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Mortality of Spanish soccer referees and coaches: a retrospective cohort study

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Abstract

There is evidence showing that elite soccer players live longer than general population, but there is no information about soccer coaches and referees. We aimed to analyze the longevity of these professionals, comparing them with soccer players and with general population. In this retrospective cohort study, 328 male Spanish soccer coaches and 287 referees, born before 1950, were compared with 1230 soccer players, divided in two cohorts matched 2:1 with coaches or referees. We compared the survival of the cohorts with Kaplan-Meier estimator and significance with the log-rank test. We calculated hazard ratios of death for coaches and referees compared with male Spanish general population of the same period. There were no significant differences in survival among cohorts. The estimated median survival time was 80.1 years (CI95% 77.7-82.4) for referees, 78 years (CI95% 76.6-79.3) for coaches, 78.8 years (CI95% 77.6-80) for players matched with referees, and 76.6 years (CI95% 75.3-77.9) for players matched with coaches. Both coaches and referees had lower mortality than general population, but this advantage disappeared after 80 years of age. In conclusion, we found no significant differences in longevity among Spanish elite soccer referees, coaches and players born before 1950.

Keywords: survival analysis; sports medicine; former soccer professionals; health outcomes.

Introduction

Scientific evidence indicates that people who practice sport show a greater life expectancy than general population [1], and this relationship has been extensively investigated in sport professionals [2,3].

Although these studies point to a positive relationship between life expectancy and elite sports, there are methodological issues that limit the interpretation and generalizability of the findings. This seems to be the case in professional soccer. Increasing evidence shows that elite soccer players live longer [4–6], but it is difficult to ascertain the true proportion of this benefit attributable to playing soccer, since there is a strong risk of bias when comparing a cohort of athletes with general population. For instance, the results are affected by the healthy worker hire effect, which explains a cohort selection in favor of athletes, since practicing sport at elite level requires a certain level of fitness and a good health [7]. There is also the healthy worker survivor effect, since players must keep a good health and fitness for continuing their career [8]. In addition, elite athletes can have some economical or healthcare access advantages over general population [9].

However, the general population is far from the ideal comparison group to delimitate the benefits of a certain sport, as we are comparing two cohorts with quite different characteristics. A methodological approach to minimize these biases is to select a comparison cohort that includes individuals with similar athletic or physiologic attributes and lifestyles [9]. Several investigations focused on different sport modalities have used this methodology [7,10,11]. In the case of soccer, two papers implementing this approach found a lower mortality benefit [5,6].

In the soccer community, there are two groups of professionals often overlooked, despite playing a key role in the game: referees and coaches. Referees are an essential part of professional soccer, yet existent research has focused mainly on physiological and

psychological variables related to their work [12]. To the authors' knowledge, no study has sought to estimate mortality rates of soccer referees.

Similarly, although research on soccer coaching has grown considerably, most studies address the professional skills of coaches or their working demands and expectations [13]. One recent work provided information regarding the life expectancy of elite soccer coaches [6]. This study found that soccer elite players that continued their careers as coaches had a similar mortality rate in comparison with those players that did not follow that path. However, no information regarding the life expectancy of coaches who had not previously been players was included.

Altogether, an analysis of mortality of soccer referees and coaches seems to be a novel contribution to the research related to the longevity of soccer professionals. In addition, it is plausible to think that referees and coaches share many characteristics with players. Referees need to stay fit to keep up with the physical demands of the game [14], while many coaches have previously been players, albeit at a non-elite level, and keep up with the daily routine of the game [6]. Thus, soccer coaches and referees could offer a suitable comparison group to account for the survival advantage of soccer players versus general population.

Therefore, this study has a double fold objective. First, to compare the mortality of Spanish soccer referees and coaches with matched cohorts of soccer players, and second, to provide information regarding the life expectancy of soccer referees and coaches in comparison with the general population.

