Stars make the difference: Does military rank effect the Long-term-Survival of Military Academy Graduates– Causation or Selection?

Ronny Westerman[1], Allan Mazur[2], Ulrich Mueller[1]
[1]Competence Center Mortality Follow-Up, German National Cohort at Federal Institute of Population Research, Wiesbaden, Germany
[2] Center for Environmental Policy and Administration, Maxwell School, Syracuse University, Syracuse, USA

Abstract:

Objectives: Military officers who retire at the highest ranks have the greatest survival benefits, especially at advanced ages. This might be causative: attaining a higher military rank more effectively promotes health and life expectancy. Alternatively, it may be selective: only men in robust health will attain the top ranks.

Methods: We investigated the long-term survival of the 1949, 1950 and 1951 graduates from the US Naval Academy (n=2206) and the US Military Academy (n=1719). In the survival analysis, we used nonparametric and parametric (gamma)-Gompertz survival models.

Results: We found the expected positive association between final rank and life span. An unexpected finding was the maximum effect for retirees who died at approximately 80 years. This pattern supports the selection hypothesis.

Discussion: The survival of the oldest-old age group in this military population was affected by selection: only individuals with robust health well into their 60s attained top ranks.

Background

Among military officers, a higher final rank is usually associated with better health conditions and longer life expectancy (Bedard and Deschênes, 2006; Magerøy et al., 2007; Silva et al., 2007; Edwards, 2008; Fear et al., 2009; MacLean and Edwards, 2010; Martins and Lopes, 2012, 2013; Loehr and O'Hara, 2013). The association between military rank and long-term survival might be causal, with the material and immaterial benefits of a higher rank resulting in a longer life expectancy. Alternatively, this association may be selective because only military officers with robust health are likely to attain the top ranks.

It remains questionable if mortality benefits will continue to grow or approximate also in the older military veterans after many years of active service and independently of their current socioeconomic background.

We used the military rank as a proxy variable for the common the Duncan socioeconomic index (SEI) which was applied also to civilian occupations (Duncan and Hodge,1963; MacLean and Edwards, 2010; Hout, 2018). In this context the military rank defines service men by socioeconomic rewards and job characteristics and is a social measure for education, income, occupation, and wealth (MacLean and Edwards, 2010).

We expect lower survival benefits for lower commissioned ranks as staff officer. This could be explained by the different exposure of psychosocial stress for those working in a lower bureaucratic hierarchy (Marmot et al., 1978). Martins and Lopez (2012) found a higher prevalence of common mental disorders (CMD) in military service men with lower commissioned ranks. As a result, military officers holding a rank of a lieutenant are more likely vulnerable for adverse health outcomes compared to officers in the highest commissioned ranks. Probably the higher vulnerability to adverse health outcomes and even higher psychosocial stress over the life course may also contribute to lower survival in lower commission rank officers after active service.

One remaining research question should focus on the impact of social determinants in long-term survival in older adults.

Probably the social disparities in age-specific mortality risks started to vanish or demonstrated at specific ages. In the context of our study the rank-specific benefits in long-term survival may getting closer within the older military veterans, with potential effects of selectivity.

Methods:

Study Population

This study included the 1949, 1950, and 1951 graduates of the US Naval Academy (USNA) (n=2206) and the US Military Academy (USMA) (n=1719), approximately 18,2%, 17,8%, and 22.6% of whom are still alive, respectively.

Moreover, we focused on subjects with at least 20 years of active military service, at which point they could retire with benefits. Death before that benchmark was usually caused by violence or accidents.

The sources of the data for the places and dates of birth and career achievements were the graduation yearbooks and the register of graduates, which are still published regularly for the Army but were discontinued in 1999 for the Navy; however, in 1999, none of the officers studied here were still in active service.

For mortality, we used different data sources, including the US social security index, US mortality index and the obituary services of the USNA and USMA. There were four cycles of mortality follow-up that ended on December 31, 2013; December 31, 2016; August 31, 2019; August 31, 2021 available.

For the recent data analysis we focus only on the last mortality-follow-up update.

