Extended Abstract

The Association of Military Rank with Oldest-Old Survival in Military Academy Graduates

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

Short Abstract:

Military officers who retired at the highest ranks gained greatest benefits in survival, especially at advanced age. This might be a causal relation: higher military ranks improve health and life expectancy. Or it may be selective: only men in robust health will reach the top military ranks. For this study we investigated the 1949, 1950 and 1951 graduates of the US Naval Academy (n=2206) and the US Military Academy (n=1719). Survivors were nearly equally distributed by graduation year (24.9%, 24.6% and 20.2%, respectively), as of August 31, 2019. This study is limited to men with more than 20 years of active service, for whom variation is low for major confounders for survival. We found a positive association between final rank and life span, most significantly for retirees, who died around age 80 years. This pattern supports the selection hypothesis. Sorting survival trajectories by final military rank shows that differences across final ranks begin early, well before final rank is attained.

1.Background

Among military officers, as in many comparable civilian settings, a higher final rank usually is associated with better health conditions and higher 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 Lopez, 2012; Loehr and O'Hara, 2013). This statistical association might be non-causal because of the affection of competing hypotheses of causation or selection (Mossakowski, 2014, Hoffmann et al 2019). The association between military rank and long-term survival can be causal while material and immaterial benefits of a higher rank in active service and thereafter may cause life to last longer. Alternatively, this association may be selective because only military officers with robust health conditions may have a greater chance to make it to the top ranks. We study the graduates of 1949, 1950, 1951 of the US Naval Academy, Annapolis (n=2206) and of the US Military Academy, Westpoint (n=1719), with app. 24.9%, 24.6%, 20.2% equally distributed survivors to this date.

However, we focus on subjects with at least 20 years of active military service, when men could retire with benefits. Deaths before the according age in most cases would be violent or accident caused.

2. Study Population

Usually those men are from a population in which the variation of several major intervening variables is mostly fractional. (1) Virtually the majority of the graduates came from a stable middle class background with a European ancestry, grew up in peacetime, and apparently experienced no extreme physical and social distress in childhood like hunger or social deprivation. (2) All men were highly screened for physical and mental fitness, and intelligence before admission to USNA and USMA. (3) All men remained healthy and fit at least until their late 40s; otherwise they would not have stayed on active duty. (4) Men's weight would have conformed with the United States Army Maximum Allowable Weight (MAW) Table, with MAWs corresponding to a BMI of 29.9 for the shortest and 27.9 for the tallest men (Institute of Medicine, 2003). (5) In a military environment the rank differences have no impact on nutrition, sanitation, or exercise facilities. All men had access to free and excellent health care which includes regular mandatory check-ups for all. (6) Income inequality is moderate. The basic monthly salary of a four-star general /admiral at present is about twice the salary for a major / lieutenant commander, the lowest final rank observed among those with 20+ years of service in the sample, and in any case, well above the US poverty line (Ash et al., 2016).

Reasonably for the data analysis we have to exclude the individuals didn't serve the minimum of 20 years for the military. A very small number of recruits have quit their active service in the first years after the graduation. Also some individuals died before that specific age, such events may be caused by accidents e.g. pilot trainings, violence and kills in action (KIA) in the Korea and Vietnam conflicts, this mostly affected junior officer ranks. Also the age distribution through Army and Navy didn't differ, also the mortality through branches (air force, artillery, infantry, engineering, artillery, armor, naval airforce and other) did not differ.

Consequently we use for the rank comparison three subgroups, following the NATO Rank Classification (OF1-OF10):

- in STAFF (Army: 2LT, 1tLT, CPT, MAJ; Navy: ENS, LTJG, LT, LCDR
- in COLONELS /CAPTAINS (Army: LTC, COL, Navy: CDR, CPT)
- in GENERALS/ADMIRALS (Army: BG, MG, LTG, GEN, Navy: RDML, RADM, VADM, ADM)

Table 1 Exclusion Criteria before data analysis

Before exclusion of officer with less than 20 years active service

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 exclusion of officers with less than 20 years active service

Rank\Class	1949	1950	1951	Total
STAFF	504	414	383	1.301
percent	16.09 %	13.21 %	12.22%	41.53 %
COLONELS/CAPTAINS	522	583	523	1.628
percent	16.66 %	18.61 %	16,69 %	51.96 %
GENERALS/ADMIRALS	63	86	55	204
percent	2.01 %	2.74 %	1.76 %	6.51 %
Total	1,089	1,083	961	3,133
percent	34.76 %	34.57 %	30.67 %	100.00 %

We had 3.920 individuals in the total sample. 789 (20,1 percent) cases had to be omitted because they served less than 20 years of active duty. For Survival analysis we included 3.131 cases with 1.944 events with 1.301 (41,5 percent) staff officer, 1.628 (52,0 percent) colonels/captains and 204 (6,5 percent) generals/admirals.

