Original Article

CAREER TRAJECTORIES OF INTERNATIONAL ATHLETES IN THE PORTUGUESE ATHLETICS CHAMPIONSHIPS HELD FROM 1990 TO 2019

TRAJETÓRIAS DE CARREIRA DOS ATLETAS INTERNACIONAIS NOS CAMPEONATOS DE PORTUGAL DE ATLETISMO REALIZADOS DE 1990 A 2019

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RESUMO

O estudo teve como objetivos: (i) identificar as trajetórias de carreira dos atletas internacionais nos campeonatos de Portugal de atletismo realizados de 1990 a 2019, e (ii) modelar o sucesso desportivo desses atletas em competições internacionais de atletismo. Foram analisadas todas as participações de atletas internacionais nos campeonatos de Portugal de atletismo realizados de 1990 a 2019 (n = 2389; Pista coberta - PC, n = 947; Ar livre - AL, n = 1442). O sucesso desportivo, medido pela obtenção de medalha em competições internacionais de atletismo, foi analisado com recurso à regressão não paramétrica local (*locally estimated scatterplot smoothing,* LOESS) para as curvas obtidas a partir de mais de 10 observações, e o ajustamento de modelos de regressão logística foi utilizado para explicar a probabilidade de ser medalhado em campeonatos internacionais (modelos: Idade, Escalão e Classificação). Observou-se que ~11% das atletas do sexo feminino (PC, 10.8%; AL, 11.3%) e ~7% dos atletas do sexo masculino (PC, 8.5%; AL, 5.8%) que participaram em idades jovens nos campeonatos de Portugal foram internacionais medalhados. Numa análise comparativa entre os atletas internacionais medalhados e não-medalhados, observou-se que os atletas medalhados (i) participam nos campeonatos de Portugal com idades mais altas (consequentemente, com escalões menos jovens); e (ii) obtém classificações e marcas melhores. A análise de modelação do sucesso desportivo dos atletas internacionais confirma os resultados obtidos a partir das análises visuais, observando-se que: (i) quanto maior for a média das idades nas participações nos campeonatos de Portugal, maior é a probabilidade de ser medalhado internacionalmente; (ii) ter uma trajetória de carreira com participação em idades jovens nos campeonatos de Portugal não altera a probabilidade de ser medalhado internacionalmente; e (iii) quanto menor (melhor) for a média das classificações, maior é a probabilidade de ser medalhado internacionalmente.

Palavras-chave: Atleta internacional; Campeonato nacional; Regressão local; Regressão logística; Sucesso internacional.

ABSTRACT

The study aimed to: (i) identify the career trajectories of international athletes in the Portuguese athletics championships held from 1990 to 2019, and (ii) model the sporting success of these athletes in international athletics competitions. All the participations of international athletes in the Portuguese athletics championships held from 1990 to 2019 were analysed (n = 2389; Indoor track and field, n = 947; Outdoor track and field, n = 1442). Sporting success, measured by winning a medal in international athletics competitions, was analysed using local non-parametric regression (locally estimated scatterplot smoothing, LOESS) for curves obtained from more than 10 observations, and logistic regression models were used to explain the probability of winning a medal in international championships (models: Age, Grade and Classification). It was found that ~11% of female athletes (PC, 10.8%; AL, 11.3%) and ~7% of male athletes (PC, 8.5%; AL, 5.8%) who took part in the Portuguese championships at a young age went on to win international medals. In a comparative analysis between medal-winning and non-medal-winning international athletes, it was observed that medal-winning athletes (i) take part in the Portuguese championships at a higher age (consequently, with younger age groups); and (ii) obtain better rankings and marks. The modelling analysis of the sporting success of international athletes confirms the results obtained from the visual analyses, observing that: (i) the higher the average age at participation in the Portuguese championships, the greater the probability of winning an international medal; (ii) having a career path with participation in the Portuguese championships at a young age does not alter the probability of winning an international medal; and (iii) the lower (better) the average ranking, the greater the probability of winning an international medal.

Keywords: International athlete; National Championship; Local regression; Logistic regression; International success.

Introduction

Athletics is an Olympic sport that, is popular and rooted in the culture of the Portuguese people. In fact, Portugal has participated in major international competitions since Paris 1938 (European outdoor championships)[1], Helsinki 1983 (World outdoor championships)[2] and Stockholm 1912 (Olympic Games)[3].

Nevertheless, lately there has been a decline in Portugal in the participation and results in major athletics competitions at both European and World-levels. From discussions between coaches, managers, and the media, there has been some suggestions regarding the reasons behind this decline, but a lack of consensus still remains.

This discussion is not exclusive to Portugal. Grix and Parker[4] report that long-distance running in the UK is declining, with no unanimity on why. These debates often occur in the written press, athletics magazines, and online forums, frequently naming specific people[4].

The justifications for the current state are often attributed to new technologies, which have changed the way free-time is used by children and young people, but also to the adoption of new training regimes and the increasing popularity of other sports[4].

In Portugal, as described by Grix and Parker[4], there is minimal academic discussion on the matter, except in athletics magazines or journalistic reports, which are often nothing more than opinion articles.

Grix and Parker[4] also note that before opining on the decline of distance running in the UK national championships, evidence must be provided stating that participation numbers have declined since the early 1980s.

There are few studies that followed the career trajectories of athletics athletes, namely the work of (i) Boccia et al.[5] who analysed the athletes classified in the top-200 of the official lists of the Italian Athletics Federation (FIDAL) (1994-2014) in the disciplines of 100 m, 100 m hurdles, 110 m hurdles, discus throw and shot put; (ii) Kearney and Hayes[6] who analysed the results of 134,313 participations of athletes (12 and 35 years old) in disciplines in the speed, middle distance, throwing and jumping sectors; (iii) Boccia et al.[7] who studied the performance of 4924 athletes (both sexes) in the speed sector and classified (between 2000 and 2018) in the lists of the International Association of Athletics Federations (IAAF); (iv) Agudo-Ortega et al.[8] who analysed the relationship between success in the youth and senior categories in disciplines in the speed sector (between 2004 and 2021) in the database of the Royal Spanish Athletics Federation; (v) Rodriguez-Gomez et al.[9] who analysed the sporting progression (from U14 to senior elite) of 300 Spanish high and long jumpers; and (vi) Moreno et al.[10] who analysed the 1759 finalists (both sexes) from all disciplines of the World youth athletics championship (1999-2009).

A well-defined developmental path to elite sporting performance is a crucial component of an inclusive talent development program[11]. Career development profiles of top athletes could also be used to help coaches with better long-term planning in a bid to achieve an Olympic medal, allowing them to adopt realistic short-term performance goals for younger athletes[11].

Pinto et al.[12] identified the age of best performance in Portuguese athletics championships, always taking in account gender and sport discipline. Pinto and Massuça[13] characterised the participation of young athletes in the Portuguese Indoor Track Athletics Championships and outdoor activities. They quantified the probability of young athletes participating, being finalists or medallists in the disciplines that characterise the Portuguese Athletics Championships.

But does participation and performance (qualitative: participant, finalist, or medallist) in the Portuguese championships (1990 to 2019) explain the sporting success of athletics in Portugal?

Given the scarcity of studies to identify the career trajectories of athletics athletes, the present work aims to: (i) identify the career trajectories of international athletes in Portugal

athletics championships held from 1990 to 2019; and (ii) model the sporting success of these athletes in international athletics competitions.

Methods

This is a retrospective descriptive study in which all participations of international athletes in the Portuguese athletics championships held from 1990 to 2019 were analysed (n = 2389; PC, n = 947; AL, n = 1442). The distribution of participation by type of competition (PC; AL), sex (female, F; male, M), disciplines (e.g., 60 m), and sectors (e.g., speed/hurdles) is presented in Table 1.

Table 1. Distribution of the number of participations of international athletes in the Portuguese athletics championships held from 1990 to 2019, concerning the type of competition (indoor track; outdoor), gender (female; male), disciplines (e.g., 60 m), and sectors (e.g. speed/barriers).

Disciplines	Indoor		Outdoor	
	Female (F)	Male (M)	Female (F)	Male (M)
60 m	61	74	-	-
100 m	-	-	34	96
200 m	52	49	33	60
400 m	51	24	48	32
60 m Hurdles [A]	50	41	-	-
100 m Hurdles [B]	-	-	37	-
110 m Hurdles [C]	-	-	-	52
400 m Hurdles [D]	-	-	37	70
800 m	46	49	53	54
1500 m	35	40	58	59
3000 m [E]	30	31	3	-
5000 m [F]	-	-	41	58
3000 m Steeplechase [G]	-	-	19	74
3000 m Race Walk	-	-	-	-
5000 m Race Walk	-	5	-	-
10000 m Race Walk [H]	-	-	1	-
20000 m Race Walk [I]	-	-	-	-
Javelin Throw [J]	-	-	23	-
Discus Throw [K]	-	-	37	30
Hammer Throw [L]	-	-	48	20
Shot Put [M]	22	46	37	51
Pole Vault [N]	30	46	45	48
High Jump	9	16	11	-
Long Jump	36	43	36	58
Triple Jump [O]	32	29	48	31
Sectors				
Sprints / Hurdles	214	188	189	310
Middle Distance	111	120	174	245
Race Walk	-	5	1	-
Throwing	22	46	145	101
Jumping	107	134	140	137
Total	**454**	**493**	**649**	**793**

Notes: Sprints / Hurdles: 60 m; 100 m; 200 m; 400 m; 60 m hurdles [A] – (F, 0.84 m; M, 1.06 m); 100 m hurdles [B] – (F, outdoor 0.84 m); 110 m hurdles [C] – (M, outdoor 1.06 m); 400 m hurdles [D] – (F, outdoor 0.76 m); M, outdoor 0.91 m). *Middle Distance: 800 m; 1500 m; 3000 m [E] – (F, outdoor 1990-1994); 5000 m [F] – (F, outdoor 1995-2019); 3000 m steeplechase [G] – (F, outdoor 2003-2019, 0.76 m; M, outdoor 0.91 m). *Race Walk: 3000 m race walk (F); 5000 m race walk; 10000 m race walk [H] (M, outdoor (2010-2019); 20000 m race walk [I] (M, outdoor 1990-2019). *Throwing: javelin throw [J] (F, outdoor 600 gr; M, outdoor 800 gr); discus throw [K] (F, outdoor 1 kg; M, outdoor 2 kg); hammer throw [L] (F, outdoor 1994-2019; 4 kg; M, outdoor 7.260 kg); shot put [M] – (F, 4 kg; M, male 7.260 kg). *Jumping: pole vault [N] (F, outdoor 1994-2019); high jump; long jump; triple jump [O] (F, outdoor 1991-2019).
Source: Authors

Procedures

The collection of information/data was appropriately described in previous studies[12,13], i.e., it was carried out between February 15, 2017, and October 15, 2019, supported by the official results from the Portuguese athletics championships held from 1990 to 2019, with the

following being recorded: (i) name of the athlete; (ii) sex (female; male); (iii) age; (iv) age group (Young people - U18, U20 or U23; Seniors); (v) type of competition (indoor; outdoor); (vi) discipline (e.g., 60 m; relay events and combined events were not considered); (vii) sector (e.g., speed/barriers); (viii) brand; and (ix) sporting result (participation; finalist – 1st to 8th place; medallist – 1st, 2nd and 3rd place).