The individuals who did not serve the minimum of 20 years in the military were excluded from the analysis. The maximum years of service in the US military were 28 years for those who achieved officer rank 4 (OF4) and OF5, the lowest ranks allowed to serve for more than 20, 30 years for those who achieved OF6 (colonels and captains), and 35 years for those who achieved OF7-10 (generals and admirals) (see below). These mandatory retirement regulations were more strictly applied in the study population than they are today.

Since most promotions to OF6 or to OF7 must have taken place before reaching the maximum number of years of service for OF5 or OF6, respectively, the difference in the maximum number of years of service is not a confounder. In contrast, the number of years served beyond 20 years had to be considered.

A very small number of recruits quit active service in the first years after graduation. In addition, some individuals died before reaching the specific age. Such deaths may be caused by accidents, e.g., pilot training incidents, violent incidents and being killed in action (KIA) in the conflicts in Korea and Vietnam. These causes of death mostly affected junior officers. The age distributions did not differ between the Army and the Navy; additionally, the mortality rates among the branches of the military (air force, artillery, infantry, engineering, artillery, armored division, naval air force and other) did not differ.

Consequently, we used three subgroups to compare ranks, based on the NATO Rank Classification system (OF4-OF10):

• STAFF (OF4-5) (Army: MAJ, LTC; Navy: LT, LCDR)

• COLONELS/CAPTAINS (OF 6) (Army: COL, Navy: CDR, CPT)

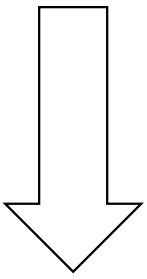
• GENERALS/ADMIRALS (OF 7-10) (Army: BG, MG, LTG, GEN, Navy: RDML, RADM, VADM, ADM, FADM)

There were 3,920 individuals in the total sample. A total of 317 (8.1%) individuals were excluded from the analysis because they survived less than 20 years after graduation. In the survival analysis, we included 3,603 individuals with 2,841 events: 1,431 (39.7%) staff officers, 1,938 (53.7%) colonels/captains and 234 (6.5%) generals/admirals.

Table 1 Exclusion Criteria before data analysis

Before Minimum Service of 20 years

Rank\Class	1949	1950	1951	Total
STAFF	658	552	495	1,705
percent	16.79 %	14.08 %	12.63 %	43.49 %
COLONELS/CAPTAINS	624	716	640	1,980
percent	15.92 %	18.27 %	16.33 %	50.51 %
GENERALS/ADMIRALS	81	93	61	235
percent	2.07 %	2.37 %	1.56 %	5.99 %
Total	1,363	1,361	1,196	3,920
percent	34.77 %	34.72 %	30.51 %	100.00 %



After Exclussion of Minimum Service of 20 years

Rank\Class	1949	1950	1951	Total
STAFF	556	454	421	1.431
percent	38.85 %	31.73 %	29.42%	39.72 %
COLONELS/CAPTAINS	611	698	629	1.938
percent	31.53 %	36.02 %	32.46%	53.79 %
GENERALS/ADMIRALS	80	93	61	234
percent	34.19 %	39.74 %	26.07 %	6.49 %
Total	1,247	1,245	1,111	3,603
percent	34.61 %	34.55 %	30.84 %	100.00 %

Covariates

Although the degree of heterogeneity in established risk factors for mortality was small within the study population, we further controlled for the branch of service, state of birth, and number of years as an officer.

We included the covariate of birth place as a grouping variable (Northeast, Midwest, South, West and abroad) to control for geographic variations in baseline risk. The geographic regions were those used in the census.

Each region contains between nine and sixteen states that were grouped together because of similar economic backgrounds, comparable population compositions, and shared historical development (U.S. Census Bureau, 1994; Montez and Berkman, 2014; Berchick and Lynch, 2017).

We also controlled for graduating class, branch (air force, artillery, infantry, engineering, artillery, armored division, naval air service, submarine, fleet and others) and length of time spent as military officer because those factors could directly affect long-term survival regardless of military rank.

Statistical Methods

For the survival analysis, we used the gamma-Gompertz model to account for unobserved heterogeneity in this population. The influence of unobserved covariates in a proportional hazard model can be addressed with a positive latent random variable, frailty, which is represented as Z. The frailty concept implies that there is a mixture of individuals in the population who vary in terms of their susceptibility to common risks (Vaupel et al. 1979; Vaupel and Missov, 2014).

