Mortality among Brazilian Air Force Officers[1]

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ABSTRACT

This study aims to (1) estimate the male mortality level for the cohorts of Brazilian Air Force officers who enrolled in the military between years 1947-1960 and were observed until June 2013; (2) compare those estimates with the national male mortality rates and (3) analyze if place of birth and career are associated with their survival. Those officers are not only selected through a strict process of recruitment which already involves demanding health, physical, cognitive and psychological criteria, but also maintain a rigid training in an extremely controlled environment. Once they are graduated, the institution requires periodic annual health screening and offers complete medical resources, housing support and other important structural aid both for themselves and their families, even after retirement. Hence, this leads to 2 main hypotheses: (1) their overall mortality level is lower than the expected for an average Brazilian male; (2) aspects which are evidenced by some studies to affect adult mortality, such as different socioeconomic backgrounds, are offset by their long-lasting exposure to a privileged health setting. Thus, we address the first hypothesis by estimating their mortality rates through Poisson regression and later comparing them with the corresponding Brazilian life table and with other countries' that are known to present low mortality levels; and address the second hypothesis through Poisson modeling and survival analysis, with the variable place of birth used as an indicator of their socioeconomic background. Due to the reliability and quality of military data, a better understanding of their mortality level relative to average Brazilian males may not only improve our knowledge of male mortality, but also contribute to further understanding the limits to life expectation and the possible influence of early-life conditions on survival in a developing country scenario.

Key-words: Adult Mortality. Early-Life conditions. Survival Advantage. Brazilian Air Force.

INTRODUCTION

The mortality advantage of certain population subgroups has attracted increasing attention of social scientists because of the spread of new high quality data and the interest on disentangling the pathways to lower mortality. Earlier research has shown for a large and heterogeneous list of countries, the survival advantage associated with higher income, higher educational attainment, better occupational status (Cutler, D. and Lleras-Muney, A., 2008; Christensen, B. and Johnson, N.,1995), gender (Crimmins, E. and Saito, Y., 2001; Case, A. and Paxson, C., 2005; Norris, K. and Nissenson, A., 2008), race (Elo and Preston, S.H., 1994; David, R.W. and Selina, 2009) and marital status (Zick, C. and Smith, 1991; Goldman, 1993; Waite, L. and Gallagher, M. 2000; Rahman, 1991), just to mention a few of the most well-know factors. All these characteristics relate to mortality through very complex pathway mechanisms. Educational attainment, for example, affects health and mortality through health behaviors, social psychological resources, and access to and utilization of health care (Hoffmann, 2008; Mirowsky and Ross, 2003; Rogers et al. 2000; Williams, 1990). Addressing each one of these mechanisms in detail surpasses the scope of this study and we refer the interested reader to the several excellent articles for a more detailed literature review.

Some studies in the literature have focused on the survival advantages of population subgroups that represent significantly smaller fractions of the populations, including certain learned societies in Europe and religious groups. For example, Kaden (2013) estimated that academicians of the Saxonian Academy of Sciences in Leipzig can expect to live at age 60 seven years more than the average German male. In addition, Winkler-Dworak (2008) showed that members of the Austrian and the Russian Academy of Sciences have lower mortality than the population with tertiary education in their respective countries. The explanations for longer lives among the learned societies include higher socioeconomic and educational levels since childhood, access to health care (Andreev, 2011) and psycho-social factors, such as autonomy, active cognitive reasoning and control at work and in life (Marmot et al., 1998). Scholars have also examined mortality differentials among religious groups. One well-known example is the low mortality levels among members of The Church of Jesus Christ of Latter-day Saints, the Mormons. Breslow (2008) showed that Mormon males can expect to live 9.8 years more than

U.S. white males for periods 1989-1991, whereas females had a life expectancy of 86.1, about 5.6 years greater than U.S. white females in 1989-1991. Among the explanations for the mortality advantage of Mormons is the adoption of healthy lifestyles including the abstention from alcohol, tobacco and stimulating drinks, such as coffee or tea, and the use of a balanced diet. Other religious groups that value healthy lifestyles, like Seventh-Day Adventists, also have substantially reduced mortality rates (Hummer et al., 1999; McCullough et al., 2000).

