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### ► To cite this version:

Juliana Antero, Hirofumi Tanaka, Quentin de Larochelambert, Maja Pohar-Perme, Jean-François Toussaint. Female and male US Olympic athletes live 5 years longer than their general population counterparts: a study of 8124 former US Olympians. *British Journal of Sports Medicine*, 2021, 55 (4), pp.206-212. 10.1136/bjsports-2019-101696 . hal-03261324

**HAL Id: hal-03261324**

**<https://insep.hal.science/hal-03261324v1>**

Submitted on 15 Jun 2021

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3 **Female and male US Olympic athletes live 5 years longer than their**  
4 **general population counterparts: a study of 8124 former US Olympians**  
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34 **Word count:** 2749  
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**ABSTRACT**

**Objective:** To quantify United States (US) female and male Olympic athletes' longevity and to determine the impact of specific causes of deaths on their life duration in comparison with the US general population.

**Methods:** Female (n=2,301) and male (n=5,823) former US athletes who have participated at least once in the summer or winter Olympic Games between 1912 and 2012 were followed up to 2016. Their life status and causes of deaths were certified by the National Death Index. The years-saved method (YS) was applied to quantify longevity gains/losses in former US Olympians in comparison to the general population.

**Results:** Former US Olympians lived 5.1 years longer (95% CI 4.3 to 6.0) than their referents in the general population, based on 2,309 deaths observed out of 8,124 former athletes. The impact of each cause of death on their years-saved total was: cardiovascular diseases (CVD), 2.2 years (1.9 to 2.5); cancer, 1.5 years (1.3 to 1.8); respiratory diseases, 0.8 years (0.7 to 0.9); external causes, 0.5 (0.4 to 0.6); endocrine and metabolic diseases, 0.4 (0.2 to 0.5); and digestive system diseases, 0.3 (0.2 to 0.4). Nervous system diseases and mental disorders mortality rates were not significantly different from their peers in the general population.

**Conclusion:** US Olympians lived longer than the general population, an advantage mainly conferred by lower risks of CVD and cancer. Nervous system diseases and mental disorders do not appear to contribute to the extended Olympian longevity.

**Keywords:** elite athletes; longevity; Americans; cardiovascular disease; years-lost

## SUMMARY BOX

### What are the new findings?

- The cohort of 8,124 US former female and male Olympians, compared to the general population, saved ~2 years of life associated with a reduction of premature cardiovascular deaths and an additional of ~1.5 years associated with a lower risk of cancer.
- At total they lived 5.1 years longer.
- Mental disorders and nervous system disorders did not contribute to the greater longevity observed among US Olympians.
- The burden of each cause of deaths on Olympians' longevity was similar between male and female athletes.

### “How might it impact on clinical practice in the future”

- Analysis of health patterns, including longevity and the assessment of causes of death, provides important information about the risks elite athletes are exposed to after their career and provides indirect information about the impact of high level training on longevity.
- Investigating different cohorts of elite athletes from different countries allows us to better understand the commonalities among the cohorts. It also reveals differences in health outcomes that can guide interventions.
- The identified risks that need increased attention include nervous systems diseases and mental disorders (*e.g.* neurodegenerative diseases).

## INTRODUCTION

Elite athletes from different countries appear to have better survival rates compared with the general population [1–5]. We have previously quantified the longevity of French Olympians and showed that these elite athletes lived 6.5 years longer, an advantage mainly attributed to a lower risk of cancer [6]. From the historical perspective, United States (US) have sent the greatest number of athletes to the Olympic Games but their longevity has not been investigated. It is unknown if previous longevity benefits seen in other countries can be extrapolated to Americans given differences in sport culture, geographic-dependent parameters that interfere with life expectancy, and lifestyle differences (*e.g.*, French paradox on low coronary heart disease) [7]. In addition, the contribution of specific causes of deaths on the athletes' overall survival is not well known, especially among women that have been the focus of very few studies [1,5]. It remains unclear if the increased longevity that elite athletes display in view of a reduced mortality from major cause of deaths (*e.g.*, cardiovascular diseases, cancer), may hide increased specific risks related to other cause of deaths (*e.g.*, neurological disorders) [8].

The overall goals of the present study were to quantify US female and male Olympians' longevity as compared with their referents in the general population and to determine the impact of specific causes of deaths on their life expectancy. Based on the attested high prevalence of CVD risk factors in the US [9] we hypothesized that US Olympians would outlive the general population mainly due to a lower CVD toll.

## STUDY DESIGN

Cohort study

## METHODS

### Studied population

All female and male US athletes who have participated at least once in the summer or winter Olympic Games between 1912 and 2012 were included in the study. A total of 8,134 athletes (2,301 women and 5,823 men) were identified (Figure 1). Follow-up for cause-specific

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3 mortality included Olympians participating in the Games between 1948 and 2012, totaling  
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5 6,681 athletes (2,172 women and 4,509 men) (Figure 1).  
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8 The biographical information on the former Olympic athletes were collected from a  
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10 reliable historians' database that draws on multiple sources (*e.g.*, official Olympic competitors  
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12 lists, birth registers, newspapers, published obituaries) available online ([www.sports-](http://www.sports-)  
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14 [reference.com/olympics](http://reference.com/olympics)) [10]. Ten of the Olympians were excluded because their date and/or  
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16 place of birth were missing.  
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19 [FIGURE 1]  
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21 The Olympians' vital status were ascertained through the National Death Index (NDI).  
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23 The NDI provided underlying causes of death, beginning in 1979 (when the death register  
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25 began), coded to the International Classification of Diseases revision in effect at the time of  
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27 death (9th revision between 1979 and 1999, 10th revision after 2000). The causes of death were  
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29 categorized based on the 17 main chapters of the 9th revision.  
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33 To minimize the influence of missing identification of deaths occurring prior to 1979,  
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35 analyses concerning the causes of death relied only on Olympians competing after World War  
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37 II from 1948 to 2012 (Figure 1). The deaths occurring before the NDI identification period, or  
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39 those that were not found by the NDI, were obtained through public sources such as internet,  
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41 media coverage, or the national sport federation (Figure 1).  
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#### 44 **Data analyses**