Methods

This retrospective cohort study followed the STROBE reporting guidelines [15]. Mortality was compared in four cohorts of male Spanish soccer professionals with Spanish male general population, and among cohorts. A cohort of referees born between 1900 and 1950,

who participated in Spanish elite soccer leagues after 1939. A cohort of coaches born between 1900 and 1950, who participated in Spanish elite soccer leagues after 1939, and who had not been previously ~~soccer~~ elite players. And two cohorts of players, one matched with referees (Players-R), and the other matched with coaches (Players-C), in both cases born between 1900 and 1950, matched individually in a 2:1 ratio with every referee or coach by year of birth, and who were alive when the corresponding referee/coach began his career.

We identified Spanish elite soccer referees and coaches from a Spanish open soccer database [16], and excluded subjects who had played formerly as soccer elite players, and those with incomplete data regarding date of birth or name. Then, from the same database, we identified soccer elite players to create two cohorts of players, one matched with referees (Players-R) and the other matched with coaches (Players-C).

The date of inclusion in the study was the first season in the elite for referees and coaches, and the same date for their matched players. If there was not a date of death for the subject, we considered the right-censoring date as the last date with evidence of life, or the last date of follow-up, on December 31st, 2020, whichever came first.

The included variables were date and place of birth, first and last season in elite soccer, date of death or the last date with evidence of life. If month or day of the month were incomplete in a date, we selected the middle date of the period. We also recorded field position for players.

Although we used BDFutbol as primary data source to identify the subjects, we checked the accuracy of the information in additional sources, including internet databases, newspapers, journals, and football club webpages. Specifically, for those subjects without date of death in BDFutbol, we looked for life status in other sources. In these cases, the right-censored date was the last date in which we found information indicating that the

subject was alive, which occurred in 612 subjects (33.2%). To compare mortality with the general population, we obtained life tables of Spanish males born in the same period as the subjects of the cohorts from official national statistical records [17]. We calculated probability of death in ten years intervals, following the same methodology for calculating mortality in the cohorts.

To reduce bias, as there were major increases in longevity in Spain in the study period, we stratified the cohorts by date of birth to compare with the general population. For the same reason, we matched the two cohorts of players by year of birth with the corresponding referee or coach. As the Spanish Civil War (1936-1939) had a major impact on mortality, we selected only coaches and referees who began their career after that moment. Referees and coaches began their elite career at older age than players. To avoid the survival advantage for referees and coaches in a direct comparison with players (i.e., immortal time bias) [18], we matched players who were alive at the inclusion date of the corresponding referee or coach. The same bias could occur in the comparison between referees and coaches, as the starting age as coach occur about five years later than as referee. To minimize this effect, we repeated the comparison between referees and coaches adjusting the date of inclusion of referees by the median starting age of coaches. Since subjects born at the end of the recruitment period (1950) could not survive more than 70 years at the end of the follow up (December 2020), in addition to the Kaplan-Meier analysis for the whole follow-up, we repeated the analysis with right censoring at 70 years and mortality until that moment.

The size of the study population limited the sample size of our study. Based on previous data [6], we estimated that there was a historical population of about two thousand coaches in Spain and a smaller number of referees, and that roughly three hundred of each group would meet the inclusion criteria. For the comparison with a cohort of matched players,

estimating a life expectancy of 80 years for players, if we recruited 600 players for a 2:1 ratio to coaches, we would be able to detect a hazard ratio of 0.77 to 1.32 between both cohorts, with power 0.8 and type I error probability of 0.05 (Power and Sample Size Calculation 3.1.6). Further increases in player recruitment at a 3:1 ratio would lead to increases in detectable survival difference below 2%.

