Dying to Win? Olympic Gold Medals and Longevity*

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Abstract

This paper investigates how status affects health by comparing mortality between Gold medalists in Olympic Track and Field and other finalists. Due to the nature of Olympic competition, analyzing performance on a single day provides a way to cut through potential endogeneity between status and health. I first document that an athlete's longevity is affected by whether he wins or loses and then detail mechanisms driving the results. Winning on a team confers a survival advantage, with evidence that higher mortality among losers may be due to poor performance relative to one's teammates. However, winning an individual event is associated with an earlier death. By analyzing the best performances of each athlete before the Olympics, I demonstrate that an athlete's performance relative to his expectations partly explains the earlier death of winners in individual events: on average, Olympic Gold medalists expected to win, but losers exceeded their expectations. Conversely, athletes considered "favorites" but who fail to win die earlier than other athletes who also lost. My results are robust to estimating a range of parametric and semi-parametric survival models that make different assumptions about unobserved heterogeneity. My central estimates imply lifespan differentials of a year or more between winners and losers. The findings point to the importance of expectations, relative performance, surprise, and disappointment in affecting health, which are not highlighted by standard models of health capital, but are consistent with reference-dependent utility. I also discuss potential implications for employment contracts in terms of a trade-off between ex post health and ex ante incentives for productivity.

JEL codes: I12, I14, M12, M50

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I. INTRODUCTION

There is no sufficient statistic for health. Large differences in mortality across and within countries are only partially explained by variation in income, education, diet, and other factors (Cutler, Deaton, and Lleras-Muney, 2006). One possible determinant of health that remains particularly poorly understood is status, which can loosely be defined as relative economic or social ranking. While the biology and epidemiology literatures have advanced our knowledge about the correlation between status and health (Sapolsky, 2004; Marmot, 2006), several reasons explain our limited understanding of status. First, the concept of status is difficult to measure empirically. Second, the channels between status and health are complex, with causality likely running in both directions. Finally, status is often correlated with other factors, such as income, that may independently influence health. Disentangling the causal channels between status and health is thus challenging.

By examining a setting where such problems are minimal, this paper attempts to shed light on how status affects long-term health. I compare mortality between Gold medalists and other finalists in Olympic Track and Field from 1896 to 1948 and explore behavioral mechanisms driving the correlation between status and health. Variation in status is based simply on winning or losing. I focus primarily on Gold medalists relative to those finishing in second through eighth place since victory is arguably the key measure of success among these athletes. Coverage in the popular press supports this claim: since 1896, there have been over 10 times as many news articles featuring the phrase "Olympic gold medal" than "Olympic silver medal" or "Olympic bronze medal" combined, based on data from the newspaper collection website newspaperarchive.com. However, I also examine the effect of winning a Silver or Bronze medal in some analyses.

The setting of Olympic Track and Field provides a number of advantages to analyze this question due to the nature of competition. First, Track and Field includes events in running, jumping, and throwing that use only time or distance to objectively measure performance (unlike some other sports, such as gymnastics, that rely in part on subjective measures for scoring). In each event, the order of finishers creates a clear and undisputed ranking, even though the differences between competitors may be just fractions of a second. The stakes of such competition are high, with an Olympic victory representing the pinnacle of the sport and carrying global recognition. Finishing place in the Olympics can thus be viewed as the key measure of status among such athletes.

A second advantage is that awarding status is rare, with the winner determined on a single day every four years. As a result, randomness is arguably more likely to influence the outcome compared to a contest judged over a longer time period. As I document below, the athlete with the best performance in the year prior to the Olympics often fails to win the Olympic final. Moreover, 21 percent of athletes who have ever held a World Record never win any Olympic medal (Gold, Silver, or Bronze).[1] Since World Records are rare, the fact that many World Record holders never finish better than fourth place demonstrates previous success does not guarantee success in the Olympics.

Third, the setting of Olympic Track and Field provides an opportunity to cut through potential endogeneity of status by comparing people who are physically similar and relatively young. Within a given event in Track and Field, the differences in health between any two athletes are likely negligible by virtue of their participation in the Olympic final. As supporting evidence of this claim, I show that differences in ability between Olympic finalists—which may positively correlate with latent health—do not predict mortality by comparing athletes who ever held a World Record (the highest ability group) and those who did not. I find that World Record holders die earlier than other athletes, which contradicts the idea that higher ability athletes have better unobserved, latent health. Moreover, once I control for finishing place, the coefficient estimate on ability is no longer statistically significant but the estimate on finishing place is. Since athletes are generally young during Olympic competition, it is natural to interpret the relationship between their finishing place and longevity as how status early in life impacts long-term health. There is therefore less concern that results are biased by reverse causality where health determines status. However, performance-enhancing drugs (PEDs) complicate this relationship to the extent that PEDs influence both health and the chance of winning. Since it is obviously difficult to determine which athletes are using PEDs, I restrict my analysis to a period when there were no signs or suspicions of PEDs in Olympic competition.[2]

Finally, income associated with winning is likely not a factor among these athletes due to the prevailing system of amateurism. Until the 1980s, regulations prohibited professional athletes from competing in the Olympics, restricting participation to amateurs. These regulations were strictly enforced, as demonstrated by stripping the legendary Jim Thorpe of his two Olympic Gold medals in 1912 for playing minor league baseball (Flatters, 2000). As additional evidence that successful Olympic athletes received little financial rewards from winning, most held other occupations while training between Olympic Games. Moreover, the Gold medal itself was worth a modest amount in terms of its metallic content (Economist,

[1]This statistic excludes athletes who competed during the years when the Olympics was canceled due to WWI and WWII and so is not artificially deflated.

[2]A recent study on doping in Track and Field found almost 30 percent of athletes competing in the 2011 World Championships reported doping within the past year, using an anonymous, randomized response survey (Rohan, 2013). However, just 2 percent of drug samples analyzed by the World Anti-Doping Agency in 2010 reveal evidence of performance-enhancing drugs.

2012).

Taken together, these advantages lead to cleaner identification of the relationship between status and health compared to previous literature. As I describe in Section II, the Whitehall studies of British civil servants provide convincing epidemiological evidence of a strong relationship between status and health in an employment setting (Marmot et al., 1991), but the causal direction and mechanisms are still debated (Chandra and Vogl, 2010; Case and Paxson, 2011). Recent research on status and health in the economics literature follows an approach similar to mine, focusing on well-defined occupations where status is based on receiving awards: Nobel laureates, Oscar winners, and Major League Baseball Hall of Famers (Sylvestre, Huszti, and Hanley, 2006; Becker, Chay, and Swaminathan, 2007; Rablen and Oswald, 2008). However, unobserved heterogeneity and the arguably less random assignment of status in these settings limits the inferences that can be drawn. Perhaps most importantly, such studies have not traced out the mechanisms through which status impacts health. A major contribution of this paper is to uncover behavioral mechanisms underlying the conditional correlations between status and health.

From a theoretical perspective, the relationship between health and higher status from winning is ambiguous. On the one hand, higher status from winning may improve health by reducing stress and increasing self-esteem. Biological studies of non-human primates provide empirical support for this theory by documenting that a lower hierarchical ranking within the community is often associated with chronic stress and compromised immunity (Sapolsky, 2005). One recent experimental study of rhesus macaques pinpointed the molecular mechanisms behind such psychosocial responses, demonstrating that manipulating social status (dominance rank) affects gene regulation tied to immune defense (Tung et al., 2012). In humans, observational analysis from the Whitehall II studies points to biological links between job stress and worse health, such as metabolic syndrome, cortisol—a hormone released in response to stress, and heart rate variability (Marmot and Brunner, 2005). Studies measuring the effect of income inequality on health status using survey data have reached mixed conclusions (Mellor and Milyo, 2002; Gerdtham and Johannesson, 2004; Hildebrand and Van Kerm, 2009; Kondo et al., 2009). In a neoclassical framework where the length of life is endogenously determined by equating the marginal costs and benefits of investments in health (Grossman, 1972), the stress from losing may reduce longevity by leading to lower flow utility per period, so that the marginal cost of an additional year of life overtakes the marginal benefits earlier among losers.

On the other hand, winning may harm health through a number of channels. First, the pressure to continue to be the best may increase stress. Other biological studies find that under certain conditions, such as when the hierarchy is unstable, the highest-ranking animals experience the greatest stress from psychosocial factors (Sapolsky, 2005). Second, winning might harm health by inducing complacency, since once someone has reached the top, the only place to go is down; recent research in personnel economics suggests informing employees of their relative performance induces top performers to exert less effort in the future (Barankay, 2012b). A third possibility is that those narrowly missing out on victory exert greater future effort, so that the health of losers improves relative to winners. Analysis of NBA basketball games demonstrate that being slightly behind in the score during halftime boosts motivation that ultimately leads more often to winning, on average, despite the initial score differential (Berger and Pope, 2011). Through laboratory evidence, Berger and Pope show their result is likely driven by heightened motivation among those narrowly behind in score, rather than diminished effort by the team ahead. So contrary to the implicit view of some previous research that higher status necessarily improves health, I assume several channels may operate (perhaps simultaneously). How status affects health is thus an empirical question.

Matching data on Olympic finishing order with each athlete's date of birth and death, I find the longevity of Olympic Track and Field athletes is highly correlated with whether they win or lose. The data allow me to control for observables like height, weight, country, event, and year of birth, which may also be correlated with both finishing place and longevity. Interestingly, the sign of the correlation hinges on whether the athlete competes in an individual event or a team event. In team events, winners live longer than losers. But in individual events, winners die earlier than losers. Although these results may initially appear conflicting, I provide evidence of specific behavioral mechanisms that may explain these patterns, and find support for the importance of performance relative to reference points.

In particular, I show that performance relative to personal expectations is a driving force behind the earlier death of winners in individual events. An athlete's ranking before the Olympics can be viewed as their expectation-based reference point (Koszegi and Rabin, 2006) by which he judges performance. To measure how an athlete performed relative to his expectations, I compile a ranking of the top 40 performances during the four-year period before each Olympics, and compare this pre-Olympic ranking to the order of finishers in the Olympic final. On average, Gold medalists were ranked near the top of the pre-Olympic ranking more often than other finalists. However, the relationship between the two rankings is still noisy, supporting the argument that randomness plays an important role in the Olympic final. For example, 13 percent of Gold medalists had the top performance prior to the Olympics compared to 2 percent of athletes finishing in 4th place or worse, but 46 percent of Gold medalists and 60 percent of athletes finishing 4th or worse were not even in the top 40 before the Olympics. Using this empirical measure of relative performance based on the "distance" from each athlete's pre-Olympic ranking, I document that athletes who surpass their expectations live longer than those who either met or performed worse than their expectations, even conditional on finishing place. In addition, athletes who were considered "favorites" based on their pre-Olympic ranking but lost die earlier than other losers. Any regression to the mean will only serve to understate the effect of deviations from the expectation-based reference point on health.

In team events, the natural reference point is how one performs relative to other teammates and I find this measure of relative performance may explain why losers in team events die earlier. Using the times recorded by each leg of the 4x400 meter relay ("splits"), slower team members die earlier than faster members within losing teams. Yet mortality does not differ between faster members of losing teams and all members of winning teams. Since I show that ability is likely not driving longevity differentials, slower members on losing teams perhaps feel guilty for "letting their teammates down." Consistent with the importance of performance relative to other team members, I show there is less within-team variation in longevity among losing teams when an individual's contribution to team performance cannot be objectively measured using results from Olympic Rowing and the Tug-of-War. These team-based events shed additional light on peer-defined reference points because each athlete's individual effort is unobservable: there is no way to measure how hard any one person is rowing or pulling the rope by watching the entire team. This lack of information on relative performance is the opposite of the 4x400 meter relay, where each team member's time can be perfectly observed. Consistent with the importance of performance relative to one's peers in team competition, I find there is substantially less within-team variation in Rowing and the Tug-of-War than in Track events. I investigate other possible mechanisms, such as the extent of newspaper coverage and winning or losing when the Olympics is in an athlete's home country, but find little support for either of these explanations.

