

High hopes: lower risk of death due to mental disorders and self-harm in a century-long US Olympian cohort compared with the general population

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ABSTRACT

Objective To determine the risk of death due to prominent mental disorders, substance abuse, and self-harm among US Olympians compared with the general population.

Methods All female (n=2301) and male (n=5823) US Olympians who participated in the summer or winter Games between 1912 and 2012 were followed until 2016. The National Death Index certified their vital statuses and causes of death. We performed a Standard Mortality Ratio (SMR) analysis for all causes studied and applied the years-saved (YS) method to quantify differences in the risk of death for (1) anxiety, depression and self-harm and (2) substance abuse and eating disorders. Additionally, we examined the YS across sports with greater than 100 total deaths and between medalists and non-medalists.

Results US Olympians had a 32% (SMR=0.68, 95% CI 0.49 to 0.91) lower risk of death compared with the general population, resulting in a longevity advantage of 0.21 YS (95% CI 0.14 to 0.29) for deaths by depression, anxiety and self-harm and 0.12 years (95% CI 0.08 to 0.15) for substance abuse and eating disorders. There were no significant differences between medalists and non-medalists, but findings varied by sports. Most sports (eg, athletics, swimming, rowing) had significantly lower risks of deaths than the general population with the exceptions of fencing and shooting. Shooting showed a trend towards a higher risk through suicide by firearm.

Conclusion Olympians have a lower risk of death, favouring an increased longevity compared with the general population for mental disorders, substance abuse and suicides.

athletes,^{1,2} and between those suffering from recurring injuries or performance difficulties.¹ Varying rates of disorders have also been reported based on the sport practised, making sport-based analyses a critical issue to investigate.⁴ As mental disorders can be long lasting and have changing prevalence based on athletes' points in their careers, longitudinal follow-up is also necessary.¹

While the prevalence of these disorders has been studied revealing it to be a risk factor in elite athletes, the consequences of this potential morbidity in terms of risk of death due to these mental disorders (through a variety of mechanism such as suicide, overdose, or liver disease) are poorly understood. In the general population, mental disorders are associated with premature mortality.⁵ Suicide in elite athletes is plausible due to a variety of predispositions, including the stress, psychological traits, retirement and injuries.⁶ However, organised sport is also capable of protecting individuals against hopelessness, while leading to increased self-esteem and social connectedness.^{6,7} Previous studies within the National Collegiate Athlete Association and National Football League have shown a lower suicide rate compared with the general population.^{8–10} However, no studies have examined the risk of death due to suicides in the overall Olympic population, except for whether steroids affect the risk in Swedish male athletes.¹¹ US Olympians comprise the largest cohort by country within the games. They are a particularly interesting cohort to study due to the higher rate of mid-life death from drug overdoses, alcohol abuse, suicides and organ diseases faced by Americans in general.¹²

Accordingly, the main aims of this investigation were to determine the risk of death due to prominent mental disorders, substance abuse and self-harm among US Olympians compared with the general population and to quantify the longevity losses or gains. Within the Olympian population, we also sought to determine if a difference existed by sport, or between medalists and non-medalists.

METHODS

Data collection

We included all the female and male US Olympians that participated in either the summer or winter Olympic Games between 1912 and 2012. Biographical information (full name, date and place of birth, and date(s) of Olympic Games

INTRODUCTION

There is a paucity of data on mental disorders in Olympic athletes,¹ and the long-term consequences remain largely unknown. Additionally, comparisons with the public in regard to prevalence, severity and risk of death continue to be challenging due to the absence of appropriate reference groups in the general population.² However, several studies have estimated the prevalence of mental disorders and substance abuse to be higher or comparable to the general population.^{1–4} The most prevalent disorders in the Olympian cohort are anxiety, depression, eating disorders and substance abuse.^{1–4} Differences in prevalence exist between former and current