In our statistical analysis, we represent data as median (interquartile range, IQR) if they do not have normal distribution, assessed with the Kolmogorov-Smirnov test, and qualitative variables are represented as absolute (n) or relative frequencies (%). We compared quantitative variables with Mann-Whitney U test, and qualitative variables with Fisher's exact test. We calculated life tables for the cohorts of referees and coaches, adjusted by decade of birth, to obtain probability of death in ten years intervals and median survival times. Using the birth-adjusted death rates, we calculated the weighted death rates in ten years intervals for the whole cohort. To compare with general population, we calculated hazard ratios (with their 95% confidence intervals) in ten years intervals adjusted for decade of birth, using the data from Spanish male population of the same period [17]. We used Kaplan-Meier estimator to compare the overall survival of referees and coaches, and of both cohorts with their corresponding cohort of matched players. Statistical significance of estimates from Kaplan-Meier curves was ascertained using the log-rank test. We repeated the Kaplan-Meier analysis establishing the end of follow-up at 70 years and defined the event as death before 70 years. To avoid immortal time bias advantage for coaches in the comparison with referees, we truncated inclusion time of referees taking as reference the median debut age of subjects as coaches. All the analyses were performed with Microsoft Excel and SPSS software, and a two-sided P value of less than 0.05 indicated statistical significance.

Informed consent

The Ethics Committee of the School of Education and Sports Sciences of the University of Vigo reviewed the study protocol. Informed consent was waived due to the nature of the data, which were completely publicly and openly accessible.

Results

We recruited 1845 subjects in the four cohorts, of which 287 were referees, 328 coaches, and 1230 players divided in two cohorts (Figure 1).

[Insert Figure 1 around here]

In Table 1 we summarize the characteristics of the cohorts. Coaches began their career later and retired later than referees. Players usually developed most of their career before the starting age of the other cohorts.

[Insert Table 1 around here]

There were losses to follow-up in the four cohorts, which account for the differences in follow-up time, age at right censoring, and the percentage of dead. However, we found no differences among the cohorts in the age of death in the 1155 subjects (62.6%) who died during follow-up.

We found no differences in survival between referees and Players-R (Figure 2a), and between coaches and Players-C (Figure 2b). The estimated median survival time was 80.1 years (CI95% 77.7-82.4) for referees, 78 years (CI95% 76.6-79.3) for coaches, 78.8 years (CI95% 77.6-80) for Players-R, and 76.6 years (CI95% 75.3-77.9) for Players-C. We also found no differences when we compared mortality up to 70 years of age of referees versus Players-R ($p=0.959$, log-rank test) or coaches versus Players-C ($p=0.089$, log-rank test). Similarly, results showed no differences when we compared the survival of referees versus coaches for the complete follow-up time (Figure 2c), or in mortality up to 70 years

of age (p=0.835, log-rank test), nor when we repeated the comparison adjusting for the differences in age of inclusion between referees and coaches (p=0.382, log-rank test).

[Insert Figure 2 around here]

In Figure 3 we show the hazard ratios of mortality of referees (Figure 3a) and coaches (Figure 3b) versus general population, in ten years periods, with weighted averages for decades. In both cohorts, there was a lower mortality than in general population, but the advantage decreased with time, disappearing after 80 years of age.

[Insert Figure 3 around here]

Discussion

In this retrospective cohort study of Spanish soccer professionals born before 1950 we did not find any survival differences between referees and coaches, nor when we compared both cohorts with soccer players. In addition, referees and coaches had lower mortality than general population, although this advantage disappeared after the age of 80 years. To our knowledge, this is the first report on this topic.

The lower mortality in referees and coaches follows a similar pattern to the survival advantage of elite soccer players found in other studies [5,6]. Part of these results could be explained by the "healthy hire effect" (i.e., only those subjects healthy and with an adequate fitness can initiate a career in elite sport) [7], a well-known bias in analyses of mortality in occupational cohorts [19]. This selection pressure is prolonged over time, since the professionals must keep a good health and fitness to pursue their career, the so-called "healthy worker survivor effect" [8]. Although the requirements were probably higher for players, referees and coaches also experienced this selection. The direct comparison of cohorts that share some common characteristics could minimize part of these biases, and this approach was applied in other sports [7,10,11]. In our study there were no differences in

survival among cohorts of referees, coaches, and players, although we cannot rule out a type II error due to our sample size, which limits the detection of small differences in longevity.