Overall, the hazard estimates are sizable in magnitude, implying lifespan differentials of a year or more between winners and losers. This is economically significant. By comparison, estimates of the role of income on mortality vary widely based on age and the type of data, ranging from zero to roughly twice as large as my estimates of status (Smith, 1999; Deaton and Paxson, 2001; Deaton, 2003; Cutler, Lleras-Muney, and Vogl, 2011). Since comparison groups are clear in the Olympics (winners and losers), unlike in many settings (Deaton and Paxson, 2004), the findings suggest status has first-order effects on health, at least among this select population. My results are robust to estimating a range of parametric and semi-parametric survival models that make different assumptions about unobserved heterogeneity. A number of sensitivity tests verify that no country- or time-specific subset of the data drives the results. Finally, my estimates are larger in Olympic Games that were more heavily publicized and in premiere events, where any status shock to winning is arguably greater.

In addition to contributing to empirical research on the gradient between status and health, the paper's findings relate to two other strands of literature. First, models of health capital form the analytic basis of health economics research on health behaviors and mortality (Grossman, 1972; Rosen, 1988; Ehrlich and Chuma, 1990; Murphy and Topel, 2006; Hall and Jones, 2007). In this framework, there is no role for ex post performance relative to expectations; individuals rationally estimate the probability distribution of outcomes ex ante and the state of the world only affects health through changes in real resources or prices. In particular, the substitution axiom of expected utility theory rules out any role for disappointment or surprise. By contrast, the mechanisms that appear to underlie the mortality differences in my setting are fundamentally behavioral, stemming from ex post performance realizations. A number of economic models focus on the role of status and rank incentives in utility (Frank, 1985; Cole, Mailath, and Postlewaite, 1992; Bagwell and Bernheim, 1996; Postlewaite, 1998; Rayo and Becker, 2007; Moldovanu, Sela, and Shi, 2007; Samuelson, 2004; Rablen, 2008) or concepts of disappointment and reference-dependent preferences (Bell, 1982; Loomes and Sugden, 1982; Koszegi and Rabin, 2006). This paper adds to the literature that empirically tests reference-dependent preferences based on expectations (Abeler et al., 2011; Crawford and Meng, 2011) and social comparisons. My findings also relate to empirical research documenting the importance of relative rank in both observational settings (Luttmer, 2005; Heffetz, 2011) and with experimental data (Heffetz and Frank, 2011; Tran and Zeckhauser, 2012; Barankay, 2012a).

Second, my results may have implications for the incentives and organizational structure of competition within firms. The issue of employee health has not received attention in seminal tournament theory models (Lazear and Rosen, 1981; Nalebuff and Stiglitz, 1983; Rosen, 1986; Lazear, 1989) or more recent extensions (Devaro, 2006; Waldman, 2013; Chen and Lim, 2013). This omission from the personnel and organization economics literature is not surprising since the key agency problems of firms relate to information asymmetries about employee productivity. Yet in addition to the value of production, employee health may enter into the objective functions of both employers and employees. Some recent tournament theory research explicitly models employee valuations about status and the philosophical concept of "desert"—defined as whether the employee "deserves" the outcome based on effort exerted by him and his opponent—which are fundamentally ex post concerns (Ederer and Patacconi, 2010; Gill and Stone, 2010). My paper's findings relate to such studies and may have implications for contracts in employment settings. For example, if an employee's health is affected by his performance relative to his own expectations, then the employer may strategically consider the messages it sends about promotion chances so the employee "does not get his hopes up." And if relative performance within competing teams affects employee health, an employer may seek to structure the composition of competing teams in terms of ability to balance production and health-related effects. As I discuss later, my findings suggest the possibility of a trade-off between (ex post) employee health and (ex ante) incentives for productivity, which bears some similarity to the incentive effects of superstars on effort in tournaments (Brown, 2011). More generally, this paper's results on teams suggests that, in some cases, peer effects may be persistent (Ichniowski and Preston, 2013) rather than temporary (Mas and Moretti, 2009).

The remainder of the paper proceeds as follows. Section II reviews previous literature on health and status. Section III discusses my setting and data. Section IV presents the empirical methods and Section V contains the main results. I detail potential mechanisms behind the relationship between status and health in Section VI. Section VII presents robustness checks and a falsification test. Finally, Section VIII discusses the findings and concludes.

II. PREVIOUS LITERATURE

Previous research, mostly from the epidemiology and medical literature, has illustrated a positive gradient between health and status. The Whitehall Study of British Civil Servants in the 1960s and its second iteration in the 1980s—known as Whitehall II—represent major contributions in the field (Marmot et al., 1978, 1991, 2001; Marmot and Feeney, 1997). The key insight from Whitehall I was the marked social gradient in health across different ranks of men in the civil service, all of whom were above the poverty level. Conventional risk factors explained only one third of the difference in mortality risk between clerical and administrative grades (Marmot and Brunner, 2005). For heart disease, for example, clerical workers faced a relative risk of dying that was 2.2 times higher than senior administrative staff, and 1.6 times higher than employees in intermediate professional and executive positions.

The aim of Whitehall II was to uncover the mechanisms behind these patterns. All members of the non-industrial British civil service between ages 35 and 55 were invited to participate, and 73 percent did, with many women this time. A social gradient in smoking and obesity explain part of the inverse relationship between status and health. Moreover, though, research from Whitehall II has traced the biological links between disease and stress, social support, and the organization of the workplace.

While the Whitehall research clearly reveals the important and sizable link between status and health, the possibility of endogenous selection into Civil Service ranks raises concerns about how to interpret the results. It is difficult to disentangle the extent to which higher status led to better health or whether better unobserved initial health led to or was otherwise correlated with higher status (Chandra and Vogl, 2010). As evidence of selection, Case and Paxson (2011) find that current self-assessed health in the Whitehall II sample predicts future civil service grade, but current civil service grade does not predict future self-assessed health. In addition, some research also disputes the mechanisms between status and health analyzed in the Whitehall research. A prospective cohort study of Finnish industrial employees found that low predictability at work was highly correlated with heart attack risk, but other organizational factors highlighted by Whitehall—such as low decision autonomy at work—were not (Vaananen et al., 2012).

Recent research largely by economists has examined major shocks to status, such as winning the Nobel Prize (Rablen and Oswald, 2008), election to the Major League Baseball (MLB) Hall of Fame (Becker, Chay, and Swaminathan, 2007), or receiving an Oscar (Sylvestre, Huszti, and Hanley, 2006). The assumption behind these studies has tended to be that status should improve health, and there is evidence of this for the Nobel Prize and MLB Hall of Fame but inconclusive results for Oscar winners. However, unobserved heterogeneity and the process of choosing winners may limit what can be drawn from these studies. For example, there are good reasons to think that the physical attributes of Oscar nominees differ in ways that affect their health, and bias may stem from correlation with the likelihood of winning an Oscar. People may also undertake different lifestyle decisions, follow different diets, and value their health in unobserved ways. The same might be said for Nobel laureates and their peers. Importantly, actors, baseball players, and academics are all professionals who can be financially compensated for their work. Higher income associated with status may thus confound comparisons of longevity within these populations. Since Olympic athletes in the early 1900s were all amateurs, my setting does not face this problem. Another issue is that these previous studies judge performance over a longer time frame. For example, baseball players nominated for the Hall of Fame are assessed over their entire career. The long duration of such assessment would seem to increase the chance that the factors that lead people to succeed may be correlated with their mortality prospects. Overall, it seems reasonable to believe that there is less unobserved heterogeneity among Olympic athletes within any given event than among Nobel laureates, Oscar nominees, or MLB players.

Only one other study has examined longevity of Olympic athletes, using data on all Olympic sports through 2010, but it did not focus on status (Clarke et al., 2012). Instead, the study compared longevity of Olympic medalists to the general population matched on age, sex, and country. Olympians were observed to live 2.8 years longer, which is not a particularly surprising finding. Moreover, relying on the general population as a control group did not permit the research design to isolate the mechanisms driving the mortality differences, which may be explained by genetics, exercise, diet, income, or status.

III. DATA AND SETTING

I focus on the setting of Track and Field because it is the oldest sport where performance is objectively measured. The only sport for the first 13 of the ancient Olympic Games that began in 776 BC was a 1-stadium length sprint—called the "stadion"—measuring 192 meters (Perrottet, 2004, p.138). Running races carried prestige even when boxing, wrestling, and chariot racing were added; the four-year period between each Games (known as the Olympiad) was named after the winner of that year's stadion, considered the "blue ribbon event of the entire Games" (British Museum, 2013; Perrottet, 2004, p145). While Swimming and Cycling are other modern day sports where performance is objectively measured, these were not part of the ancient Olympics that lasted for 12 centuries. Moreover, in today's modern Olympic Games, fewer nations and fewer athletes compete in Swimming or Cycling than in Track and Field. As a result, Track and Field is arguably the most prestigious Olympic sport and the one where any evidence of status affecting health seems most likely to be detected.

My primary data source includes the order of finish, year of birth, and date of death of Olympic athletes collected from the site SportsReference.com. The data also includes the country the athlete competed for, their height (measured in centimeters) and weight (measured in kilograms) at the time of the Olympic Games. Due to the high correlation between height and weight, I construct body mass index as $weight/height^2$. Appendix Table A.1 lists the number of observations per country to provide a sense of the geographical composition of my sample. Since there are slight changes to the distances of some events between Olympic Games (e.g. the 400 meter hurdles replaced the 200 meter hurdles), I construct indicators of the following different event classes: sprints, middle-distance, distance, throws, and field. Appendix Table A.2 categorizes events into each of the five classes. In cases where the athlete competed in more than one Olympic final, I record the rank, event, and year of their best performance. For all athletes, I calculate the number of Olympic Games they have competed in during their career and the number of Olympic medals won during their career.

I calculate lifespan as the number of days between the date of death and the starting date of the Olympic Games. When the athlete participates in more than one Olympics, I use their first Games as the start date and their best performance as their finishing place. My empirical results are similar if I use the athlete's date of birth instead of the date of first competition as the initial period in calculating lifespan. The rationale for using the date of first Olympic competition to "start the clock" is that participation in the Olympics represents the timing of the shock to status. This timing issue is likely less relevant in my setting where athletes are largely the same age at competition than in the context of Nobel laureates or Oscar winners, where variation in ages of winners and losers is greater. Using the date of competition as the initial period is also consistent with my identifying assumption that finalists are similar at baseline, conditional on the observables such as country, event class, year of birth, and body mass index.

A key limitation of the data source is that cause of death is not systematically available for each athlete. Such information would be useful to examine whether stress-related conditions like heart disease are responsible for deaths linked to status shocks. Although cause of death data for each athlete is unavailable, I have collected deaths due to war, accidents (car or plane), and murders. The site SportsReference.com maintains a list of such deaths for all Olympians. Within the time period I consider, fifty-three athletes died in War, two died in car or plane crashes, and two were murdered. I exclude these athletes from my sample because they die from causes that are arguably exogenous and unrelated to behavior. I am instead interested in any behavioral effects possibly associated with finishing place, so that deaths may be endogenously determined by the athlete's performance in the Olympics. As expected, the correlation between winning and dying from one of these exogenous causes is low (0.02), and so including these athletes would only serve to introduce noise.