Using the information made available by the Portuguese Athletics Federation, it was gathered information on the athletes who participated in the Portuguese championships and also participated in European championships (indoor and outdoor), World championships (indoor and outdoor), and Olympic Games held between 1990 and 2019 (Figure 1).
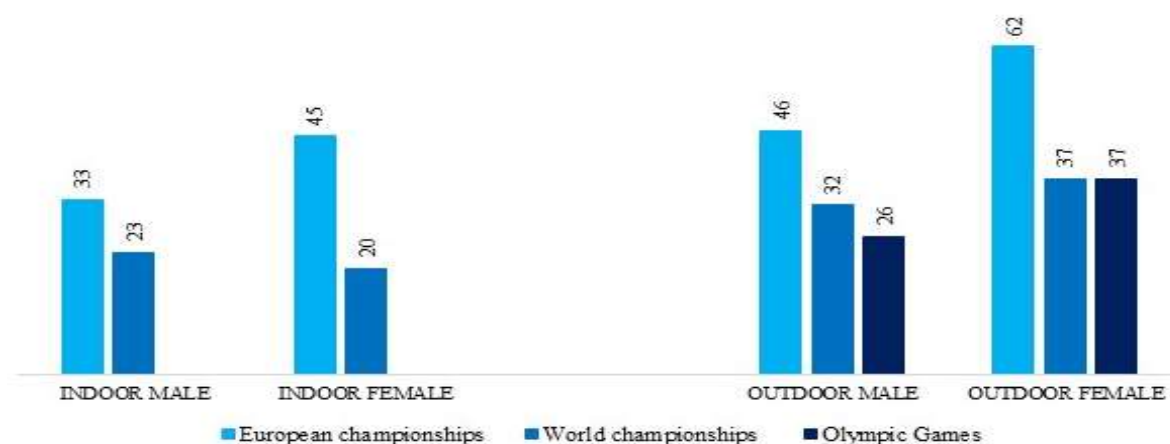
Figure 1. Number of athletes that participated in the Portuguese championships between 1990 and 2019, the European Championship (indoor and outdoor), the World Championship (indoor and outdoor), and the Olympic Games.
Source: Authors

Statistical analysis

Initially, the career trajectories of international athletes in the Portuguese athletics championships held from 1990 to 2019 were analysed, considering six levels (U18, U20, U23, Senior, International, and International Medallist). This was followed by visual analysis of typical trajectories using regressions (LOESS, locally estimated scatterplot smoothing) for each of the disciplines, gender and type of competition (this analysis was only carried out for the curves obtained from more than ten observations, i.e., omission of the 5000 m walking events indoor, and 3000 m, 10000 m walking and high jump outdoor). After this visual analysis, descriptive statistics were calculated with particular emphasis on the start of international athletes' participation in national championships and their status as medallists (or not). This analysis served as the basis for defining the athletes' paths.

As a complement, the individual career trajectories of medal-winning athletes were visually analysed in the context of the trajectories of all international athletes. For this visualisation, points with a distance greater than three (3) times the interquartile range below and above the first and third quartiles, respectively, were omitted (in this way, the careers of the medal-winning athletes are emphasised). The analyses were carried out only for the disciplines, gender, and type of competition with the presence of medallists.

In addition to the visual analysis of the trajectories of the medal-winning athletes, a comparative analysis was also carried out between the international medal-winning and non-medal-winning athletes using four categories: (i) the age of participation, (ii) the age group, (iii) the classification obtained, and (iv) the mark obtained. This analysis was carried out for each discipline, gender, and type of competition separately and served as a starting point for modelling sporting success (obtaining a medal) in international athletics competitions.

The sporting success of international athletes was modelled by fitting a logistic regression model to the complete data (aggregating gender, discipline, and type of competition). Sporting success, the response variable, was measured by obtaining a medal. The explanatory variables used were the age of participation, age group, and classification obtained. For each of the explanatory variables, three (3) models were used separately: (i) Age model (Medal Winner ~ Sex + Competition + Age), (ii) Age group model (Medal winner ~ Sex + Competition + Age group), and (iii) Classification model (Medal winner ~ Sex + Competition + Classification). For the variable "Age group", it was decided to consider only two (2) categories: Young and Senior. In all models, sex and type of competition were also used as explanatory variables. Thus, the significance of the three (3) selected variables already integrates this information.

For statistical treatment, it was used the computer program Statistical Package for the Social Sciences SPSS (version 28.0, IBM SPSS, Chicago, IL, USA) and the R language (version 4.3.1, The R Foundation for Statistical Computing, Vienna, Austria).

Results

Regarding the participation of international athletes in the Portuguese athletics championships held between 1990 and 2019, in the analysis of the 13 career trajectories, considering six levels (U18, U20, U23, Senior, International, and International Medallist), it was noted in the indoor, (i) the participation of 37 female athletes, of which 4 young athletes (10.8%) managed to win medals; and (ii) 47 male athletes, of which only 4 young athletes (8.5%) managed to become medallists. In the outdoors, there was (i) the participation of 53 female athletes, of which 6 young athletes (11.3%) managed to become medallists, and (ii) 69 male athletes, of which only 4 young athletes (5.8%) managed to become medallists.

In a comparison between common disciplines (indoor vs. outdoor), it was observed that 4 female athletes won 8 medals, and 6 male athletes won 10 medals.

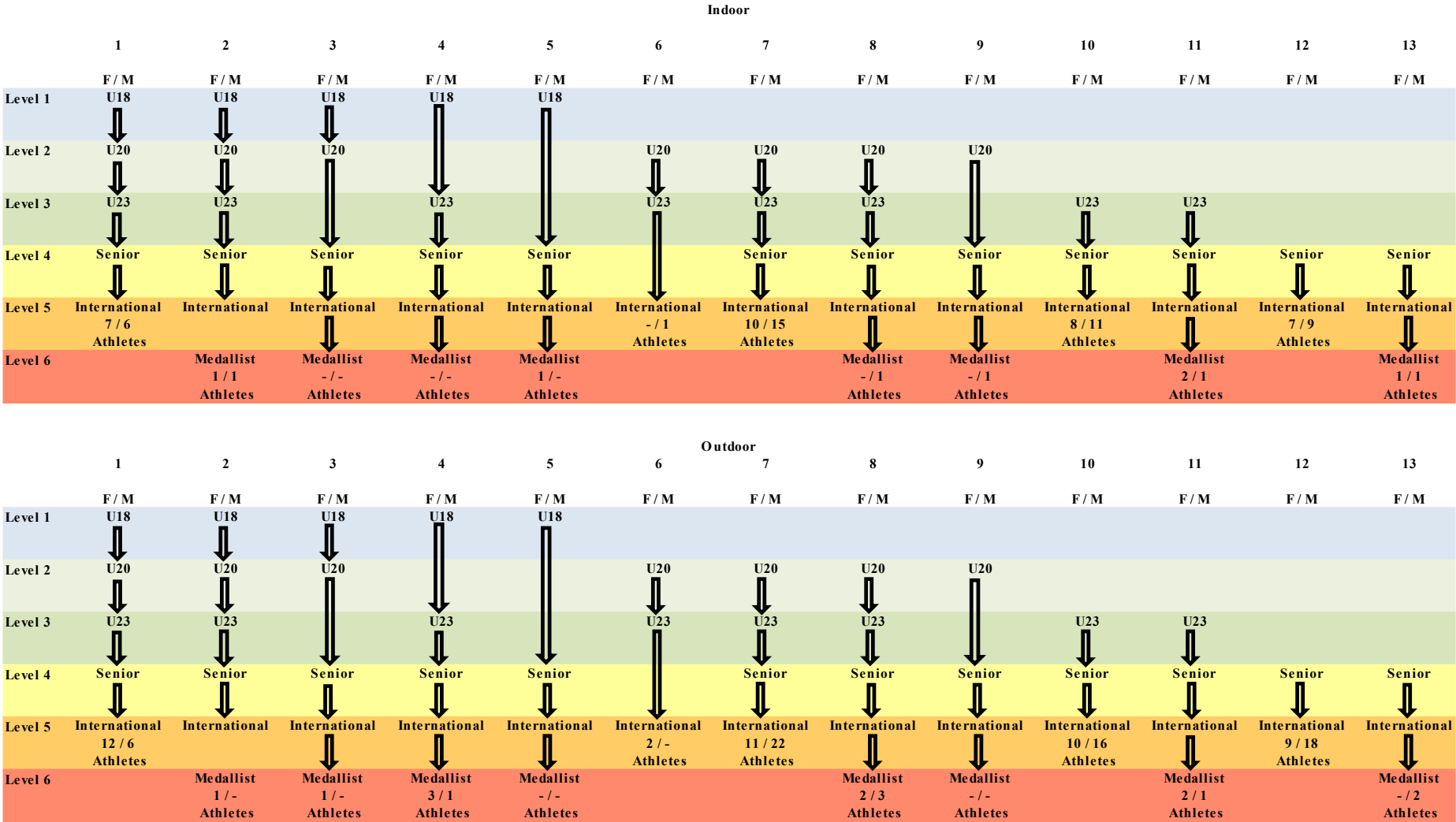The results are shown in Figure 2.