Sometimes, the mortality advantage of some population groups looks surprising and paradoxical. This is the case, for example, of the mortality advantage of Hispanics relative to non-Hispanic whites in the U.S., despite their lower socio-economic status (Palloni and Morenoff, 2001). Several factors are associated with the lower mortality among Hispanics including the selection of healthy immigrants (Turra and Elo, 2007), selective return migration (Abraido-Lanza et al., 1999), data problems (Hummer et al., 2004; Markides and Eschbach, 2005; Palloni and Arias, 2004), as well as cultural and behavioral factors (Eschbach et al., 2004; McDonald and Kennedy, 2004). The mortality advantage of foreign-born groups are not limited to the U.S. and have been reported in Europe as well, including among the Turkish in German and Mediterranean in France (Razum, 2002;Darmon, 2003).

Another somewhat surprising example of low mortality is the military group. Although it is reasonable to assume that members of the military are healthier than the average citizen, it is not entirely expected that they experience lower mortality than several large groups in the society even in the context of war. Preston and Buzzell (2007) estimated the death rates of United States troops in Iraq since the beginning of the U.S invasion and showed that Air Force personnel death rates were lower in combat than of the civilian U.S populations of comparable age (Buzzell and Preston, 2007). According to the authors, death rates for black males aged 20-34 in 2002 living in Philadelphia were 11% higher than for troops in combat in Iraq. An earlier work from MacIntyre (1978), using the U.S Navy's cohort of 800 survivors from World War II and the Korean conflict showed that pilots experienced not only lower all cause mortality, but also lower mortality from cardiovascular, cancer, and accidental causes when compared to the U.S civilian population. The main explanation, according to the author, was the generally good socioeconomic background of members of the military. He also speculated about the positive

genetic influence of long-lived parents, above average intelligence, and the health and fitness orientation of the military aviators (MacIntyre, 1978).

Besides presenting a surprisingly low mortality even in the context of armed conflicts, the military group also challenges some other well-known evidence in the demography field, such as the association of mortality with race, gender, and marital status. For example, four of every five unintentional injury victims of the U.S Armed Forces were white males, with rates about 1.3 times higher than blacks, in years 1980-1993. Female death rates for homicides (6.4 per 100,000) are higher than for males (5.0 per 100,000) during years 1980-1993, not in armed conflict (NIOSH, 1996). A married female serving in a combat troop in Iraq had the most potential to get injured or killed, compared to single women and men, and married servicemen were more likely to be involved in hostile incidents than single servicemen (Ozcan, 2012).The main explanation is the occupational profile and the demands of military duties, especially during conflict. Others also argue that the survival advantage of the military accrues from a selection bias at enlistment or recruitment, called the 'healthy soldier effect' (Mclaughlin, 2008; Shah, 2009), in which the selection of the healthier and fitter results in lower mortality rates. However, the underlying factors that account for the sex differentials in mortality and the controversial effect of marital status are still uncertain.

Other research use military data not specifically to address the surprising survival advantage or mortality determinants of the group, but to approach epidemiologically the pathways through which more risky and stressful situations affect veterans' survival or causes of death related to warfare (Costa and Kahn, 2010; Boscarino, 2006b; Spiro, 2009; Costa, 2010; Clipp, 1996; Spiro, 1997; Boscarino, 1997). Recent research evidenced that veterans from the American Civil War who experienced greater stress in battle had higher mortality rates at older ages and were at greater risk of developing Post-Traumatic Stress Disorder (Costa, 2010). Some research also uses military data to evaluate the relationship between nutritional status and some anthropometric measures, such as height and weight, and their impact on subsequent mortality levels (Costa and Fogel, 2004; Fogel, 1997; Costa, 2004). Also, some studies examine the effect of specific early-life infections such as stomach ailments, measles, respiratory infections, diarrhea, and tuberculosis on reduced cause-specific longevity by using evidence of the Union

Army veterans (Costa, 2003). On those cases, however, the use of military data is more restricted to the reliability and availability of those measures and is not really interested in more closely analyzing the characteristics of the military group.