I also drop athletes whose date of death is missing since I am unable to verify their death. Some of these athletes may still be alive, but excluding them is a safer strategy since athletes who win Olympic medals are more likely to have a recorded date of death than other finalists. In my data, the date of death is missing for 2.9 percent of Gold medalists, 1.3 percent of Silver medalists, 4.5 percent of Bronze medalists, 6.3 percent of 4th place finishers, 8.3 percent of 5th place finishers, and 11.6 percent of athletes finishing in 6th place or lower. Including all censored observations would thus bias the lifespan of non-medalists upwards. As a result, no athletes are censored in my data. This reduces my sample size by less than six percent. Finally, I analyze male athletes only since women did not compete in Track and Field until 1928 (and in some events not until the 1980s or 1990s).[3]

After these restrictions, my final sample includes 1,082 athletes with complete dates of birth, death, and finishing place. Data on height and weight is available for 709 of these athletes. Table I presents descriptive statistics of my sample for all events combined, based

[3]Female athletes competed in just five events in 1928. Women first competed in the Olympic marathon in 1984. The triple jump, hammer throw, pole vault, and 5000 meters were first held in 1996 or later for women.

on whether the athlete ever won an Olympic Gold medal. Table II divides the sample into individual events and team event (relay). While winners and losers overall have similar lifespans based on Table I, Table II suggests the results vary by type of event. I present more rigorous evidence of these differences and mechanisms that may explain the patterns in Sections V and VI.

There do not appear to be collinearity problems based on a Belsley, Kuh, and Welsch (1980) test measuring the condition index or based on the variance inflation factors (VIF) of each variable. The VIFs are all below 5, except for two event class variables which have VIFs below 7. And although the condition index including a constant term is extremely large at 525, there are only high variance decomposition proportions for the constant and year of birth variables. The condition index drops to 19 if I exclude the constant from the design matrix.

Although I have argued that unobserved heterogeneity is likely to be minimal conditional on competing in an Olympic final, country, event, and year of birth, it is fair to question whether ability may also play a role in explaining differences in longevity. One way to control for ability would be to include the personal bests of each athlete over his entire career (i.e. in every competition, not just the Olympics) and to also include a series of event indicators rather than the broader event classes I describe above. However, personal bests are likely almost collinear with year of birth since each event's annual top performances improve over time. One way to sidestep such collinearity would be to choose cohorts of competitors (by event and years) and develop a relative ranking of personal bests for each cohort. However, choosing the years to define the cohort is arbitrary and athletes overlap in the length of their career and which Olympic games they compete in.

Instead, I examine whether ability is likely to be empirically important by comparing lifespans of athletes who ever held a World Record to other Olympic finalists. It certainly seems reasonable to label athletes who set a World Record at some point in their career as those with the highest ability since World Records are rare. I estimate a variety of hazard models (described in Section IV below) that include a dummy variable for whether the athlete ever held a World Record in their event, also controlling for year of birth, country effects, and either indicators for event class or indicators for each event. I furthermore only include World Record holders who also made an Olympic final and are thus in my sample. I consistently find that World Record holders actually die earlier than other finalists (the hazard of dying ranges between 1.3 and 1.5 and is statistically significant at the 5 percent level or better across specifications). This finding runs counter to the idea that higher ability athletes are innately healthier and live longer than lower ability athletes. Moreover, once I control for winning or losing in the Olympics—my primary variable of interest—the coefficient estimate on the World Record holder dummy falls closer to 1 and becomes statistically insignificant, whereas the coefficient estimate on losing is statistically significant.

These results suggest that finishing place is a more important factor than ability in my setting, which is not surprising to the extent that athletes good enough to compete in an Olympic final are initially similar in terms of unobserved health. Based on this investigation, I do not attempt to control for ability in my main empirical results. The fact that the highest ability athletes die younger suggests behavioral patterns likely explain differences in longevity between these athletes, rather than unobserved latent health.

IV. METHODS

I model lifespan using several parametric and semi-parametric hazard models. I do not run OLS on log life expectancy because the data generating mechanism for mortality is likely to be Gompertz rather than log normal. The Gompertz distribution has been the workhorse of actuarial science to model mortality since the distribution provides a simple analytic formula for survival based on the observation from many settings that mortality rises exponentially with age (Olshansky and Carnes, 1997). Using simulations, Basu, Manning, and Mullahy (2004) show that the Cox proportional hazard model performs better than log OLS under a Gompertz data generating mechanism, even when there is no censoring. The Cox model is also more efficient in terms of lower root mean square error. While the performance of the Cox model is poor if the proportional hazards assumption is violated, I confirm the proportional hazards assumption is met in my data using tests of Schoenfeld residuals.

The baseline model is the standard Cox proportional hazards model:

$$\lambda = \lambda_0(t)\exp(x'\beta) \tag{1}$$

where the hazard of death λ depends on an unspecified baseline hazard $\lambda_0(t)$ and an exponential function of observables. The explanatory variable of interest is an indicator for whether the athlete lost (i.e. did not win a Gold medal). I control for the athlete's year of birth, the athlete's country, the number of Olympics competed in during the athlete's career, the number of Olympic medals earned during their career, and indicators for event class. In my main analysis, I do not include fixed effects for event and year, which would use variation within each individual event to identify the effect of losing. Instead, I include event class and year of birth so the effect of losing is identified by comparing longevity between winners and losers over time and events, controlling for the variables listed above. This decision is made because including 56 fixed effects for years and events, plus an additional 30 country fixed effects, may create an incidental parameters problem in such non-linear models. As a check, Appendix Table A.3 presents specifications that also include year and event fixed effects. The findings are qualitatively similar to the main results presented below, and the statistical significance of the estimates is higher—likely a result of the well-known downward bias in the standard errors (Greene, 2004). Therefore, to be cautious, my main analysis focuses on models without event and year fixed effects. Robust standard errors are clustered by country, with 30 countries total.

I also estimate Cox models with shared frailty by country instead of country indicators since there may still be concern about an incidental parameters problem with 30 country fixed effects. This model, also known as the mixed proportional hazards (MPH) model, is specified as:

$$\lambda = \lambda_0(t)\exp(x'\beta + c) \tag{2}$$

where the inclusion of country-specific variable c allows for unobserved heterogeneity by country to affect the hazard multiplicatively, similar to a random effect.

As a parametric alternative to these Cox regression models, I also specify a Gompertz distribution for the baseline hazard. In these models, I allow for individual-level frailty that has a Gamma distribution by specifying the hazard as

$$\lambda = \nu_i \exp(x'\beta + \gamma t) \tag{3}$$

Specifications (2) and (3) allow for unobserved heterogeneity either at the country or individual level, but the frailty is assumed to be constant over time. My final specification, largely used as a robustness check, allows for individual time-variant unobserved heterogeneity by modeling the individual heterogeneity as a random walk:

$$\lambda = \lambda_0(t)\exp(x'\beta + \sum_{j=0}^{t} W_j), \qquad W_j \sim N(0,1) \tag{4}$$

This specification resembles the Increasingly Mixed Proportional Hazards (IMPH) model developed by Frijters, Haisken-DeNew, and Shields (2011). To estimate (4), I draw 8000 sample paths of the random walk for each individual and then average the estimates over these draws. As described by Frijters, Haisken-DeNew, and Shields (2011), allowing for time-variant unobservables is intuitively appealing when the researcher observes detailed information about the individual during the baseline period but little else about him later in life. This situation characterizes my setting, where there is arguably little unobserved heterogeneity in health status at the time of the Olympic final but I do not observe potentially important variables like occupation, marital status, and other lifestyle decisions after the competition.

V. RESULTS

I first provide non-parametric, unconditional estimates of lifespan that preview my main results. Figure I displays three Kaplan-Meier survival curves based on the type of event. The top graph (Figure Ia) suggests slightly lower mortality among Gold medalist 20 to 40 years post competition when all events are combined together, but displays limited differences overall. Splitting the data by individual versus team performance shows sizable mortality differences that work in opposite directions. Gold medalists in individual events die earlier, on average, (Figure Ib) while Gold medalists in team events die later (Figure Ic). In individual events, Gold medalists face higher mortality prospects relative to other finalists starting 50 years after the Olympics. In team events, the mortality advantage for Gold medalists manifests itself starting 20 years after the Olympics. These differences are significant based on log-rank tests.

Table III presents the results of the survival models of lifespan described in Section IV. Coefficient estimates are exponentiated and so should be interpreted as hazard ratios. The top panel presents regressions that do not control for body mass index and the bottom panel presents regressions that include these variables. The first three columns show regressions that do not control for whether the event was a team or individual. Gold medalists represent the omitted finishing place. In these regressions, there is no difference in lifespan between Gold medalists and other finalists. However, similar to the Kaplan-Meier survival curves, controlling for team events reveals sizable differences between winners and losers. In columns 4 through 7, the omitted category is Gold Medalists in an individual event. The coefficient estimate of 0.786 on losing in column 4 (Panel A) indicates that losing finalists in individual events have a lower probability of dying than Gold medalists. The coefficient estimate of 0.666 on the team indicator (Column 4, Panel A) shows that Gold medalists in team events also have lower mortality rates than Gold medalists in individual events. Consistent with the non-parametric survival curves, the interaction between the team and losing indicators has a coefficient estimate above 1, revealing that losing as part of a team is associated with higher mortality compared to winning as part of a team. Nearly all the estimates in columns 4 through 7 are statistically significant at the 5 percent level or better. Comparing whether Gold medalists in individual events have lower mortality than athletes losing as part of a team requires adding the three coefficient estimates together and calculating standard errors based on the covariance between the variables. Doing so reveals point estimates that are close to 1 in magnitude and statistically insignificant.

The results are robust across survival models that make different assumptions about unobserved heterogeneity. The results are also robust to including body mass index as a control variable as shown in Panel B. The similarity between Panels A and B is perhaps not surprising given that the indicators for event class (sprints, distance, throws, etc.) likely already pick up much of the variation in body composition between competitors that affects mortality. Nevertheless, the coefficient estimate on body mass index is always above 1, as one would expect, and statistically significant.

To summarize the key qualitative findings, Gold medalists in individual events die earlier than both losers in individual events and Gold medalists in team events. Gold medalists in team events live longer than losers in team events. Quantitatively, the hazard ratios imply changes in longevity that are sizable in magnitude. In individual events, losers live 2 years longer than winners, on average. In team events, losers die over 3 years earlier than winners.[4] All else equal, longevity is greatest among athletes who win as part of a team. Since only 10 athletes win Gold in both individual and team events, I do not focus on the effect of winning both types of events. Nevertheless, the magnitude and statistical significance of the estimates are similar if I exclude these 10 athletes.