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46 For overall survival analyses, we performed Kaplan Meier analyses. The survival curves  
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48 illustrated the survival probability of the Olympians in comparison with the expected survival  
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50 based on the mortality rates of the general population [11]. The athletes' follow-up started at  
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52 their first Olympic Games participation and ended at their date of death or at the study's end  
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54 point: January 1, 2016. For the period effect analyses on Olympians' survival, the whole cohort  
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56 was divided according to six Olympic historical periods [12].  
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3 In order to quantify longevity gains or losses, we used the years-saved method (YS)  
4 previously applied in a cohort of French Olympians [6]. The average number of years lost/saved  
5 was estimated by calculating the areas' difference of the probability of dying curves between  
6 the US Olympians and their referents in the general population. The total number of years saved  
7 was calculated from the time of the first Olympic participation until the age of death, or the  
8 study's end point or until the age of 90 (age chosen to assure comparability with previous  
9 studies [13]), whichever came first. All expected rates were estimated based on the national life  
10 tables, available by the Berkeley Mortality database (<http://bmd.mortality.org/>) and the Human  
11 Mortality database (<https://www.mortality.org/>).  
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24 The years-saved method was also employed to isolate the burden of the specific causes  
25 of death found among US Olympians, since it is based on the competing risks model. This  
26 method considers that an individual can potentially die from any cause of death, not only from  
27 the studied causes. It maintains the coherence that the sum of the years-saved/lost by each cause  
28 corresponds to the total number of years of life saved. This differs from a standard but  
29 potentially biased survival analysis that treats death other than the studied cause as censored -  
30 as if the individual were alive [14–16]. The athletes cause-specific mortality was compared with  
31 the general population mortality using the underlying causes of death rates of the US Centers  
32 for Disease Control and Prevention's WONDER database (<https://wonder.cdc.gov/>) [17]. For  
33 cause specific analyses, the Olympians were followed up from 35 years old (supplementary  
34 file) until the age of death, the study's end point or the age of 90, whichever comes earliest.  
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49 All the comparisons with the general population were adjusted by sex, birth date, and  
50 periods of follow-up. Confidence intervals were stated at the 95% level. A 2-tailed p-value  
51 <0.05 was considered as evidence of statistical significance. Statistical analyses were carried  
52 out using the R software v3.5.3.  
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## Sensitivity analyses

To account for the 71 missing causes of death (8%), the most adjusted model was used to interrogate the data using multiple imputation with chained equations (MICE) [18,19]. We created 8 different datasets with the imputed causes of deaths, corresponding to the percentage of missing data [18] (see supplementary file for details).

The protocol for the present study was approved by the Institutional Review Board at the University of Texas at Austin and was assigned to the approval number 2015-03-0035. The data were strictly subjected to the confidential data control plan according to the specification set by the NDI.

## RESULTS

### Overall survival

A total of 2,309 deaths occurred among the 8,124 US athletes who participated in the Olympic Games between 1912 and 2012. The mean age of death was  $72.4 \pm 16.1$  years. For Olympians alive up to 2016, the mean follow-up time was  $28.6 \pm 16.8$  years.

Both female and male US Olympians displayed better survival rates as compared to the general population (Figure 2A). The gap in the survival rate that male Olympians displayed in comparison with the general population was greater than that of female Olympians (Figure 2A).

The Olympians survival showed better survival rates with time, presenting a greater increase after the World War II and continuous improvements thereafter (Figure 2B), in spite of the higher mortality rates observed in period 3 among younger Olympians. This higher mortality is explained by an air plane crash involving the young figure skate team that had participated in the 1960's Games while heading to a world championship (see supplementary file for details).

[FIGURE 2]



## Overall Years lost/saved

Olympians demonstrated a lower probability of death compared with the general population (Figure 2C), resulting in a total of 5.1 (95% CI 4.3 to 6.0) years of life saved (Figure 2D). The longevity advantage is observed as early as the first 15 years after the first Olympic Games participation (Figure 2E & 2F), but more clearly later in life, as shown in Figure 2G and 2H for Olympians 50 years and older.

## Years saved/lost per causes of deaths

Regarding the 6,681 Olympians competing between 1948 and 2012, a total of 869 deceased before the study's end point. Overall, former Olympians followed up from age 35 to 90 years demonstrated a significantly lower probability of death resulting in a 5.3 (95% CI 4.9 to 5.8) years of life saved.

[FIGURE 3]

The cumulative incidence of the observed causes of US Olympians' deaths are illustrated in Figure 3C. Among female (n=2,172) and male (n=4,509) Olympians, the primary cause of deaths contributing to their greater longevity was a lower risk of CVD (*i.e.* ischemic heart diseases, cerebrovascular diseases) (Figure 4A & 4B). Among women, 1.8 years (95% CI 1.3 to 2.3) were saved through premature CVD avoidance and 2.3 years (2.0 to 2.6) among men. The lower risk of cancer deaths contributed to 1.1 (0.5 to 1.8) years saved among women and 1.6 (1.3 to 1.9) years among men. The other causes contributing to a greater longevity among US Olympians are (Figure 4A & 4B): a lower risk of death by respiratory diseases (*i.e.* chronic lower respiratory diseases, influenza, pneumonia)  $YS_{\text{female}} = 0.7$  (0.4 to 0.9),  $YS_{\text{male}} = 0.8$  (0.7 to 0.9); external causes (*i.e.* injuries, accidents, intentional self-harm)  $YS_{\text{female}} = 0.4$  (0.3 to 0.5),  $YS_{\text{male}} = 0.6$  (0.4 to 0.7) ); endocrine and metabolic diseases (*i.e.* diabetes, hyperlipidemia, amyloidosis)  $YS_{\text{female}} = 0.4$  (0.2 to 0.5),  $YS_{\text{male}} = 0.3$  (0.2 to 0.4); and digestive system diseases (*i.e.* fibrosis and cirrhosis of liver, hepatic failure)  $YS_{\text{female}} = 0.3$  (0.2 to 0.4),  $YS_{\text{male}} = 0.3$  (0.2 to 0.4). Nervous system diseases (*i.e.* Alzheimer's and Parkinson's diseases,

