Journal of Science and Medicine in Sport 25 (2022) 710–714

Contents lists available at ScienceDirect

Journal of Science and Medicine in Sport

journal homepage: www.elsevier.com/locate/jsams

Original research

Reduced death rates of elite Australian Rules footballers compared to age-matched general population

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ARTICLE INFO

Article history:
Received 9 April 2022
Received in revised form 4 August 2022
Accepted 6 August 2022
Available online 8 August 2022

Keywords:
Life expectancy
Sport
Athletes
Australia

ABSTRACT

Objectives: To determine age-matched death rates of current and retired elite male Australian football players (Australian and/or Victorian Football League) with the general population.
Design: Analysis of publicly-available birth, debut and death data for all Australian Victorian Football/Victorian Football League players who debuted prior to (and were still alive at) the start of 1971 or debuted 1971–2020.
Methods: Wikipedia was used to source the dates of death (or record that the player was alive in 2021) for the cohort. New players became part of the cohort for analysis on debut and existing cohort members left it at death. Actual death rates (per year and per decade) were then compared to expected deaths, based on age-specific population death rates.
Results: There were 5400 players and ex-players in the cohort at the start of 1971 (average age 47.3) and a further 4532 players debuted between 1971 and 2020 inclusive (a total of 9932 players). The expected deaths for the cohort in this 50-year period were 4955, but only 3914 deaths occurred (Standardized Mortality Ratio 0.79, 95 %CI 0.76–0.82). For younger members of the cohort (age <50) the discrepancy between expected (222) and actual (98) deaths was also significant (Standardized Mortality Ratio 0.44, 95 %CI 0.35–0.56).
Conclusions: We conclude that the death rates of elite male Australian footballers are lower than the reference general population, similar to other studies of elite athletes. Some of this may be explained by "healthy cohort" selection bias, a limitation which affects almost all studies in this genre.

Practical implications

- Previous studies on elite athlete longevity have been undertaken, particularly in the Olympic sports, and generally finding that Olympic (and other elite) athletes live for longer than the general population.
- There have been recent concerns about premature deaths in retired AFL players due to neurodegenerative diseases.
- Elite male Australian football players (from the VFL and AFL) have 21 % lower death rates compared to the age-matched general population, therefore enjoying greater longevity.
- If there is any excess death attributable to neurodegenerative diseases in retired AFL players, which was not assessed by this study, it is more than counterbalanced by reduced deaths from more common causes.
- Previous studies of British rock musicians and Finnish powerlifters have shown rates of death higher than the general population, so until each elite athlete or celebrity group is specifically studied, it should not be assumed that all have lower death rates than the general population.

1. Introduction

Olympic athletes from individual countries have been shown to enjoy greater longevity than the general population.[1,3,4] This trend is supported further by systematic review of athlete longevity from all sports[2] and studies of Olympians from multiple countries.[5] Where broken down by cause of death, most of the greater longevity relates to cause-specific reductions in cancer and cardiovascular disease, which happen to be the most common causes of death in the general population.[1] Greater longevity for athletes (or other celebrity groups) has not been demonstrated universally when comparing to the general

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[1] Christopher Semsarian is the recipient of a National Health and Medical Research Council (NHMRC) Practitioner Fellowship (#1154992).

https://doi.org/10.1016/j.jsams.2022.08.003
1440-2440/

population of the relevant country. Finnish powerlifters had greater all-cause mortality than the general population (thought to be related to the use of anabolic steroids)[6] and British rock musicians had greater all-cause mortality than the general population (related to drug overdoses and other misadventures during early adulthood).[7] A retrospective cohort of German international soccer players had lower survival than the general population.[8] A substantial proportion of this excess mortality in the football group was attributed to the increased likelihood of death through combat in World War II. Having outlined these exceptions, it is important to note that dozens of studies have shown athlete cohorts outliving the general population.[2]

Longevity for elite/professional Australian Rules football players (or any other athlete group exclusively from Australia) has not previously been reported. There have been recent concerns about premature death in Australian footballers due to neurodegenerative diseases, with some high-profile cases of Chronic Traumatic Encephalopathy being reported post-mortem in retired ex-Australian Football League (AFL)/Victorian Football League (VFL) players.[9,10] Neurodegenerative deaths are known to be increased in collision sports in ex-Olympians, but this increase is smaller than the other all-cause reductions, so collision sport Olympians still enjoy greater life expectancy than the general population.[11] The team sport with the highest known concerns about occupational neurodegenerative disease is American football, and all-cause mortality of National Football League players is also lower than the general US population.[12,13] This is in keeping with the observation that any increased risk of neurodegenerative disease is at least balanced by reduced cancer and cardiovascular risk.[14]

We hypothesized that professional Australian Rules footballers would exhibit similar patterns to Olympian and most other football cohorts (i.e. lower mortality compared to the general population). We aimed to determine the annual age-matched death rates of current and retired elite male Australian football players compared to the general population in the years 1971–2020 inclusive.