Little is known about mortality differentials among adults in Brazil. Despite the long lasting effort to produce reliable mortality estimates for the total population by age, sex and main geographic areas, the results are still timid compared to those from other countries. The absence of more detailed information on mortality according to different factors, such as socioeconomic characteristics, is particularly worrying in Brazil, a heterogeneous country where it remains unclear the extent to which the numerous pathways linking mortality with several well established factors operate. In this study, we benefit from reliable mortality data available for Brazilian Air Force officers, to try to fill part of the gap in the literature by looking more closely at the survival of a selected group of Brazilians. We are particularly interested in learning whether this group presents a survival advantage relative to their national counterparts and if despite being a healthy selected male subgroup, others factors are still associated with their survival. For that purpose, we obtained information from 706 male officers who enrolled in the Brazilian Air Force between the years 1947 and 1960. We followed these individuals until 30th June 2013 and recorded information on place of birth and career (pilot or administrative officer), in addition to mortality (total and by large groups of causes of death).

The choice for the variable place of birth is not only due to the availability of that information, but also for addressing the possible influence of early-life conditions on their survival. According to Preston, Hill and Drevenstedt (1998), childhood conditions may influence adult mortality through a physiological, direct mechanism or through a non-physiological, indirect mechanism. These two mechanisms may also be positive or negative. A direct and positive effect is one that has a permanent impact or a scarring effect that influences later health and survival, for example, the influence of having tuberculosis in childhood and higher mortality at later ages. An indirect and negative effect, on the other hand, is acquiring immunity due to exposure to certain diseases in childhood and presenting lower mortality afterward. Some other research focus on the exogenous influences on childhood and their impact on adult mortality, such as economic recessions, climate change and starvation periods (Bengtsson, 2000; Van den

Berg, 2007; Van den Berg, 2009; Doblhammer, 2003). Conversely, there is also evidence that other important mid-life factors affect mortality, such as behavior related to tobacco and alcohol abuse and sedentary life styles, sometimes offsetting the influence of earlier life events on old age mortality (Kannisto, 1997; Kannisto, 1994). Since the group of military officers of this research enrolled in the institution Brazilian Air Force (BAF) at relatively young ages (15-24 years old), we use the variable place of birth as a proxy for their childhood conditions, considering the different levels of regional development in Brazil. Because officers are submitted to an extremely controlled environment that offers an overwhelmingly good health, nutritional and physical structures, this study hypothesizes that the working environment may offset the effect of being born in more or less developed regions. In addition, we use the information on career since officers graduate as pilots or administrative officers, and therefore, may be exposed to different mortality risk factors throughout their working lives. Different careers may also indicate different personal characteristics at graduation that can be related to the risk of dying at later ages, such as better health.

Women engaged in military duties become administrative officers only in 1991 and only after 2003 they enrolled to become pilots in the BAF. Therefore, mortality data for this study are available only for males, avoiding us from analyzing sex differentials in mortality. All male officers in this database enrolled, graduated and had permanent contact with the Air Force throughout their lives, until their moment of death or end of period study. Further understanding their possibly privileged survival relative to Brazilian males may not only improve our knowledge of male mortality, but also contribute to better acknowledging male life expectation in a developing country scenario (Rosero-Bixby, 2008).

MILITARY CULTURE AND SPIRIT

Some features of the military institution and of the time period here considered are important to account for when analyzing this group of individuals, since these features guide a military´s particular behavior and mindset, influencing how choices are made on all realms of life. One important aspect related to the characteristics of the military institution is that it is a "totalizing" social environment, in terms of German sociologist Georg Simmel. Another important aspect is related to the time period considered in this study and the change in social origins and social

perception of the individuals who enrolled in the military. As Castro (1990; 2000) shows, through a deep anthropological work and application of Simmel´s concept of a totalizing social environment, that individuality in the military is not a value to be emphasized and how their social circles are more restricted. The professional pathways are standardized and they go through similar experiences of socialization, as well as "the same institutional rites and career turning point" (Castro, 2000). These aspects are what make up a totalizing institution, in which the idea of a unique body of values and conduct guides the behavior of individuals. Castro's research also shows how the social origins of the military and the society´s perception of the institution changed over time in Brazil. Throughout the 1940's 78.8% of the enrolled military were from the bourgeoisie, with some especial participation of the elite (19.8% were from the traditional higher classes). In the 60's, however, the participation of the higher classes decreased to 6%, while the participation of the working class raised from 4% to 9% and the participation of individuals who had a military parent increased from 21% to 35% (Castro, 1990). Those decades were very prestigious and the military were accepted and respected in the most refined social circles at the time, as well as usually considered good partners for marriage. That scenario changed after the dictatorship period, which altered society's acceptance of the military institution. The prestige of the military was also affected by changes in the social structures that conflicted with some of the traditional aspects of the military profession. One example is the increase in women labor force participation, which affected marriage patterns for the military. By the 90's the military had already lost its prestige before the civil society (Castro, 1990). Therefore, the individuals in our study were both from traditional higher classes and the bourgeoisie, but also from the working class, since the cohort being examined here is composed of individuals who entered the Air Force from the 1940's until the 1960's. Also, they probably shared fundamental elements made explicit by Castro, such as similar social experiences and standardized pathways in their careers. These aspects are important to better understand the features of this cohort of individuals and how despite coming from different social origins and diverse backgrounds to some extent, the effort of the military school was to standardize their behavior and experiences, in order to enable them to fulfill military duties and cope with the demanding expectation of the military service.