multiple sclerosis)  $YS_{\text{female}} = 0.1$  (-0.2 to 0.4),  $YS_{\text{male}} = -0.1$  (-0.3 to 0); and mental disorders (*i.e.* dementia, mental disorders due to psychoactive substance use)  $YS_{\text{female}} = 0.1$  (0 to 0.3),  $YS_{\text{male}} = 0$  (0 to 0.1) did not contribute significantly to the longevity advantage of the US women or men Olympians. No significant difference was observed in the risk of deaths from such diseases in comparison to the general population (Figure 5).

The impact of each cause of death on the US Olympians' total longevity is represented in Figure 4C, after the imputation of the 71 subjects with missing causes of deaths. The sensitivity analysis performed is illustrated in the supplementary file.

[FIGURE 4]

[FIGURE 5]

## DISCUSSION

### Longevity advantage

The present study demonstrated that former US Olympians lived on average ~5 years longer than their peers in the general population. The survival gap between Olympians and the general population was bigger in men although female Olympians lived longer than male Olympians. This longevity advantage was mainly attributed to a lower risk of CVD. The other causes impacting significantly and positively the Olympians longevity, according to a decreasing gradient on the number of years-saved were: cancer, respiratory diseases, external causes, endocrine and metabolic diseases, and digestive system diseases. Mental disorders and nervous system disorders, however, did not contribute to the greater longevity observed among US Olympians. The burden of each cause of deaths on Olympians' longevity was similar between male and female athletes.

Elite athletes of every nationality studied so far have shown a greater longevity compared with their fellow citizens in the general population [5]. Our recent study showed that French Olympians lived 6.5 years longer [6]. Given the slightly lower life expectancy in US (<2 years compared to France in the last decades) [20], it could be expected a greater advantage

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3 among US Olympians as the longevity gap would change accordingly to the mortality of the  
4 cohort's reference. However, our present results indicate a slightly lower longevity benefit  
5 among US Olympians (a difference of ~1.5 years), reinforcing the idea that the Olympian status  
6 does not completely obviate the mortality pressure of the environment. Elite athletes seem to  
7 follow the mortality trends observed in the general population but with diminished risks,  
8 particularly for the death causes that mortality rates are markedly elevated (*e.g.*, cardiovascular  
9 diseases). This is particularly interesting given the fact that the primary cause of death  
10 impacting the longevity advantage of US Olympians relates to cardiovascular disease, while  
11 cancer is the main cause underlying the longevity advantage of French Olympians [6]. The  
12 observations that female Olympians lived longer than male Olympians and that this pattern was  
13 the same observed in the general population also reinforces this notion. Another illustration of  
14 this phenomenon is the increased survival that Olympians displayed with time, especially after  
15 the World War II, again following the pattern observed in the US general population [21].

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33 Previous community-based studies have shown benefits of sport or physical activity on  
34 longevity starting with small amounts of regular activity [22]. The benefits seem to increase  
35 with the amount of physical activity following a non-linear fashion [23]. A cohort selection  
36 effect, such as the supposedly good lifestyle habits [24], socio-economic status as well as a  
37 favorable set of genetic and non-genetic predispositions [12,25], certainly may have also  
38 contributed to the extended longevity in Olympians. However, the specific contribution of each  
39 factor remains unknown. Yet, the extent of the cohort selection effect might be smaller than  
40 previously thought, given the large longevity differences with the general population that  
41 Olympians display even when analyzed from 50 years old onwards (Figure 2G & 2H). The  
42 observation that not all causes of death are reduced in Olympians reinforce this notion of a  
43 limited cohort selection effect.  
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## **Mental and nervous system disorders**

The absence of mortality benefits regarding mental and nervous system disorders is unlikely to be related to statistical power. Endocrine and metabolic diseases and digestive system diseases show consistent and clear differences with the general population, despite the fact that their impact on the population mortality is very low and equivalent to the impact of mental and nervous systems disorders. The equivalent mortality between US Olympians and their peers concerning mental and nervous system disorders is consistent with the emerging evidence indicating that regular physical activity does not contribute to a large reduction of the neurodegenerative diseases (a sub-category assembling the greatest disorders within the mental and nervous system disorders categories) incidence [26]. Previous studies have investigated the mortality due to mental and nervous system disorders in French Olympians [1] and professional cyclists [27], as well as neurodegenerative diseases in professional American football (NFL) players [8]. Based on smaller samples and standard mortality ratio analyses (a transversal method that does not capture mortality changes with time), a higher neurodegenerative mortality was shown in NFL players. No significant differences in French elite athletes (except for reduced mental disorders in Olympians) were demonstrated in relation to the general population.

### **Limits and strengths**

One limitation of the present study concerns the missing survival adjustments by race, which would have allowed better description of this cohort characteristics. However, we had no official information regarding the race of US Olympians. We also acknowledge the missing causes of death in some athletes as another limitation. We attempted to address this limitation by imputing them: the method applied demonstrated that the results were not affected by the missing causes of death, although the magnitude of such findings may have slightly varied.