VI. MECHANISMS

VI.A The Role of Finishing Place

As a first step to uncover what factors drive the main results in Table III, I decompose the coefficient estimate on the losing indicator by the influence of each finishing place. So far I have described anyone who did not win the Gold medal as losing, but second and third place finishers still earn a medal that represents a major accomplishment.[5] One might expect that 4th place may be an important finishing place since that athlete just misses out on the Bronze medal. Table IV presents Cox and Gompertz hazard models that include indicators for 2nd through 6th place and these five indicators interacted with the team variable. There are relatively few finishers in 7th or 8th place in these earlier Olympics and so I combine these finishers with 6th place. In individual events, the coefficient estimates

[4] Haybittle (1998) derives the formula $\triangle life\ expectancy = -\ln(\beta)/k$ from the Gompertz function to relate hazard ratios to changes in life expectancy, where β is the hazard rate and k is the regression coefficient of log mortality against age. I convert my estimated hazard rates presented into changes in longevity using this formula, taking the coefficient estimates from Table III, Panel A, column 5, for β. This particular specification—a Cox model with country-level frailty—yields estimates that are on the more conservative end of my results, and there is little difference if the coefficient estimates from another regression specification are used instead for β. I use $k = 0.1$ based on the results from Strulik and Vollmer (2013) who estimate this parameter across countries and over time. This value is higher than the empirical estimate of 0.076 using data on mortality by age in my sample, but a higher value of k serves to understate change in life expectancy and so is more conservative.

[5] Gold, Silver, and Bronze medals were first awarded in the 1904 Games in St. Louis. In 1896, winners were actually awarded a silver medal and second-place finishers were awarded bronze medals and in 1900, winners were awarded paintings because they were viewed as being more valuable than Gold medals (**?**).

on all losing places are below 1, but the result is driven by 4th place and 6th, 7th, and 8th places. In team events, almost all the losing places have statistically significant coefficient estimates above 1, although the 4th place finishers again have the largest estimates (in absolute value). The results are generally similar whether or not body mass index is included as a control. Overall, the results by finishing place suggest that the mechanism driving mortality differences operates for all finalists losing out on a Gold medal, with some evidence that 4th place finishers in both team and individual events are affected the most.

VI.B More Publicized Olympic Games and Premiere Events

If status is truly driving the results, then the association between winning and mortality should be stronger in Olympic Games that were more highly publicized. To investigate this question, I run regressions that split the sample into two halves. The coefficient estimates should be larger in absolute value in later years because more nations competed and the Games received greater media attention. For example, the New York Times published 81 articles containing the word "Olympics" in 1896 and 36 articles in 1900 compared to 1,490 articles in 1932 and 1,450 in 1936.[6] Additionally, the 1936 Games were the first ones televised. Both 1920 and 1924 could be used to divide the sample and so I run regressions that split the sample both ways. Table V presents the results of Cox models of the basic specification from Table III in these two periods. The results are consistent with the importance of status. In fact, there is no association between winning and longevity in the early periods. The estimates are all driven by observations after 1920, when competition was global and media coverage increased publicity for the Olympics.

In line with greater publicity, the relationship between mortality and winning should be stronger in Olympic events viewed as being "premiere" events. Although determining which events the public cares most about is somewhat arbitrary, the marquee events in Track and Field are arguably the 100m ("the fastest man in the world"), 200m (roughly the distance of the main race in the ancient Olympics), 400m (one lap of the track), 1500m (metric mile), marathon (always the final event of the Olympics in any sport), and the decathlon ("the greatest athlete in the world"). I estimate hazard models that include indicators for one of these "premiere" events interacted with winning and losing. I run these regressions for individual events only after 1920, based on the results in Table V showing the relationship is stronger in more publicized games and because there are no team "premiere" events. The

[6] Performing a search for articles with the word "Olympics" on the New York Times site during the entire year of an Olympic Games reveals the following counts: 1896: 81, 1900: 36, 1904: 201, 1908: 204, 1912: 533, 1920: 323, 1924: 1,170, 1928: 1,190, 1932: 1,490, 1936: 1,450, 1948: 695. It is not clear why the number of articles drops off in 1948, but one possibility is greater coverage on television and radio. There is a similar pattern in coverage using nationwide results from the website newspaperarchive.com.

omitted category is winning in a non-premiere event. Table VI presents the results of these regressions that show that winning a premiere event is associated with even higher mortality than winning in a non-premiere event, and losing in a premiere event is associated with even lower mortality than losing in a non-premiere event.[7] The coefficient estimates on the interaction terms thus amplify the results in non-premiere events, which is consistent with the way status is expected to operate. However, while the estimates on the interaction terms are of the expected sign, most are not statistically significant.

I also examined whether the relationship between winning and longevity is stronger when the Olympic Games took place in the athlete's home country. It is reasonable to conjecture that competing in front of one's country may elevate the importance of an athlete's performance. In results not shown, I did not find support for this hypothesis, either by including triple interactions between winning, losing, and home Games, or by estimating the main specifications separately in home versus away settings.

VI.C News coverage

Although amateurism prevented athletes being directly compensated for their performance, it is possible that athletes (winners, medalists, or other finalists) received non-monetary rewards, like housing or job opportunities, that could have first-order effects on longevity. To investigate this, I collect text-based data on newspaper coverage of each athlete through the website newspaperarchive.com, which has been used by others for news coverage (Gentzkow, Shapiro, and Sinkinson, 2011). The site mainly includes U.S. newspapers and so I focus on U.S. athletes. Restricting this analysis to the United States is also informative in that it rules out any possible differential treatment of athletes post-Olympics across countries. For each athlete, I search for stories containing their first and last name, the word "Olympics", and the year and event they participated in. In case the athlete is known primarily by his nickname, I also include searches that replace the athlete's first name with the nickname reported on sportsreference.com. Since the long jump was historically called the "broad jump" during my sample, I search for this term in that event. The total number of hits over all athletes and all years is 32,593. I focus on two summary measures of newspaper coverage for each athlete: whether an athlete was mentioned in at least 100 stories within two decades of the Olympic Games and whether an athlete's name appeared on the front page of the paper within two decades. The rationale for restricting the coverage period to two decades is that any real changes to material living standards as a result of performance are likely to be reflected in coverage closer to the competition. For example, there was very little newspaper coverage of athletes competing in the first few Olympic Games, but much more coverage in

[7]This table does not include estimates with BMI because the models failed to converge.

the 1960s and later after most were deceased. In reading some of the individual stories about athletes competing in 1896 and 1900, the coverage in later years tends to recount the the experience of these early athletes to establish the history of the Games. Table VII presents the means of several variables that characterize newspaper coverage by year and finishing place. There was far more coverage in later years and, not surprisingly, Gold medalists receive a disproportionate fraction of the coverage. However, many other finalists are also featured in stories and I use this variation to explore how coverage is correlated with lifespan, conditional on finishing place.

Table VIII reports hazard regressions that include newspaper coverage variables estimated on the U.S. sub-sample after 1924 when news coverage was prevalent. I run models with and without year effects since newspaper coverage varies considerably by year. For reference, columns 1 and 2 run Cox regressions from the main specification without coverage variables. The magnitudes of the coefficient estimates on finishing place are similar to the results from the full sample and larger in absolute value, but most fall short of statistical significance due to the reduced sample size. Columns 3 and 4 include indicator variables for whether an athlete had at least 100 stories and appeared on the front page, but exclude the finishing place variables. More coverage is associated with a longer lifespan, although the estimates are not statistically significant. Finally, both the coverage and finishing place variables are included in columns 5 and 6. The absolute value of the news coverage estimates increases and the estimates become more precise, but are still not statistically significant. However, the finishing place estimates also increase in magnitude and become statistically significant. Including the news coverage variables, which have the expected sign, helps to isolate the effect of finishing place related that is unrelated to any material rewards.

VI.D Performance Relative to Individual Expectations

One important mechanism that may link status and health is how an athlete performs relative to his expectations. An athlete whose win was expected may receive less of a boost to self-esteem than an athlete who did not even expect to make the final and finished third. To the extent this occurs, one reason Gold medalists in individual events die earlier than losers may be that the former were already favored to win. In this case, a win may thus represent more of a relief than any positive psychic effect. Prior expectations based on past performances serve as a natural reference point for utility in this setting (Koszegi and Rabin, 2006).

To examine the role of prior expectations, I have collected the top 10 annual times by each event dating back to 1891 from the site http://trackfield.brinkster.net. For each event and each Olympic Games, I construct a ranking of the top performers in the four years prior to the date of the opening ceremonies of that particular Olympics. I rank unique athletes, not performances, so that only the best performance of an athlete counts towards the ranking. In calculating the pre-Olympic rankings for the 100 meter and 1500 meter runs, I also consider times posted in the 100 yard and mile runs, respectively, since the distances are extremely close. I subtract 18 seconds from mile times to convert to 1500 meter times and multiply 100 yard times by 1.1 to convert to 100 meter times. These conversions are consistent with the scoring metrics of the International Association of Athletics Federations.

Table IX presents the percentage of athletes who were ranked in the top 10, top 5, top 1, and not ranked prior to the Olympics by finishing place. It is clear that Gold medalists tended to post the best performances prior to the Olympics. Compared to other finalists, winners were more likely to be in the top 10, top 5, and top 1, and less likely to not have been ranked. The prior rankings of athletes finishing 6th or lower exhibit the reverse pattern, and rankings of intermediate finishing places land somewhere in the middle. While being ranked higher before the Olympics increases the chances of better performance in the Games "when it counts", success is far from predetermined. This pattern supports the earlier argument that conditional on making an Olympic final, chance plays a key role in assigning status. But the positive correlation between prior rankings and Olympic finishing place shows winning is not completely random.

I construct an empirical measure of relative performance based on the "distance" between each athlete's finishing place and his pre-Olympic ranking. Figure II plots the distribution of relative performance, where a positive number indicates finishing better than one's pre-Olympic ranking and negative number indicates performing worse. The striking element of the histogram (with unit bin width) is the mass of athletes in individual events who were not ranked prior to the Olympics: fifty-seven percent. I split the sample into four groups based on relative performance: (1) worse than expectations (finished behind their pre-Olympic ranking); (2) met expectations (finished within 5 places ahead of their pre-Olympic ranking); (3) surpassed expectations and previously ranked (finished more than 5 places above pre-Olympic ranking), and; (4) surpassed expectations and not previously ranked. I separate those who surpass expectations into two groups because not being ranked at all arguably represents the greatest "surprise" and this group is particularly large. By restricting my sample to finalists, there are not many athletes who finish worse than expectations (i.e. were ranked in the top 8 before the Olympics and finish worse than their ranking but better than 9th place). Fifteen percent of athletes were previously ranked and performed more than five places better than their ranking. Twenty-two percent finished within five places of their pre-Olympic ranking, and six percent placed below their ranking. By construction, no winner finished worse than his expectations. However, 36 percent of winners met their expectations, which means they were initially ranked within the top 5. This is a much higher share than other finalists: 23 percent of 2nd-place finishers met their expectations, about 19 percent of both 3rd and 4th place did, and roughy 14 percent for 5th, 6th, or lower positions did. By contrast, as shown in Table IX, a larger share of lower place finishers were not ranked prior to the Olympics. These tabulations suggest that Gold medalists expected to win more often than other finalists.

Table X presents regressions that include these measures of performance relative to expectations. I restrict the sample to those whose best performance is in an individual event and exclude racewalkers, since I lack data on their pre-Olympic rankings. Column 1 reports the specification without the expectations variables for reference. Columns 2 includes the expectations variables, with performing worse than expectations as the omitted group, and excludes the indicator for losing. Athletes who surpass their expectations live longer than those who either met or performed worse than their expectations. Both indicators for losing and the expectations variables are included in Column 3. The coefficient estimates on the expectations variables remain statistically significant and are larger in magnitude than on the estimate for losing, although they are not statistically distinguishable.