Mortality-Follow-up

For the Mortality-Follow-Up we used different data source including the US social security index, US Mortality index and the obituary service from US Naval Academy Annapolis and US Military Academy West Point. There were three cycles of Mortality-Follow-Up until December 31, 2013, December 31, 2016 and August 31, 2019 available.

Covariates

Although the internal heterogeneity with regard to established factors for differential mortality is small within the study population, we also considered further information of branch of service, state of origin, years as officer to control for any confounding.

We included the covariate of origin as grouping variable (Northeast, Mid-West, South, West and Abroad) to control for geographic variation in baseline hazard. The geographic regions were grouped in the five-category Census measure: Northeast, Midwest, South, West and Abroad. Each region contains between nine and sixteen states and were grouped because of similar economic background, comparable population composition, and common historical development (U.S. Census Bureau, 1994; Montez and Berkman, 2014; Berchick and Lynch, 2017).

We have also controlled for graduation class, the branch (air force, artillery, infantry, engineering, artillery, armor and other) and the time length staying as military officer because those can directly affect the long-term survival for any military ranks.

3. Statistical Methods

For survival analysis we used the Gompertz-(Gamma) Model to account for unobserved heterogeneity in this population. The influence of unobserved covariates in a PH model can be treated by a positive latent random variable, the frailty Z. The frailty concept implies a mixture of individuals in population varying in their susceptibility to common risks (Vaupel, 1979). The frailty variable requires for the parametric paradigm, the specification of one parametric distribution. The most popular parametric specification for the frailty variance 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. It has to be mentioned, that there are no biological or empirical arguments justifying the use of the gamma distribution, its simply computational or mathematical convenience that determines the preferences of any parametric version for the frailty (Yashin et al. 2001, Wienke, 2010).

Follow the Perks Model (Butt and Habermann, 2004, Vaupel et al. 2014) we will provide a parametric frailty model, with Gompertz-specification for the baseline and Gamma for the frailty.

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

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

Parametric modeling of Survival or Hazard-Functions with Gompertz distribution supports also the argument that the exponential growth of the force of mortality with age (the Gompertz law) is followed by a period of mortality deceleration and a mortality decline after age of 75-80 years. This mortality deceleration eventually produces "late-life mortality leveling-off" and "late-life mortality plateaus" at extreme old ages (Gravilov and Gravilova, 2019).

However, we assumed a positive association between final rank and life span/survival, with maximum differentials by rank around age 75-80, but then to decrease. This pattern supports the selection hypothesis. Modeling unobserved heterogeneity suggests that the levelling off of differential mortality rates at higher ages is caused by the differential loss rate of subjects by final rank from the sample with advancing age. The trajectories leading to different final ranks, and indirectly also to different lifespans seem to drift apart already in early careers. This fits in with the deliberate sorting candidates for leadership positions starting in hierarchies like the military already at around age 30.

Additional covariates are origin, graduation class, the branch, the time length staying as military officer.

All statistical analysis (non-parametric and parametric estimates) was computed with STATA 14 SE.