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participation) was collected from reliable databases including official Olympic competitors' lists, birth registers, newspapers, published obituaries, and so on, and is available online (www.sports-reference.com/olympics).¹³ We excluded Olympians if their date and/or place of birth were missing. We confirmed the vital status of every Olympian through the National Death Index (NDI—https://www.cdc.gov/nchs/data_access/index.htm), which provides the underlying cause of death starting from 1979 when the death register began, through restricted and controlled access to their database to ensure data confidentiality. At the end of our data verification process at the NDI, the last year of available verified cause of death data was the end of 2015, which was used as the endpoint of our study. We obtained the cause of death through public sources (the internet, media coverage or the national sports federation) for deaths that occurred before 1979. To ensure the quality of results was maintained, a sensitivity analysis was performed. We recalculated the outcomes using different periods of inclusion (before and after NDI registry) and compared the magnitude and direction of the results to determine if including the causes of deaths found via the internet affected the final results.

Mental disorder and suicide definition

We defined death by a mental disorder or suicide as those listed with a primary cause linked to substance abuse, anxiety, depression, eating disorder or self-harm based on the International Classification of Diseases codes at the time of death provided through the NDI. Coding of these causes used the version of that was in effect at the time of death (8th revision before 1978, 9th revision between 1979 and 1999, and 10th revision after 2000; online supplemental file). We focused on these causes as they have been identified as the most prevalent mental disorders among elite athletes.¹² We created two subcategories: (1) deaths from anxiety, depression or self-harm and (2) deaths from substance abuse or an eating disorder. These categories were created due to the detailed causes of death, where those in the first group had more sudden forms of death, such as suicide, related to mood disorders, while those in the second group had deaths related to longer or more chronic illnesses, such as liver disease.

Cohort of reference: general population

Overall mortality rates for the general population was obtained through the national life tables, available by the Berkeley Mortality database (<http://bmd.mortality.org/>) and the Human Mortality database (<https://www.mortality.org/>) which provides death rates since 1900. Death rates for the underlying causes studied were obtained via the WONDER database provided by the US Center for Disease Control and Prevention (wonder.cdc.gov/) which provides death rates since 1968.¹⁴ Since no specific death rates exists before 1968, we extrapolated deaths rates back until 1912 based on the trend for the period between 1968 and the end of 2015. A sensitivity analysis was conducted to verify the effect of this extrapolation by limiting the analysis to the period without extrapolation. The outcomes were compared with verify the direction and magnitude of the effect from using extrapolated data on final results.

Patient and public involvement

Neither athletes nor the public were involved in the design of this study.

Data analyses

To quantify differences in the overall mortality rates due to the studied causes, we performed a Standard Mortality Ratio

(SMR) analysis, which has previously been applied in studies of elite athletes with similar methodology.^{15–17} The SMR allows comparison of the mortality of the studied cohort (US Olympians) with that of the total population containing this cohort, with age, sex and period adjustment. In practical terms, SMR is the ratio between the number of deaths observed in the Olympic cohort and the number of expected deaths if the Olympians had the same death rates as the US population. We calculated the expected deaths in the general population using the population mortality values for (1) the studied causes of death, (2) the individuals of the same sex, and (3) those born in the same calendar year. This was done for each individual in our study. We used the values, for each age, from the time of participation in the Olympics until the end of our follow-up (end of 2015). Through this, all the comparisons made with the general population were adjusted for sex, date of birth, and period of follow-up. An SMR <1 indicates a lower mortality among US Olympians, whereas an SMR >1 indicates higher mortality compared with the US general population.

To quantify the impact of the mortality due to these causes on the Olympians total longevity, we applied the years-saved method previously used in US Olympians and a cohort of French Olympians.^{18–19} This method enables us to quantify longevity losses or gains due to a specific causes of death without neglecting the existence of competing risks (ie, the risk of dying from other causes).²⁰ This considers the potential that an athlete can die from any cause of death and not just from the studied causes. It maintains the rationality that the sum of years lost/saved by each cause corresponds to the total number of years lost/saved. This is preferable over a standard survival analysis where deaths outside of the causes studied are treated as censored—as if the individual was alive—and therefore could introduce bias.^{20–22} First, we estimated the cumulative incidence function [$F_k(t)$] of the analysed causes using the Aalen-Johansen method via the R package *mstate*.²³ This function was then compared with the one based on the general population of the same age and sex, living in the same calendar period obtained through the national life tables. Then, we calculated the difference between the areas below both functions to estimate the number of years lost or saved to these causes.