Note that any regression to the mean in performance serves to understate the importance of surprise or disappointment among these athletes. Due to variability in performance, those ranked below the mean before the Olympics may rank closer to the mean in the Olympic final. And the winner in the Olympics may have previously been ranked closer to the mean, finding himself the fortunate recipient of good luck on the day that counts. To the extent that competitors rationally factor in such regression to the mean in forming their reference point, then my measure of the distance between Olympic rank and pre-Olympic rank understates the importance of how ex post performance departs from expectations.

To focus on the effect of "underperforming" on health, I also construct an indicator for whether the athlete was ranked in the top 5 before the Olympics and lost. Intuitively, such athletes may have believed they had a good chance of winning and were more disappointed than athletes who were initially ranked lower and lost. All of these athletes are classified as having met or performed worse than their expectations (based on the variables described in the last paragraph and presented in columns 2 and 3), but not vice versa. The final two columns of Table X display the results with this indicator variable instead of the expectations variables described above, with the sample restricted to losing athletes in individual events. As shown by the hazard estimates above unity, losing athletes within the top 5 die earlier than losing athletes ranked outside the top 5. This finding is consistent with the idea that those who are strong contenders but fail to win experience more stress that is harmful to health. The results are qualitatively robust to classifying the pre-Olympic "favorites" as those ranked in the top 3 through the top 9 performances. Overall, the results in Table X are consistent with the importance of performance compared to expectations in affecting health. In addition, the magnitude of the coefficient estimates on underperforming are larger than those on exceeding expectations, consistent with loss aversion.

If this mechanism helps to explain the results in the individual events, it is reasonable to question whether performance relative to expectations may also matter for team events. It may be the case that in team events, expectations matter less because there is more uncertainty due to four athletes competing for each team. Viewing each athlete's performance as a random variable, the expectation for the team is just the sum of the expected times of each individual athlete. However, the variance may be larger in team events because there is likely positive covariance in the performances of athletes within any given team, since teammates often live, train, and eat together. So this larger variance may mean athletes in team events focus less on expectations than in individual events. Perhaps more naturally, though, one might imagine that in team contests the reference point shifts to how an athlete measures up to his teammates. I now provide evidence suggesting athletes on teams may focus instead on their own performance relative to their teammates.

VI.E Peer Effects: Performance Relative to Other Team Members

Athletes who underperform relative to their peers may feel disappointment they have let others down and the team lost because of their relatively weaker performance. To examine this issue, I classified the relay split times of athletes in the 4x400m relays using the London Olympics Athletics Statistics Book. Times are measured in tenths of a second. Among losing teams, I compare the two fastest runners to the two slowest runners within a team. Since non-leadoff legs of the relay have faster splits because they receive running starts, all else equal, I make the leadoff leg faster if there is a tie between him and another leg of the relay. I also control for the order of the leg of the relay, since teams—which are endogenously constructed to begin with based on ability and other factors—may place faster runners in certain positions (generally last or "anchor"). I test whether slower runners die earlier by including an indicator variable for the slower half of the relay.

The sample ends up being quite small since I only have data on the 4x400m relay and I exclude athletes on losing teams whose best performance is in an individual event (since these athletes are not used to identify the coefficient on losing teams in Table III). Yet with just 45 observations and around 15 regressors, I am still able to detect a significant coefficient estimate on being a slower teammate that is of the anticipated sign. Table XI reports that the hazard ratio for slower runners on losing teams is more than twice as high as for faster runners on losing teams. In results not shown, I also analyze whether the mortality hazard is different between faster runners on losing teams and all runners on winning teams. There is no statistically significant difference, and since these regressions include more observations than in Table XI where the null hypothesis of no difference is rejected, the result is likely not due to low statistical power.

If the mechanism of relative peer performance explains in part why losing teams die earlier than winning teams, then there should be less of a difference in mortality within losing teams when performance cannot be measured. As discussed earlier, a notable characteristic of Track and Field is that performance is objectively evaluated. However, individual performance cannot be measured in team events in Rowing. I collect the dates of birth and death for male rowers on teams finishing second or third in events with more than one rower: double sculls, coxless pairs, coxed pairs, quadruple sculls, coxless fours, coxed fours, and coxed eights. I again do not include athletes who ever won a Gold medal in another event or year to focus on losers. Using a simple analysis of covariance (ANCOVA) between teams and lifespan that also controls for year of birth, I find that the within-team variance in mortality relative to the between-team variance is smaller for losing teams in Rowing than losing teams in Track (Table XII). For rowing, the p-value on the model's F-statistic is 0.01 compared to 0.64 in Track. This result is consistent with the theory that objectively worse performance relative to one's peers is at least a partial explanation for why losing teams die earlier than winning teams. [8]

VII. ROBUSTNESS CHECKS AND FALSIFICATION TESTS

I perform several checks in an attempt to verify the validity of my results. First, I test that no one country is overly influential in my analysis by dropping several sets of countries. Table XIII lists the main results from the Cox specification in Table III when I drop the following regions: the United States and Canada; Scandinavia; Western Europe; Eastern Europe; Asia, Australia, and New Zealand. I also verify that no one year drives my results by dropping each year in turn. As shown in Table XIV, the estimates are robust. While my specifications include country fixed effects or shared frailty by country, one may wonder whether time-variant unobservables at the country level bias the results. For example, perhaps over time some countries provide benefits in kind to winners so that even though winners are not

[8] I also examined the Tug-of-War as a sport where relative performance cannot be measured within teams. This sport was part of the Athletics program at the Olympics until 1920, when it was discontinued because it lacked an international governing body (Track and Field had one). I find the same pattern in Tug-of-War as for Rowing—that the ratio of the between- to -within-team variation is larger than that observed for Track—which is consistent with the importance of relative performance within teams as a key reference point. In fact, there is even less within-team variation in the Tug-of-War (F-statistic=1.87), but with only 29 athletes in the Tug-of-War sample, it is not statistically significant (p=0.16).

financially compensated directly, they receive jobs, housing, or other "star treatment" by their country that increases their consumption bundle. Or perhaps the quality of medical care improves differentially across countries. To test this, I run regressions on separate samples for the United States, Sweden, and Great Britain. Collectively, these three countries account for 55 percent of the sample and I run separate Cox regressions by country. In each country, the point estimates are similar in magnitude to my main results from Table III. Although the estimates are not statistically significant perhaps due to the reduced sample sizes, the similar magnitudes do not suggest my findings are driven by time-variant unobservables between countries. As additional robustness checks, I verify my findings are not sensitive to dropping the 10 athletes who win at least 4 medals or the 29 athletes who win at least 3 medals.

As a falsification test, I model mortality as a function of the number of letters in the athlete's name instead of as a function of winning or losing. I divide name length (number of letters in first and last name combined) into five quintiles and also construct an indicator for whether the number of letters is even or odd. Clearly, there is no conceivable reason why name length should affect longevity, especially after controlling for country effects. For the falsification test, I include the same control variables as in my main specification. Table XV presents the results of these regressions. As expected, the coefficient estimates are all near 1 and only two out of 30 tests are statistically significant. I interpret the number of significant coefficients—2 out of 30—as what should be expected by chance.

VIII. DISCUSSION

This paper has documented that the longevity of Olympic Track and Field athletes is affected by whether they win or lose. The hazard estimates are sizable in magnitude, with lifespan differentials of a year or more between winners and losers. Analyzing recorded times and marks during the Olympics indicates relative performance may be a key mechanism driving the results. Winning on a team confers a survival advantage, with poor performance relative to one's teammates partly explaining why losing teams die earlier. Winning an individual event, though, is associated with an earlier death, which may be explained by how athletes perform relative to their best times prior to the Olympics: winners generally expected to win, but the performance of losers more often exceeded their personal expectations.

It is important to underscore that income or wealth are likely not important factors in this context. First, Olympic Track and Field athletes during this time earned no money from winning due to the system of amateurism, which prevents athletes from being paid for their performance. Until the 1980s, rules restricted professional athletes from competing in the Olympics and these regulations were strictly enforced. For example, in 1913, Jim

Thorpe—the legendary multi-sport athlete—was stripped of his two 1912 Olympic Gold medals for earning money to play minor league baseball in 1909 and 1910 (Flatters, 2000). As additional evidence that successful Olympic athletes received little financial rewards from winning, most held other occupations while training between Olympic Games. For example, Hannes Koheleman—4-time gold medalist in distance events in 1912 and 1920—laid bricks in construction (New York Times, 1921). Charlie Paddock—the first sprinter to be crowned the "fastest man alive" in 1920 and a Silver medalist in 1924—worked for a newspaper (Dallas Morning News, 1943). Another sprinter, New York City policeman Bob McAllister was nicknamed the "Flying Cop". Perhaps the most illuminating account of what could be expected financially after the Olympics comes from the autobiography of Mel Sheppard, winner of 3 Gold medals in the 1908 Games. Sheppard describes the parting words he and his Track and Field teammates received from President Theodore Roosevelt during a visit to the White House upon returning from the 1908 London Olympics: "I'm going to give you lads the same friendly bit of advice I gave to my Rough Riders. Remember you're heroes for ten days—when that time's up, drop the hero business and go to work" (Sheppard, 1924, p52). Sheppard went on to become a customs inspector while training for the 1912 Games, where he won another Gold medal as well as a Silver.

In addition, the Gold medal itself was worth a modest amount in terms of its metallic content; before 1912, the gold in the winner's medal was worth about $350 adjusted for inflation and the commodity prices of the year it was awarded (The Economist, 2012).[9] After 1912, gold was no longer used and the winner's medal was made mostly of silver and copper, making it worth even less (International Olympic Committee, 2011). Moreover, omitting income should understate the longevity differential between winners and losers attributable to status. Based on how professional contracts operate, any positive income shocks from winning are more likely in individual events than team events. And since my results indicate winners in individual events die earlier than losers, including income would only increase the effect of status on longevity. As a result, omitting income in this setting is not a serious concern. The result that including variables related to newspaper coverage serve to increase the coefficient estimates on finishing place support this argument.

Comparing the magnitude of my estimates to the effect of income on health is useful to gauge the economic importance of status. Estimates of the effect of income on health vary widely based on age and whether the data is individual-level or aggregated, and cross-sectional or panel data (Smith, 1999; Deaton and Paxson, 2001; Deaton, 2003; Cutler, Lleras-Muney, and Vogl, 2011). On one extreme, some older studies have estimated that among

[9]Due to higher commodity prices and the larger size of the Olympic medals, the value of the metal contents in a 2012 Gold medal is roughly $700.

adults, mortality rates are at least twice as high at the bottom 5 percent of the income distribution than at the top 5 percent, with lifespans about 25 percent shorter among the poorest at all ages (Rogot et al., 1992). Deaton (2003) estimates an elasticity of mortality to income of roughly -0.5. I lack a continuous measure of status, but the mortality hazards between winners and losers in my analysis are about half the size as the ratio of the rates from the tails of the income distribution in (Rogot et al., 1992). It is difficult to know whether such income levels are the appropriate comparison, but it seems safe to conclude that the effect of income is no more than twice as great as that of status. On the other extreme, research from recessions (Ruhm, 2000) and changes to Social Security notches (Snyder and Evans, 2006) suggest income may not actually protect health.

While my analysis suggests status may have a first-order effect on health, not knowing the athlete's cause of death represents a major limitation. I attempted to collect obituaries on each athlete to determine cause of death, but was unable to find obituaries with this information for most athletes, especially in earlier years. Documenting that diseases linked to stress, such as heart disease, were more prevalent among those dying earlier would provide support to the behavioral mechanisms described above. As a partial attempt to remedy this shortcoming, I have excluded athletes who died in War, accidents, or murders—which are arguably exogenous—using externally compiled lists of such deaths. A list of Olympic suicides reveals there are (fortunately) only three suicides in my sample, so I can at least rule out that dramatically different rates of this outcome are found between winners and losers. Yet I cannot make any statements about the prevalence of depression or other mental health outcomes associated with finishing place.

