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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Summary Box

What are the new findings?

- US Olympians had a 32% (SMR = 0.68, 95% CI 0.49 to 0.91) lower risk of death compared with the general population for studied mental disorders, eating disorders, and suicide.
- Whilst elite athletes are still vulnerable to mental disorders and suicides, it is possible that high-level training has an impact on longevity related to these causes.

How might it impact on clinical practice in the future?

- Elite athletes, who can appear invincible to some, are not immune to these disorders and an open, stigma-free dialogue is necessary on the topic of mental disorders and suicides.

Abstract

Objective: As previous studies showed that elite athletes have rates of anxiety, depression, substance abuse, and eating disorders higher than or comparable to the general population, our aim was to determine the risk of death due to these prominent mental disorders, substance abuse, and suicides among US Olympians compared with the general population.

Methods: All female (n=2,301) and male (n=5,823) 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 applied the years-saved (YS) method to quantify differences in the probability of death for 1) anxiety, depression, and self-harm and 2) substance abuse and eating disorders in comparison to the general population. We performed a Standard Mortality Ratio (SMR) analysis.

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 for both categories of mental disorders, resulting in a longevity advantage of 0.21 YS (95% CI 0.14 to 0.29) in group 1 and 0.12 years (95% CI 0.08 to 0.15) in group 2. There were no significant differences between medalists and non-medalists, but findings varied by sports. Most sports had significantly lower risks of deaths except for shooting, which showed a trend toward 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.

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Keywords: elite athletes; Americans; mental disorders; suicide; years-lost

1. Introduction

There is a paucity of data on mental disorders in Olympic athletes, and the long-term consequences remain largely unknown. Additionally, comparisons with the general population continue to be challenging due to the absence of appropriate reference groups [1], but 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 exist between former and current athletes [1,2], along with those suffering from recurring injuries or performance difficulties [2]. Varying rates of disorders have also been reported based on the sport practiced [4]. Therefore, longitudinal follow-up and sport-based analyses are critical issues to investigate.

The risk of death due to these mental disorders is poorly understood. Suicide in elite athletes is plausible due to a variety of predispositions, including the stress, psychological traits, retirement, and injuries [5]. However, organized sport is also capable of protecting individuals against hopelessness, while leading to increased self-esteem and social connectedness [5,6]. Previous studies within the National Collegiate Athlete Association and National Football League have shown a lower suicide rate compared with the general population [7–9]. 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 [10]. 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 [11].

Accordingly, the main aims of this investigation were to determine the risk of death due to prominent mental disorders, substance abuse, and suicides among US Olympians compared to 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.

2. Methods

2.1 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 participation) was collected from reliable databases including official Olympic competitors' lists, birth registers, newspapers, published obituaries, etc., and is available online (www.sports-reference.com/olympics) [12]. 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), which provides the underlying cause of death starting from 1979 when the death register began. Currently, the NDI lists causes until 2016, which is 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 to determine the effect of causes of death found via internet on the final results.

2.2 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 (ICD) 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) (supplementary file).We focused on these causes as they have been identified as the most prevalent mental disorders among elite athletes [1,2]. We created two subcategories: 1) deaths from anxiety, depression, or self-harm and 2) deaths from substance abuse or an eating disorder.

2.3 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 [13]. 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 2016. A sensitivity analysis was conducted to verify the effect of this extrapolation by limiting the analysis to the period without extrapolation.

2.4 Data Analyses

To compare the probability of death from the analyzed causes with the general population we applied the years-saved method previously used in a cohort of French Olympians [14]. First, we estimated the cumulative probability of dying for Olympians using the Aalen-Johansen estimator. Then, the expected probability of death was calculated for the referents in the general population: for each individual in our study, the general population mortality values of individuals of the same sex and born in the same calendar year were considered. We used their values for each age from the time of participation in the Olympics until the end of follow-up. Through this, all the comparisons with the general population were adjusted by sex, birth date, and period of follow-up. The average number of years lost/saved was then estimated by calculating the difference of the areas below these two curves.