For US Olympians, analyses began at an athlete's first Olympics and lasted until either the athlete's age at death, our study's endpoint, or age 90, depending which came first. Age 90 was chosen to allow comparison with other studies²¹ and to be consistent with the years-lost/years-saved method that requires a specific cut-off timepoint in order to avoid the problem of overvariability due to data sparsity at high ages.²⁴ For comparisons with the general population, the Olympians follow-up was synchronised with the mortality rates of the general population. Therefore, the comparisons with the general population use the exact same periods of follow-up as the Olympians and take in account only the mortality rates in the general population where people have the same age and sex.

We completed sub-analyses in each sport that could provide enough statistical power for analysis between Olympians and general population, based on the mortality rates observed in the US Olympians for the studied causes. We also compared the risk of death between medalists and non-medalists within the two subcategories to see if performance influenced the outcome.

We set CIs at 95% and we considered a two-tailed *p* value <0.05 statistically significant. R software (V.3.5.3; The R Foundation for Statistical Computing, Vienna, Austria) was used for our statistical analyses.

Table 1 Description of the detailed causes of death obtained via the National Death Index

Causes of deaths	Detailed causes	N (women)
Self-Harm, anxiety and depression	Self-harm	
	Suicide by firearms	12
	Intentional self-poisoning	8 (1)
	Others	9
Anxiety and depression	Depressive disorders not classified elsewhere	1 (1)
Substance abuse and eating disorders		
Substance abuse	Alcoholic liver disease	8
	Mental disorders due to the harmful use of alcohol or tobacco	3 (1)
	Others	2
Eating disorders	Unspecified eating disorders	1

RESULTS

Overall description

Between 1912 and 2012, 8134 athletes (2301 women and 5833 men) participated in either the summer or winter Games. Ten were excluded from our analysis due to a missing birthplace or birthdate. In total, 2309 deaths occurred throughout the century of follow-up, of which 44 primary cause were attributed to a mental disorder or suicide. The mean age of death for the 44 athletes was 57.5 ± 17.6 years. Eight deaths from mental disorders were not certified by the NDI since they occurred between 1920 and 1965. By restraining the analysis to the certified

period, we found a mortality reduction among Olympians of 43% (SMR=0.57, 95%CI 0.42 to 0.77) and by extending the analysis to the period with non-certified data the mortality reduction is of 32% (SMR=0.68, 95%CI 0.49 to 0.91). Additionally, the sensitivity analysis that we performed, regarding extrapolated cause specific mortality rates, showed no significant difference in the magnitude nor the direction of the results when we included the period relying on extrapolated data compared with restraining the analysis to exclusively the certified period. Therefore, based on this sensitivity analysis, our YS analysis includes the whole data set.

Deaths attributed to self-harm, anxiety and depression

Thirty deaths (2 women, 28 men) were due to anxiety, depression or self-harm. The most frequent mechanism was suicides due to firearms (table 1). US Olympians had a significantly lower risk of death by these causes in comparison to the general population with 0.21 YS (95%CI 0.14 to 0.29; figure 1A, B).