Nevertheless, this paper's results provide new insights on the link between status and health. Unlike previous research from Whitehall and other settings, my results indicate that, in some cases, higher status may worsen long-term health. Given the nature of competition in Olympic Track and Field and the research design comparing winners and losers, competing explanations like differences in genetics, lifestyle, or income are unlikely to be as important as status. How performance compares to some benchmark—personal expectations or the performance of other team members—is a plausible channel through which status could affect health. This pattern is consistent with reference-dependent utility.

The findings point to an overlooked factor in economic models of health capital. Standard models adopting an ex ante perspective (Grossman, 1972; Ehrlich and Chuma, 1990; Murphy and Topel, 2006) are powerful because they are tractable, rooted in economic theory, and able to generate sharp predictions. The substitution axiom of expected utility theory rules out any role for surprise or disappointment in affecting utility. Instead, the realized state of the world only affects ex post utility through real resources or prices. However, this paper shows that how performance compares to expectations or with regard to one's peers can be empirically important in affecting health. In some applications, it may be useful to model decisions about health behaviors taking into account such behavioral concerns.

The findings may also have implications for the optimal design of employment contracts. In short, there may be a trade-off between ex post employee health and ex ante incentives for productivity. In many employment settings, the chance of receiving a promotion is tied to how hard employees work. If an employee expects a promotion because he exerted high effort, but then does not receive one, his health may suffer since he falls short of expectations. Understanding this, the employer could strategically decide to announce to the employee that promotions are more difficult to achieve than they really are so the employee "does not get his hopes up." But sending this false message would rationally induce lower effort from the employee if the marginal probability of a promotion is decreasing in effort and the cost of effort is convex. The employer thus would seek to balance incentives for effort against ex post employee health.

A similar trade-off may exist for team-based competition within firms. Firms sometimes allocate employees to different competing divisions or teams, with the team's performance partly determining an employee's individual salary. This paper's findings suggest the health of employees who objectively underperform on losing teams may deteriorate. Suppose the overall performance of a team is a (stochastic) function of the ability and effort levels of its team members. Foreseeing how relative performance affects employee health, the firm might seek to compose teams of people with similar abilities to minimize variation in ex post performance within teams. Depending on how ability is distributed, such an arrangement could lead to creating one team full of "superstars." If other teams recognize this superstar team will likely win the competition, the incentive for weaker teams to exert costly effort is dulled (Brown, 2011).

These stylized examples are meant only to be illustrative of potential trade-offs between ex post health and ex ante incentives. Admittedly, it may be a stretch to connect an analysis of longevity among Olympians born before 1930 to employment contracts today. Yet similar to some other economic research on sports, studying athletic competition is economically interesting when it provides deeper insights into human behavior (Duggan and Levitt, 2002; Price and Wolfers, 2010). This paper has shown that relative performance in competitions—with respect to one's prior expectations or the performance of teammates—can impact health.

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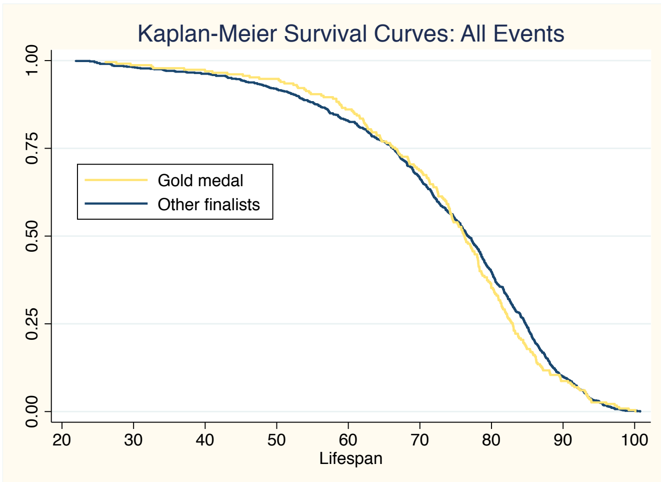
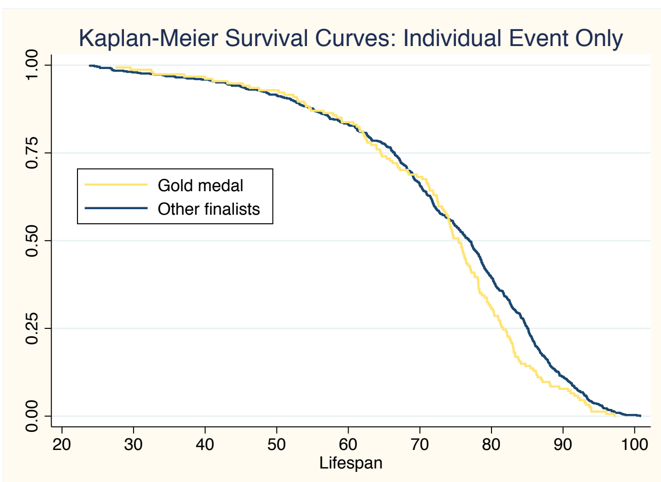
Figure I: Kaplan-Meier Survival Curves by Finishing Place

(a) All events



(b) Individual events only



(c) Team events only

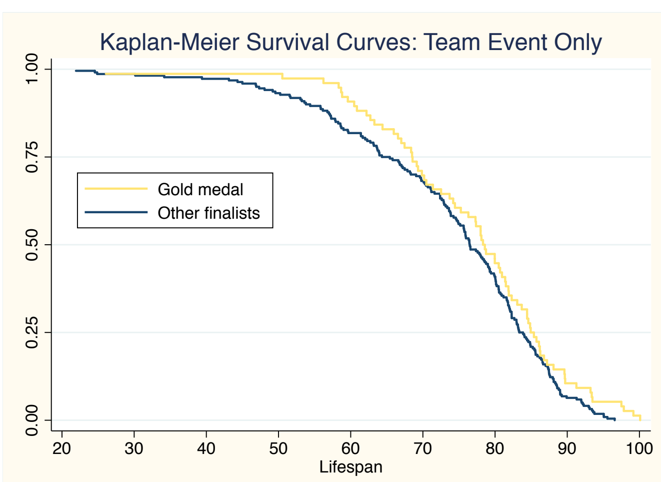


Figure II: Distribution of Olympic finishing place relative to pre-Olympic ranking

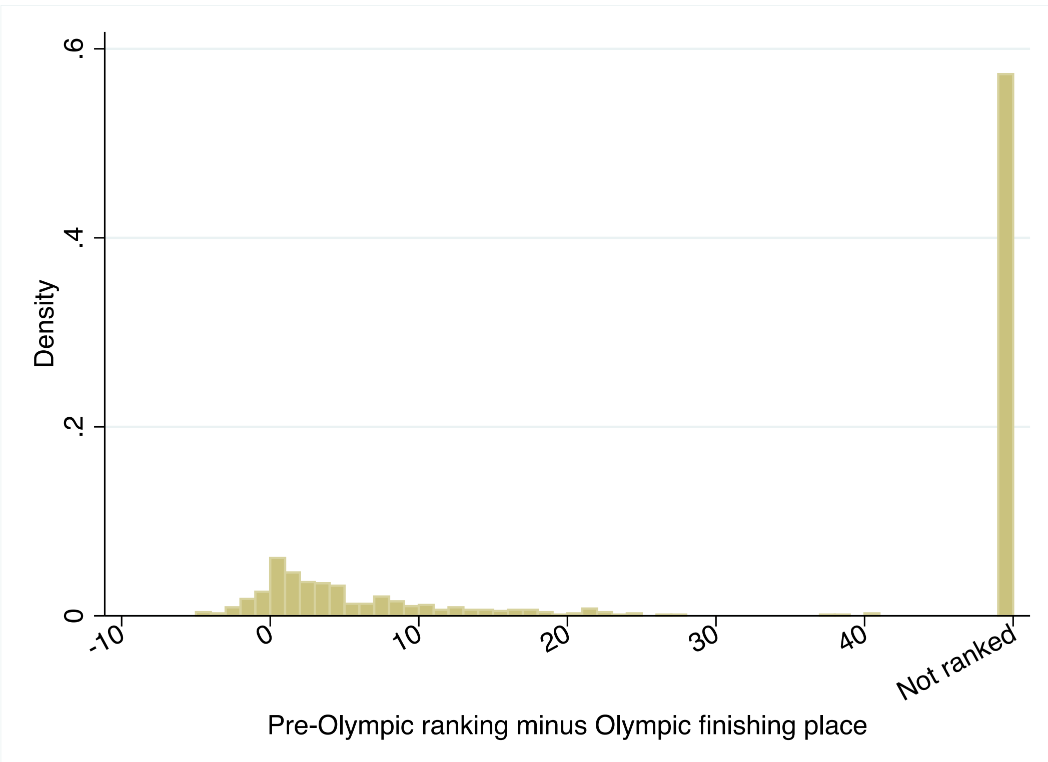


Table I: Descriptive Statistics: All Events Combined

Variable	Lose (N=852)				Win (N=230)			
	Mean	s.d.	Min	Max	Mean	s.d.	Min	Max
Lifespan (years)	73.61	15.17	21.93	100.76	73.86	13.71	26.07	100.10
Lifespan post 1st Olympic Games (years)	48.61	15.41	1.67	78.53	49.51	13.88	0.09	79.08
Team event	0.26	0.44	0	1	0.33	0.47	0	1
Number of Olympic Games in career	1.11	0.36	1	3	1.34	0.61	1	4
Number of Olympic Medals in career	0.57	0.67	0	5	1.81	1.38	4	12
Distance	0.19	0.40	0	1	0.23	0.42	0	1
Middle-distance	0.07	0.26	0	1	0.06	0.24	0	1
Sprints	0.31	0.46	0	1	0.34	0.47	0	1
Field	0.21	0.41	0	1	0.21	0.41	0	1
Throwing	0.17	0.37	0	1	0.12	0.33	0	1
Body mass index (BMI)	22.84	2.89	17.99	38.22	22.55	2.40	17.17	33.24
Year of birth	1899	13.56	1864	1929	1896	14.38	1868	1930

Table II: Descriptive Statistics: Individual vs. Team Events

A. Individual Events

	Lose (N=632)		Win (N=154)	
Variable	Mean	s.d.	Mean	s.d.
Lifespan (years)	73.58	15.48	72.43	14.03
Lifespan post 1st Olympic Games (years)	48.33	15.73	47.82	14.07
Number of Olympic Games in career	1.12	0.36	1.38	0.64
Number of Olympic Medals in career	0.52	0.66	1.77	1.20
Distance	0.18	0.38	0.18	0.38
Middle-distance	0.09	0.29	0.07	0.26
Sprints	0.16	0.37	0.21	0.41
Field	0.28	0.45	0.31	0.46
Throwing	0.23	0.42	0.18	0.39
Body mass index (BMI)	23.13	3.08	22.89	2.74
Year of birth	1898	14.20	1895	15.73

B. Team events

	Lose (N=220)		Win (N=76)	
Variable	Mean	s.d.	Mean	s.d.
Lifespan (years)	73.65	14.25	76.76	12.64
Lifespan post 1st Olympic Games (years)	49.40	14.44	52.94	12.89
Number of Olympic Games in career	1.10	0.37	1.28	0.56
Number of Olympic Medals in career	0.70	0.67	1.89	1.68
Distance	0.25	0.43	0.37	0.49
Middle-distance	0.00	0.00	0.01[a]	0.11
Sprints	0.75	0.43	0.62	0.49
Field	0.00	0.00	0.00	0.00
Throwing	0.00	0.00	0.00	0.00
Body mass index (BMI)	21.75	1.55	21.88	1.34
Year of birth	1901	11.23	1898	11.13

a. Melvin Sheppard is the single runner classified as middle-distance who also ran on the 4x400m relay. He is classified as middle-distance instead of sprints because he won the 800m and 1500m races in the 1908 Olympics.