DATA AND METHODS

DATA

The data for this study come from the Brazilian Air Force Health Center (DIRSA), where military records are kept on an electronic database for the Air Force pension fund. The access to those records were granted and formally approved by the director of the Center, Brig. Gen. Jorge Marones de Gusmão. The database contains information for officers who are still alive and retired, officers who are already deceased but whose families receive survival benefits, and officers who died on duty and did not support any designated beneficiary in the BAF pension plan. Therefore, we are missing a minority group of individuals who did not die on duty and had no wives and children or whose beneficiaries are also dead. All individuals receive a service identification number in the system, which helps the data managers to keep track of them. Since the BAF pension system demands utmost control due to legal accountability issues within the government, the data are continuously updated and checked, making them particularly reliable when compared to other cohort data in Brazil.

Because our objective was to examine mortality during most of officers lifetime, we looked for the oldest cohorts for whom mortality and demographic information was reliable and readily available. Following these criteria, we collected data for officers who joined the BAF from 1947 through 1960. Of the 808 eligible individuals from those cohorts, we excluded officers for whom there was no information on place of birth (n=90), and cases with missing birthdates (n=12). Thus, our analysis is based on a sample of 706 individuals: 395 survivors and 311 deceased. We compared the proportion of total deaths, the proportion of deaths during military service, and the occupational profile of the 102 individuals excluded from the analysis with the remaining 706 officers in our sample, and found no statistically significant differences between the two groups (results available upon request).

VARIABLES

To measure the mortality patterns among BAF officers, we recorded complete dates of enrollment, birth and death (or end of follow-up, which was set at 30th of June 2013, date of the last system update). We were able to classify deaths into two groups of causes of deaths: deaths

during military service (on duty deaths) and other causes of death. We also obtained information on place of birth as of the enrolment date in the BAF, which was categorized according to two main geographic regions: the Northern states located in the northeast, north and center-west parts of Brazil and the Southern states located in the south and southeast parts of the country. Whereas the northern area comprise the least socially and economically developed states of Brazil, the southern area include the wealthiest states.

The individuals enrolled in the 1947-1960 cohorts could follow aviation or administrative careers: We were able to measure those two categories as of the enrollment date. Because we have not data for career shifts during the military service, we assumed that each career was fixed over the observation time. Our hypothesis is that pilots have higher mortality than administrative personnel, due to their riskier occupational profile.

ANALYTICAL APPROACH

We fit non-parametric Kaplan-Meier survival curves to graphically describe the proportion of officers who died during the follow-up period. We first estimated a survival curve for all officers in our sample. We then fit survival curves by region of birth and career. Log-rank tests were performed to assess the statistical significance of the survival curves for the different subgroups. Because deaths on duty represented a relatively large proportion of total deaths (25%) and we wanted to measure their effect on the survival curves, we present two sets of analysis: one accounting for all causes of death and a second one based on the subsample of individuals who did not die on duty. In a second step, we used Poisson regression models to estimate the number of deaths during the follow-up period as a function of person years of exposure, age, place of birth and career.

Each officer's exposure began at the date of enrollment and terminated at the time of death or June 2013. We treated age as a continuous variable. Due to the relatively small number of deaths, especially after age 80, we split the records for each officer in our dataset by age groups using the *stplit* syntax in STATA (Statacorp, 2005). In addition, we censured the follow-up of officers at age 80. We measured age according to seven groups: 15-24, 25-34, 35-44, 45-54, 55-

64, 65-74 and 75-79. Both the number of deaths and person-years lived were computed for each age group, for all cohorts together.