In the parametric paradigm, the frailty variable requires one parametric distribution to be specified; the most popular choice follows the gamma distribution. This is one of the most flexible statistical distributions and can be used as an approximation for any other parametric version.

Following the Perks model (Butt and Habermann, 2004; Vaupel and Missov, 2014), we will provide a parametric frailty model that uses the Gompertz distribution for the baseline as ae^{bt} and specifies the gamma distribution for the frailty Z:

$$\lambda(t) = \frac{ae^{bt}}{1 + \frac{\sigma^2 za}{b}(e^{bt} - 1)}$$

$$\text{with } \lambda_0(t) = ae^{bt} \text{ and } \Lambda_0(t) = \frac{a}{b}(e^{bt} - 1).$$

Parametric modeling of survival or hazard functions with the Gompertz distribution also supports the argument that the exponential growth in mortality with increasing age (the Gompertz law) is followed by a period of mortality deceleration and a decline in mortality after the age of 75-80 years. This mortality deceleration eventually produces “late-life mortality leveling off” and “late-life mortality plateaus” at extremely old ages (Gravilov and Gravilova, 2019, Böhnstedt et al. 2021).

We assumed a positive association between final rank and life span/survival, with maximum differentials according to rank reached at approximately 75-80 years and then decreasing. This pattern would support the selection hypothesis. Modeling unobserved heterogeneity suggests that the levelling off the differences in mortality rates at older ages is caused by the difference in the rate of loss of subjects according to their final rank from the sample with advancing age. For the statistical analysis, we used the nonparametric Kaplan-Meier estimator and three statistical (Peto-Peto, Tarone-Ware and Wilcoxon) tests of differences in survival. The Wilcoxon and Tarone-Ware tests are sufficient if the hazard ratio is not constant. The Peto-Peto test is also efficient if the proportional hazard assumption is violated.

For the parametric survival models, we used the hazard ratio to allow a comparison of the relative survival in the three military rank categories, with 95% confidence intervals.

To capture the individual onset of mortality risks before and after graduation, we use a delay-entry approach, while individuals of the three graduation classes entered the study population at different time points.

All statistical analyses (nonparametric and parametric estimates) were performed with STATA 16 SE, (StataCorp LLC, College Station, Texas 77845-4512 USA

Results

The results of the nonparametric estimates (Kaplan-Meier estimates) showed significant overall survival benefits for generals/admirals compared to staff. Officer with ranks as colonels or captains have not significant lower mortality risk compared to staff. Overall, survival advantages for officers with the highest commissioned ranks seemed to decelerate at the age of 80 years.