Given the observed rate of 1.3% deaths from these causes among the total number of deaths, we determined that a minimum of 100 deaths was necessary for sports to have specific subanalysis. Five sports had more than 100 general deaths: athletics, rowing, swimming, fencing and shooting. For the five sports analysed, differences between sports were uncovered (figure 2; table 2). In rowing, out of the 160 total deaths, no deaths occurred due to the investigated causes. In athletics and swimming, there were significantly less deaths compared with the general population and there were 0.19 YS (95%CI 0.06

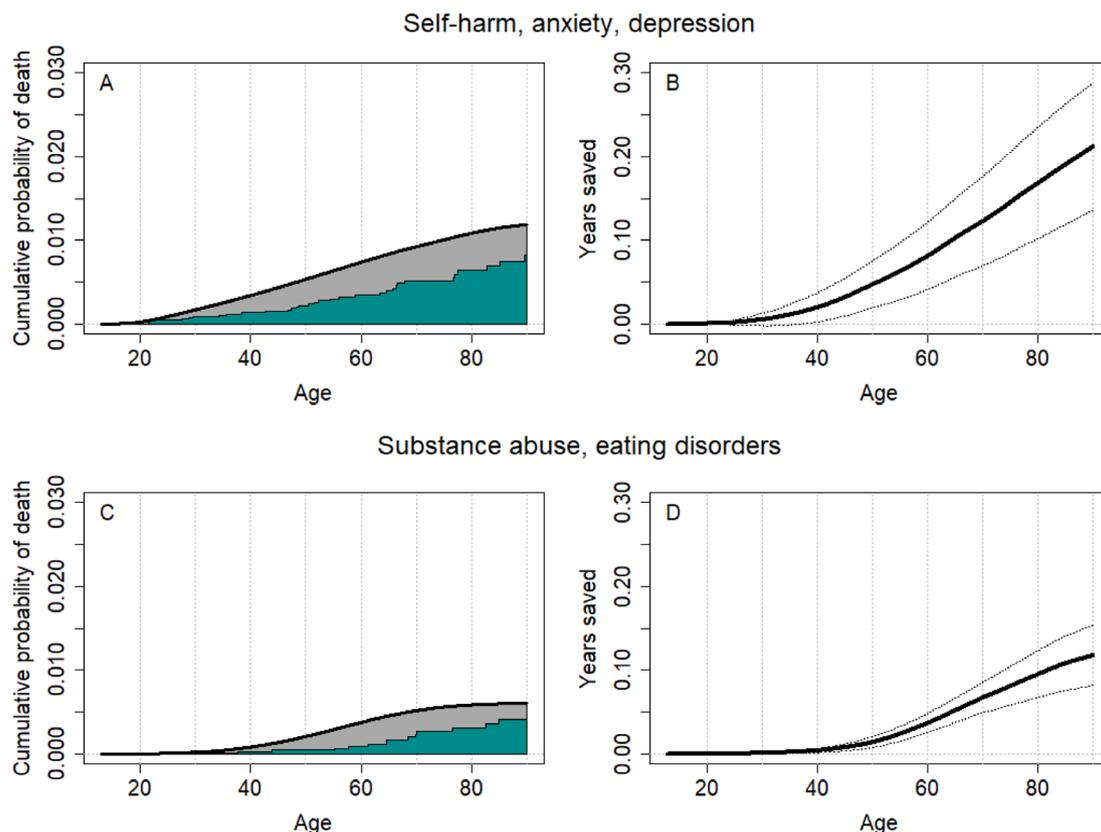


Figure 1 (A) Cumulative probability of death by self-harm, anxiety and depression among US Olympians (teal area) in comparison with the general population (black line). (B) The years saved among US Olympians (thick line) and the 95% CI (thinner lines) due to death by self-harm, anxiety and depression. (C) Cumulative probability of death by substance abuse and eating disorders among US Olympians (teal area) in comparison with the general population (black line). (D) The years-saved among US Olympians (thick line) and the 95% CI (thinner lines) due to death by substance abuse and eating disorders.

