positions. Women defenders peaked approximately a year earlier than men defenders, whereas the corresponding women midfielders peaked close to a year later than men. These differences may be attributed to different playing styles between women's and men's soccer associated with physiological sex differences (Pedersen et al., 2019; Palade et al., 2020), which may affect how nominators and judge committees perceive soccer performance. Regarding the difference in peak age of midfielders, Kutnjak et al. (2023) found that playing midfield and fullback or winger as professional women soccer player is physically more demanding than playing as central defender. Knowing that women reach their sprint performance peak approximately 0.8 years later than men (Haugen et al., 2018), it is plausible that the more physically demanding roles of midfielders and wide players in women's football contribute to this delayed peak compared to their male counterparts. Otherwise, the variations between playing positions were similar in each sample, with the defenders, and even more the goalkeepers, being the oldest and forwards being the youngest when nominated for awards.

In our sample, forwards represented more than 40% of the total, likely because most top goal scorers play in that position. Forwards are not only overrepresented among nominated players but also have the highest market values, along with attacking midfielders (Poli et al., 2020), and earn higher salaries (Bernardo et al., 2022). However, the number of goalkeepers and defenders in particular in our sample was rather limited, with the latter group being severely underrepresented relative to their number on the pitch, which is similar to the number of midfielders.

The average age of soccer players at their first-ever nomination for major international awards has been argued to indicate the earliest age at which players can consistently perform at the very top level in the game of soccer (Oterhals et al., 2021). In our study of women players, that age was 25.3 years but also varied between playing positions from 24.3 years among forwards, 25.6 years among midfielders, 25.7 years among defenders, to 27.1 years among goalkeepers. Thus, it seems to take longer either for defending players to develop the necessary qualities than attacking ones or for such qualities to be recognized. The latter hypothesis would find support insofar as defending player positions are massively underrepresented among nominees for the awards (see Table 1). Oterhals et al. (2021) is the only study but the present that has distinguished between first-ever and last-ever nomination in their analysis of peak soccer performance age. Compared with that study the average peak soccer performance age at first nomination was lower in women (25.3 compared to 25.7) although the average age at first

nomination for women midfielders were somewhat higher. Although small, the sex difference observed between the study on men (Oterhals et al., 2021) and the present study on women, might be attributed to the age at which they enter the top level, and also, because of a larger pool of world-class players in men's soccer, men may require more time to build the recognition needed to be nominated for the first time.

The age at a player's last-ever nomination serves as an indicator that elite soccer performance can be sustained until a comparatively advanced age. Furthermore, this observation suggests that soccer players do not exhibit a singular performance peak; rather, they may experience multiple peaks over the course of their careers. It also implies that high-level soccer performance can persist for many years following their initial nomination for major awards, and long after physiological peaks. Compared with men players in Oterhals et al.'s (2021) study, the age at last-ever nomination among women players in our study was quite similar, though woman midfielders notably seemed to maintain their absolute top level about a year longer.

The finding of an average peak soccer performance age at around 27 years or more, depending on the playing position, supports the ten-year rule of Ericsson and Lehmann (1996), stating that an individual needs ten years of deliberate practice in order to become an expert. Deliberate practice means specific practice of whatever they are attempting to become experts at. Thus, for soccer players, it is not relevant that they may have more than ten years of soccer experience at the youth level before they make their senior debuts, however deliberate. The practice does not become specific for top-level soccer until the players actually practice at that level; training together with and playing against other players at that same top level. The peak soccer performance age of 27 years coincides quite well with the age at which players have played ten years at the highest level.

In a scoping review of developmental pathways among elite female athletes, Peters et al. (2022) identified several deviations from the expertise-development trajectories commonly reported in the literature, which has largely been based on male athlete samples. Specifically, female athletes tended to maintain participation in multiple sports throughout adolescence, including the specialization and investment stages of development. Despite this comparatively lower degree of early sport specialization, the present findings suggest that the age of peak performance in women's soccer is broadly comparable to that observed among men. More importantly, Peters et al. (2022) underscored a substantial gender gap in the current understanding of developmental pathways leading to expertise in girls' and women's sport. In this context, the present findings on the peak performance age of elite women soccer players contribute to the still limited evidence base on developmental trajectories and key career milestones in female athletes.

No trend of an increasing age of peak soccer performance over time was evident in our data. Barreira et al. (2021) identified an increasing age, from 25.0 to 26.2 years of women soccer players participating in the Olympic Games from 1996 to 2016. That same year, Poli et al. (2021_b) found a steadily increasing average age, from 24.3 to 25.3 years, among elite women soccer players across 10 professional leagues

from 2017 to 2021. The average peak age in our sample of soccer players was 0.65 years older than in the 2016 Olympic Games and 1.75 years older than among Olympian women soccer players in 1996 (Barreira et al., 2021). Those differences arguably indicate a further increase on top of what Barreira et al. (2021) have reported, or they may stem from the mentioned differences in levels of performance between the datasets. The time span that we analyzed was far shorter than that for men players in Oterhals et al.'s (2021) study, which included the entire period from 1956 to 2021. Oterhals et al. (2021), however, observed a notable increase in peak performance age after 2000 that was not evident among women players in our sample (see Fig. 2). Due to fluctuations in peak soccer performance age in the studied period, it was impossible to identify any clear trends.