The years-saved method can be applied to cause specific death as it is based on the competing risks model [15]. 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 [15–17]. For US Olympians, analyses began at an athlete's first Olympics and lasted until either the athlete's age at death, age 90 (chosen to allow comparison with other studies [16]), or our study's end-point. For comparisons with the general population, the Olympians follow-up was synchronized 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 morality rates in the general population where people have the same age and sex.

To quantify differences in the overall mortality rates and to conduct the sensitivity analysis, we performed a Standard Mortality Ratio (SMR) analysis. The SMR allows comparison of the mortality of the studied cohort 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.

For sports that had over 100 total general deaths (athletics, rowing, swimming, fencing, and shooting), we completed sub-analyses comparing the risk of death in each sport between Olympians and general population for those who died from self-harm, anxiety, or depression. 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 confidence intervals at 95% and we considered a 2-tailed p-value <0.05 statistically significant. R software (V3.5.3; The R Foundation for Statistical Computing, Vienna, Austria) was used for our statistical analyses.

2.5 Ethical Approval and Patient and Public Involvement

This study received ethics approval from the Institutional Review Board at the University of Texas at Austin (2015-03-0035). Data analyses and protection strictly adhered to the confidential data control plan based on the specifications set by the NDI. Neither athletes nor the public were involved the in the design of this study.

3. Results

Between 1912 and 2012, 8,134 athletes (2,301 women and 5,833 men) participated in either the summer or winter Games. Ten were excluded from our analysis due to a missing birthplace or birthdate. In total, 2,309 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. The sensitivity analysis performed show no significant difference in the magnitude nor direction of the results when limiting the analysis to the period with NDI certification and without mortality rates extrapolation. By restraining the analysis to the certified period, for the two groups of mental disorders, we found a mortality reduction among Olympians of 43% (SMR = 0.57, 95% CI 0.42 to 0.77). 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). YS analysis includes the whole data set.

3.1 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 probability of death by these causes in comparison to the general population with 0.21 YS (95% CI 0.14 to 0.29) (Figure 1AB). For the 5 sports analysed, differences between sports were uncovered (Figure 2). In rowing, 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 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). Shooting showed a non-significant trend toward a higher risk with -2.49 YS (95% CI -6.41 to 1.43) compared with the general population. All suicides 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).

3.2 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 to 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 to non-medalists (p = 0.82) (Figure 3B).

4. Discussion

4.1 Athletes vs the General Population

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. This is similar to previous research on other causes of death, in which elite athletes demonstrated lower risks of dying from cancer and CVD [14,18–21] with an estimated 5-6 additional years for Finnish male elite athletes [21] and 6.5 years for French Olympians [14] of added longevity.

4.2 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 [1–4]. It is not surprising that these disorders exist due to the pressure to excel [4], constant suffering from injuries or decreased performance, and all the changes faced upon retirement [1]. Substance abuse is also prevalent as it stems from binging during off-seasons or transitional distress at the end of athletes' careers [1]. Eating disorders could be attributed to sports requiring a lean body shape [2]. However, the factors that contribute to the existence of these disorders are most likely different to those that contribute to disorders that ultimately culminate in deaths. Using the mortality as an outcome allows us to have an entirely 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. Increased 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 [22]. They display lower levels of anxiety and depression and an overall increase in general well-being [23]. Athletes score higher on questionnaires for a set of positive personality traits, including perseverance, positivity, resilience, self-esteem, and self-efficacy [24]. 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 [25], along with higher levels of positivity, self-esteem, and self-efficacy are associated with a better mental health [6,26].

The social conditions of athletes could also contribute to a reduced risk of mortality from these mental causes by affording them more favorable 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 [27]. A higher socioeconomic status is associated with a lower rate of suicides [28], while disadvantaged neighbourhoods are linked to a higher prevalence of depression and substance abuse disorder [29]. 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 [27]. A higher level of education has been associated with a lower rate of suicides [30], although there is some discrepancy within the literature [31].