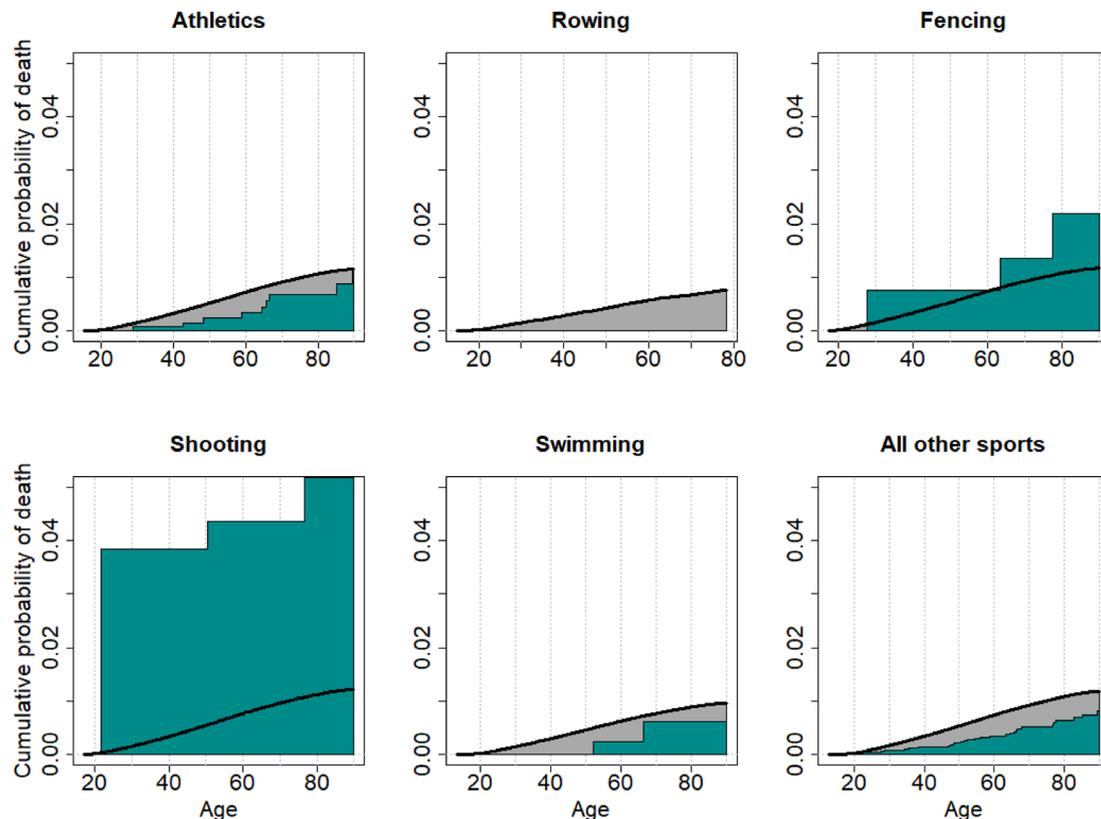


Figure 2 Cumulative probability of death by self-harm, anxiety and depression stratified by sports among US Olympians (teal area) in comparison with the general population (black line) for sports with over 100 total general deaths.

to 0.32) and 0.19 YS (95% CI 0.1 to 0.37), respectively. There was no significant difference between fencing and the general population with -0.3 YS (95% CI -1.11 to 0.5), where 3 of 110 deaths occurred due to anxiety, depression and self-harm. Shooting showed a non-significant trend towards a higher risk with -2.49 YS (95% CI -6.41 to 1.43) compared with the general population. All deaths in shooting were due to firearms ($n=3$). Medalists and non-medalists had an equivalent risk regarding self-inflicted deaths ($p=0.95$; [figure 3A](#)).

Deaths attributed to substance abuse and eating disorders

Substance abuse or an eating disorder were listed as the cause of death for 14 athletes (1 woman, 13 men). The most common mechanism of death was those related to alcohol abuse ([table 1](#)) The risk of death was lower among Olympians compared with the general population resulting in a longevity advantage of 0.12 years (95% CI 0.08 to 0.15; [figure 1CD](#)). There was no significant difference in the risk of death by substance abuse or eating disorders for medalists compared with non-medalists ($p=0.82$; [figure 3B](#)). Specific sport analysis could not be performed within this group due to lack of statistical power.