Indoor

Outdoor

Figure 2. Career trajectories of athletes (female; male) in Portuguese athletics championships, considering six levels (U18; U20; U23; Senior; International - participation in European, World Championships and/or Olympic Games; International Medallist).
Source: Authors

In the visual analysis of the trajectory of international athletes, curves close to quadratic functions are observed - there is an increasing in the marks up to a maximum/minimum point followed by a reversal of the trend. It is also seen that, typically, the trajectory of male athletes are better than those of female athletes (Figure 3 and Figure 4).

In the comparative analysis between medal-winning and non-medal-winning international athletes, very different patterns can be seen. Regardless of gender, type of competition, and discipline, the trajectories of medal-winning athletes are well distinguished from the other international athletes with better marks throughout their career trajectories. In fact, international medal-winning athletes stand out in their trajectories concerning the evolution of sporting performance as a function of age in the Portuguese indoor and outdoor championships (Figure 5 and Figure 6).

In the comparison between the four selected categories (age of participation, age group, classification obtained, and mark obtained), there are also distinct patterns for both sexes and type of competition and all disciplines (Figures 7 to 14). Typically, medal-winning athletes participate in national championships at older ages (Figure 7 and Figure 8) and, consequently, at higher age groups (Figure 9 and Figure 10). Furthermore, they obtain better rankings (Figure 11 and Figure 12) and marks (i.e., lower time marks and greater distance or height marks) (Figure 13 and Figure 14).
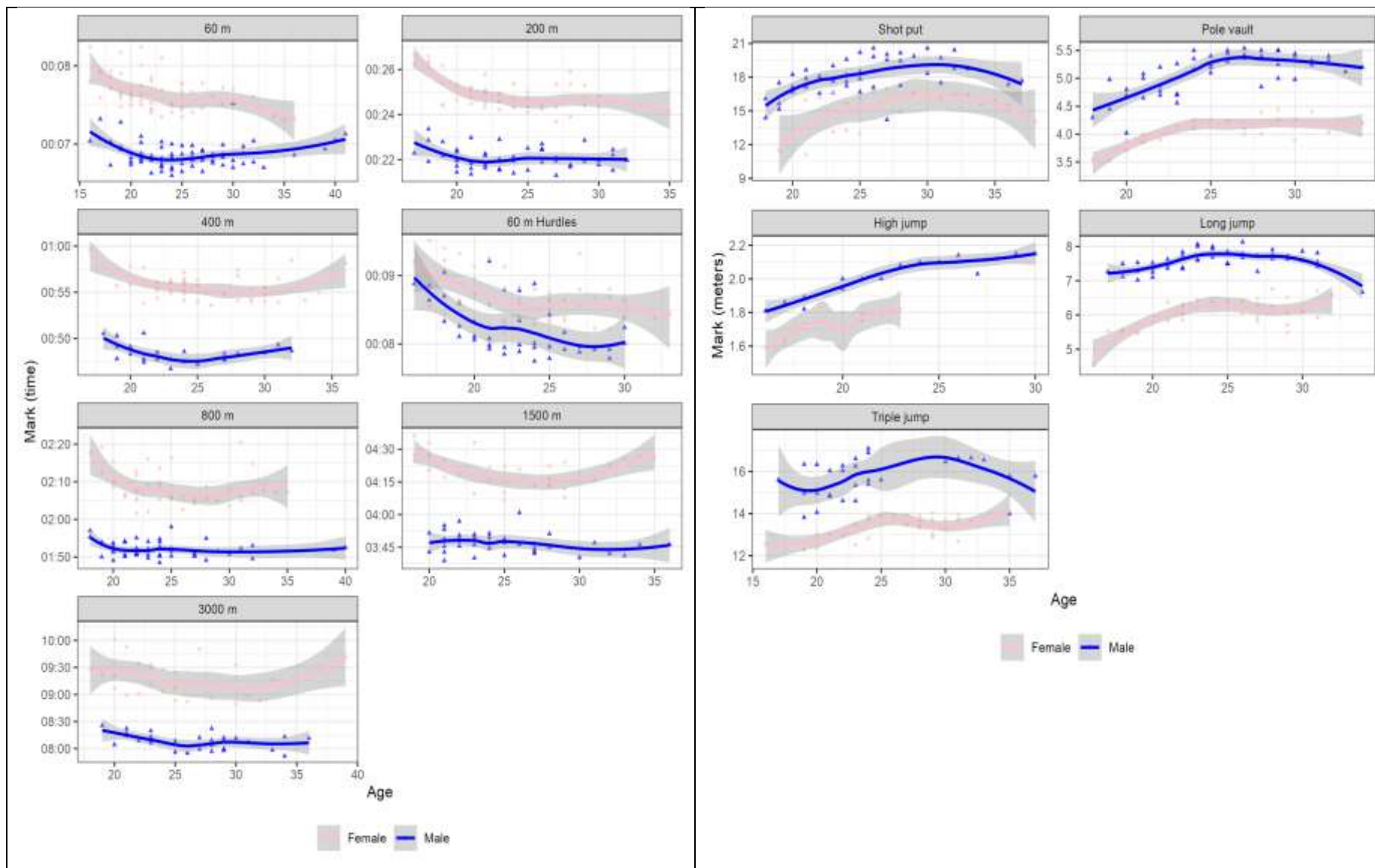
Figure 3. Sports performance trajectories (marks) of international athletes in Portuguese championships (indoor) disciplines.
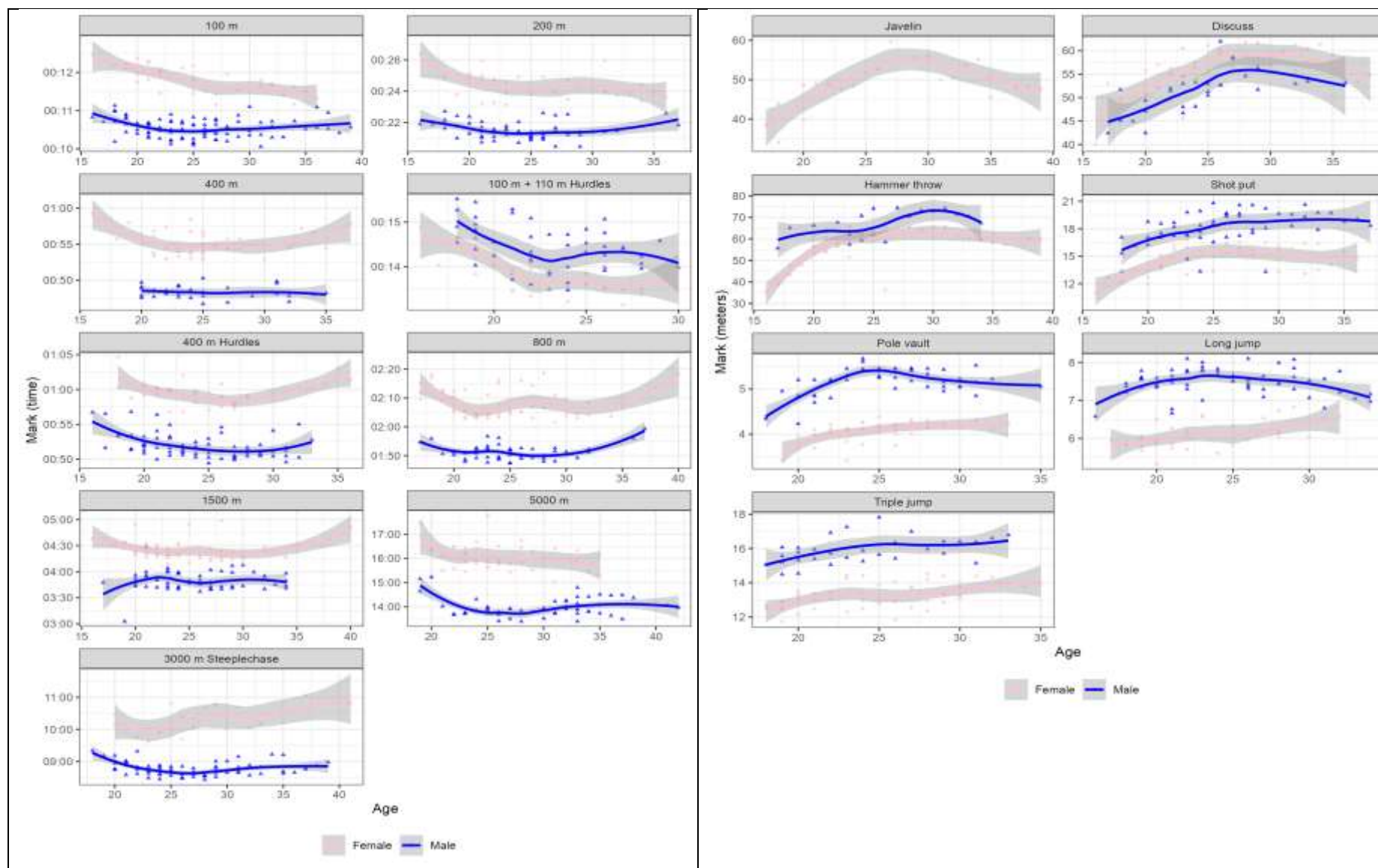**Source:** Authors