Cohort selection effects 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. Olympians could possess genetic and non-genetic predispositions that are more favourable, and have healthier lifestyle habits compared with the general population [32,33]. Once again, 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.

4.3 Athletic Performance and Risks

Whilst the risk of death is lower, the fact that athletes exhibit deaths linked to suicides and mental disorders reinforces the notion that they are still vulnerable to the struggles faced by the general population. Mental disorders are physical conditions with physiological causes, and therefore they exist in all populations [34]. 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 [35]. This could prevent them from seeking help when needed [36]. 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.

4.4 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 group 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 US. 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 [37]. It is plausible that these added stressors, not faced by other athletes, could have an impact on shooters' well-beings.

4.5 Strengths and Limitations

The survival analyses performed in the present study were not adjusted by race, which would have allowed us to better characterize 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. 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.

4.6 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 to 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 also 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.

5. **Declarations**

5.1 Author Contributions

SD: conceptualization, wrote manuscript, approved manuscript

HT: data collection, approved manuscript

QDL: data analysis, approved manuscript

JS: reviewed and approved manuscript

JFT: conceptualization, supervision, approved manuscript

JA: conceptualization, data analysis, reviewed, and approved manuscript

5.2 Competing Interest and Funding

None.

5.3 Data Sharing

General population data is available from the websites listed in the methods section of this manuscript. Olympian data is not publicly available.

5.4 Ethical Approval

This study received ethics approval from the Institutional Review Board at the University of Texas at Austin (2015-03-0035). Data analyses and protection strictly adhered to the confidential data control plan based on the specifications set by the NDI.

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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

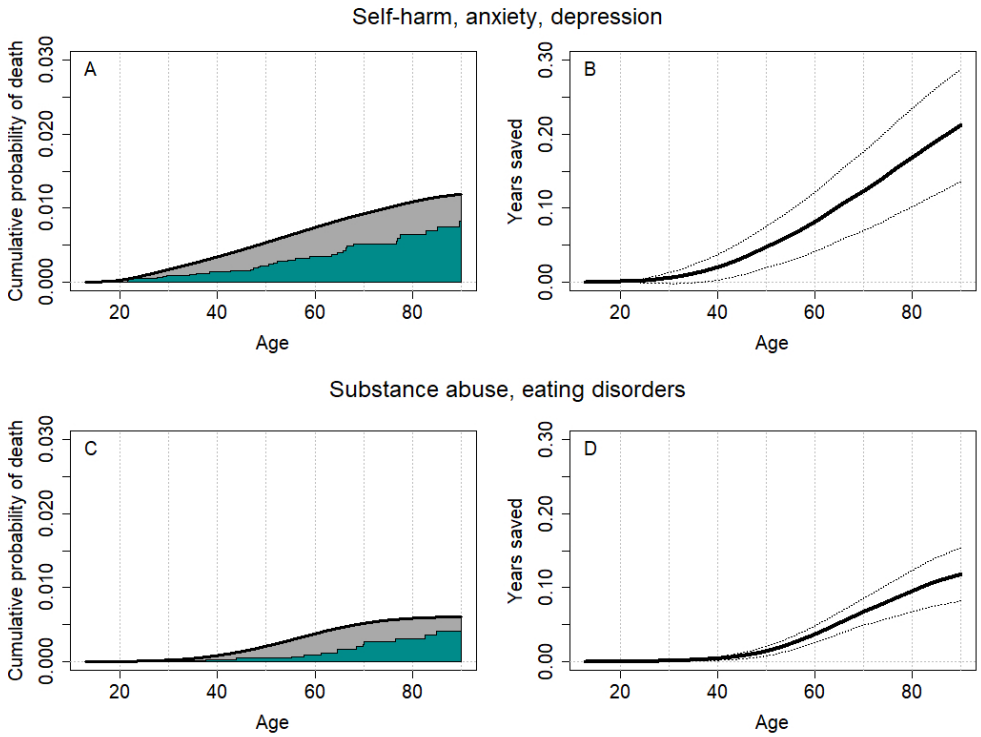


Figure 1. A. Cumulative probability of death by self-harm, anxiety, and depression among US Olympians (teal area) in comparison with the general population (black line). Figure 1B. The years-saved among US Olympians (thick line) and the 95% CI (thinner lines) due to death by self-harm, anxiety, and depression.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