4. Preliminary Results

Table 2 Mean age at graduation for classes 1949, 1950, 1951

Class	Mean Age	Std. Err	95% CI	
1949	23.193	0.321	23.129	23.256
1950	23.041	0.322	22.978	23.105
1951	23.163	0.342	23.096	23.230
Class	contrast	Std. Err.	t	P>ltl
1950 vs1949	-0.151	0.0454	-3.33	0.001
1951 vs 1949	-0.029	0.0469	-0.63	0.531
1951 vs 1950	0.121	0.0469	2.59	0.010

Graph 1 Kaplan-Meier survival estimates for Rank

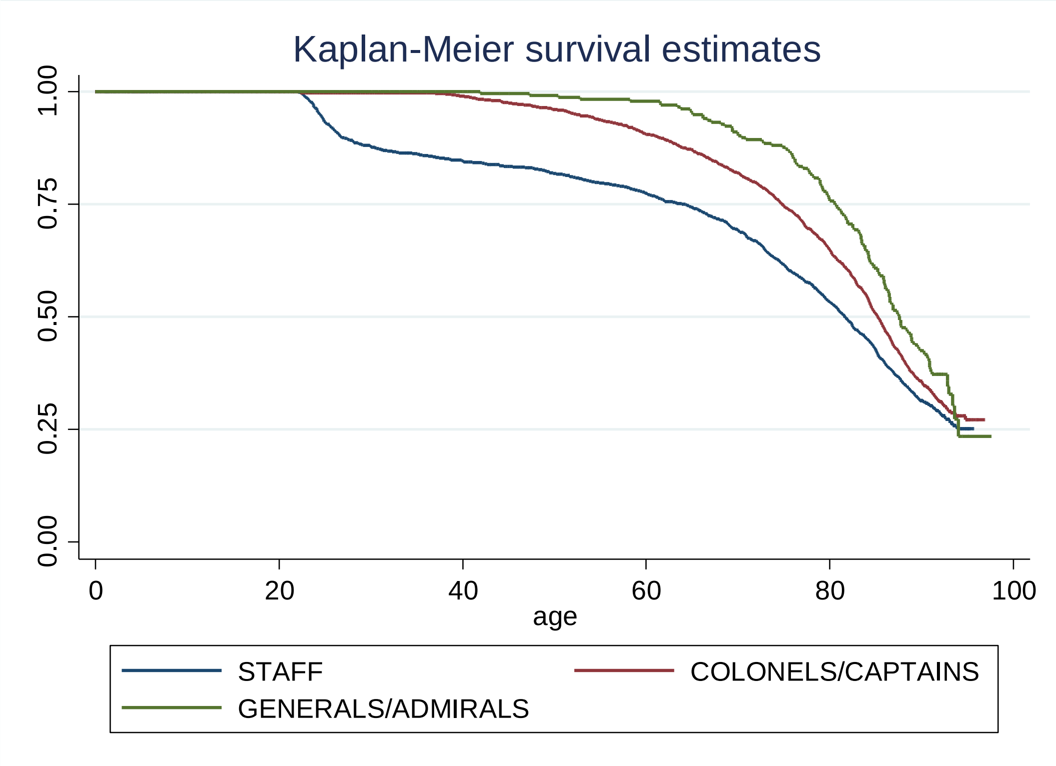


Table 3 Test the equality of survival function for rank

	Events observed	Events expected	Peto-Peto	Tarone-Ware	Wilcoxon
STAFF	810	769.43			
COLONELS/CAPTAINS	1013	1032.28			
GENERALS/ADMIRALS	121	142.29	18.34	12.15	19.44
total	1944	19.44	Pr>chi²= 0.0001	Pr>chi²= 0.0023	Pr>chi²= 0.0001

Results from nonparametric estimates (Kaplan-Meier estimates) showed overall significant survival benefits for Generals/Admirals compared to colonels and staff. These survival advantages seemed to decelerate at age 80 years.

These findings were underlined with the results (Model 1) from Gompertz(Gamma)-Model estimates.

Hence, Colonels/Captains (HR 0.749, 95% CI 0.654-0.859) and Generals/Admirals (HR 0.636, 95% CI 0.494-0.820) had statistical significant lower mortality hazards compared to Staff. The mortality hazards for Admirals/Generals (HR 0.559, 95% CI 0.358-0.872) compared to Colonels/Captains were also lower and statistically significant.

Individuals with Midwest origin (HR 1.189, 95% CI 1.017-1.391) had higher mortality hazard compared to peers from the East coast. Another protective risk factor and even beneficial for the long-term-survival was the time as military officer (accounted as years as military officer) that forwarded military officer staying longer in commissioned ranks followed with better chances to achieve higher final military ranks.

As a conclusion the final top ranks had shown the lowest vulnerability. Then it is more plausible that only the fittest individuals will survive longer and make it to the top ranks.