Our results could be partially explained by some aspects. It has been reported that physical activity levels of referees during a professional soccer match, including the total distance covered, was not very different from that of players [20,21]. In any case, physical demands for referees were probably not higher in the mid-20th century, as referees were mainly amateurs which had to organize their training schedule on a personal basis [22]. Also, whereas both UEFA and FIFA orderly assess referees' fitness through field tests, these were implemented after 1990 [23]. Therefore, it is plausible to think that the amount of physical activity was higher for our cohorts of players during their careers, due to the trainings and the games.

Nevertheless, soccer referees appear to maintain higher levels of VO2max than non-elite population, possibly through the regular vigorous intensity physical activity during their professional stage [24], lower levels of body fat and a lower incidence of obesity [25], and these factors could partially explain the results of our study [26]. The lack of studies that have analyzed mortality in soccer referees prevents us to compare our results with previous research.

In the case of coaches, they did not have physical nor fitness requirements, as they did not have to participate in games. However, most coaches had played soccer formerly, although we excluded those who reached an elite level. Thus, selection bias to play soccer and their level of physical activity during this stage could also introduce the healthy worker effect bias when we compare mortality rates between players and coaches [6]. It has been suggested that working as a professional coach can be associated with better health outcomes [27]. Coaches are involved in training sessions, share healthy eating habits with

the players and have easy access to medical care [6]. Also, regardless of the exposure to the public opinion and the level of responsibility that coachers have at high levels of sport performance, they do not appear to show increased levels of stress or burnout [28], negatively associated with health outcomes.

It is also important to highlight what could happen after retiring from soccer. The longer career of referees and coaches compared to players could be an advantage, as they kept a sport related activity that could urge them to keep an adequate fitness level. Nevertheless, players and, to a smaller extent, coaches and referees, could have sequelae of injuries that affected their quality of life [29]. Soccer is a sport with contact and danger of bodily collision, which has been shown as a risk factor for increased mortality in Olympians [30]. There is increasing concern about the risk of neurodegenerative diseases associated with repetitive head impacts in several professional sports, including soccer [5]. Obviously, players had greater exposition to these risks than referees or coaches.

Taken together, the pros and cons of the cohorts related to their sport activity, along with some shared lifestyles, could explain the similar longevity we have found. Further investigation is warranted to draw firm conclusions about how being a soccer professional may influence survival.

This study has several limitations and strengths that should be considered when interpreting the results. It was a retrospective study, and we did not collect direct information from the subjects but from public sources, so there was the possibility of errors. Nevertheless, we have no reason to assume that there was a systematic error in favor of any of the cohorts during data collection. About one third of the subjects were right-censored as alive, and for some we could not establish the live status in a date near the end of the follow-up period, although we had a median follow-up of about 30 years even in right-censored subjects. As we did not record causes of death, risk factors or other

confounders of the cohorts, we cannot offer a consistent explanation of the mortality trends. We collected subjects born over a long period to have a large sample to analyze longevity, but we stratified the cohorts by date of birth to account for differences in longevity in Spain during the study period. The size of the cohorts of referees and coaches limits the power of the study to detect small differences in mortality, but this sample size is conditioned by the population size of Spanish referees and coaches in that period. Since referees and coaches began their career at older age than players, they could have a survival advantage in a direct comparison with players, and to avoid that we matched them with players who were alive at the inclusion date of the corresponding referee or coach. Finally, the subjects in our study developed their soccer activity in a wide interval of time, during which the characteristics of soccer had major changes, including a gradual shift from an amateur to a professional system. Therefore, we cannot provide a unified profile of the characteristics of the cohorts. The temporal and geographical context in which our cohorts developed their activity limits the generalizability of our results. Life conditions in Spain where very different for people born after 1950, which resulted in a lower mortality rate. Elite soccer had also major changes, and the activity of players, coaches and referees is very different in the 21st century. Our results cannot be applied directly to recreational or amateur soccer players.