Graph 1 Kaplan-Meier estimates by Rank

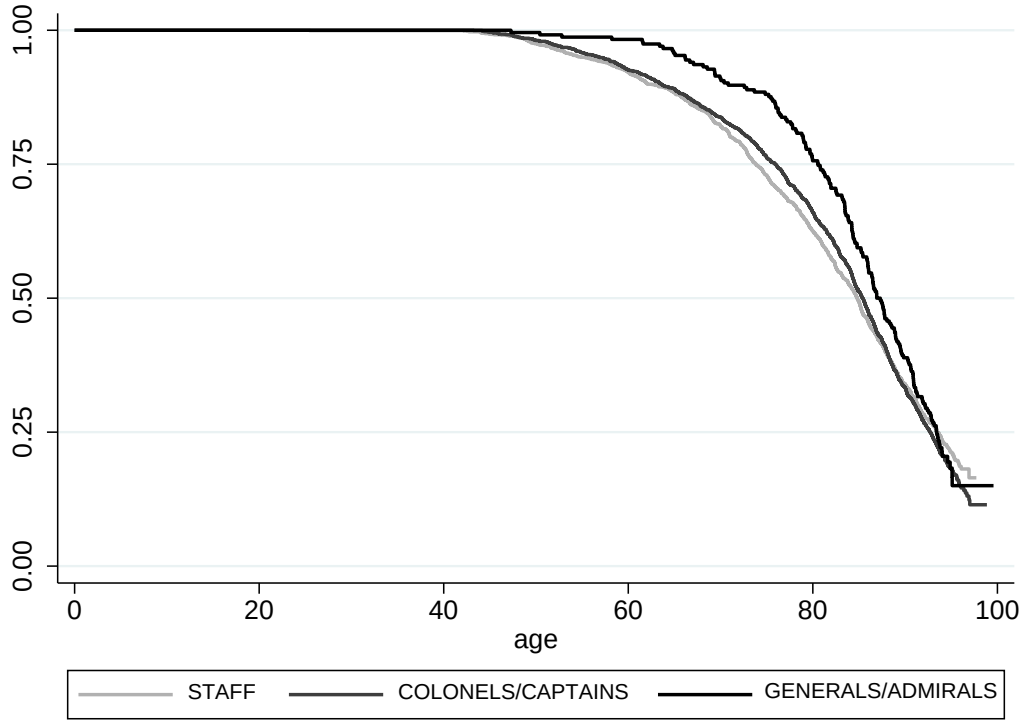


Table 2 Test the equality of survival function for rank

	Events observed	Events expected	Peto-Peto	Tarone-Ware	Wilcoxon
STAFF	1104	1110.42			
COLONELS/CAPTAINS	1552	1523.21			
GENERALS/ADMIRALS	185	207.36	10.14	6.11	9.67
Total	2841	2841	Pr>chi²=0.0063	Pr>chi²=0.0047	Pr>chi²=0.0080

These findings were supported by the estimates (Model 1) from the gamma-Gompertz model. Hence, general/admirals (hazard ratio (HR) 0.759, 95% CI 0.578-0.995) had significantly lower risks of mortality than staff. For officers with the highest commissioned rank (hazard ratio (HR) 0.780, 95% CI 0.603-0.999) the mortality risks were also lower and significant compared to colonels/captains. Surprisingly, the risk of mortality for colonels/captains (hazard ratio (HR) 0.962, 95% CI 0.826-1.116) was lower than that of staff, although the difference was not significant.

Individuals from Midwestern states (hazard ratio (HR) 1.092, 95% CI 1.048 - 1.294) and had slightly higher risks of mortality than their peers from the East Coast but did not suffer a disadvantage with regard to their careers.

The Branch (hazard ration (HR) 1.003, 95% CI 1.001-1.005) was generally associated with low but significant effect on mortality risks.

A protective factor that was beneficial for long-term survival was time spent as a military officer (years) (hazard ratio (HR) 0.986, 95% CI 0.979-0.992), which could be explained by military officers who stayed in the commissioned ranks for longer having a better chance of achieving a relatively higher final military rank.

The statistical test for the frailty variable was positive and significant. This indicates that there is an unmeasured component that drives the selection process for survival in our study sample

Table 4 Modell 1 Gompertz-Gamma Modell for Ranks and Covariates

	HR	Std. Err	z	P>IzI	95 % CI	
RANK						
COLONELS/CAPTAINS vs. STAFF	0.960	0.074	-0.53	0.596	0.826	1.116
GENERALS/ADMIRALS vs. STAFF	0.759*	0.105	-2.00	0.046	0.578	0.995
GENERALS/ADMIRALS vs. COLONELS/CAPTAINS	0.780*	0.126	-1.88	0.048	0.603	0.999
ORIGIN						
SOUTH vs. EAST	1.102	0.103	1.05	0.294	0.9184	1.324
MIDWEST vs. EAST	1.092*	0.095	2.03	0.038	1.048	1.294
WEST vs. EAST	1.097	0.125	0.82	0.414	0.877	1.371
ABROAD vs. EAST	0.894	0.184	-0.54	0.589	0.597	1.339
BRANCH	1.003**	0.001	2.72	0.007	1.001	1.005
CLASS	0.986	0.040	-0.32	0.752	0.906	1.073
YEARS AS MILITARY OFFICER	0.986***	0.003	-3.97	0.000	0.979	0.992
_cons	0.2724	2.28e+08	0.18	0.860	1.40e-65	5.31e+77
gamma	0.109	0.005	21.21	0.000	0.989	0.119
ln_the	0.202	0.177	1.14	0.254	-0.184	-0.370
theta	0.330	0.124			0.158	0.690
LR test of theta=0: chi2=8.04						
Prob > chi2 =0.002						
Log likelihood =207.387						

n=2,841

Discussion:

There is still a debate regarding whether or how active military duty affects health and mortality (McLaughin et al., 2008; Hartal et al., 2015).