Model 1 Gompertz-Gamma Modell for Ranks and Covariates

	HR	Std. Err	z	P>IzI	95 % CI	
RANK						
COLONELS/CAPTAINS vs. STAFF	0.749***	0.052	-4.12	0.000	0.654	0.859
GENERALS/ADMIRALS vs. STAFF	0.636***	0.082	-3.49	0.000	0.494	0.820
GENERALS/ADMIRALS vs. COLONELS/CAPTAINS	0.559**	0.126	-2.56	0.010	0.358	0.872
ORIGIN						
SOUTH vs. NORTHEAST	1.087	0.094	0.97	0.333	0.918	1.287
MIDWEST vs. NORTHEAST	1.189*	0.095	2.17	0.030	1.017	1.391
WEST vs. NORTHEAST	1.114	0.115	1.05	0.296	0.909	1.366
ABROAD vs. NORTHEAST	1.146	0.212	0.73	0.462	0.797	16.483
BRANCH	0.999	0.002	-0.37	0.710	0.996	1.003
CLASS	1.006	0.040	0.16	0.876	0.931	1.088
YEARS AS MILITARY OFFICER	0.992**	0.003	-2.48	0.013	0.986	0.988
_cons	1.38e-11	1.07e-09	-0.32	0.747	1.36e-77	1.41e+55
gamma	0.172	0.009	18.07	0.000	0.153	0.190
ln_the	0.202	0.177	1.14	0.254	-0.144	0.548
theta	1.223	0.216			0.865	1.730
LR test of theta=0: chi2=47.84						
Prob > chi2 =0.000						
Log likelihood = -288.03051						

N=3131, events = 1944,

5. Discussion:

In the scientific literature there is the remaining debate if or how military active duty forces health and mortality (Hartal et al., 2015). Some arguments support the negative health consequences of military service, especially for those service men 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 in military veterans that are consistent with the epidemiological argument of military recruitment criteria that initially select healthier men into the service (Spiro et al. 2016). Over time, these health advantages for veterans probably will be decreasing and eventually the gap between former service men and non-service men will be enclosed (Hardy and Reyes, 2016, Spiro et al. 2016).

For the current study we only focused on military service men in commission ranks with minimum service time of 20 years, to prove the mortality advantage after active service for different military positions.

The highest benefit in survival will be defined for Admirals/Generals in comparison to Staff. The benefit for the highest officer ranks may be caused in length of their active service time. MacLean and Edwards (2010) showed that veterans who served as officers have better health outcomes than veterans who served in the enlisted ranks, even after taking their higher levels of education and income into account. Our results showed that men who stayed longer in the lowest commissioned rank (staff officers) had lower significant benefits in survival. This could be explained by the different exposure of psychosocial stress for those working in a lower in a bureaucratic hierarchy (Marmot et al. 1978, Langenberg et al. 2005).

Another plausible explanation for that phenomenon is described by Martins and Lopez (2012) who found higher prevalence of common mental disorders (CMD) among those officers holding the rank of a lieutenant. The lowest commissioned ranks (also include the lieutenants) may be higher effected by psychosocial stress in certain differing and concomitant directions (Fear et al. 2009, Martins and Lopez, 2013). In relation to the hierarchy, the need for esteem and approval may be directed towards both superiors and subordinates, given that it is quite common for the highest non- commissioned ranks (Sergeant-Majors in US Army and the Warrant officers in Navy) to have served many more years in the armed forces than the lowest commissioned ranks, nearly all of whom have been performing military duties for only a few years.

Also, the possibility of undesirable changes at work, which is greater at the lower commissioned ranks, this could be also a cause of stress (Siegrist, 1996, Shimanzu and de Jonge, 2009).

Otherwise the higher risk in vulnerability for the lower commissioned ranks vanished with the higher age (see Graph 1). This is pattern supports the selection hypothesis. The trajectories in lifespan between lowest and mid commission and the highest rank category start drifting apart earlier, so only the fittest individuals will make it to the top final ranks.

References:

Asch BJ, Hosek J, Kavanagh J, Mattock MG (2016) Retention, Incentives, and DoD Experience under the 40-Year Military Pay Table. Rand Defense National Defence Research Institute. RAND Corporation, Santa Monica, Calif.