2. Methods

The study was performed using publicly-available data only, i.e. complete player dates of birth and death freely available online (via Wikipedia and other sources[15]) and age-standardized death rates for the Australian population after 1970. The study included male players only as it has only been in the last decade that there have been organized high-level competitions involving female players, which does not allow enough follow-up time to meaningfully compare relative death.

Wikipedia was used to source the dates of death (or record that the player was alive as of 1 January 2021) for the 9954 AFL/VFL players who debuted prior to (and were still alive at) the start of 1971 or debuted 1971–2020. All players had Wikipedia pages with the all-time players lists cross-checked with alternate sources.[15] New players became part of the cohort for analysis on debut and existing cohort members left the cohort on death. Actual death rates (per year and per decade) were then compared to expected deaths, based on age-specific population death rates.

The reference (control) group was chosen to be the entire Victorian male population in each year of the study (1971–2020) respectively, as age-stratified population death rates were available each year. These were obtained from the Australian Bureau of Statistics online Stat Date Explorer (https://explore.data.abs.gov.au/), specifically the dataset "Deaths, Year of Registration, Age at Death, Age-specific death rates, Sex, States and Territories and Australia" using filters All Years (1971–2020), Sex = Male, Region = Victoria and Measure = Age-specific death rate.[16]

A small number of ex-players were presumed dead on Wikipedia with no date of death recorded. As the vast majority of these were born in the 1800s, we presumed almost all of them had died prior to 1971 and did not include these players in the cohort.

The number of expected deaths each year was calculated using the number in the cohort alive at the start of the year in each 5 year age bracket (15–19, 20–24, 25–29…95–99, 100 and over) and the expected death rate in that cohort based on the average death rate within that age group for that year based on Victorian male norms for that year (Table 1).

The confidence intervals for the number of actual deaths compared to expected deaths (Standardized Mortality Ratios (SMRs)) were calculated by Taylor series expansions[17] in Excel (Microsoft, Seattle).

This study was ethics exempt being an analysis of publicly-available data without any individual identification. We used our Institutional Online tool to confirm that the study would be clearly graded as "negligible risk" and therefore not requiring formal Ethics Committee assessment, along with confirmation that other published studies that only used publicly-available data had not required Ethics Committee assessment.[18–20]

Table 1(a) and (b) shows the detailed methodology for calculating expected deaths using the years 1971 and 2011 (the start year of the first and final decades) as examples. Players were classified into 5-year age groups with the recorded death rate per 1000 male residents in Victoria for 1971/2011 for that age group used to calculate the number of expected deaths for that age group. The number of expected deaths for the entire cohort was the sum for each category. The cohort in 2011 compared to 1971 was slightly larger and substantially older (percentage 75 or more = 16.2 % in 2011 vs 5.8 % in 1971), but with substantially lower expected death rates in each age group. Despite being an older and larger group, fewer deaths were expected in 2011 than in 1971 because the population had become healthier.[16]

3. Results

There were 5400 players and ex-players in the cohort at the start of 1971. This included 954 players under the age of 30 (mainly current players at the start of 1971) and 4446 players aged 30 and over (mainly retired players who were still alive at the start of 1971 (Table 2(a))). A further 4532 players debuted between 1971 and 2020 inclusive, meaning there was a total of 9932 players in the cohort, either alive at the

Table 1
(a) and (b) – Calculation of number of expected deaths for the 5400 players in the cohort in 1971 and the 5793 in 2011.