Figure 4. Sports performance trajectories (marks) of international athletes in Portuguese championships (outdoor) disciplines.
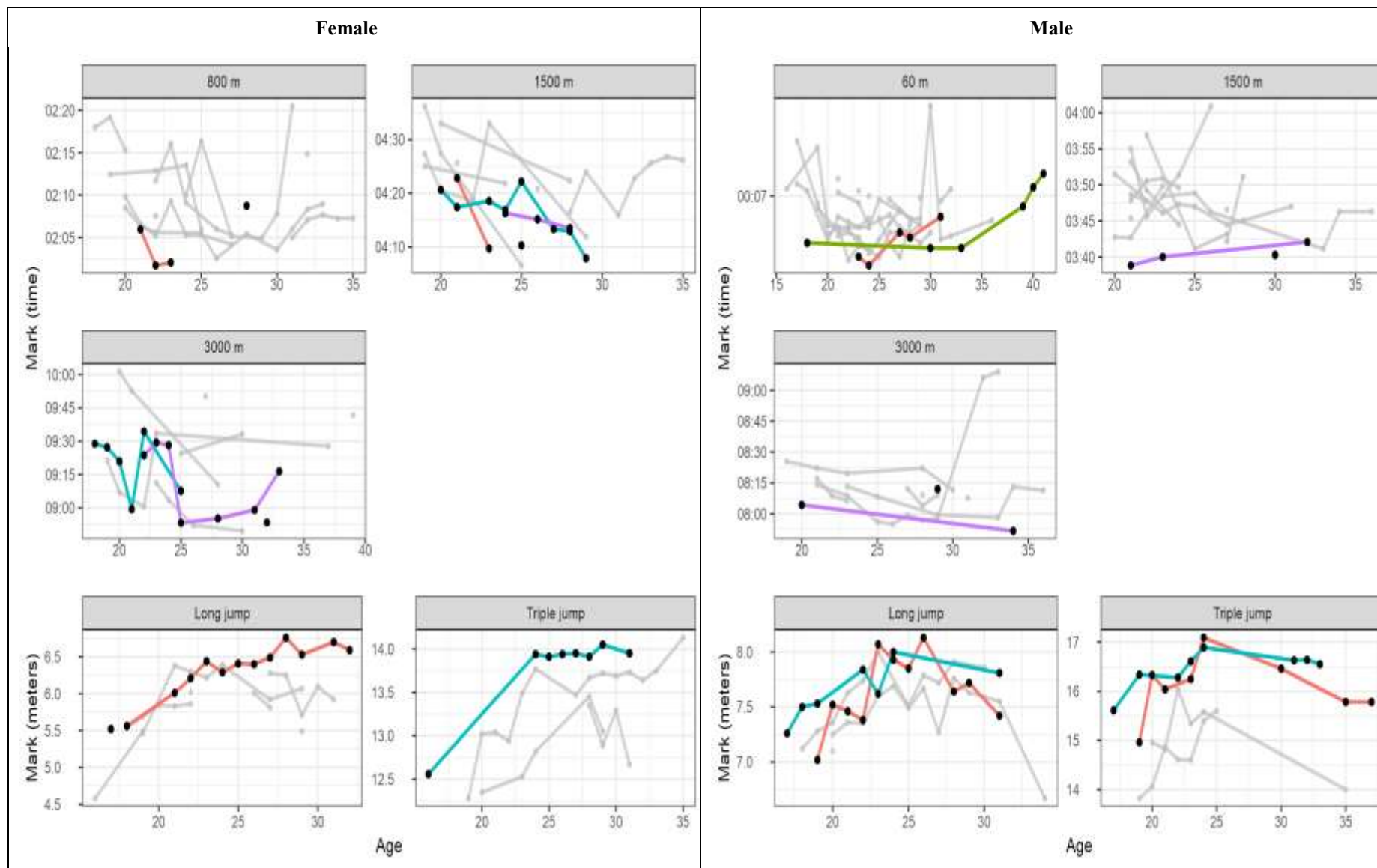**Source:** Authors

Figure 5. Individual trajectories of medal-winning athletes (indoor) with coloured trajectories.
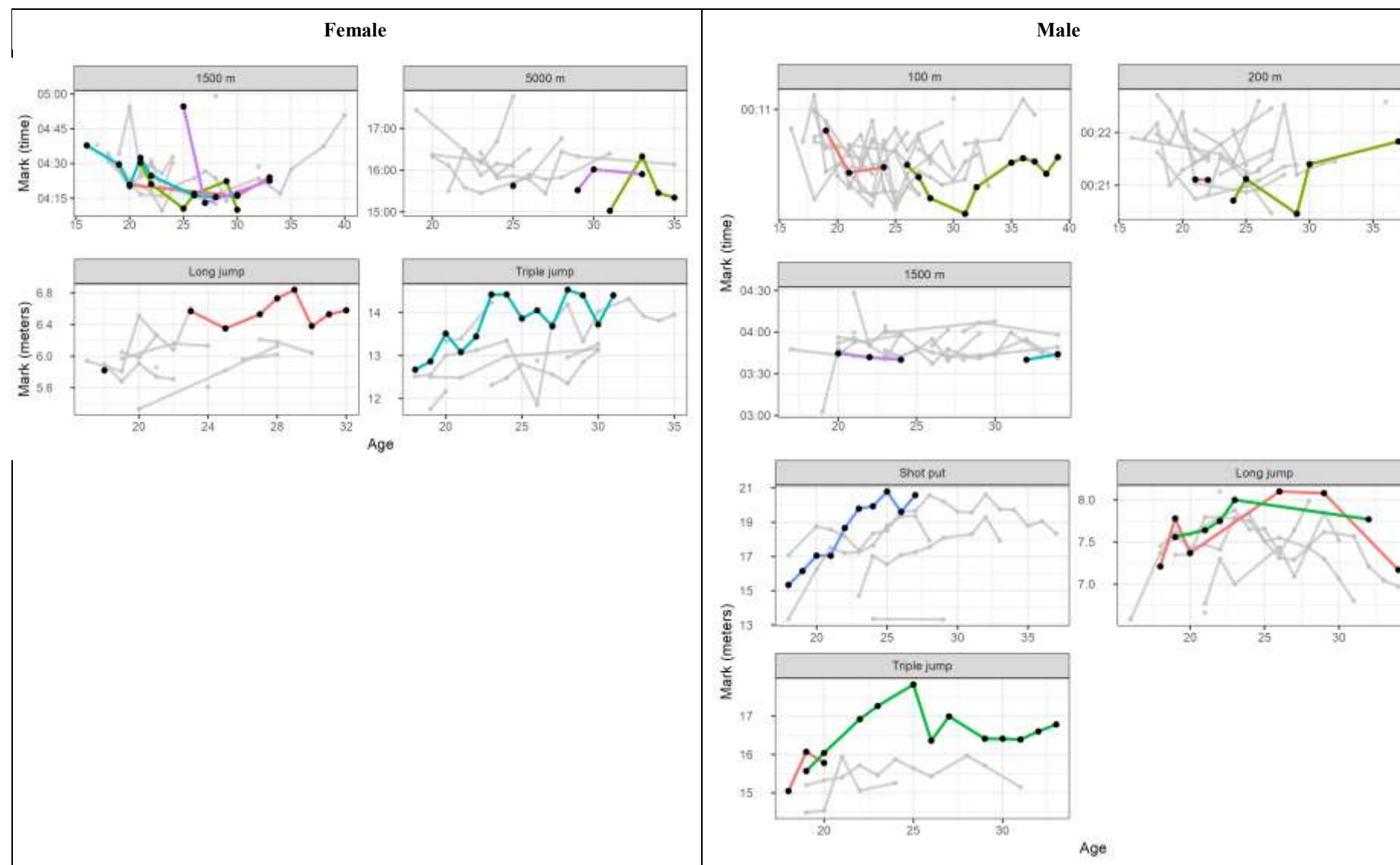**Source:** Authors