Bedard K, Deschênes O (2006) The Long-Term Impact of Military Service on Health: Evidence from World War II and Korean War Veterans. Am Econ Rev. 96(1):176-194.

Berchick ER, Lynch SM (2017) Regional Variation in the Predictive Validity of Self-Rated Health for Mortality. SSM Popul Health. 3:275-282.

Boehmer TK, Flanders WD, McGeehin MA, Boyle C, Barrett DH (2004) Postservice mortality in Vietnam veterans: 30-year follow-up. Arch Intern Med 164(17):1908-16.

Butt Z, Haberman S (2004) Application of frailty–based mortalitymodels using generalized linear models. ASTIN Bulletin 34(1): 175–197.

Edwards RD (2008) Widening Health Inequalities Among U.S. Military Retirees Since 1974. Soc Sci Med. 67(11): 1657–1668.

Fear NT, Rubin GJ, Hatch S, Hull L, Jones M, Hotopf M, et al.(2009) Job strain, rank and mental health in the UK Armed Forces. Int J Occup Environ Health 15:291–298.

Gavrilov LA, Gavrilova NS (2019) New Trend in Old-Age Mortality: Gompertzialization of Mortality Trajectory. Gerontology 65(5):451–45

Hardy MA, Reyes AM (2016): The Longevity Legacy of World War II: The Intersection of GI Status and Mortality. Gerontologist 56(1):104-14.

Hartal M, Kreiss Y, Yavnai N (2015) Relative longevity among retired military personnel: a historical cohort. Mil Med Res 2:29.

Hoffmann R, Kröger H, Geyer S (2019) Social Causation Versus Health Selection in the Life Course: Does Their Relative Importance Differ by Dimension of SES? Soc Ind Resh 141(3): 1341–1367.

Institute of Medicine (2003) Weight Management: State of the Science and Opportunities for Military Programs. Washington, DC: The National Academies Press.

MacLean A and Edwards RD (2010) The Pervasive role of Rank in the Health of U.S. Veterans. Armed Forces Soc 36(5):765-785.

Margerøy N, Riise T, Johnsen BH, Moen BE (2007) Health related quality of life in the Royal Norwegian Navy: does officer rank matter. Mil Med 172(8):835-42

Marmot MG, Rose G, Shipley M, Hamilton PJ (1978) Employment grade and coronary heart disease in British civil servants. J Epidemiol Community Health 32(4): 244–249.

Martins, LC and Lopes CS (2012) Military hierarchy, job stress and mental health in peacetime. Occup Med 62(3):182-7.

Martins LC and Lopes CS (2013) Rank, job stress, psychological distress and physical activity among military personnel. BMC Public Health 13:176

Montez JK, Berkman LF (2014) Trends in the Educational Gradient of Mortality Among US Adults Aged 45 to 84 Years: Bringing Regional Context into the Explanation. Am J Public Health 104(1):82–90.

Mossakowski KN (2014) Social Causation and Social Selection: In William C. Cockerham, Robert Dingwall, and Stella Quah (Eds.), The Wiley-Blackwell Encyclopedia of Health, Illness, Behavior and Society. Oxford, UK: Blackwell Publishing Ltd.

Langenberg C, Shipley MJ, Batty GD, Marmot MG (2005) Adult socioeconomic position and the association between height and coronary heart disease mortality: findings from 33 years of follow-up in the Whitehall Study.
Am J Public Health 95(4):628-32.

Levin-Rector A, Hourani LL, Van Dorn RA, Bray RM, Stander VA, Cartwright JK, et al. (2018) Predictors of Posttraumatic Stress Disorder, Anxiety Disorders, Depressive Disorders, and Any Mental Health Condition Among U.S. Soldiers and Marines, 2001-2011. J Trauma Stress 31(4):568-578.

Loehr J, O'Hara RB (2013) Facialmorphology predicts male fitness and rank but notsurvival in Second World War Finnish soldiers. Bio Lett 9(4): 20130049.

Siegrist J (1996) Adverse health effects of high-effort/low-reward conditions. J Occup Health Psychol 1(1):27–41.

Silva M, Santana V, Dourado I (2007) Military rank and AIDS proportionate mortality in the Brazilian Navy. Cad. Saúde Pública 23(2): 419-426.