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3 Finally, as in all observational studies, the present findings do not allow us to determine  
4 any causation effect as we have no information regarding physical activity habits of the former  
5 Olympians after the athletic retirement.  
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10 Several strengths should be mentioned. This is the first study decomposing the burden  
11 of each cause of death in both female and male elite athletes. In addition, the analyses based on  
12 the competing risk model allowed for a proper quantification of the total number of years saved,  
13 and the years saved per cause of death without censoring deaths. Finally, the dataset is based  
14 on verified data certified by national institutions.  
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## 20 21 **Perspectives**

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23 An emerging trend in ageing research in recent years targets a strategy to compress  
24 morbidity in later life years and extend the healthspan in older adults. It will be important to  
25 determine whether the increased longevity in Olympic athletes is also accompanied by a better  
26 quality of life. Finally, in view of the present absence of benefits on nervous systems and mental  
27 disorders, it will be relevant to investigate if sports associated with frequent concussions (*e.g.*,  
28 rugby, boxe, wrestling) place their practitioners at higher risks for these causes of mortality.  
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## 37 **Conclusions**

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39 US Olympians lived 5.1 years longer than their peers in the general population. This  
40 longevity benefit was mainly associated with a reduction of premature cardiovascular deaths,  
41 contributing to ~2 years of life extension, followed by a lower risk of cancer, whose benefit was  
42 additional ~1.5 years for both sexes. The decreased death rates from external causes,  
43 respiratory, digestive, endocrine and metabolic diseases also contributed to their expanded  
44 lifespan. Mortality ratios associated with mental disorders or nervous system diseases, however,  
45 are equivalent between US Olympians and their peers and did not contribute to the large  
46 longevity advantage demonstrated in these high level athletes.  
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## ACKNOWLEDGMENTS

**Contributorship:** JA designed the study, analysed the data and wrote the manuscript, MPP analyzed the data and reviewed the paper, HT collected the data and reviewed the paper, JFT designed the study and reviewed the paper.

**Competing interests:** The authors confirm that there are no conflicts of interest. All authors read and approved the final version of the manuscript.

**Funding:** This work was supported by grant from the *Assistance Publique - Hôpitaux de Paris (AP-HP)*.

**Acknowledgments:** The authors thank the *Institut National du Sport, de l'Expertise et de la Performance (INSEP)* and the University of Texas at Austin for their full support.

**Role of funding source:** The funding source had no role in the design and conduct of the study; collection, management, analysis and interpretation of the data; preparation, review or approval of the manuscript; and decision to submit the manuscript for publication.

**Ethical approval:** The protocol for the present study was approved by the Institutional Review Board at the University of Texas at Austin and was assigned to the approval number 2015-03-0035. The data were strictly subjected to the confidential data control plan according to the specification set by the NDI.

**Patient and Public Involvement:** This work was designed in the French National Sports Institute where more than 800 high level athletes prepare their Olympic season. In this context, many athletes have personally acknowledged us their concern regarding their health after their career, providing input to this research programme. In this context they have participated in the research question with us as well as in the dissemination plan of our research, concerning everyone working with high level sports.

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## FIGURE LEGENDS

**Figure 1:** Flow chart of the US Olympians cohort.

**Figure 2:** A) Survival probability for former US Olympians with 95% CI (shaded areas) in time since Olympic Games participation, split by sex. Referents from the general population given for comparison (dotted lines). B) Survival probability by age, reported according to six historical periods. p1: pre-World War I, 1912; p2: between World Wars, 1920-1936; p3: post World War II and beginning of the Cold War, 1948-1964; p4: Cold War and the Olympic boycotts, 1968-1984; p5: post-Olympic boycotts, 1988-1996; p6: latter, 1998-2012. C) Cumulative probability of death per age among former US Olympians (green area) and the general population (black curve). Zoom in: Cumulative probability of death among Olympians 15 years after their first Olympic Games (OG) participation. D) Years-saved among US Olympians per age. Zoom in: Years saved among Olympians from age 50 onwards.

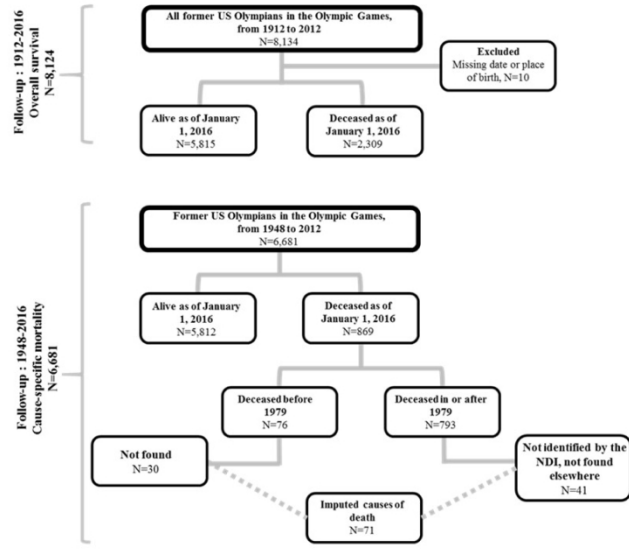
**Figure 3:** A) Cumulative incidence of death per causes of deaths observed among US Olympians and its 95% CI (shaded areas). Years-saved per cause of death among female (B) and male (C) US Olympians (thicker lines) and its 95% CI (thinner lines). CVD=cardiovascular diseases.

**Figure 4:** Representation of the impact of each cause of death on the US Olympians' total longevity before and after imputation. The upper and lower thin lines in the square represent the average of the CIs of each of the eight new data sets built after imputation. The thickest lines represent the average of years-saved calculated after imputation. The discontinued lines represent the years-saved before imputation. The dotted black line represents the longevity of reference based on the general population. CVD=cardiovascular diseases.

**Figure 5:** Cumulative probability of death per specific causes of deaths among former US Olympians (blue area) in comparison with the general population (black line).