Table III: Lifespan Regressions

	Panel A: Without body mass index						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cox	Cox	Gompertz	Cox	Cox	Gompertz	IMPH
Place (relative to Win)							
Lose	0.907 (-0.89)	0.932 (-0.80)	0.976 (-0.29)	0.786** (-2.47)	0.819** (-1.96)	0.848* (-1.95)	0.786** (-2.32)
Team				0.666*** (-6.49)	0.702** (-2.31)	0.714*** (-3.90)	0.672** (-2.54)
Team x lose				1.520*** (6.13)	1.466** (2.26)	1.490*** (4.15)	1.503** (2.35)
Country effects	Yes	No	Yes	Yes	No	Yes	Yes
Frailty	None	Country	Individual	None	Country	Individual	Individual random walk
Observations	1082	1082	1082	1082	1082	1082	1082
Log likelihood	-6452.7	-6477.8	-264.2	-6449.0	-6474.6	-260.8	-6841.3

	Panel B: With body mass index						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cox	Cox	Gompertz	Cox	Cox	Gompertz	IMPH
Place (relative to Win)							
Lose	0.939 (-0.56)	0.973 (-0.28)	0.969 (-0.33)	0.752*** (-2.82)	0.799** (-1.99)	0.761** (-2.32)	0.777** (-2.12)
Team				0.622*** (-5.80)	0.680** (-2.34)	0.636*** (-2.67)	0.631*** (-2.68)
Team x lose				2.055*** (10.48)	1.781*** (3.03)	2.015*** (3.44)	1.978*** (3.34)
Country effects	Yes	No	Yes	Yes	No	Yes	Yes
Frailty	None	Country	Individual	None	Country	Individual	Individual random walk
Observations	709	709	709	709	709	709	709
Log Likelihood	-3914.9	-3900.0	-166.2	-3908.4	-3927.0	-143.5	-4044.7

*p<0.1, **p<0.05, ***p<0.01. Exponentiated coefficients (hazard ratios). Robust t-statistics clustered by country in parentheses, except in shared frailty and IMPH models. All regressions include year of birth, number of Olympic games competed in career, number of Olympic medals in career, and indicators for distance, middle distance, sprint, field, racewalk, or throwing event. Regressions in Panel B also include indicator variable for whether best rank recorded in both individual and team event.

Table IV: Lifespan Regressions by Place

	Panel A: Without BMI			Panel B: With BMI		
	(1)	(2)	(3)	(4)	(5)	(6)
	Cox	Cox	Gompertz	Cox	Cox	Gompertz
Place (relative to Gold)						
Silver	0.789 (-1.48)	0.823* (-1.65)	0.792 (-1.55)	0.781 (-1.52)	0.819 (-1.46)	0.781* (-1.66)
Bronze	0.812** (-2.02)	0.852 (-1.28)	0.818** (-2.03)	0.804* (-1.70)	0.845 (-1.16)	0.809* (-1.70)
4th	0.662*** (-4.32)	0.716** (-2.18)	0.672*** (-4.30)	0.668*** (-2.99)	0.784 (-1.37)	0.677*** (-2.94)
5th	0.905 (-0.99)	0.943 (-0.38)	0.920 (-0.81)	0.834 (-1.33)	0.886 (-0.68)	0.852 (-1.15)
6th or lower	0.809** (-2.15)	0.839 (-1.24)	0.817** (-2.06)	0.906 (-0.64)	0.947 (-0.33)	0.913 (-0.61)
Team	0.673*** (-6.47)	0.710** (-2.24)	0.685*** (-6.74)	0.636*** (-5.64)	0.696** (-2.18)	0.648*** (-5.65)
Silver x team	1.487*** (2.91)	1.438* (1.74)	1.470*** (2.87)	1.632*** (3.92)	1.579* (1.90)	1.611*** (3.87)
Bronze x team	1.451*** (2.95)	1.413 (1.60)	1.443*** (2.77)	2.195*** (3.87)	1.948** (2.55)	2.177*** (3.84)
4th x team	1.840*** (2.83)	1.725** (2.09)	1.812*** (2.84)	2.981*** (3.92)	2.230** (2.46)	2.922*** (3.93)
5th x team	1.184 (1.22)	1.142 (0.48)	1.157 (1.00)	2.402*** (3.51)	1.761 (1.41)	2.328*** (3.43)
6th or lower x team	1.703** (2.33)	1.596* (1.84)	1.655** (2.27)	1.406** (2.05)	1.285 (0.51)	1.393* (1.93)
Country Effects	Yes	No	Yes	Yes	No	Yes
Frailty	None	Country	Individual	None	Country	Individual
Observations	1082	1082	1082	708	708	708
Log likelihood	-6432.0	-6458.4	-223.1	-3900.4	-3921.0	-133.4

*p<0.1, **p<0.05, ***p<0.01. Exponentiated coefficients in columns 2-6 (hazard ratios). Robust t-statistics in parentheses clustered at country level. All regressions include year of birth, number of total medals in Olympic career, number of Olympic Games competed in, and indicators for distance, middle distance, sprint, field, racewalk, or throwing event.

Table V: Cox Regressions by Year of Olympic Games

	Panel A: Without body mass index			
	(1)	(2)	(3)	(4)
	Before 1920	After 1920	Before 1924	After 1924
Place (relative to Win)				
Lose	1.076	0.648***	0.913	0.694***
	(0.99)	(-3.87)	(-0.77)	(-3.59)
Team	0.875	0.544***	0.938	0.432***
	(-1.02)	(-3.06)	(-1.13)	(-3.09)
Team x lose	1.086	1.851***	1.172	2.112***
	(0.80)	(4.46)	(1.34)	(3.11)
Country effects	Yes	Yes	Yes	Yes
Observations	463	619	608	474
Log likelihood	-2356.9	-3326.6	-3265.1	-2414.5

	Panel B: With body mass index			
	(1)	(2)	(3)	(4)
	Before 1920	After 1920	Before 1924	After 1924
Place (relative to Win)				
Lose	1.113	0.667***	0.951	0.725**
	(1.12)	(-3.07)	(-0.37)	(-2.49)
Team	0.849	0.539***	0.966	0.449***
	(-1.42)	(-2.74)	(-0.35)	(-3.02)
Team x lose	1.700***	2.131***	1.860***	2.044***
	(4.91)	(4.82)	(5.01)	(3.18)
Country effects	Yes	Yes	Yes	Yes
Observations	247	461	336	372
Log Likelihood	-1097.0	-2339.6	-1601.6	-1802.9

*p<0.1, **p<0.05, ***p<0.01. Exponentiated coefficients (hazard ratios). Robust t-statistics clustered by country in parentheses. All regressions include year of birth, number of Olympic games competed in career, number of Olympic medals in career, and indicators for distance, middle distance, sprint, field, racewalk, or throwing event, and an indicator variable for whether best rank recorded in both individual and team event.

Table VI: Lifespan Regressions by Event Status, Individual Events after 1920

	(1) Cox	(2) Cox	(3) Gompertz
Place (relative to Win)			
Win x Premiere event	1.080 (0.30)	1.485 (1.42)	1.448** (2.24)
Lose x Premiere event	0.961 (-0.11)	0.734 (-1.02)	0.753 (-1.22)
Lose	0.614*** (-3.37)	0.741* (-1.80)	0.742** (-2.11)
Country effects	Yes	No	No
Level of frailty	None	Country	Individual
Observations	444	444	444
Log likelihood	-2232.8	-2255.1	-91.5

*p<0.1, **p<0.05, ***p<0.01. Exponentiated coefficients. Robust t-statistics in parentheses clustered at country level. Premiere events are 100m, 200m, 400m, 1500m, marathon, and decathlon and other multi-events. All regressions include year of birth, number of total medals in Olympic career, number of Olympic Games competed in, and indicators for distance, middle distance, sprint, field, racewalk, or throwing event.

Table VII: Means of News Coverage Variables for U.S. Athletes

	Number of stories within two decades of Games	100+ stories within two decades of Games (0=no, 1=yes)	On front page within two decades of Games (0=no, 1=yes)	% total stories within two decades of Games
		A. By year of Olympics		
1896 (N=10)	0.0	0.00	0.10	0.0
1900 (N=22)	0.3	0.00	0.05	3.6
1904 (N=61)	0.3	0.00	0.03	8.1
1908 (N=27)	0.4	0.00	0.00	13.1
1912 (N=31)	6.7	0.00	0.19	42.4
1920 (N=47)	6.6	0.00	0.13	65.4
1924 (N=57)	24.5	0.05	0.32	84.1
1928 (N=33)	69.3	0.21	0.67	88.5
1932 (N=45)	112.0	0.27	0.51	94.4
1936 (N=36)	212.2	0.56	0.75	89.8
1948 (N=17)	148.2	0.41	0.59	89.5
		B. By finishing place		
First (N=118)	102.5	0.24	0.46	52.8
Second (N=87)	36.2	0.13	0.25	57.2
Third (N=58)	17.0	0.03	0.14	56.9
Fourth (N=41)	30.3	0.10	0.37	77.5
Fifth (N=36)	30.8	0.06	0.19	82.7
Sixth or lower (N=43)	18.7	0.04	0.22	83.8
Total (N=386)	50.4	0.13	0.30	62.6

Table VIII: Cox Regressions with U.S. News Coverage Variables, 1924-1948

	(1)	(2)	(3)	(4)	(5)	(6)
Place (relative to Win)						
Lose	0.677	0.586*			0.548*	0.529*
	(-1.21)	(-1.67)			(-1.80)	(-1.92)
Team	0.738	0.748			0.621*	0.691
	(-1.21)	(-1.09)			(-1.83)	(-1.31)
Team x lose	1.716	2.117			2.366	2.497*
	(1.05)	(1.45)			(1.64)	(1.68)
Athlete ever on front page (0=no, 1=yes)			0.844	0.807	0.789	0.778
			(-1.02)	(-1.26)	(-1.42)	(-1.49)
At least 100 stories (0=no, 1=yes)			0.971	1.206	0.840	1.015
			(-0.14)	(0.85)	(-0.82)	(0.06)
Year effects	Yes	No	Yes	No	Yes	No
Observations	181	181	181	181	181	181
Log likelihood	-782.2	-795.6	-782.5	-796.4	-780.7	-794.5

*p<0.1, **p<0.05, ***p<0.01. Exponentiated coefficients (hazard ratios). Robust t-statistics in parentheses. All regressions include year of birth, number of Olympic games competed in career, number of Olympic medals in career, and indicators for distance, middle distance, sprint, field, racewalk, or throwing event.