Shimazu A, de Jonge J (2009) Reciprocal relations between effort-reward imbalance at work and adverse health: a three-wave panel survey. Soc Sci Med 68(1):60-8.

Spiro III A, Stettersten R, Aldwin CM (2016) Long-term Outcomes of Military Service in Aging and the Life Course: A Positive Re-envisioning. Gerontologist 56(1): 5–13.

Thomas MM, Harpaz-Rotem I, Tsai J, Southwick SM, Pietrzak RH (2017) Mental and Physical Health Conditions in US Combat Veterans: Results From the National Health and Resilience in Veterans Study. Prim Care Companion CNS Disord 19(3):17m02118

U.S. Census Bureau (1994). Statistical groupings of states and counties. In Geographic Areas Reference Manual.
http://www2.census.gov/geo/pdfs/reference/GARM/Ch6GARM.pdf

Vaupel JW, Manton K, Stallard E (1979) The impact of heterogeneity in individual frailty on dynamics of mortality. Demography 16(3):439-454.

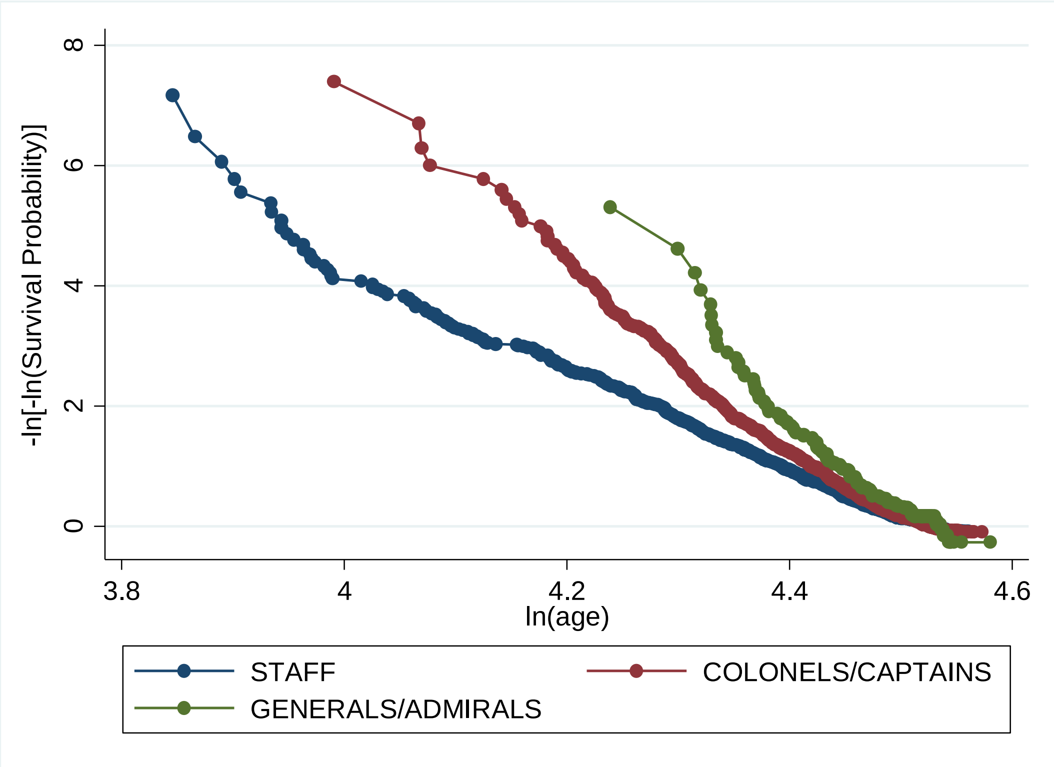
Vaupel JW, Missov TI (2014) Unobserved population heterogeneity: A review of formal relationships. Demographic Research 3(22):659-688.

Wienke A (2010) Frailty models in survival analysis. Boca Raton, Florida: Chapman
& Hall/CRC.

Yashin AI, Iachine IA, Begun AZ, Vaupel JW (2001) Hidden Frailty: Myths and Reality. Research report 34. Max Planck Institute for Demographic Research, Rostock Germany

Appendix

Graph 2 Test of the proportional-hazards assumption for rank, controlling for age



Graph 3 Smoothed hazard estimates for rank