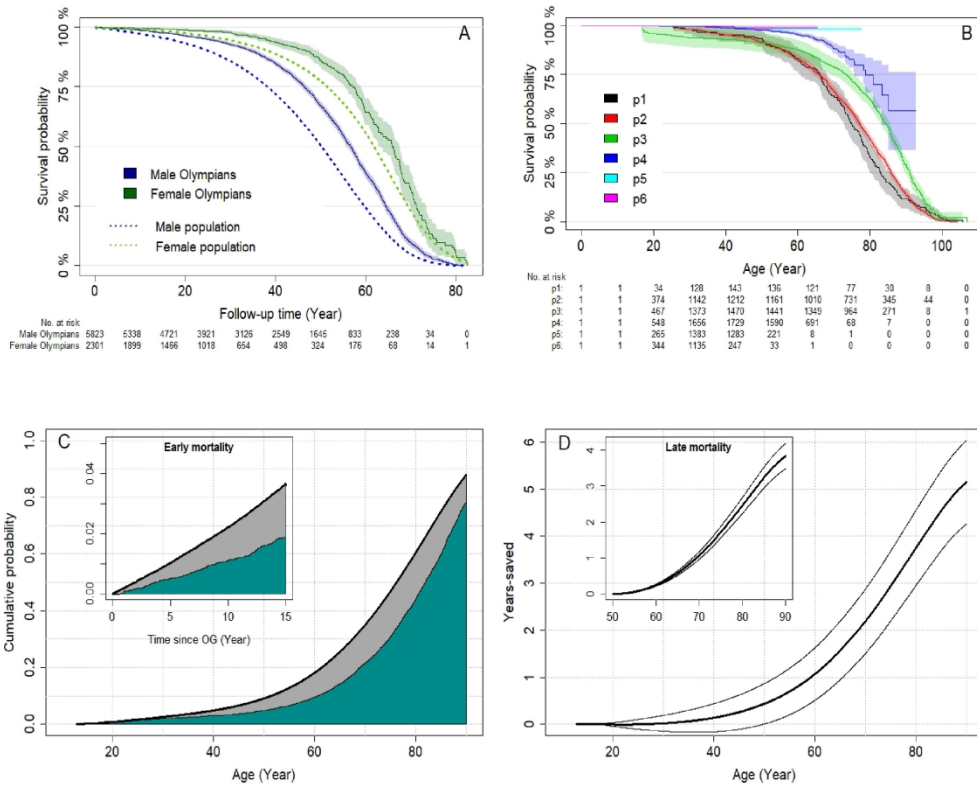
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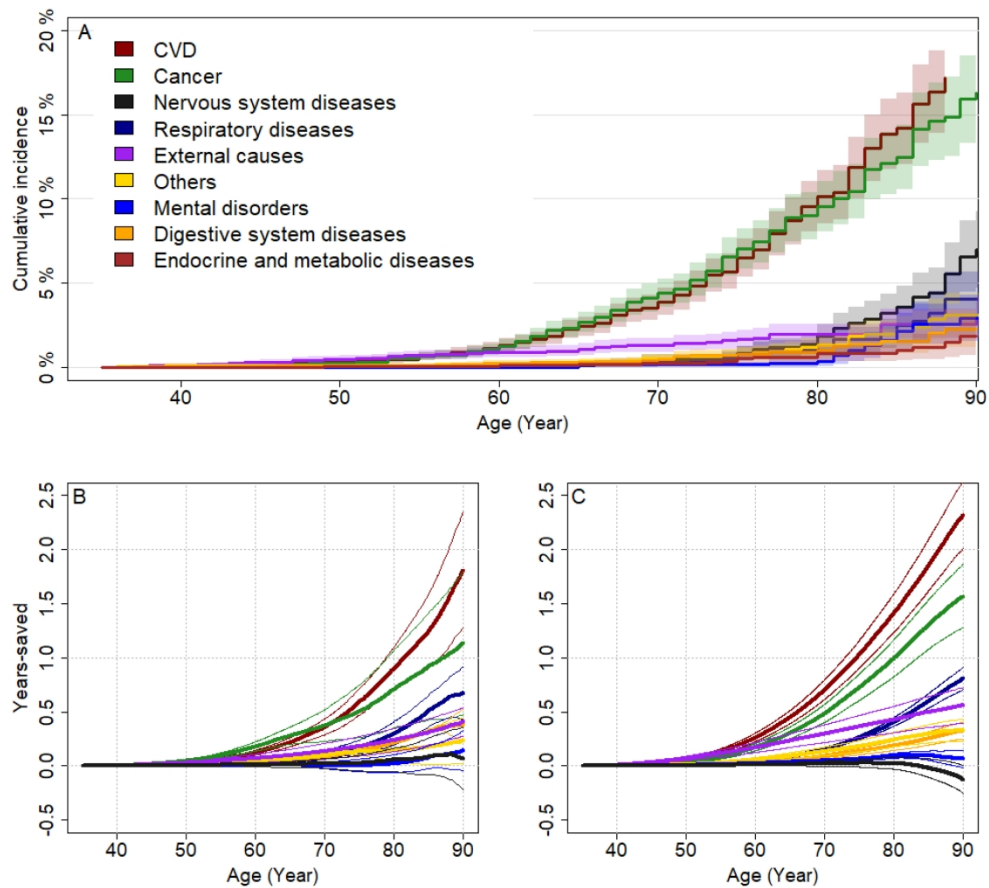
Flow chart of the US Olympians cohort.