Conclusion

Our results showed no differences in longevity among Spanish elite soccer referees, coaches and players born before 1950. Referees and coaches had lower mortality than the general population.

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Declarations of interest

None.

Data availability statement

The data used to identify the participants is freely available at https://www.bdfutbol.com/en/index.html. The data used in the statistical analysis is available upon request to the authors.

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Table 1. General characteristics of the cohorts.

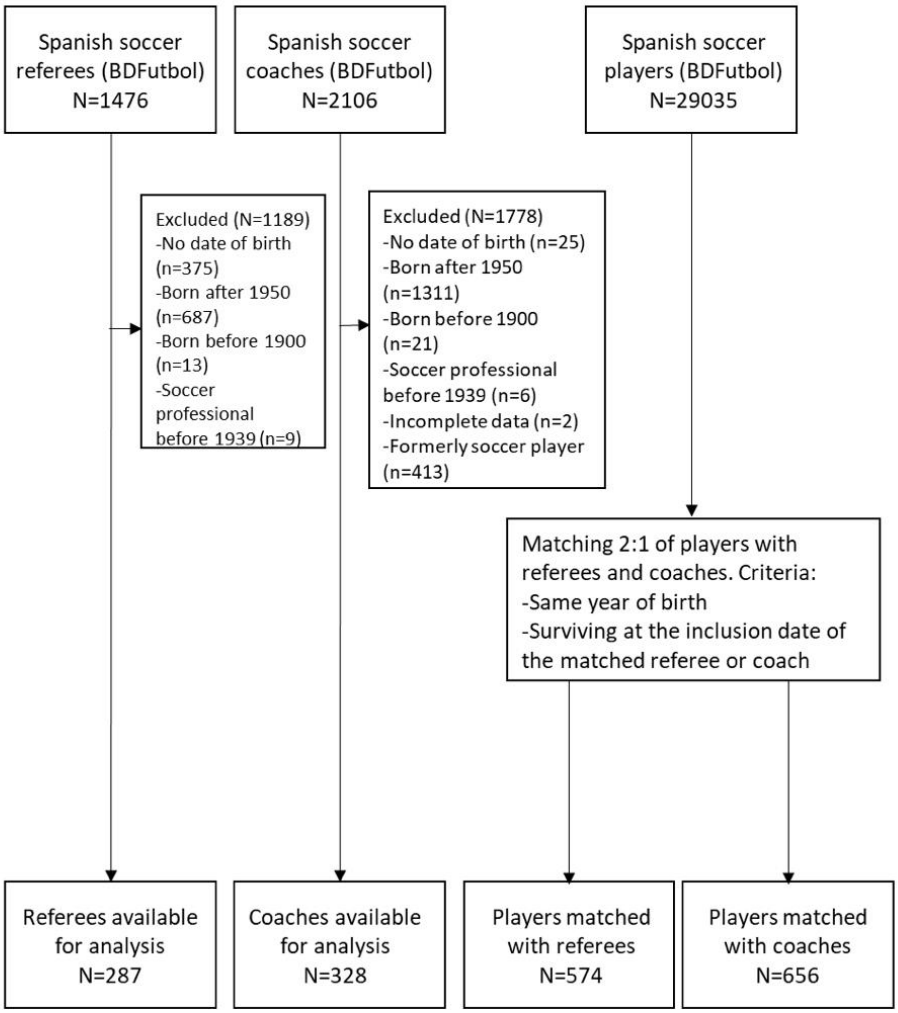
	Referees (n=287)	Coaches (n=328)	Players-R (n=574)	Players-C (n=656)	Total (n=1845)
Year of birth	1932 (1919-1943) [a]	1920 (1910-1944) [a]	1932 (1919-1943)	1920 (1910-1944)	1929 (1913-1944)
Starting age as professional (years)	34,0 (30,6-37,0) [a,b]	39,7 (35,5-44,4) [a,c]	21,1 (19,5-23,3) [b]	21,1 (19,4-23,2) [c]	23,3 (20,3-32,4)
Final age as professional (years)	45,6 (41,0-47,0) [a,b]	49,1 (42,9-55,1) [a,c]	29,8 (27,2-32,5) [b]	30,0 (27,2-32,8) [c]	32,4 (28,4-41,9)
First season as professional	1966 (1953-1977) [b]	1958 (1949-1987) [c]	1953 (1942-1964) [b]	1942 (1931-1964) [c]	1954 (1941-1967)