Figure 6. Individual trajectories of medal-winning athletes (outdoor) with coloured trajectories.
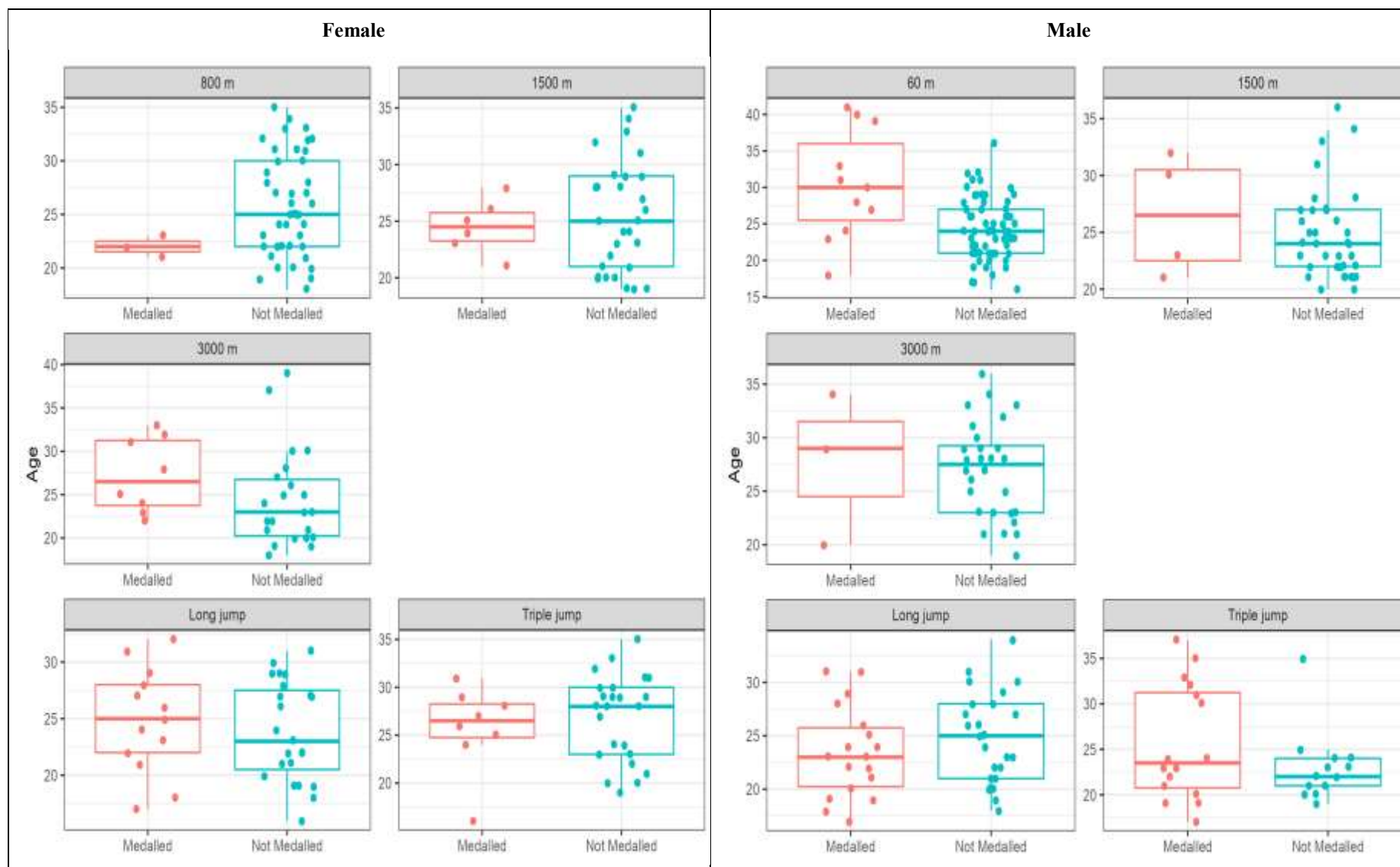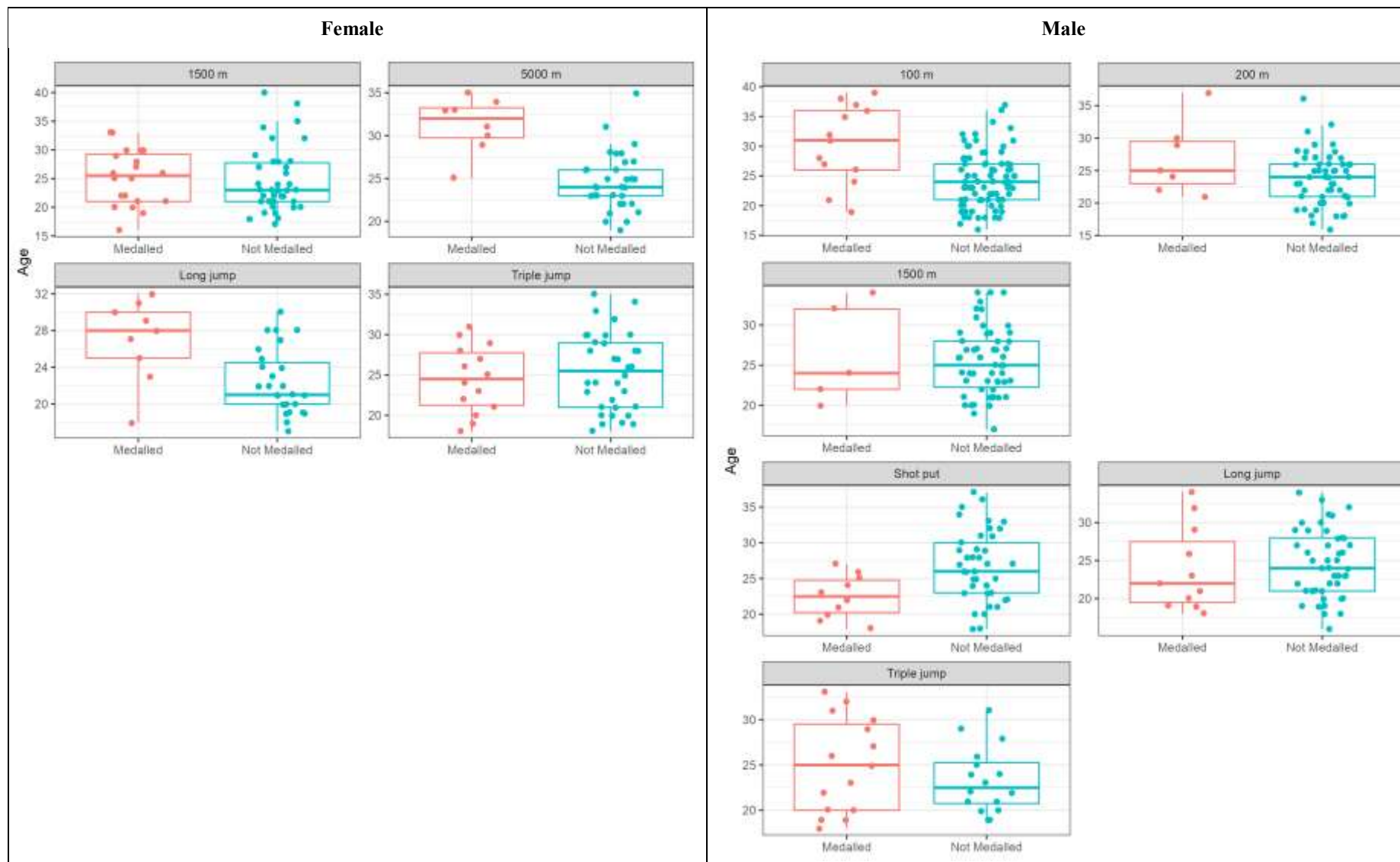**Source:** Authors

Figure 7. Age of participation (in years) of international athletes in Portuguese championships held from 1990 to 2019, grouped by medalists and non-medalists in international competitions (indoor).
Source: Authors

Figure 8. Age of participation (in years) of international athletes in Portuguese championships held from 1990 to 2019, grouped by medalists and non-medalists in international competitions (outdoor).
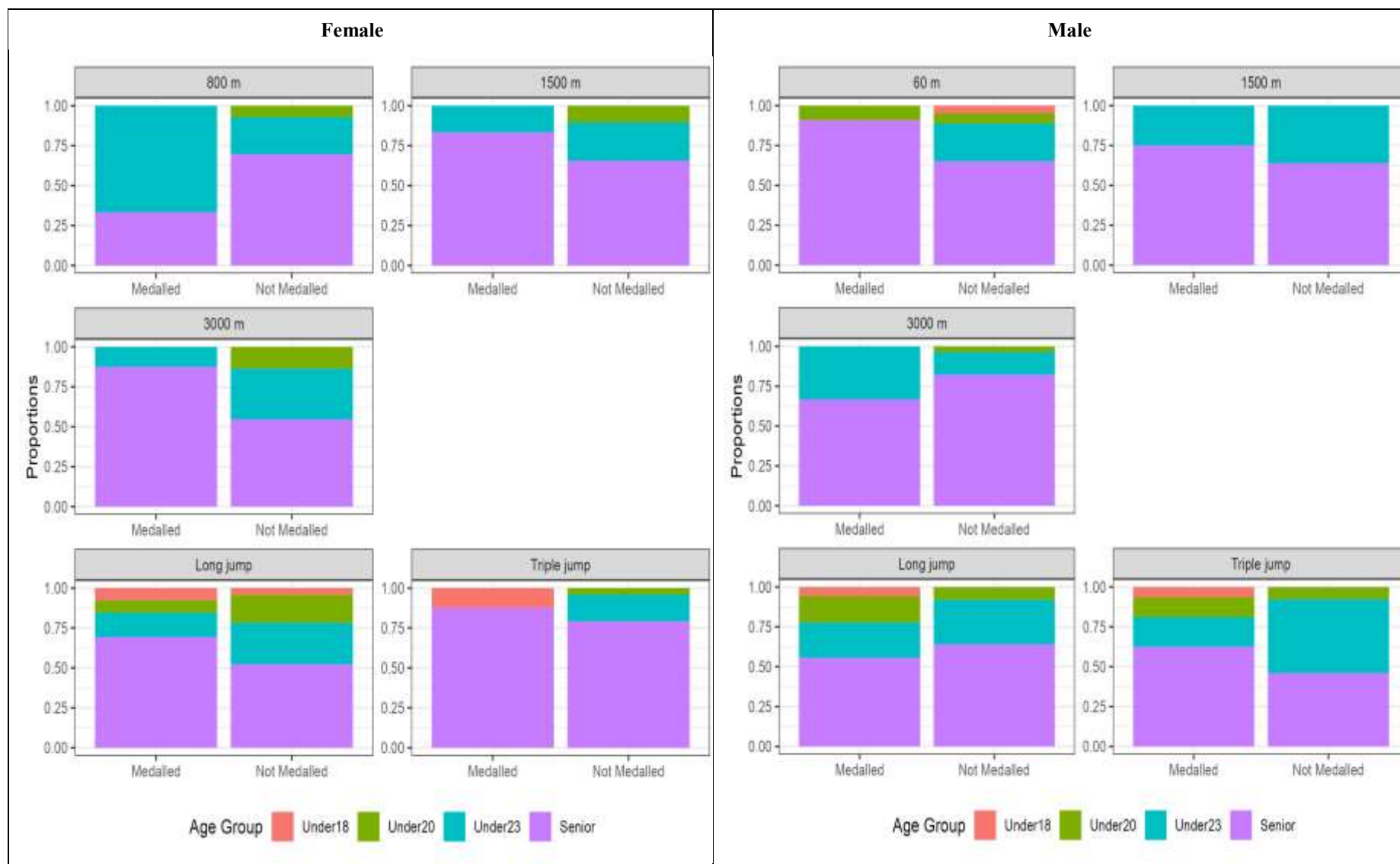**Source:** Authors