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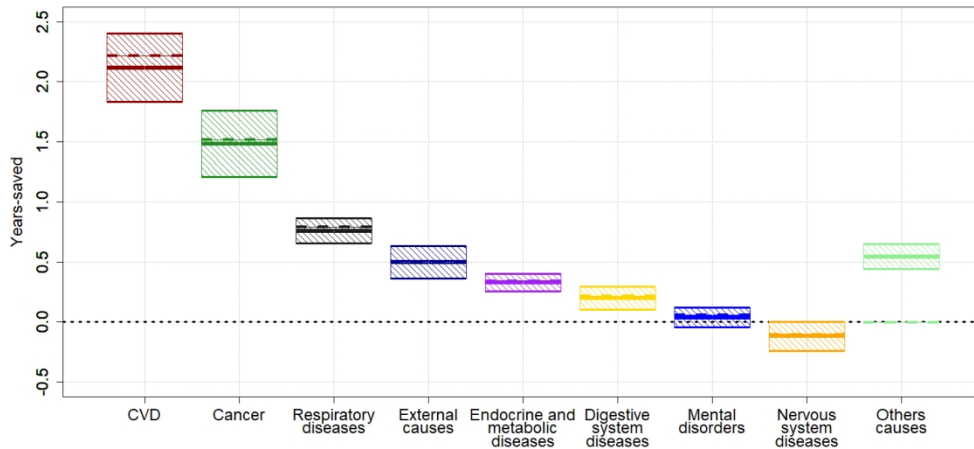
A) Survival probability for former US Olympians with 95% CI (shaded areas) in time since Olympic Games participation, split by sex. Referents from the general population given for comparison (dotted lines). B) Survival probability by age, reported according to six historical periods. p1: pre-World War I, 1912; p2: between World Wars, 1920-1936; p3: post World War II and beginning of the Cold War, 1948-1964; p4: Cold War and the Olympic boycotts, 1968-1984; p5: post-Olympic boycotts, 1988-1996; p6: latter, 1998-2012. C) Cumulative probability of death per age among former US Olympians (green area) and the general population (black curve). Zoom in: Cumulative probability of death among Olympians 15 years after their first Olympic Games (OG) participation. D) Years-saved among US Olympians per age. Zoom in: Years saved among Olympians from age 50 onwards.

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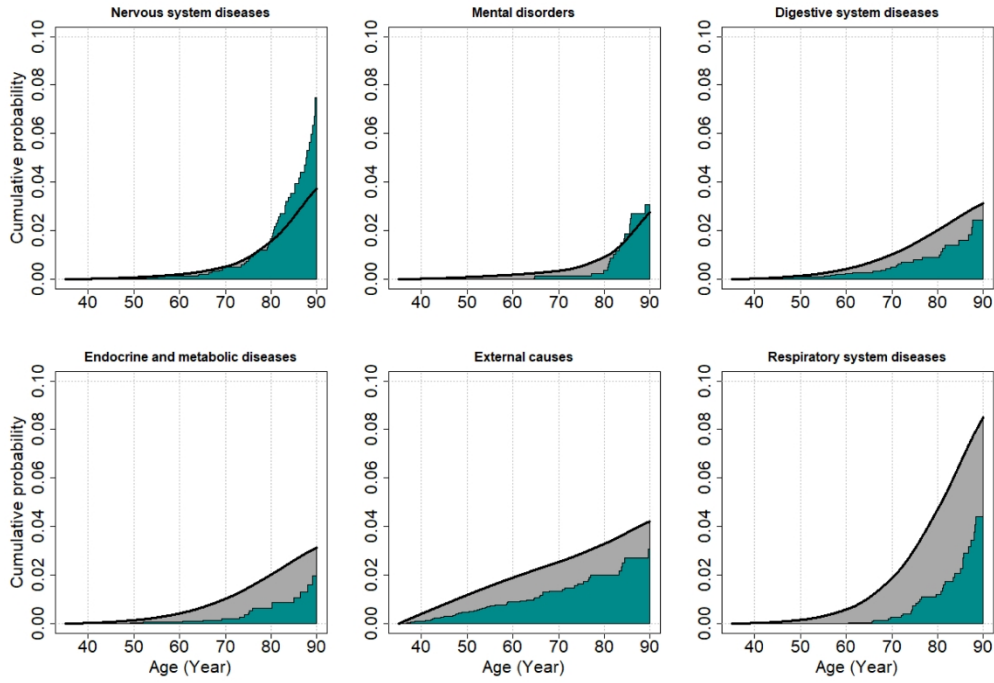
A) Cumulative incidence of death per causes of deaths observed among US Olympians and its 95% CI (shaded areas). Years-saved per cause of death among female (B) and male (C) US Olympians (thicker lines) and its 95% CI (thinner lines). CVD=cardiovascular diseases.

263x238mm (300 x 300 DPI)



Representation of the impact of each cause of death on the US Olympians' total longevity before and after imputation. The upper and lower thin lines in the square represent the average of the CIs of each of the eight new data sets built after imputation. The thickest lines represent the average of years-saved calculated after imputation. The discontinued lines represent the years-saved before imputation. The dotted black line represents the longevity of reference based on the general population. CVD=cardiovascular diseases.

391x198mm (300 x 300 DPI)



Cumulative probability of death per specific causes of deaths among former US Olympians (blue area) in comparison with the general population (black line)

326x224mm (300 x 300 DPI)

## SUPPLEMENTARY FILE

### Years of Life Saved and Causes of Death in Former US Olympians

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<sup>4</sup>Paris Descartes University, EA 7329, Sorbonne Paris Cité, Paris, France