Age group	(a)			(b)		
	Number of living VFL players in cohort (start of 1971)	Annual death rate per 1000 male residents in this age group	Expected deaths (1971)	Number of living VFL players in cohort (start of 2011)	Annual death rate per 1000 male residents in this age group	Expected deaths (2011)
100 and over	0	240.0	0.0	0	496.6	0.0
95–99	1	407.4	0.4	11	354.7	3.9
90–94	8	309.1	2.5	57	210.3	12.0
85–89	53	232.0	12.3	156	122.9	19.2
80–84	101	149.4	15.1	298	66.5	19.8
75–79	151	101.3	15.3	417	36.3	15.1
70–74	247	61.4	15.2	431	20.4	8.8
65–69	369	41.8	15.4	486	12.5	6.1
60–64	479	24.8	11.9	512	7.6	3.9
55–59	519	15.6	8.1	492	4.7	2.3
50–54	510	9.7	4.9	470	2.9	1.4
45–49	456	6.1	2.8	460	2.1	1.0
40–44	485	3.0	1.5	446	1.5	0.7
35–39	556	1.9	1.1	426	1.0	0.4
30–34	511	1.2	0.6	393	0.8	0.3
25–29	521	1.1	0.6	386	0.7	0.3
20–24	407	1.8	0.7	352	0.6	0.2
15–19	26	1.3	0.0	0	0.3	0.0
	5400		108.3	5793		95.3

Table 2(a)
Expected and actual deaths by decade for all age groups.

Decade	Cohort size (start of decade)	Average age of cohort (start of decade)	Number of cohort age >65 (start of decade)	Expected deaths	Actual deaths	Standardized Mortality Ratio (SMR)	95 % CIs
1971–80	5400	47.3	930	1046	818	0.78	0.71–0.86
1981–90	5477	49.2	1210	1011	867	0.86	0.78–0.94
1991–00	5564	50.4	1319	984	774	0.79	0.71–0.87
2001–10	5725	51.8	1567	922	731	0.79	0.72–0.88
2011–20	5793	53.7	1856	991	724	0.73	0.66–0.81
All years (1971–2020)				4955	3914	0.79	0.76–0.82

start of 1971 or yet to be born. Three thousand, nine hundred and fourteen players died during that 50-year period.

In every single year from 1971 to 2020 the number of actual deaths in the AFL/VFL cohort was fewer than the age-matched expected deaths for the Victorian male population (Supplementary Tables A1(a)–2(e)). Each decade had significantly fewer deaths than expected (see Table 2 (a)). No player was reported to have died during a match or immediately following the consequences of an injury sustained in a match. The vast majority of deaths were in older age groups: of the 3914 deaths, 15 were players/ex-players in their 20s, 24 in their 30s, 59 in their 40s, 216 in their 50s, 569 in their 60s, 1160 in their 70s, 1398 in their 80s, 463 in their 90s and 7 at an age of 100 or over. The most common age of death of the 3914 who died was age 83, an age at which 157 ex-players died.

The overall number of deaths in the cohort over 50 years was 3914 (expected deaths 4955, SMR 0.79, 95 % CIs 0.76–0.82, Table 2(a)).

Deaths at young age. When considering only the 98 players/ex-players who died below the age of 50, this sub-group also died at a fraction of the rate expected (Table 2(b)). The overall number of deaths of players/ex-players below the age of 50 in the five decades was 98 (expected deaths 222, SMR 0.44, 95 % CIs 0.35–0.56, Table 2(b)).

For the 98 players who died below the age of 50, about half of these had a cause of death listed on Wikipedia. The causes of death from which at least 5 players under the age of 50 were listed as dying from were: Cancer (n = 13), motor vehicle accidents (n = 7), suicide or suspected suicide (n = 6) and other accidents (n = 7). There were <5 players listed as having died under the age of 50 from cardiovascular causes, although the true number may be higher than this taking into account those death causes not listed. There were no players who suffered cardiovascular deaths associated with games (i.e. cardiac arrest on the field). No statistical analysis was performed to look at cause of death given the incomplete data.

Survival by decade of birth. Fig. 1 shows that each decade cohort of AFL/VFL players lived slightly longer than those born in the previous decade. The vast majority of players born in 1921–1930 had died by 2020, but over 50 % of those born 1931–1940 were still alive at the end of 2020. The lines for the players born in 1961–1970, 1971–1980, 1981–1990, and 1991–2000 while listed in the legend cannot be distinguished in the chart, as the vast majority of players born in these 4 decades are still alive hence their survival curves are on top of each other (≥98 % of players still alive) at the top of the chart.

Table 2(b)
Expected and actual deaths by decade, players and ex-players under the age of 50.