DISCUSSION

This is the first study to investigate the risk of death due to mental disorders, substance abuse and suicides in former elite athletes across multiple sports compared with the general population. We demonstrated that former US Olympians followed similar mortality trends throughout the follow-up time compared with the general population but with diminished risks and a longevity advantage. Previous research has demonstrated that compared with the general population, US Olympians have a longevity advantage of 5 years for all causes.¹⁹ This is similar to other populations, with an estimated 5–6 additional years for Finnish male elite athletes²⁵ and 6.5 years for French Olympians.¹⁸ More prevalent diseases and disorders, such as cancer and cardiovascular disease, explain a larger amount of these years saved,^{15 16 18 25 26} between 1.5 and 2 years.¹⁸ So, while the longevity advantage due to the specific mental disorders studied is smaller, it needs to be understood in the context of all other causes of death. Anxiety, depression, self-harm, substance abuse and eating disorders alone explain 2 of the 60 months saved by US Olympians and this analysis aids in further explaining the 5 total years saved.

Table 2 Number of deaths by medalist status and by sport

Causes of deaths	Medalists (n=3190)	Non-medalists (n=4934)	Shooting (n=251)	Fencing (n=247)	Athletics (n=1595)	Swimming (n=638)	Rowing (n=595)	Others (n=4798)
Self-Harm, anxiety and depression (cause specific deaths/total deaths)	13/1004	17/1305	3/106	3/110	9/637	2/158	0/160	13/1138
Substance abuse and eating disorders (cause specific deaths/total deaths)	5/1004	9/1305						

n = total number of participants, alive or dead.