We estimated three sets of models, one that included only age, another one that included both age and region, and a third model that added type of career. In exploratory analyses, we also tested for the inclusion of interaction terms but they proved to be not statistically significant, and we decided to keep only the additive models.

We used the Poisson regression coefficients to examine the existence of mortality differentials by place of birth and career among the BAF officers. In addition, we predicted age-specific death rates based on the coefficients of first model that controls only for age. We compared the age specific death rates for the BAF officers with male death rates for a selected number of countries which are known for their low levels of mortality and high quality mortality data. The list includes Chile, Sweden, France and Japan. The mortality data for these countries were obtained in HMD (The Human Mortality Database). We also compared our estimates with mortality data for Brazil obtained from IBGE (Instituto Brasileiro de Geografia e Estatística, 2000). The mortality estimates for the selected countries are for the year 2000, because this is the earliest year we were able to get official mortality data for Brazil. 60% of the deaths of the 1947-1960 BAF cohorts occurred between the years 1995 and 2013 and thus, some of the mortality differences may arise from inconsistency in time. To improve our comparative analysis, we also estimated age-specific mortality rates for the Brazilian males born in 1935 (the mean year of birth of the BAF cohorts) using data from the United Nations complete life tables for the years 1950 to 2015. Further, we used the mortality data and life table techniques to estimate truncated life expectancy at age 80 for all populations being considered in the analysis.

RESULTS

Table 1 shows the distribution of cases according to survival status and the variables used in our analysis. The total distribution of individuals according to survival status are categorized as alive, deceased from other causes and deceased on duty. The results show that one fourth of all deaths occur on duty and 56% of the cohort is alive by June 30th, year 2013. When we analyze the differences by place of birth, 56% of officers who were born on the Northern region

of Brazil are deceased, whereas that proportion is of 36% for those who were born on the Southern region. Also, of all causes of death, 13% of on duty deaths occurred to officers born on the Southern region, while 34% of officers born on the Northern region died on duty. As for their careers, of all pilots, deaths occurred to 43%, while that proportion is of 50% for administrative officers. As expected, of all causes of death for pilots, 34% occurred on duty, while that number for administrative officers is 0.03%.

**Table 1.** Descriptive statistics for all variables

Variables	Number enrolled	Alive	Deceased		Proportion of deaths %
			on duty	other causes	
Total	**706**	395	74	237	44%
Region					
Northern	**283**	124	54	105	56%
Southern	**423**	271	20	132	36%
Career					
Pilot	**573**	328	72	173	43%
Adm. Officer	**133**	67	2	64	50%

Source: DIRSA/Air Force Health Center

SURVIVAL BY TIME OF FOLLOW-UP

To describe the mortality patterns among the BAF officers, we first compare Kaplan-Meier survival curves for all individuals regardless of place of birth and occupation, accounting for i) all causes of death and ii) other causes of death after dropping officers from the sample who died on duty. Afterwards, the same scenarios are considered for the analyses by place of birth and career. When we account for all deaths (Figure 1), we find a sharp decline in the number of survivors during the first twenty years of observation. By the 63rd year of observation, 50% of the members of the cohorts have deceased.