<sup>5</sup>CIMS, Hôtel-Dieu, AP-HP, Paris, France

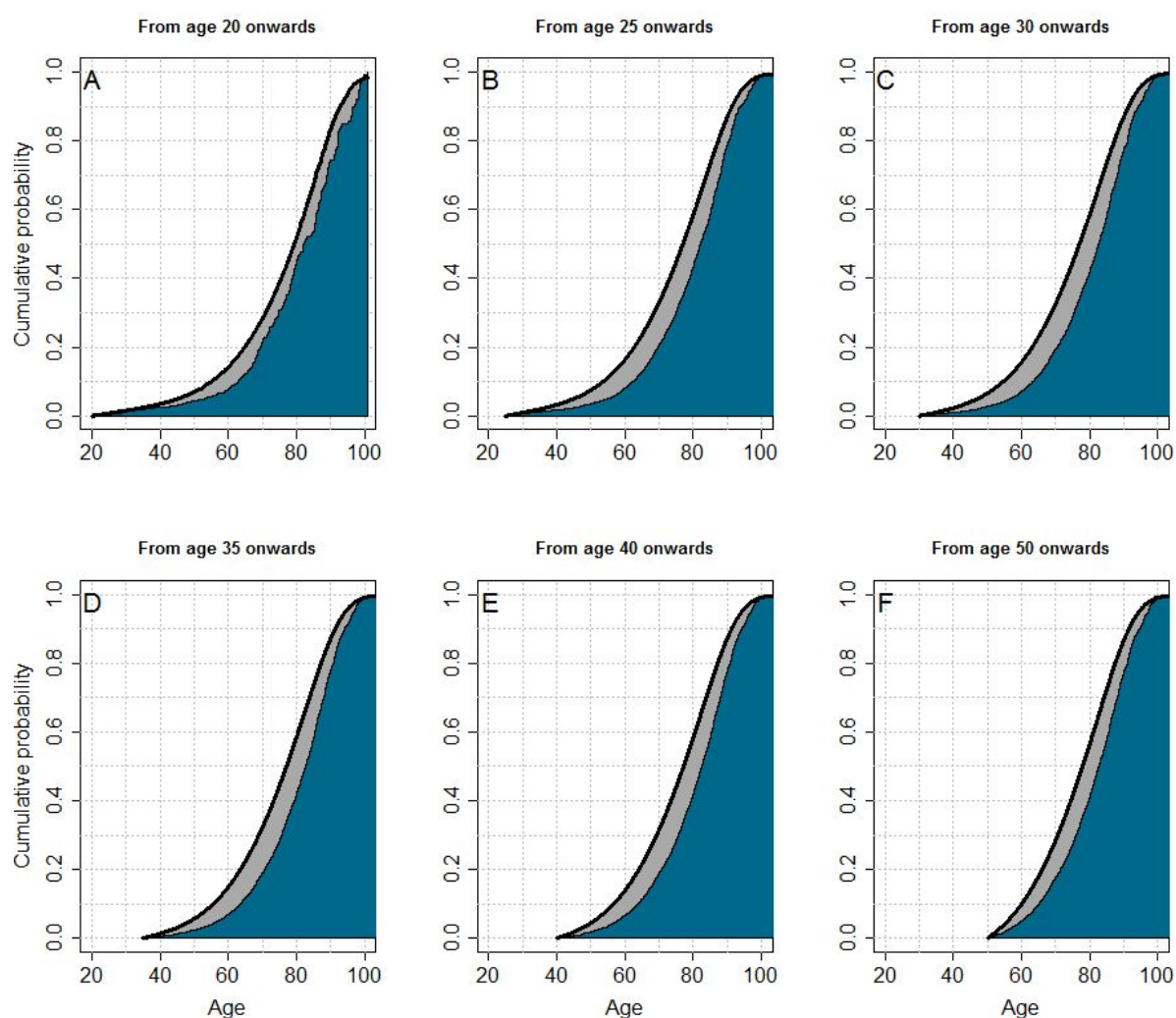


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### The effect of the age at the cohort' entry

We assumed that at a certain age, all individuals have the same risk regardless of the age they competed in their first Olympiad. To test the effect of age at the cohort entry we analyzed the cumulative probability of death considering only individuals who had already been at Olympics by the age of 20, 25, 30, 35, 40 and 50 years (Figure S1).



**Figure S1:** Cumulative probability of death conditional to the age of first Olympic participation. A) From age 20 onwards. B) From age 25 onwards. C) From age 30 onwards. D) From age 35 onwards. E) From age 40 onwards. F) From age 50 onwards.

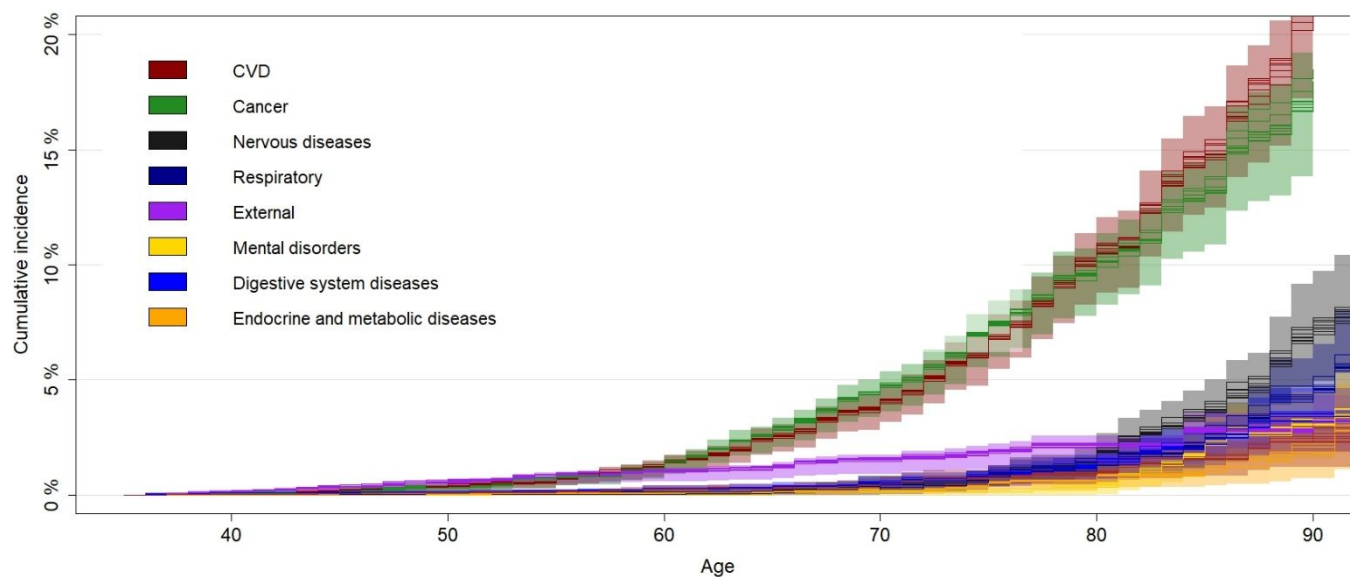
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3 The cumulative probability of death is similar for every group of age, with the exception  
4 of the youngest group (which is based on the smallest sample). There is little gain in the number  
5 of years saved before turning 40, since mortality in the general population is also low.  
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10 With the age of the athletes as the time scale of interest, the cause of death analyses were  
11 performed conditional on athletes surviving to a certain age and excluding those who competed  
12 in the OG at a later age. The age of 35 was chosen, as this age represents the best concession  
13 between a loss of information (for athletes competing at older ages) and the longest follow-up.  
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### Sensitivity analyses of the imputed data