Last season as professional	1976 (1961-1985) [b]	1969 (1956-1993) [c]	1959 (1950-1971) [b]	1951 (1939-1971) [c]	1963 (1948-1975)
Years as professional	9 (6-14) [a,b]	6 (2-14) [a,c]	8 (5-11) [b]	8 (5-12) [c]	8 (4-12)
Age at inclusion (years)	34,0 (30,6-37,0) [a]	39,7 (35,5-44,4) [a]	33,9 (30,7-37,2)	39,6 (35,5-44,2)	36,7 (32,5-40,9)
Follow-up from inclusion					
Years	34,9 (18,1-45,0) [a,b]	29,6 (18,8-40,4) [a]	38,0 (29,4-46,8) [b]	29,8 (21,0-41,3)	33,7 (22,7-43,1)
Person-years	9241	9603	20843	20348	60035
Age at right censoring (years)					
All	68,7 (50,5-78,1) [a,b]	70 (61,8-78,7) [a]	72,5 (64,7-79,8) [b]	71,7 (64,6-80,1)	71,2 (63,3-79,4)
Dead	77,1 (66,8-84,6)	76,1 (68,6-84,2)	76,3 (67,9-84,3)	74,4 (65,8-82,6)	75,7 (67,5-83,5)
Alive	62 (46,9-69,4) [a,b]	63,4 (53,2-69,6) [a,c]	69,1 (59,2-73,9) [b]	68 (62,1-72,3) [c]	66,9 (53,3-76,6)
Dead, n(%)	135 (47) [a,b]	193 (58,8) [a,c]	352 (61,3) [b]	475 (72,4) [c]	1155 (62,6)
Dead before 70 years, n (%)	42 (14,6)	57 (17,4) [c]	102 (17,8)	160 (24,4) [c]	361 (19,6)
Year of death	2003 (1992-2013) [a]	1991 (1981-2004) [a]	2003 (1990-2011)	1992 (1980-2007)	1997 (1983-2010)
Player's position					
Goalkeeper, n (%)	-	-	89 (15,5)	72 (11)	161 (13,1)
Defense, n (%)	-	-	170 (29,6)	174 (26,5)	344 (28)
Midfielder, n (%)	-	-	150 (26,1)	190 (29)	340 (27,3)
Forward, n (%)	-	-	165 (28,7)	220 (33,5)	385 (31,3)