Table IX: Distribution of Prior Rankings by Finishing Place

Place in Olympics	Not Ranked Before Olympics (%)	Top 10 Before Olympics (%)	Top 5 Before Olympics (%)	Top 1 Before Olympics (%)
1	46.1	46.8	38.3	13.0
	(4.0)	(4.0)	(3.9)	(2.7)
2	54.2	33.5	25.2	7.7
	(4.0)	(3.8)	(3.5)	(2.2)
3	57.7	30.0	18.5	3.8
	(4.3)	(4.0)	(3.4)	(1.7)
4	60.2	24.3	12.6	1.0
	(4.8)	(4.2)	(3.3)	(1.0)
5	57.9	25.3	14.7	2.1
	(5.1)	(4.5)	(3.7)	(1.5)
6 or lower	68.3	20.4	7.0	2.1
	(3.9)	(3.4)	(2.2)	(1.2)

Standard error of the mean in parentheses.

Table X: Hazard Regressions: Role of Prior Expectations in Individual Events

	All finalists			Losers only	
	(1)	(2)	(3)	(4)	(5)
	Cox	Cox	Cox	Cox	Cox
Place (relative to win)					
Lose	0.815**		0.821**		
	(-2.12)		(-2.07)		
Ranking compared to expectations (relative to worse)					
Better, not previously ranked		0.800**	0.785**		
		(-1.99)	(-2.27)		
Better, previously ranked		0.826**	0.806**		
		(-2.20)	(-2.54)		
Met expectations		0.953	0.915		
		(-0.45)	(-0.90)		
Ranked within top 5				1.333**	1.261**
				(2.42)	(2.01)
Frailty	None	None	None	None	Country
Country effects	Yes	Yes	Yes	Yes	No
Observations	741	741	741	595	595
Log Likelihood	-4123.1	-4122.6	-4121.5	-3178.7	-3198.1

*p<0.1, **p<0.05, ***p<0.01. Exponentiated coefficients (hazard ratios). Robust t-statistics clustered by country in parentheses, except in shared frailty models. All regressions include year of birth, number of Olympic games competed in career, number of Olympic medals in career, and indicators for distance, middle distance, sprint, field, or throwing event.

Table XI: Lifespan Regressions by Relative Performance on Team

	(1) Cox	(2) Cox	(3) Cox
Slower half of relay team	2.348*	2.203	2.355*
	(1.71)	(1.62)	(1.76)
Country effects	Yes	Yes	Yes
Year effects	Yes	Yes	Yes
Indicators for order on relay	None	Each leg	Anchor leg
Observations	45	45	45
Log likelihood	-122.6	-118.9	-122.6

*p<0.1, **p<0.05, ***p<0.01. Exponentiated coefficients in columns 2-6 (hazard ratios). Robust t-statistics in parentheses clustered at country level.

Table XII: ANCOVA for Team Events in Track and Rowing

Track	Partial Sum of Squares	Degrees of freedom	Mean sum of squares	F	Prob > F
Model	25708.18	127	202.42	0.93	0.646
Team	16921.38	81	208.91	0.96	0.570
Year of birth	6960.12	46	151.31	0.70	0.912
Residual	19982.93	92	217.21		
Total	45691.11	219	208.64		
Rowing	Partial Sum of Squares	Degrees of freedom	Mean sum of squares	F	Prob > F
Model	31511.47	115	274.01	1.55	0.012
Team	18346.15	65	282.25	1.60	0.017
Year of birth	15646.06	50	312.92	1.77	0.008
Residual	17638.88	100	176.39		
Total	49150.35	215	228.61		

The Track sample includes 220 athletes from 16 countries and 9 Olympic Games. The Rowing sample includes 227 athletes from 14 countries and 10 Olympic Games.

Table XIII: Robustness Test: Cox Regressions Dropping Regions

	(1)	(2)	(3)	(4)	(5)
	Drop USA, Canada	Drop Scandanavia	Drop Western Europe	Drop Eastern Europe	Drop Asia, Australia, New Zealand
Place (relative to Win)					
Lose	0.667***	0.843	0.805*	0.806**	0.800**
	(-2.87)	(-1.60)	(-1.93)	(-2.14)	(-2.19)
Team	0.735	0.636***	0.713*	0.690**	0.680**
	(-1.39)	(-2.58)	(-1.93)	(-2.34)	(-2.47)
Team x lose	1.622**	1.497**	1.365	1.476**	1.458**
	(2.03)	(2.10)	(1.50)	(2.25)	(2.20)
Country effects	Yes	Yes	Yes	Yes	Yes
Observations	658	861	775	1040	1045
Log likelihood	-3576.6	-4923.0	-4344.1	-6147.4	-6183.8

*p<0.1, **p<0.05, ***p<0.01. Exponentiated coefficients (hazard ratios). Robust t-statistics clustered by country in parentheses. All regressions include year of birth, number of Olympic games competed in career, number of Olympic medals in career, and indicators for distance, middle distance, sprint, field, racewalk, or throwing event. Regressions in Panel B also include indicator variable for whether best rank recorded in both individual and team event.

Table XIV: Robustness Test: Cox Regressions Dropping Each Year

	(1) Drop 1896	(2) Drop 1900	(3) Drop 1904	(4) Drop 1908	(5) Drop 1912	(6) Drop 1920	(7) Drop 1924	(8) Drop 1928	(9) Drop 1932	(10) Drop 1936	(11) Drop 1948
Place (relative to Win)											
Lose	0.793**	0.818*	0.782***	0.733***	0.748**	0.778**	0.860**	0.796**	0.808*	0.826**	0.818**
	(-2.46)	(-1.92)	(-2.74)	(-2.89)	(-2.27)	(-2.55)	(-2.30)	(-1.98)	(-1.85)	(-2.32)	(-2.00)
Team	0.684***	0.678***	0.653***	0.613***	0.717***	0.652***	0.642***	0.787***	0.672***	0.684***	0.724***
	(-6.61)	(-6.19)	(-5.76)	(-5.11)	(-3.85)	(-5.30)	(-7.22)	(-3.17)	(-5.61)	(-6.65)	(-5.48)
Team x lose	1.497***	1.446***	1.587***	1.620***	1.411***	1.569***	1.529***	1.357**	1.465***	1.374***	1.445***
	(5.96)	(4.30)	(6.20)	(4.87)	(2.69)	(5.33)	(5.69)	(2.16)	(5.40)	(4.26)	(4.33)
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1051	1033	1014	1002	998	931	937	979	958	959	958
Log likelihood	-6217.8	-6094.8	-5963.7	-5882.0	-5852.3	-5396.3	-5430.9	-5724.9	-5587.5	-5578.9	-5576.2

*p<0.1, **p<0.05, ***p<0.01. Exponentiated coefficients (hazard ratios). Robust t-statistics clustered by country in parentheses. All regressions include year of birth, number of Olympic games competed in career, number of Olympic medals in career, and indicators for distance, middle distance, sprint, field, racewalk, or throwing event. Regressions in Panel B also include indicator variable for whether best rank recorded in both individual and team event.

Table XV: Falsification Regressions

	Without BMI			With BMI		
	(1)	(2)	(3)	(4)	(5)	(6)
	Cox	Cox	Gompertz	Cox	Cox	Gompertz
Number of letters in name (relative to highest quintile)						
2nd quintile	1.103	1.117	1.099	1.051	1.084	1.042
	(1.420)	(1.078)	(1.360)	(0.510)	(0.652)	(0.442)
3rd quintile	1.110	1.108	1.105	0.988	0.992	0.979
	(1.211)	(0.948)	(1.206)	(-0.121)	(-0.061)	(-0.215)
4th quintile	0.897	0.914	0.898	0.825**	0.857	0.822**
	(-1.194)	(-0.822)	(-1.224)	(-1.961)	(-1.123)	(-2.117)
5th quintile	0.944	0.951	0.935	0.910	0.937	0.899
	(-0.688)	(-0.475)	(-0.839)	(-1.268)	(-0.521)	(-1.548)
Even	0.963	0.965	0.968	0.990	0.983	0.994
	(-0.553)	(-0.569)	(-0.506)	(-0.150)	(-0.215)	(-0.096)
Country effects	Yes	No	Yes	Yes	No	Yes
Frailty	None	Country	Individual	No	Country	Individual
Observations	1082	1082	1082	708	708	708
Log likelihood	-6435.6	-6460.5	-226.5	-3907.0	-3924.8	-139.8

*p<0.1, **p<0.05, ***p<0.01. Exponentiated coefficients in columns 2-6 (hazard ratios). Robust *t*-statistics in parentheses clustered at country level. All regressions include year of birth, number of total medals in Olympic career, number of Olympic Games competed in, and indicators for distance, middle distance, sprint, field, racewalk, or throwing event.

Table A.1: Number of Observations by Country

Country	N (total)	N (with height and weight data)
Australasia (Australia and New Zealand)	19	11
Argentina	7	6
Austria	2	0
Belgium	10	1
Brazil	4	3
Canada	38	20
Denmark	11	0
Estonia	2	2
Finland	85	74
France	57	27
Great Britain	122	46
Germany	51	42
Greece	15	6
Hungary	31	15
Ireland	3	2
Italy	35	19
Jamaica	3	3
Japan	18	16
Latvia	3	1
Luxembourg	3	0
Netherlands	17	7
Norway	18	9
Poland	2	2
South Africa	16	8
Switzerland	10	4
Sweden	105	68
Czechoslovakia	7	6
USA	386	307
Yugoslavia	2	2

Table A.2: Categorization of Event Classes

Sprints	Middle-distance	Distance	Throws	Field	Racewalk
100m	800m	3000m	56lb weight	Decathlon	3000m walk
100m hurdles	1500m	3000m steeplechase	Discuss	Heptathlon	3500m walk
110m hurdles		3200m steeplechase	Discuss, ancient style	Pentathlon	10km walk
200m		4000m steeplechase	Discuss, both hands	Triathlon (long jump, shot, 100y)	10 mile walk
200m hurdles		5000m	Hammer	High jump	20km walk
400m		5000m team	Javelin	High jump, standing	50km walk
400m hurdles		5 miles	Javelin, freestyle	Long jump	
60m		3 miles team	Shot put	Long jump, standing	
80m hurdles		4 miles team	Shot put, both hands	Pole Vault	
4x100 relay		Cross country		Triple jump	
4x400 relay		Cross country team		Triple jump, standing	
		10000m			
		Marathon			

Table A.3: Lifespan Regressions: Sensitivity Test

	(1)	(2)	(3)	(4)	(5)	(6)
	Cox	Cox	Gompertz	Cox	Cox	Gompertz
Place (relative to Win)						
Lose	0.907	0.907	0.915	0.776**	0.776**	0.792**
	(-0.87)	(-1.07)	(-1.07)	(-2.37)	(-2.06)	(-2.03)
Team				0.643***	0.175***	0.177***
				(-8.84)	(-17.29)	(-16.83)
Team x lose				1.590***	1.663***	1.596***
				(6.05)	(3.45)	(3.25)
Country effects	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	No	Yes	Yes	No	Yes	Yes
Event effects	No	Yes	Yes	No	Yes	Yes
Event class effects	Yes	No	No	Yes	No	No
Frailty	None	Country	Individual	None	Country	Individual
Observations	1064	1064	1064	1064	1064	1064
Log likelihood	-6312.8	-6251.5	-172.3	-6308.6	-6246.6	-167.9

*p<0.1, **p<0.05, ***p<0.01. Exponentiated coefficients (hazard ratios). Robust t-statistics clustered by country in parentheses, except in shared frailty. All regressions include year of birth, number of Olympic games competed in career, number of Olympic medals in career. The sample excludes 18 athletes whose best performance is recorded in both a team and individual event.