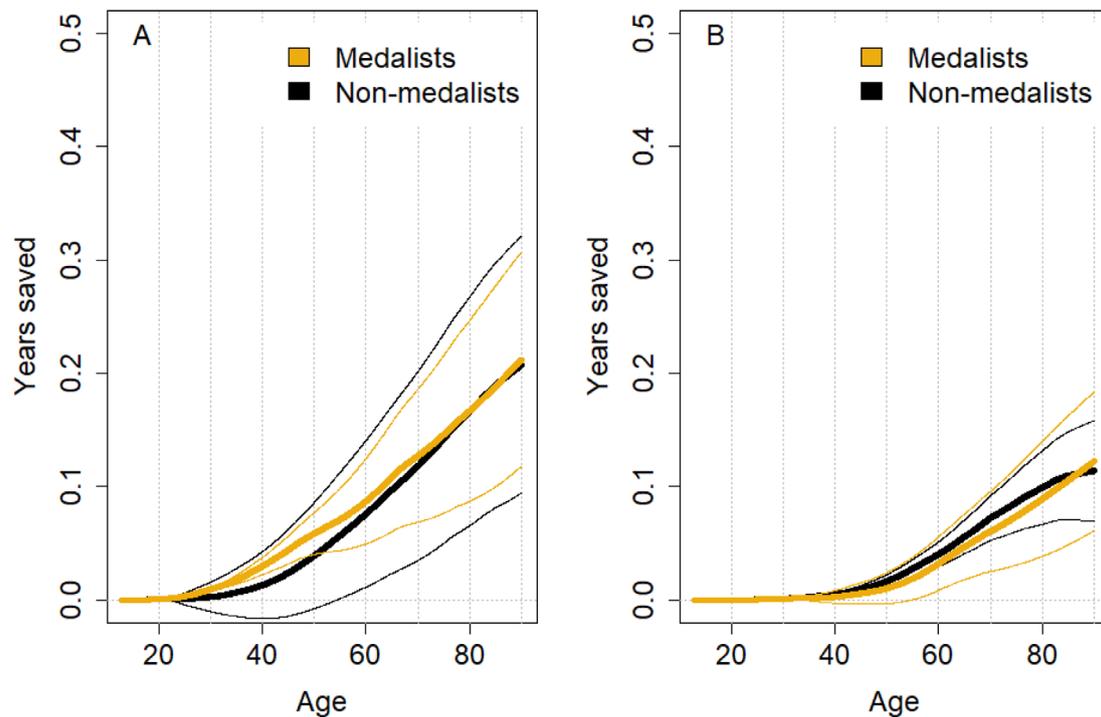


Figure 3 (A) The years saved among Olympic medalists (thick yellow line) and the 95% CI (thinner yellow lines) compared with non-medallists (thick black line) and 95% CI (thinner black lines) for the causes of self-harm, anxiety and depression. (B) The years saved among Olympic medalists (thick yellow line) and the 95% CI (thinner yellow lines) compared with non-medallists (thick black line) and 95% CI (thinner black lines) for the causes of substance abuse and eating disorders.

Mental disorder and suicide risk reduction

Previous studies have shown an equivalent or higher prevalence of mental disorders in elite athletes including all stages and levels of symptoms compared with the general population.¹⁻⁴ Multiple factors, including the pressure to excel,⁴ suffering from musculoskeletal injuries, overtraining, depressed athletic performance and changes faced on retirement (a lack of social attention, a loss of comradery from teammates),² may contribute to mental disorders. Substance abuse is also prevalent as it stems from frequent use of pain killers, bingeing during off seasons or transitional distress at the end of athletes' careers.² Eating disorders are prevalent in sports requiring a lean body shape.¹ In spite of these risk factors, death rates from mental disorders were smaller in Olympic athletes. Most likely, the factors that contribute to the existence of these disorders may be different from those that contribute to severe disorders that ultimately culminate in deaths. Using the mortality as an outcome allows us to have an objective and quantifiable measure that may permit a greater understanding of severe mental disorders in elite athletes.

The lower risk of death in US Olympians compared with the general population is most likely attributable to a multitude of intertwined factors. Cohort selection effects could have potential influences on the results. For instance, there are certain mental disorders that do not exist in the US Olympian population, which is why we chose to focus only on the most prevalent disorders instead of looking at mental disorders in general. Additionally, Olympians could possess genetic and non-genetic predispositions that are more favourable, and have healthier lifestyle habits compared with the general population.^{27 28} Due to a possible bidirectional relationship with high-level sport, the lifestyles of these athletes could partially explain some of the demonstrated risk reduction from dying from a mental disorders or suicides.

We speculate that the increased levels of physical activity in this population could also explain the diminished risk, as physical activity is associated with many positive outcomes, including mental health benefits. Individuals who engage in regular physical activity demonstrate a better quality of life, functional capacity, and mood state.²⁹ They display lower levels of anxiety and depression and an overall increase in general well-being.³⁰ Athletes score higher on questionnaires for a set of positive personality traits, including perseverance, positivity, resilience, self-esteem and self-efficacy.³¹ The explanation for this is likely bidirectional, with personality traits leading to sports involvement and participation in sports influencing personality development. A greater level of resilience, defined as the ability to adapt to the circumstances encountered,³² along with higher levels of positivity, self-esteem and self-efficacy are associated with a better mental health^{7 33} and could help explain the diminished risk of death. Additionally, the social conditions of athletes could also contribute to a reduced risk of mortality from these mental causes by affording them more favourable lifestyles. For instance, a study in a cohort that ranged from pre-World War II to 1992 found that US Olympians were more likely to experience steep increases in socioeconomic status, with 60% reporting that being an Olympian aided them in their job acquisitions.³⁴ A higher socioeconomic status is associated with a lower rate of suicides,³⁵ while disadvantaged neighbourhoods are linked to a higher prevalence of depression and substance abuse disorder.³⁶ Due to the prominent role that the college system plays in American sports, Olympians are more likely than the general population to attend and graduate from colleges.³⁴ A higher level of education has been associated with a lower rate of suicides,³⁷ although there is some discrepancy within the literature.³⁸