Our data were collected in 2024 and extend through 2023. Data from recent years would clearly have provided a larger data set, but it is unlikely that it would alter the results. What is most time-dependent is the change in peak age over historical time but given the complete lack of a trend of increasing peak performance age in our data, there is no reason to believe that two additional years would be sufficient to detect such a trend, even if it exists. However, based on the current extremely rapid development of women's soccer, it would be interesting to revisit the question in a few years' time to investigate whether there might be a similar trend of an increasing peak age as previously found among men players (Oterhals et al., 2021).

Even so, the individual peak soccer performance age for most players in our sample remains unknown because we cannot be certain that they have indeed peaked in their performances. As mentioned, using the average age of participation in a particular league or tournament can be problematic. In their study on men players, Oterhals et al. (2021) included a sample of retired players, for whom peak soccer performance age is certain because they are no longer active players. In the present study, we did not include data on retired players which, at the time of data collection, were too scarce for analysis since not enough players had retired. This is a limitation to the present study, and future studies should investigate samples of retired players in order to obtain an even better estimate of their actual peak soccer performance age.

Conclusion

This study offers new insights into the peak soccer performance age of world-class women soccer players, providing stakeholders with women-specific evidence to inform career decisions rather than relying on evidence derived from men players. By providing a methodologically robust estimate of peak performance age in women's soccer, our findings may have practical implications for player recruitment, contract planning, squad planning, and career management.

Based on age at nomination for major international individual women's soccer awards, the average peak soccer performance age is just under 27 years, with notable differences between playing positions. Reflecting different physical and tactical demands across positions, goalkeepers peak later, and

forwards earlier. However, the observed differences in nomination numbers between positions may reflect possible biases.

Our findings align closely with comparable research on men players, suggesting that physiological sex differences do not significantly alter the timing of peak soccer performance between men and women at the highest levels.

While our study increases the understanding of career development in elite women's soccer, further research is needed, particularly on retired players to capture possible impact of sex dependent factors such as pregnancy and career breaks. In addition to practical implications for player development, these results underscore the ongoing progression toward equity in the highest levels of soccer.

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Footnotes

1. 1 Collected from Wikipedia because no overall list including all nominations across all years exists on FIFA.com https://en.wikipedia.org/wiki/The_Best_FIFA_Women%27s_Player
2. 2 Collected from: <https://www.fifpro.org/en/articles/2023/10/history-womens-world-11>
3. 3 Collected from Wikipedia because no overall list including all nominations across all years exists on fifpro.com https://en.wikipedia.org/wiki/UEFA_Women%27s_Player_of_the_Year_Award
4. 4 Collected from Wikipedia because no overall list including all nominations across all years exists on www.francefootball.fr https://en.wikipedia.org/wiki/Ballon_d%27Or_F%C3%A9minin
5. 5 Collected from Wikipedia because no overall list including all nominations across all years exists on www.bbc.com https://en.wikipedia.org/wiki/BBC_Women%27s_Footballer_of_the_Year

6. 6 Collected from Wikipedia because no overall list including all nominations across all years exists on [www.guardian.com](https://www.theguardian.com/football/series/the-100-best-footballers-in-the-world) <https://www.theguardian.com/football/series/the-100-best-footballers-in-the-world>
7. 7 Collected from: <https://offsiderulepodcast.com/top-100-female-footballers/>