Figure 9. Age group (U18, U20, U23, and Senior) of international athletes in Portuguese championships held from 1990 to 2019, grouped by medalists and non-medalists in international competitions (indoor).
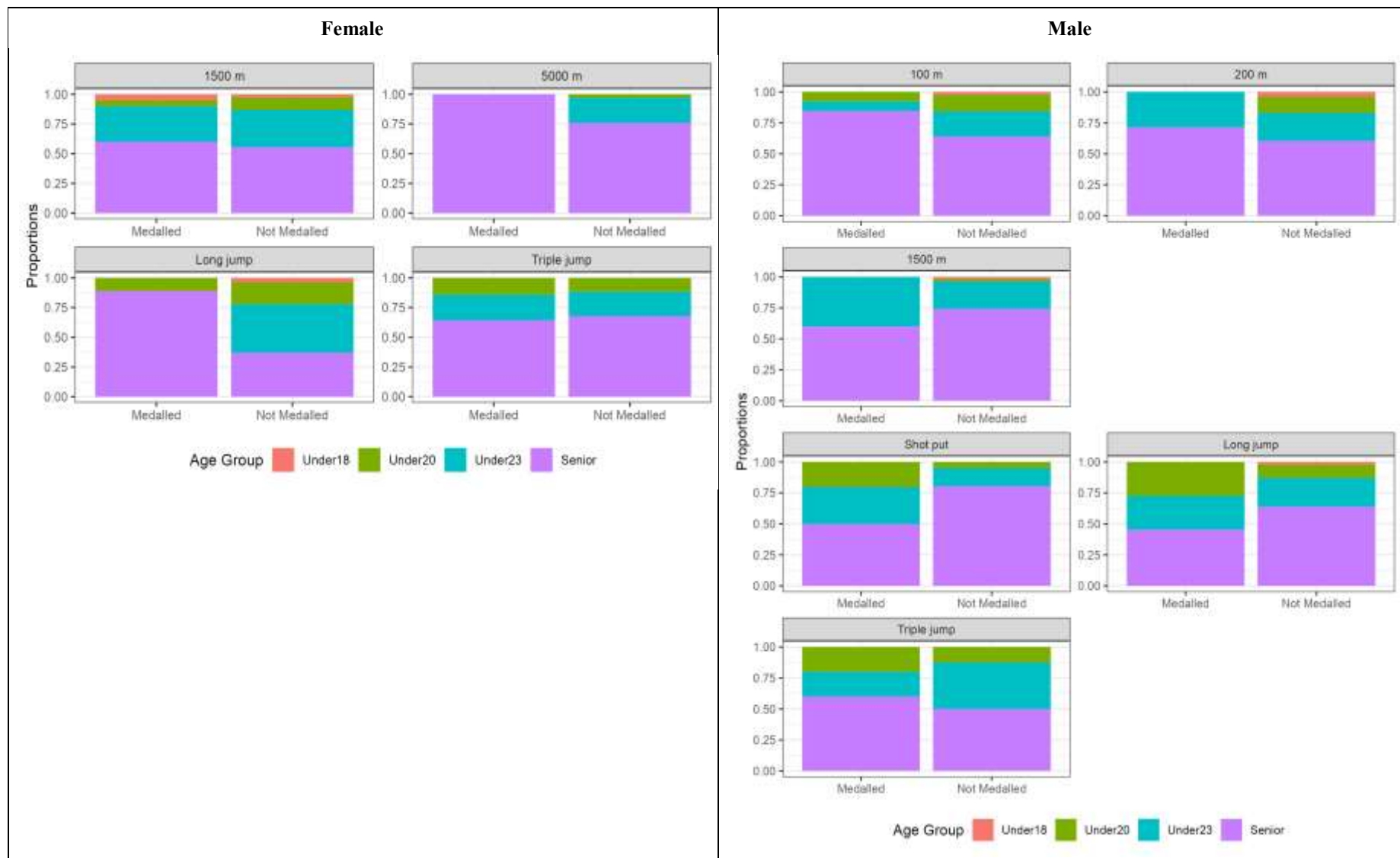**Source:** Authors

Figure 10. Age group (U18, U20, U23, and Senior) of international athletes in Portuguese championships held from 1990 to 2019, grouped by medallists and non-medallists in international competitions (outdoor).
Source: Authors

Figure 11. Classification of international athletes (1st to 8th place) in Portuguese championships from 1990 to 2019, grouped by medallists and non-medallists in international competitions (indoor).
Source: Authors

Figure 12. Classification of international athletes (1st to 8th place) in Portuguese championships held from 1990 to 2019, grouped by medallists and non-medallists in international competitions (outdoors).
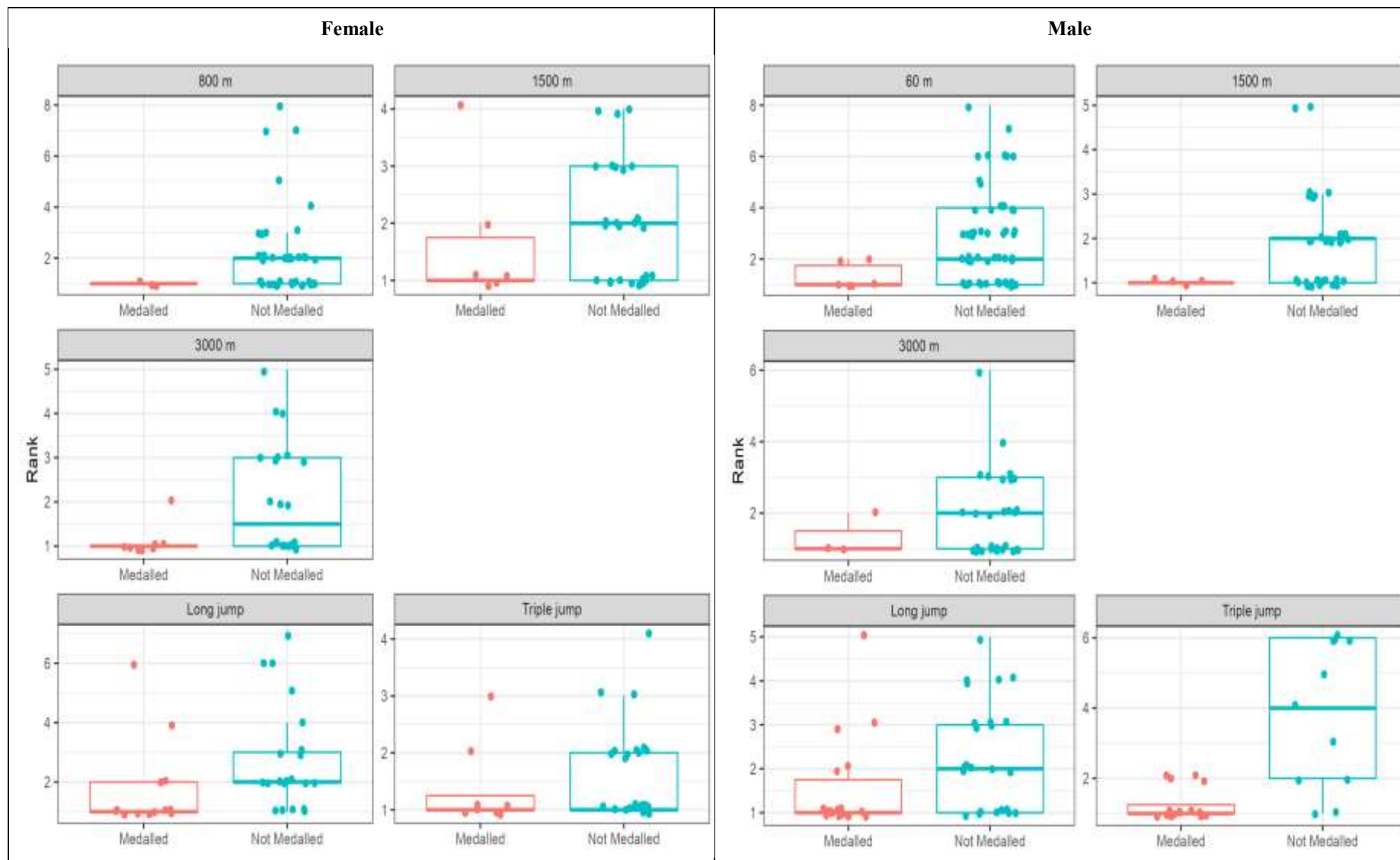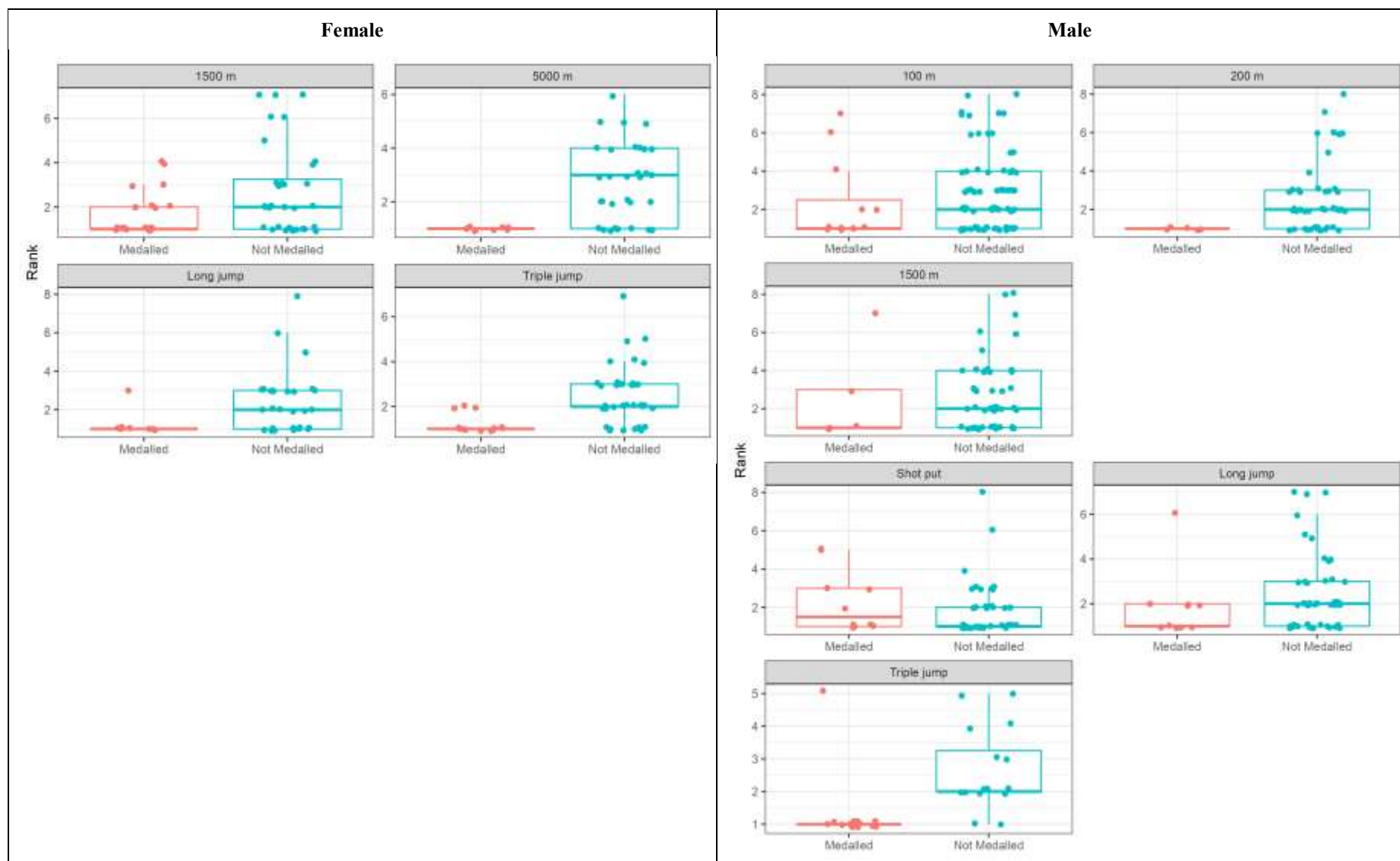**Source:** Authors