Decade	Expected deaths (<50 years)	Actual deaths (<50 years)	Standardized Mortality Ratio (SMR)	95 % CIs
1971–80	68	27	0.40	0.25–0.62
1981–90	52	31	0.59	0.38–0.92
1991–00	43	14	0.32	0.18–0.59
2001–10	32	14	0.43	0.23–0.81
2011–20	26	12	0.45	0.23–0.90
All years (1971–2020)	222	98	0.44	0.35–0.56

4. Discussion

This study shows that professional male Australian Rules football players live longer than the general male population, consistent with previous studies published in other elite sporting cohorts.[21–23] Although studies in multiple countries have been published previously, we believe that this is the first study to look at an Australian cohort. Australian Rules football is a mixed high endurance–power sport and therefore of moderate–high cardiovascular stress.[24] Our study was unable to assess cause of death, but similar studies have suggested that in elite athletes, cancer deaths are reduced and cardiovascular deaths are at similar or lower rates to the general population.[14,25]

No player died during a game in the period 1971–2020 and no player died immediately or directly from injuries sustained during a game in this time period. We are unaware (i.e. it is not listed on Wikipedia) of any player who has died during a first grade VFL or AFL game in the history of the sport (from over 12,000 players). Of the few players who died while active players in the VFL/AFL, all of them appear to have suffered tragic events or illnesses unrelated to the sport. Although our dataset was not able to comprehensively assess cause of death, it is consistent with other studies of athletes where motor vehicle accidents are the most common cause of death in young players.[26]

The strengths of this study are its reproducibility, using publicly available data and the apparent completeness of death data on Wikipedia. This study could be replicated by any interest group of researchers and updated in future years using similar methods. There is a small risk of data error, both in the creation/editing of Wikipedia pages and in the transfer of death data into a database. From our work in reviewing the Wikipedia pages on elite VFL/AFL players, we feel that the data for those who lived beyond 1970 appears to be highly accurate. The actual deaths fell short of expected deaths by hundreds, meaning that a handful of errors would not have affected the overall finding.

Another strength is that we chose to look at expected deaths per year as a more accurate measure of longevity rather than life expectancy or simply age at death. By definition, a player must have been alive when he debuted in the VFL or AFL, so he cannot have been part of a cohort (considered at risk of death) prior to this. A comparison of simply age of death or life expectancy of professional footballers to the general population would suffer from the error of ignoring death in the general population in the first two decades of life.

We chose a method of looking at the age-expected death rates for each five year age group (finishing at 100+ being a single age group as no player lived beyond 104) to calculate expected deaths among the age profile of all known living players in each year. This methodology we feel is as accurate as it can be for a comparison. It still does not eliminate what is known as the "healthy worker effect" in that active AFL players in their 20s and 30s are being compared to the general population that includes disabled and ill people. This is a limitation for almost every study in this genre, as the methodology for the vast majority is to compare an athlete cohort to life tables (risk of death at each age each year) in the general population.[2] Some over-estimate of the extent of difference in death rate between the cohort of footballers and the general population is unavoidable because of the healthy worker effect. Since AFL players generally retire by early-mid 30s, the