Figures

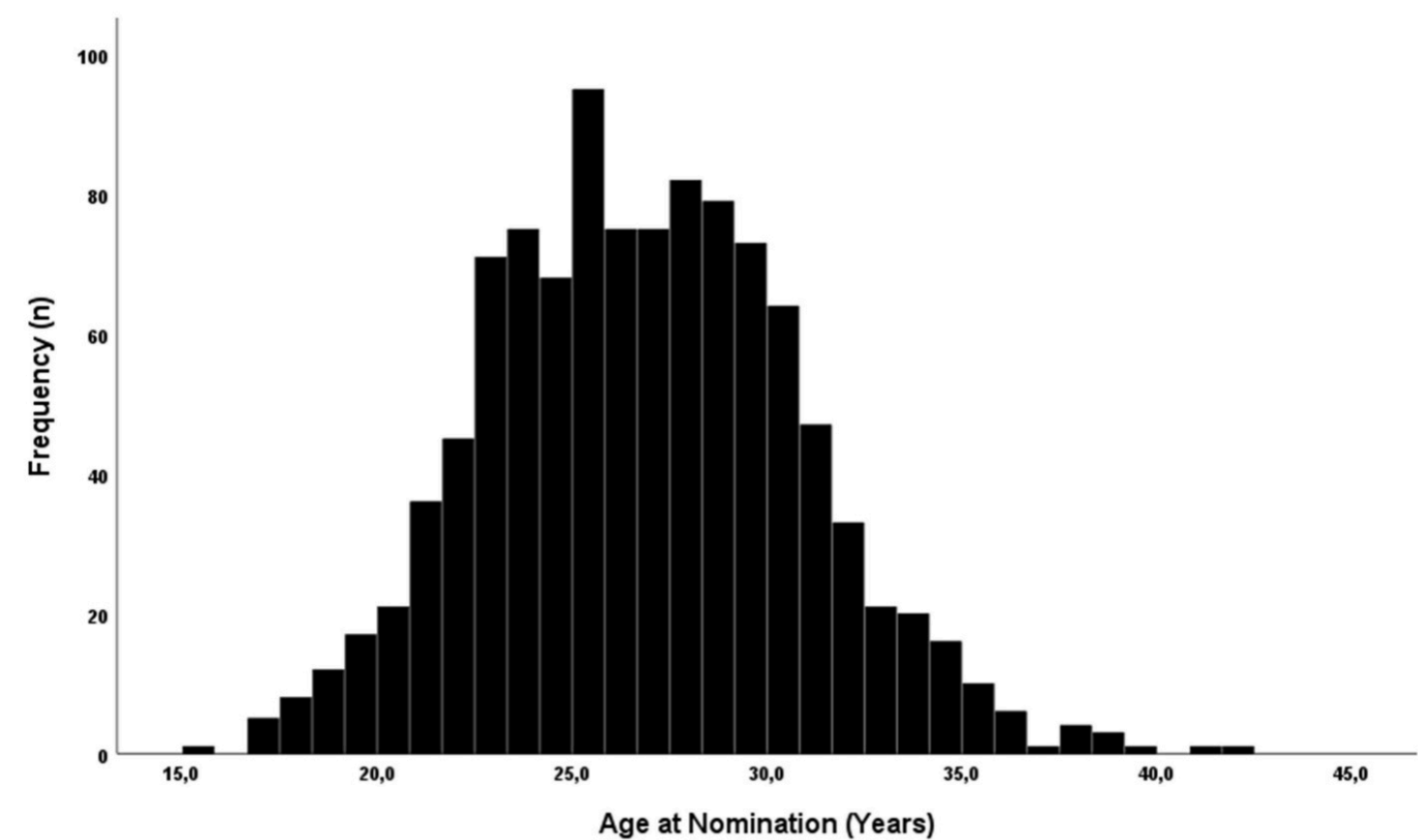


Figure 1

Frequency of nominations at different ages for the overall sample

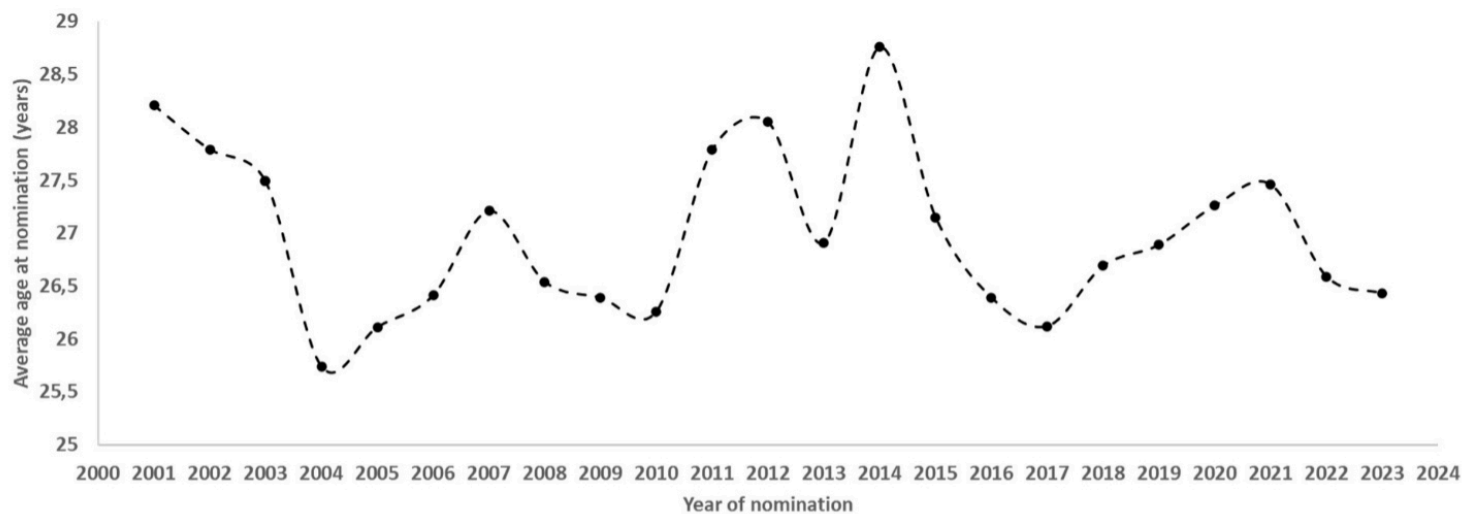


Figure 2

Development of mean age at nomination, 2001-2023