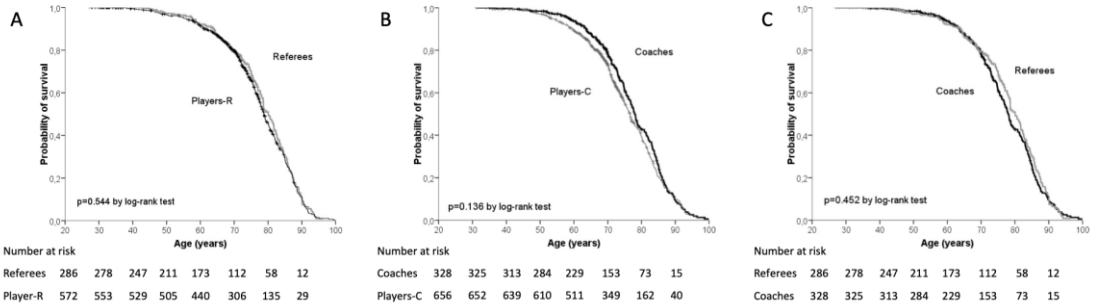
Values are median (IQR) unless stated otherwise. Differences analysed with Mann-Whitney U test. Players-R: Players matched with referees. Players-C: Players matched with coaches. [a]: $p<0,05$, Coaches vs Referees; [b]: $p<0,05$, Referees vs Players-R; [c]: $p<0,05$, Coaches vs Players-C.

Figure 1: Flow diagram of cohorts recruitment.

Figure 2. Kaplan-Meier probability of survival for the four cohorts, compared by pairs. A: Referees vs Players-R. B: Coaches vs Players-C; C: Coaches vs Referees. Players-R: Players matched with referees. Players-C: Players matched with coaches.

Figure 3. Hazard ratios for death of referees (A) and coaches (B), as compared with general population, in ten years intervals, adjusted by decade of birth. Bars represent 95% confidence intervals. Values under 1 indicate lower death rates in referees or coaches.

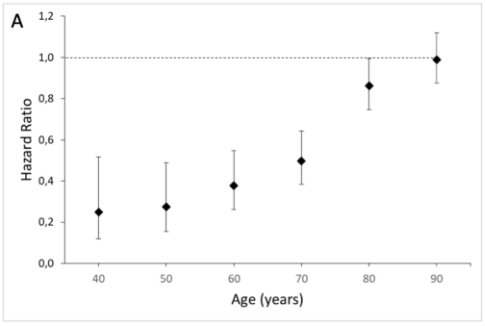

Spanish soccer referees (BDFutbol) N=1476
Spanish soccer coaches (BDFutbol) N=2106
Spanish soccer players (BDFutbol) N=29035
Excluded (N=1189)
-No date of birth (n=375)
-Born after 1950 (n=687)
-Born before 1900 (n=13)
-Soccer professional before 1939 (n=9)
Excluded (N=1778)
-No date of birth (n=25)
-Born after 1950 (n=1311)
-Born before 1900 (n=21)
-Soccer professional before 1939 (n=6)
-Incomplete data (n=2)
-Formerly soccer player (n=413)
Matching 2:1 of players with referees and coaches. Criteria:
-Same year of birth
-Surviving at the inclusion date of the matched referee or coach
Referees available for analysis N=287
Coaches available for analysis N=328
Players matched with referees N=574
Players matched with coaches N=656

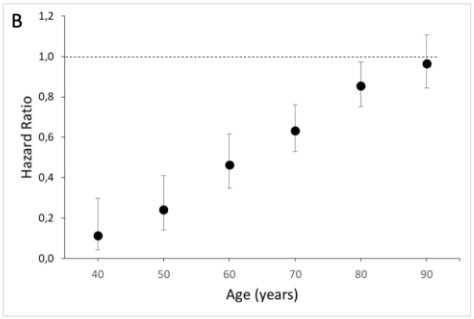


Number at risk								
Referees	286	278	247	211	173	112	58	12
Player-R	572	553	529	505	440	306	135	29

Number at risk								
Coaches	328	325	313	284	229	153	73	15
Players-C	656	652	639	610	511	349	162	40

Number at risk								
Referees	286	278	247	211	173	112	58	12
Coaches	328	325	313	284	229	153	73	15


A
1,2
1,0
0,8
0,6
0,4
0,2
0,0
Hazard Ratio
40
50
60
70
80
90
Age (years)


B
1,2
1,0
0,8
0,6
0,4
0,2
0,0
Hazard Ratio
40
50
60
70
80
90
Age (years)