The cumulative incidence of the different causes are represented after imputation in figure S2. All the 8 data sets built with imputed data for missing causes of deaths show similar cumulative incidences: all cumulative incidence curves are comprised in the 95% CI of the original data. This illustrates a high concordance and the robustness of the chosen imputation model.

In addition, the missing causes of death are not related with the causes itself. For the deaths occurring before 1979 (42%), data are missing due to the lack of official sources to confirm death certificates. For the missing identification of cause of deaths occurring after this period (58%), data are missing completely at random, mostly related to the communality of the athletes' names. We observed that the more unusual their names were, the easier their identification in the NDI database.

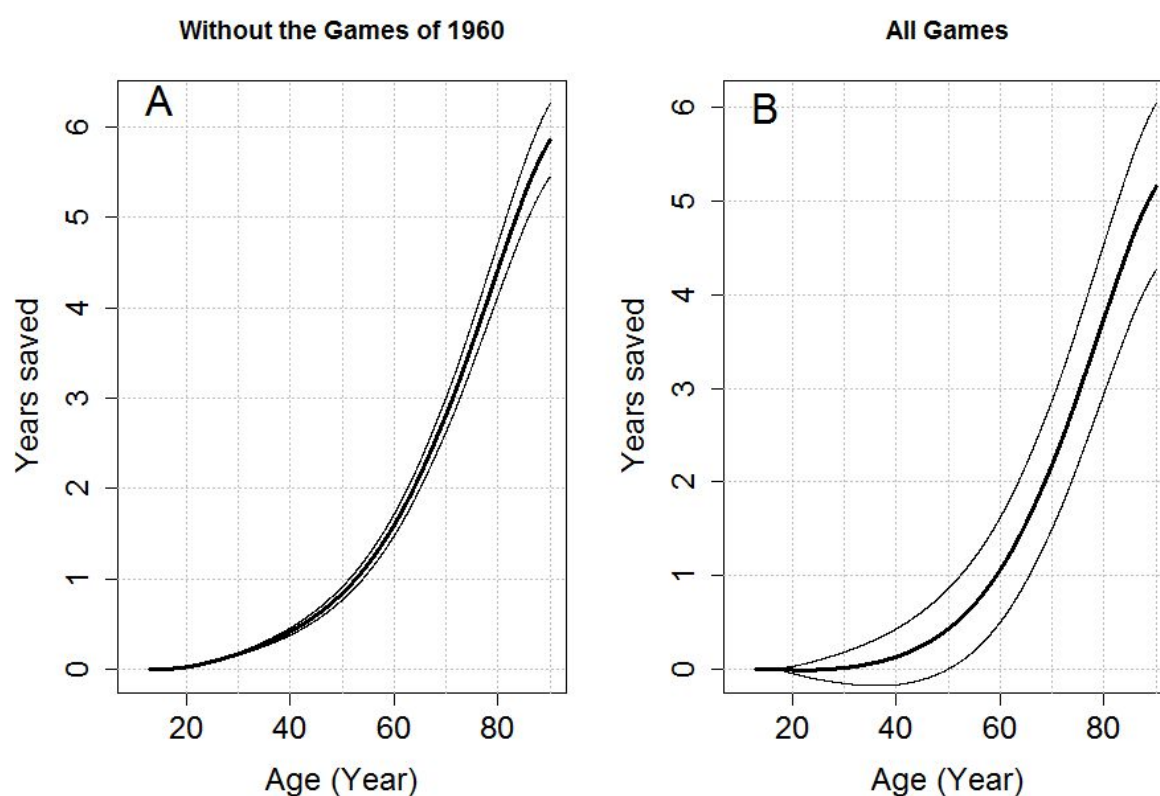


**Figure S2:** The cumulative incidence of causes of deaths for each of the eight different datasets created after imputation (thin lines). The 95% CI (shaded areas) is based on the data before imputation.

### Premature deaths in the period 3 (post WWII, 1948-1964)

We observed an unusual number of deaths among young Olympians during period 3, occurring simultaneously and related to external causes. All these deaths concerned Olympians who participated to the 1960's Games. The single reason for these deaths relates to a plane crash, killing the entire US figure skating team one year after their participation in the Games, as confirmed through public sources <sup>1</sup>.

The effect of such an incident in the years-saved analysis is illustrated in Figure S3.



**Figure S3:** Years-saved among US Olympians. A) Excluding all the athletes (n = 270) participating in the 1960 Olympic Games. B) All US Olympians (n= 8124).

We observed that the 95% CI is much narrower when excluding the 1960 Games, resulting in a total of 5.8 years-saved (5.5 to 6.3). This single accident affects the analyses

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3 because the athletes were very young (under 20 years old) and mostly women, for which the  
4 mortality rates in the general population are extremely low.  
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8 Acknowledging the atypicality of these deaths, we still could not exclude them as they  
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10 were associated with the status of Olympian (they all were heading to a competition). Yet, the  
11 analysis of the causes was not affected by this incident, since it starts at 35 years old.  
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