Figure 1. Kaplan-Meier Survival Curve, BAF, all causes of death
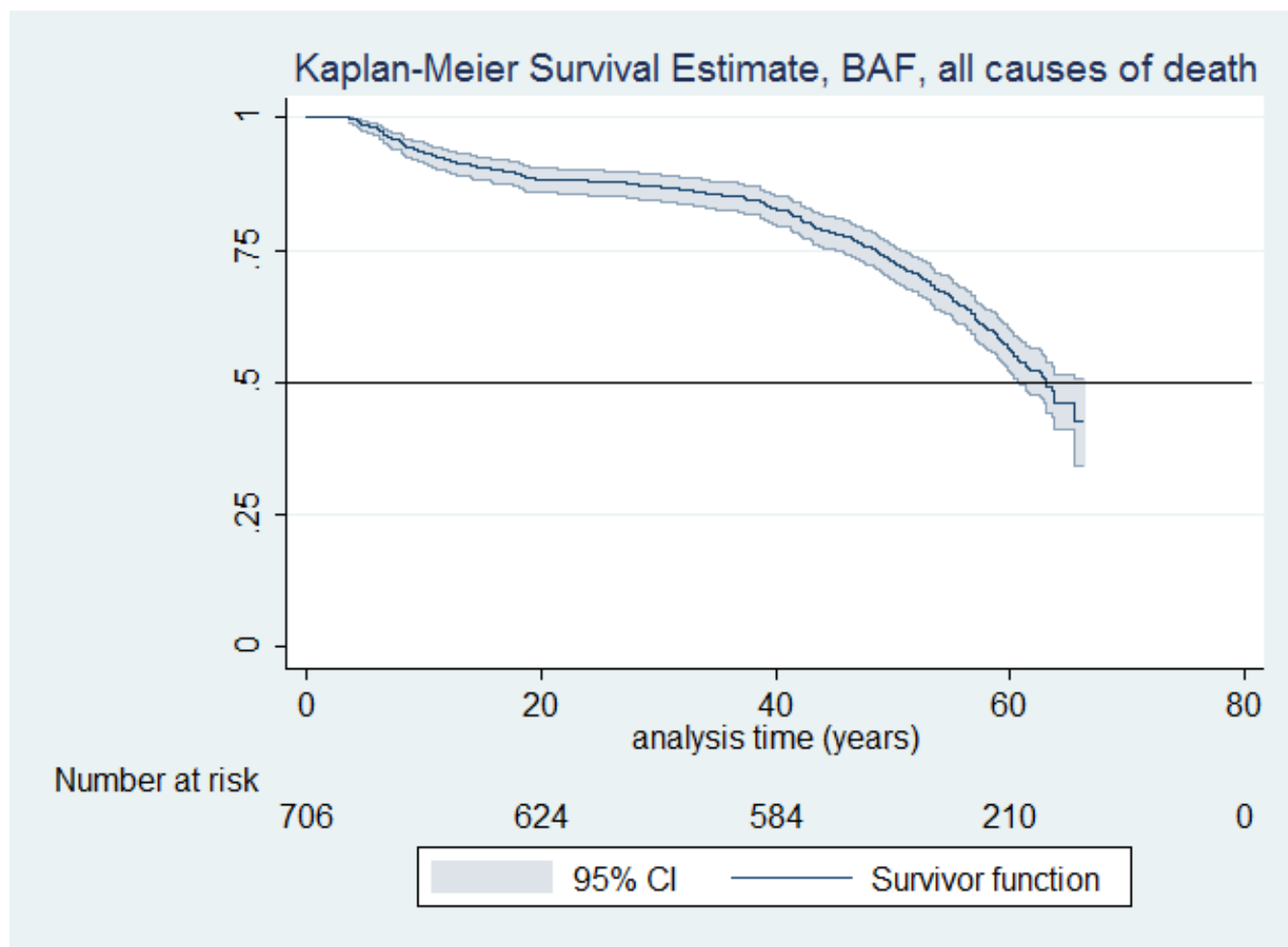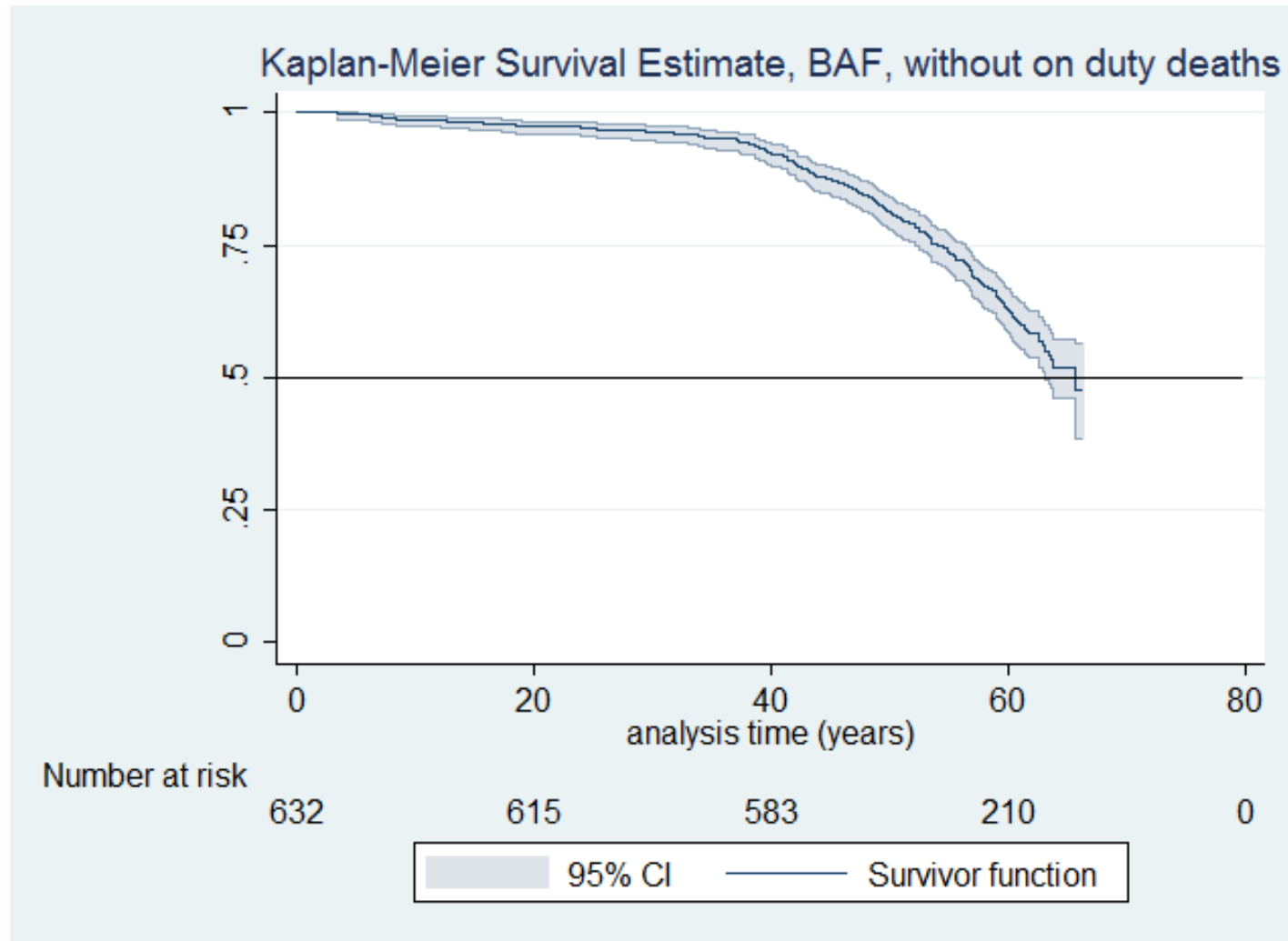