Some arguments support the negative health consequences of military service, with higher risks of postservice mortality, especially for those who served in or after the Vietnam War (Boehmer et al., 2004; Thomas et al., 2017; Levin-Rector et al., 2018). In contrast, there is evidence for health advantages for military veterans that are consistent with the epidemiological argument that the military recruitment criteria initially select healthier men for inclusion (Spiro III et al., 2016).

Over time, these health advantages for veterans will probably decrease, and eventually, the gap between those who served in the military and those who did not will be closed (Hardy and Reyes, 2016; Spiro III et al., 2016).

Similar findings were reported in a large Scottish study focusing on veterans, in which longer-serving veterans had a significantly lower risk of mortality than nonveterans (Bergmann et al., 2019). The risk of mortality decreased with increasing length of service and more recent birth years. Adverse health-related behaviors, such as smoking, increased mortality in those who left the military early, exerting a selective effect.

In the current study, we only focused on those in the commissioned military ranks who survived a minimum of 20 years after graduation to investigate the survival advantage after active service for people with different military ranks.

The group with the greatest survival benefit was the admirals/generals when compared with staff. The benefit observed in the highest officer ranks may be the result of the length of time spent in active service.

However, the higher risk in the lower commissioned ranks disappeared at more advanced ages (see Graph 1). This pattern supports the selection hypothesis. The differences in the trajectories of lifespan between those in the lower and middle ranks and those in the higher ranks start to

become apparent relatively early in the course of a career, which means that only the fittest individuals achieve the top final ranks.

We also found some evidence of negative regional effects on mortality in military veterans from Midwestern states. These findings are consistent with those in the literature, which have shown that there is relatively more excess midlife mortality in the industrial Midwest (Indiana, Kentucky, Ohio, West Virginia) (Woolf and Schoomaker, 2019). There is weak evidence for a gradient, with lower expected survival for white males aged 75–84 years from areas of the Midwest and South (Detroit, Georgia, Kentucky and Louisiana) with a low socioeconomic status (Mariotto et al., 2018), which corresponds with our findings.

The years spent serving as an officer was a protective factor against mortality, possibly because officers who remain on active duty for longer gain the benefits of regular and mandatory physical examinations, financial stability and often further education from non-military institutions.

A recent study by Blosnich et al., 2020 showed that adverse social constraints will have a 27% increase in odds of premature mortality in military veterans. A stable social background more common in officers in the highest commission-ranks will be beneficial for the oldest-old survival.

Surprisingly, the branch in which the officers served have small but significant effect on the long-term survival. All the men in the study sample were commissioned officers, and while there might be minor variations in specific occupational risks, such as pilot training, the long-term effects of these variations are quite small.

Conclusion

In our study, officers with the highest commissioned rank (admiral/general) had the lowest risk of mortality. This effect was observed after controlling for external variables and unobserved heterogeneity. Regarding the question of whether the effect is causal or selective, there is more evidence for selection. The number of years spent as an officer was a protective factor against mortality, so it is more plausible that only the fittest stay longer on active duty and achieve the top ranks. Originating from Midwestern states was negatively associated with long-term survival, which indicates there might also be geographic patterns in mortality among veterans.

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List of Abbreviations

ADM	Admiral
αe^{bt}	Gompertz-Function
BG	Brigadier General
BMI	Body Mass Index
CDR	Commander
CI	Confidence intervall
CMD	common mental disorders
COL	Colonel
CPT	Captain
FADM	Fleet Admiral
G	General
HR	Hazard Ratio
$\lambda(t)$	Hazard Function
$\Lambda_0(t)$	Cumulative Hazardfunction
KIA	killed in action
LCDR	Lieutenant Commander
LT	Lieutenant
LTC	Lieutenant Colonel
LTG	Lieutenant General
MAJ	Major
MAW	Maximum Allowable Weight
MG	Major General
n	sample size
NHANES IV	The National Health and Nutrition Examination Survey IV
p	p-Value
PR	probability
RDML	Rear Admiral (lower half)
RADM	Rear Admiral (upper half)
SD	standard deviation
SEI	socioeconomic index
Std.Err	standard error
t	t-value
US	United States
USMA	United States Military Academy
USNA	United States Naval Academy
VADM	Vice Admiral
WWII	World War Two
Z	Frailty