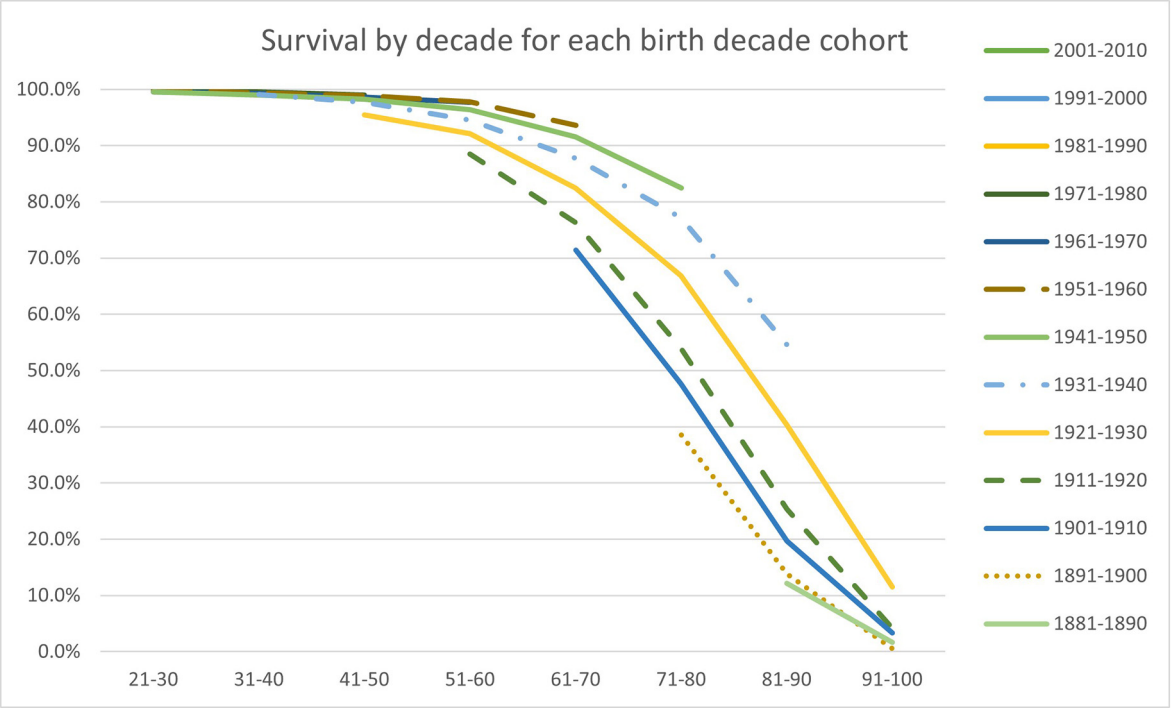

Fig. 1. Survival of each decade cohort of AFL/VFL players, listed by decade of birth.

remainder of the general population at this age is also typically very healthy at this age. Deaths in 20s and 30s are very rare and typically from sudden events that could affect both the general population and healthy footballers (e.g. accidents, suicides, drug overdoses).[27] We also note that despite this "healthy cohort" effect that a small number of previous studies have found higher rates of death than the general population in Finnish powerlifters,[6] German footballers[8] and British rock musicians.[5] It is not inevitable that an elite athlete group will always have lower death rates than the general population.

We consider the number of deaths likely to be "missing" on Wikipedia to be relatively small, especially given that the rate of deaths was similar for all recent years. Sourcing celebrity and elite athlete deaths on Wikipedia has been used previously where the entire cohort is prominent enough to have a Wikipedia page,[7,8,28] which was the case for this Australian football cohort. There is therefore a limitation that some deaths may not be listed although almost certainly not by a number that would invalidate the trend observed. Although Wikipedia appears to reliably list date of death, it does not reliably list cause of death for all deceased professional athletes. For those who die at a young age (<50 years old) it is more usual for the cause of death to be recorded, but it is usual for it to *not be* recorded for those who have a normal lifespan (other than for the most famous players), as the passing of a person of >75 years old is not a notable event that is necessarily reported on in the media. The state of living for all players was assumed to be Victoria in that all players were compared to the general male population. There were only trivial differences in life expectancy of Victorian males compared to Australian males between 1971 and 2020 with Victorians having a marginally increased life expectancy. While the general population is the most valid comparison cohort, this does not rule out selection bias of the "healthy population" member when the cohort is formed on debut in the VFL/AFL competition. Finally, the apparent health benefit reflected in this study generally applies to footballers who played in the previous century. For players who have participated in the AFL in the 21st Century, the expected rate of deaths is so low that it is too early to make any assumptions about their longevity compared to the general population.

5. Conclusions

Death rates of elite male Australian footballers are lower than the general population, consistent with other elite sports previously studied. This is most likely driven by reduced rates of the most common causes of death, such as cardiovascular diseases and cancer, for which exercise is known to offer protection. This study was not able to specifically examine rates of death due to neurodegenerative diseases in footballers compared to the general population.

Funding information

No funding was received for this study.

Declaration of interest statement

None of us have any conflicts with respect to the AFL that would be considered substantial and recent.

JWO did get paid as the primary Injury Survey coordinator for the AFL from 1992 to 2014 (8 years ago) but has no major relationship in the past 7 years.

CS, ALG and JWO have very minor associations (e.g. occasionally consulting an AFL player) but we consider these conflicts are trivial and it puts us at "arm's length" from the AFL.

Confirmation of ethical compliance

The study was ethics committee-exempt, by only analyzing publicly-available data. By the Australian NHMRC guidelines and that of our parent institution (University of Sydney) it represents and is formally considered of "negligible risk" to any past AFL/VFL player. That is, no player is identified in this study and the only significant data considered was date and cause of death (if listed) which was obtained from a publicly-available source. The primary source (Wikipedia) represents far more potential invasion of privacy than this study, and even that is trivial.

Data is shared openly in a supplementary file.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jsams.2022.08.003.

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