Figure 13. Marks of international athletes (time in minutes:seconds; distance in meters) in Portuguese championships from 1990 to 2019, grouped by medallists and non-medallists in international competitions (indoor).
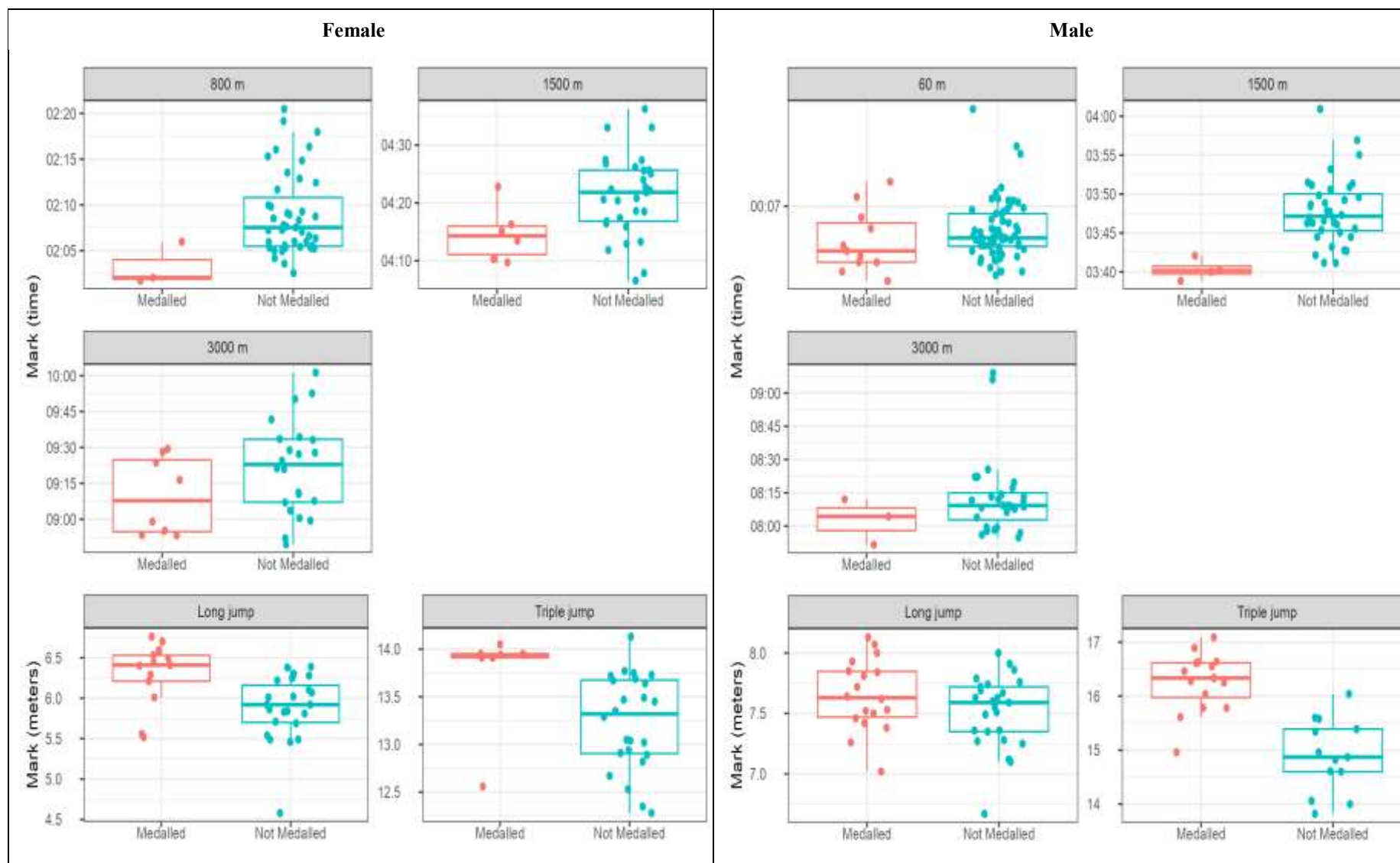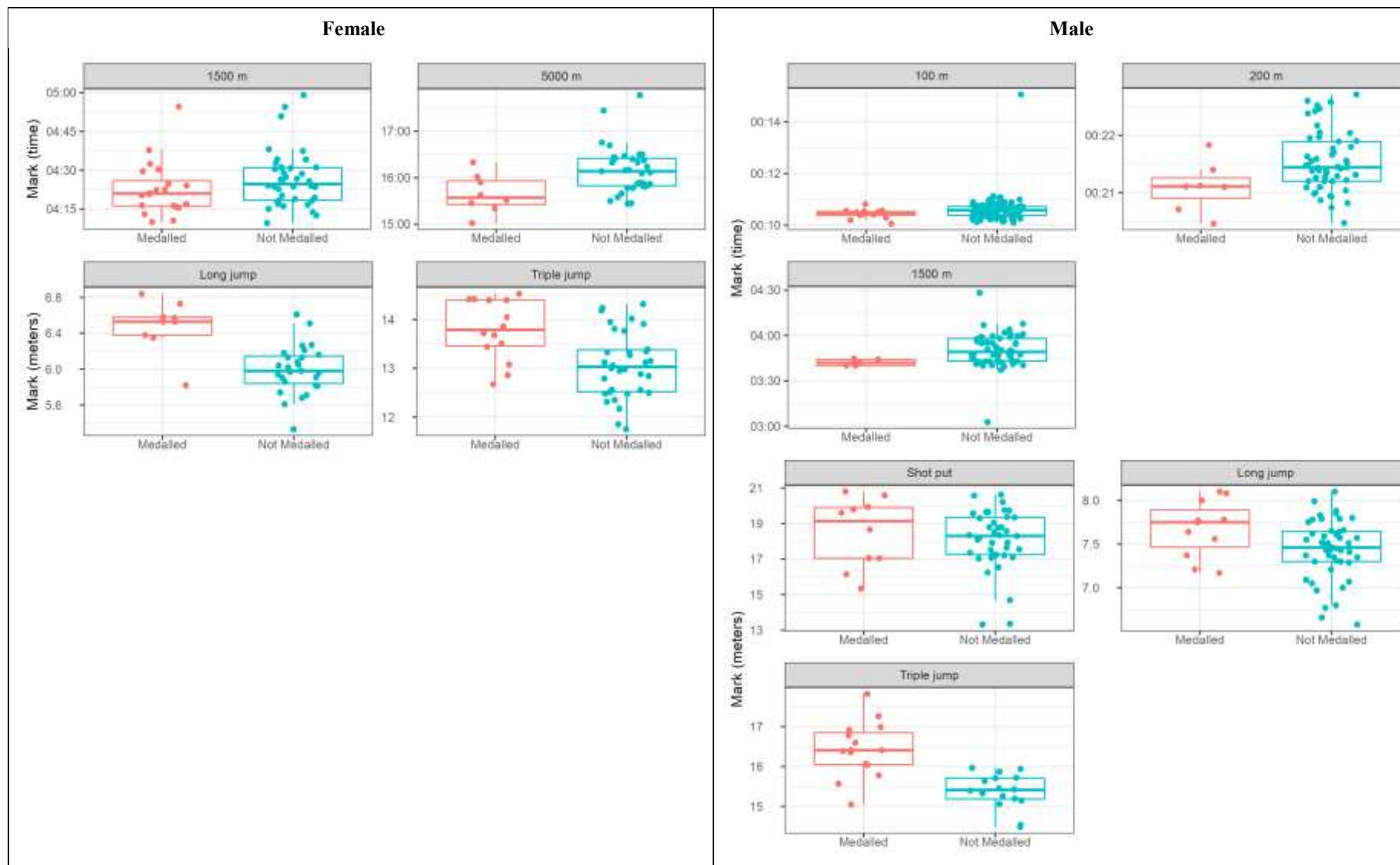**Source:** Authors

Figure 14. Marks of international athletes (time in minutes:seconds; distance in meters) in Portuguese championships from 1990 to 2019, grouped by medallists and non-medallists in international competitions (outdoor).
Source: Authors

Modelling the sporting success of international athletes, using binary logistic regression models to explain the probability of being a medallist in international athletics championships (European championships, World championships, and/or Olympics), confirms the results obtained from visual analyses. From the three (3) models considered (Age model; Age group model; Classification model), it was observed that: (i) the average age in participation in the Portuguese championships has a statistically significant effect on being awarded a medal, i.e. the higher the average age, the greater the probability of being a medallist; (ii) having a presence at the youth level (U18, U20, U23) in the Portuguese championships does not have a statistically significant effect on winning a medal, and having a career path through youth levels does not change the probability of being awarded a medal; (iii) the average classification in participation in Portuguese championships has a statistically significant effect on winning a medal, i.e., the lower (better) the average classification, the greater the probability of being awarded a medal; and (iv) the previous observations are independent of the athletes' gender and the type of championship (indoor or outdoor) in which they participated. The results are presented in Table 2.