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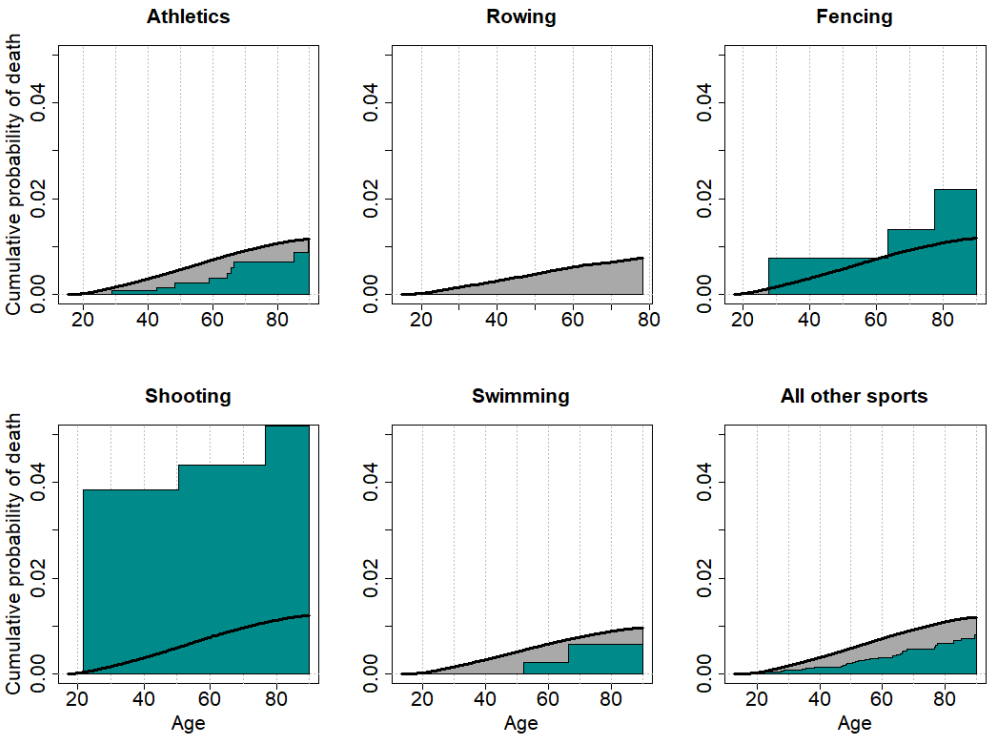


Figure 2. Cumulative probability of death by self-harm, anxiety, and depression stratified by sports among US Olympians (teal area) in comparison with the general population (black line) for sports with over 100 total general deaths.

277x210mm (96 x 96 DPI)