Athletic performance and risks

While the risk of death is lower, the fact that athletes still exhibit deaths linked to suicides and mental disorders reinforces the notion that they are also vulnerable to the struggles faced by the general population. Mental disorders are physical conditions with physiological causes, and therefore they exist in all populations.³⁹ We found the same risk of death by such causes for medalists and non-medalists, demonstrating that the success of these athletes in their respective field does not affect their risks. There is still stigma associated with mental disorders, especially in the athletic culture, where athletes are expected to be mentally tough and resilient.⁴⁰ This could prevent them from seeking help when needed.⁴¹ Continuing to have an open dialogue around mental health will be important for improving the attention these disorders receive both in the elite athlete population and in the general public.

Access to firearms

Within the sports that had over 100 general deaths, shooting was the only sport to have a higher trend for suicides though it was not statistically significant. Deaths in this sport were due to the use of firearms. While we cannot draw any definitive conclusions from this finding, the trend towards higher death rates in former shooters may be related to the access to guns and the surrounding issues related to the use of guns. These athletes are continually inserted into the gun debate ongoing in the USA. An article leading to the Rio 2016 Olympic Games, stated that these Olympians are often the targets of media questioning, travel issues, and even death threats.⁴² It is plausible that these added stressors, not faced by other athletes, could have an impact on shooters' well-beings.

Limitations and strengths

The survival analyses performed in the present study were not adjusted by race, which would have allowed us to better characterise this cohort. As is the case for all observational studies, we cannot determine any causation effects, as we have no information on the lifestyle or physical activity habits of the Olympians after their retirement. For Olympians, causes of deaths before 1979 were not certified by the NDI, but our sensitivity analysis demonstrated that using this data did not change the magnitude or direction of our findings. Additionally, cause specific mortality rates were extrapolated for years prior to 1968, but once again, our sensitivity analysis demonstrated that this did not change the magnitude or direction of our findings. Lastly, while it is the number of survivals that mainly drive the findings, the low number of deaths related to these illnesses limits the statistical power to compare the risk of death across all sports.

Our study is the first to determine the impact of mental disorders that culminate in death on US Olympians' longevity compared with the general population. This dataset includes verified data that were certified by national institutions. In addition, the century of collected data allows us to make strong conclusions. Lastly, we completed our analysis using the competing risk method, which provides accurate quantification of years-saved without censoring deaths from other causes.

Conclusions and future perspectives

We found a lower risk of mortality from mental health issues and suicides in former US Olympians, with a mortality reduction of 43%. The risk was not different between the medalists and non-medalists. Except for shooting, which displayed higher trends of suicides, and fencing, with similar risks compared with

the general population, most sports consistently showed lower risks of deaths from mental disorders and suicides. This novel finding requires replication in other elite populations and in a wider range of sports. The present findings remind us that elite athletes, who can appear invincible to some, are not immune to these disorders and that an open, stigma-free dialogue is necessary on the topic of mental disorders and suicides. Screening for mental disorders should become common practice, and athlete follow-up should be consistent throughout and after their career to ensure those in need receive any treatment they require.

What are the new findings?

- ▶ US Olympians had a 32% lower risk of death compared with the general population for studied mental disorders, eating disorders and suicide (SMR=0.68, 95% CI 0.49 to 0.91).
- ▶ While elite athletes are still vulnerable to mental disorders and suicides, they have an increased longevity compared with the general population related to these causes regardless of whether or not they were a medalist.

How might it impact on clinical practice in the future?

- ▶ Elite athletes, who can appear invincible to some, are not immune to anxiety, depression, self-harm, substance abuse, or eating disorders and an open, stigma-free dialogue is necessary on the topic of mental disorders and suicides.

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Contributors SD conceptualised the study, wrote the manuscript and finalised the manuscript. HT completed data collection and approved manuscript. QDL completed the data analysis and approved manuscript. JS reviewed and approved manuscript. J-FT conceptualised the study, supervised the process and approved manuscript. JdSA conceptualised the study, did data analysis and reviewed and approved manuscript.

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