Table 2. Coefficients of logistic regression models for predicting medallists in international athletics competitions (European, World Championships, and/or Olympics).

	model Age	model Age group	model Classification
Sex: Male [a]	-0.166 (0.129)	-0.167 (0.129)	-0.102 (0.135)
Competition: Indoor Track [a]	0.11 (0.131)	0.096 (0.131)	0.079 (0.137)
Age	0.032 (0.013) *		
Level: Young [a]		-0.151 (0.138)	
Classification			-0.258 (0.055) **
Constant	-2.819 (0.349) **	-1.956 (0.117) **	-1.520 (0.148) **
Comments	2388	2389	2227
Log-Likelihood	-840.667	-843.179	-774.047
AIC	1689.334	1694.358	1556.094

Note:
[a], the base categories considered are Sex - Female; Competition - Outdoors; Level - Senior. *, $p < 0.05$; **, $p < 0.01$.
Source: Authors

Discussion

This study aimed to identify the career trajectories of international athletes in Portuguese athletics championships held from 1990 to 2019 and to model the sporting success of these athletes in international athletics competitions.

According to Tróznai et al.[14], athletics requires individualised skills, which mostly depend on a compromise between speed, endurance and strength duly combined with the age and maturation of each athlete. In Portugal, athletes under the age of the age group being competed in are allowed to take part in the Portuguese athletics championships (indoor, outdoor), as long as they meet the minimum participation requirements [15].

In an analysis of the indoor international athletics championships, it was observed (i) the participation of 37 female athletes, of which only 4 athletes (10.8%) who began their participation in the Portuguese championships at a young age managed to be medallists; and (ii) 47 male athletes, of which only 4 athletes (8.5%) who began their participation in the Portuguese championships at a young age managed to become medallists. In outdoor, it was

observed (i) the participation of 53 female athletes, of which only 6 athletes (11.3%) who started their participation in the Portuguese championships at a young age managed to become medallists; and (ii) 71 male athletes, of which only 4 athletes (5.6%) who began their participation in the Portuguese championships at a young age managed to become medallists.

These results are similar to the results observed by Kearney and Hayes[6,] who analysed 134,313 participants aged between 12 and 35 years in the disciplines of speed, middle distance, throwing, and jumping, and found that only a low percentage of athletes (female, 13%; male, 9%) of the top 20 senior athletes were also ranked in the top 20 in U13. Boccia et al.[5] analysed the 200 best athletes from the official lists (1994-2014) of the Italian Athletics Federation (FIDAL) in speed and throwing disciplines, observing that 17% to 26% of high-level senior athletes were considered as such when they were between 14 and 17 years old. In the study by Boccia et al.[7] with 4924 athletes (of both sexes) from the speed sector of the 2000-2018 IAAF lists, it is highlighted that 21% of female athletes and 17% of male athletes in the category U18 managed to be among the 50 best senior athletes. Agudo-Ortega et al.[8], in the study of young and senior categories in speed events carried out between 2004–2021 of the Royal Spanish Athletics Federation, concluded that reaching the national top 20 in speed disciplines sometimes occurs prematurely. Therefore, this achievement is not foreseen as a prerequisite for being in the top 20 in the senior category. Pinto and Massuça[13] observed (i) in the Portuguese indoor athletics championships, observed that 27.8% of young athletes (female) and 37.7% of young athletes (male) continued their participation until the senior level; and (ii) in the Portuguese outdoor championships, they observed that 29.4% of young athletes (female) and 21.5% of young athletes (male) continued their participation until the senior level. Rodriguez-Gomez et al.[9], in an analysis carried out from the U14 level to the Senior level with 300 Spanish jumpers, found that 6.3% of the top 20 athletes in the U14 level were successful as Senior athletes.

Additionally, it should be noted that the number of international athletes who participated in the events that are part of the Portuguese outdoor championships (1990 to 2019) and also participated in major international championships has remained relatively low (European championship indoor - female, n = 33 - male, n = 45; World cup indoor - female, n = 23 - male, n = 20; European Cup outdoor - female, n = 46 - male, n = 62; Olympic Games - female, n = 26 - male, n = 37)[1].

In a comparative analysis between medal-winning and non-medal-winning international athletes it was observed that the trajectories of medal-winning international athletes are higher (regardless of the athletes' gender, type of competition, and discipline). It was found that female athletes' results are lower than male athletes and that the athletes' performance decreases with age (in both sexes).

In the literature, research on indoor competitions is much less prevalent than on outdoor competitions. In this study, a comparison is made between the ages of international athletes considering both female vs male and indoor vs outdoor. It was found that the average age of female athletes is slightly higher in the disciplines of the middle-distance sector, whether in indoor (26.90 - 25.86 years) or in outdoor (26.50 - 26.00 years). In the disciplines of the jumping sector, a lower average age of female athletes was recorded in the disciplines of the jumping sector in the indoor (28.88 - 29.43 years) and an equal average age in the disciplines of the jumping sector in the outdoor (28.00 years).

The results of this study are (i) similar when compared with the results of Hollings et al.[16] in the Olympic Games and World championships (2000-2009) in the disciplines of the middle-distance sector (female, ~26 years; male, ~25 years) and higher in the jumping sector disciplines (female/male, 28 years – female/male, ~25 years); (ii) similar in the disciplines of the middle-distance sector for female athletes (~26 years old) and higher for male athletes (~26

years old). In the jumping disciplines, they are similar for female athletes (~28 years old) and higher for male athletes (~28 years old), when compared with the study by Longo et al.[17] from the London 2012 Olympic Games; (iii) similar when compared with the results of Haugen et al.[18] in the top-100 (2002-2016) in the disciplines of the middle-distance sector (~26 years) and slightly lower in the disciplines of the jumping sector (female, 26 years; male, ~26 years); and (iv) lower than the results observed by Pinto et al.[12] in the study on the reference ages of medal-winning athletes in the Portuguese athletics championships (1990-2019), in which the average age of best performance of athletes in disciplines in the athletics sector middle distance was ~25 years (indoor: female, 24.88 years and male, 25.11 years; outdoor: female, 25.45 years and male, 25.88 years) and in the jumping sector disciplines it was ~23 - 24 years (indoor: female, 23.21 years and male, 24.97 years; outdoor: female, 23.21 years and male, 24.44 years). Notably, the international athletes in this study reach their best performance age at approximately the same age as other international athletes.

The results of the modelling of success (i.e., being a medallist in International Competitions) allowed us to verify that, regardless of the athletes' gender and the type of championship in which they participate, it was observed that: (i) the average age when participating in Portuguese championships has a statistically significant effect on being awarded a medal (i.e.: the higher the average age, the greater the probability of being awarded a medal), observing average ages in indoor (female, 27.89 years; male, 29.43 years) and outdoor (female, 27.25 years; male, 26.00 years) being relatively higher than the results of Pinto et al.[12]; (ii) having a presence in the youth ranks in national championships does not have a statistically significant effect on winning a medal (i.e.: having a career path through the youth ranks does not change the probability of being awarded a medal) - indeed from all the athletes participating in international championships, who began their participation in Portuguese championships at young ages (indoor, n = 84; outdoor, n = 124), only ~8% (indoor, ~9%; outdoor ~7%) were medallists in international championships; and (iii) the average classification in participation in Portuguese championships has a statistically significant effect in relation to being a medallist (i.e.: the lower (better) the average classification, the greater the probability of being a medallist).

Finally, it should be noted that the small number of medal-winning athletes in Portugal is one of the limitations of this study, as it limits statistical analyses and makes it impossible to perform finer analyses in which all disciplines/sectors are considered separately. However, the results of this study provide concrete information on all of the Portuguese athletes who participated in international competitions between 1990 and 2019 (i.e., European indoor and outdoor championships, indoor and outdoor World Championship, and Olympic Games).

Conclusions

This study (i) identified the career trajectories of international athletes in Portuguese athletics championships held from 1990 to 2019 and (ii) modelled the sporting success of these athletes in international athletics competitions.

In conclusion, it is highlighted that:

- The average age of participation in the Portuguese championships has a statistically significant effect on winning a medal, i.e., the higher the average age of the athlete, the greater the probability of winning a medal in international competitions.
- Having a presence at a young age level (Under18, Sub20, Sub23) in the Portuguese championships does not have a statistically significant effect on being awarded an

international medal, i.e., having a career path through the young age groups does not change the probability of being awarded a medal in international competitions.

- The average classification in participation in the Portuguese championships has a statistically significant effect on winning a medal, i.e., the lower (better) the average classification, the greater the probability of winning a medal in international competitions.

Finally, it is emphasised that the previous conclusions are independent of the sex of the athletes (female; male) and the type of championship in which they participated (indoor; outdoor), which emphasises the need for reflection by all sports agents on the relevance of the participation of young athletes in the Portuguese championships, that is, in the National Senior Championships.

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