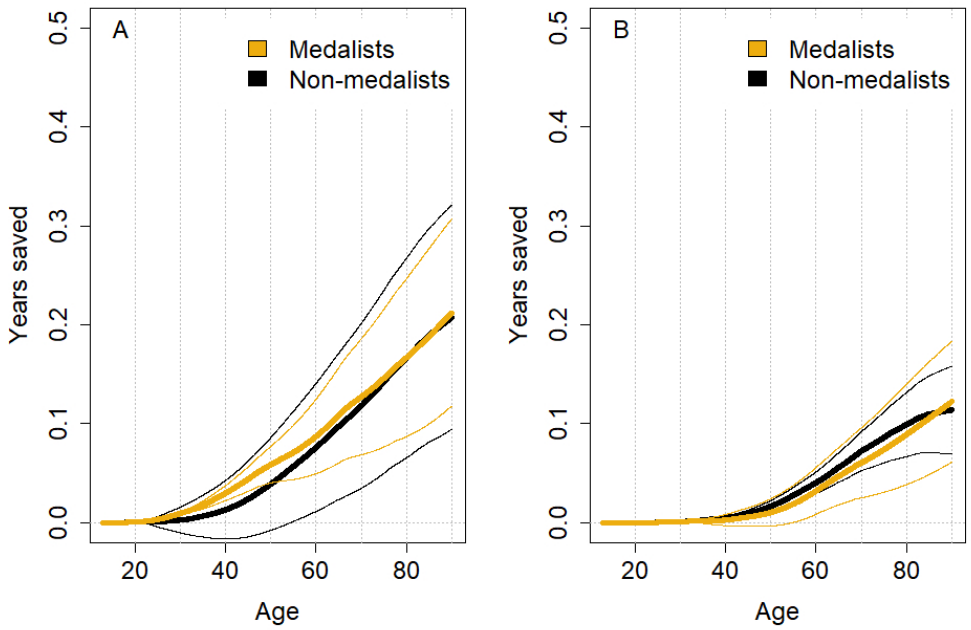


Figure 3. A. The years-saved among Olympic medalists (thick yellow line) and the 95% CI (thinner yellow lines) compared to non-medallists (thick black line) and 95% CI (thinner black lines) for the causes of self-harm, anxiety, and depression. B. The years-saved among Olympic medalists (thick yellow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

252x181mm (96 x 96 DPI)

	ICD-8 Code	Description	ICD-9 Code	Description	ICD-10 Code	Description
Substance Abuse	291	Alcoholic psychosis	291	Alcoholic psychosis	F10	Use of alcohol
	294.3	Psychosis associated with drug or poison	292	Drug psychosis	F11	Use of opioids
	303	Alcoholism	303	Alcohol dependence syndrome	F12	Use of cannabinoids
	393	Other/unspecified alcoholism	304	Drug dependence	F13	Use of sedatives or hypnotics
	304	Drug dependence	305	Drug abuse	F14	Use of cocaine
	571	Alcoholic cirrhosis	357.5	Alcoholic polyneuropathy	F15	Use of other stimulants including caffeine
			357.6	Drugs polyneuropathy	F16	Use of hallucinogens
			425.5	Alcoholic cardiomyopathy	F17	Use of tobacco
			535.3	Alcoholic gastritis	F18	Use of volatile solvents
			571.0	Alcoholic fatty liver	F19	Multiple drug use or use of other psychoactive substances
			571.1	Acute alcoholic hepatitis	G62.0	Alcoholic polyneuropathy
			571.2	Alcohol cirrhosis of liver	G62.1	Drug-induced polyneuropathy
			571.3	Alcohol liver damage unspecified	I42.6	Alcoholic cardiomyopathy
					K29.20	Alcoholic gastritis without bleeding
					K70	Alcoholic liver disease
Eating Disorders	306.5	Feeding disturbance	307.1	Anorexia nervosa	F50	Eating disorders
			307.5	Other eating disorders	R63.0	Anorexia
			783	Anorexia		
Anxiety and Depression	296	Affective psychoses	296	Affective psychoses	F30	Manic episodes
	298	Depressive psychoses	298	Depressive psychoses	F31	Bipolar affective disorder
	300.0	Neurotic disorders	300	Neurotic disorders	F32	Depressive episode
	300.4	Depressive neurosis	309	Adjustment reaction	F33	Recurrent depressive episode
	790.2	Nervousness and debility	311	Depressive disorder	F40	Phobic anxiety disorders
	309.1	Mental disorders not specified as psychosis associated with physical conditions with drug, poison, or systemic intoxication			F41	Other anxiety disorders
Self-Harm	E950-E959	Intentional self-harm	E950-E959	Intentional self-harm	X71-X83	Intentional self-harm