Source: DIRSA/Air Force Health Center.

When we consider the sample without on duty deaths, the KM curve (Figure 2) shows that survival time is longer. After dropping cases of those who died on duty 50% of the remaining cohort members died by the 65.5[th] year of follow-up. These results are not surprising since most of the deaths on duty occur in the first decades of the working life. Indeed, the largest difference between the two scenarios is on the 25% first deaths: when considering all causes of death (Figure 1), 25% of the individuals fail by time of analysis 48.07 years, whereas when considering the sample without on duty deaths, 25% of the individuals fail by time 54.07 years. Figure 3 shows the KM survival curves by region of birth for all causes of death. Clearly, the officers born on the most developed regions of Brazil have an overall higher survival than those born on the less developed regions (p-value=0.000).

By the end of the observation period (about 63 years of follow-up), more than half of the members of the cohorts born in the Southern states was still alive (64%). On the other hand, by the year 57.57, 50% of the officers from the Northern region have deceased. Most of the difference between the survival curves is due to deaths that occur in the first 30 years of observation. We estimated that the first 25% of deaths occurred by the follow-up year 29.46 in the Northern region, while it took another 23.79 years to occur for the members born in the Southern region. When we dropped the cases who died from on duty deaths (Figure 4), the overall difference between the survival curves by place of birth reduced substantially but it remained statistically significant (p-value = 0.0128). By the follow-up time 52.10, 25% of officers born in the Northern region have died from other causes, about 22.64 more years than when all causes of deaths were accounted for. It took only another 3.04 years for 25% of the members of the cohorts born in the Southern region to die.

Figure 2. Kaplan-Meier Survival Curve, BAF, without on duty deaths

Source: DIRSA/Air Force Health Center.

Figure 3. Kaplan-Meier Survival Curves by region of birth, all causes of death
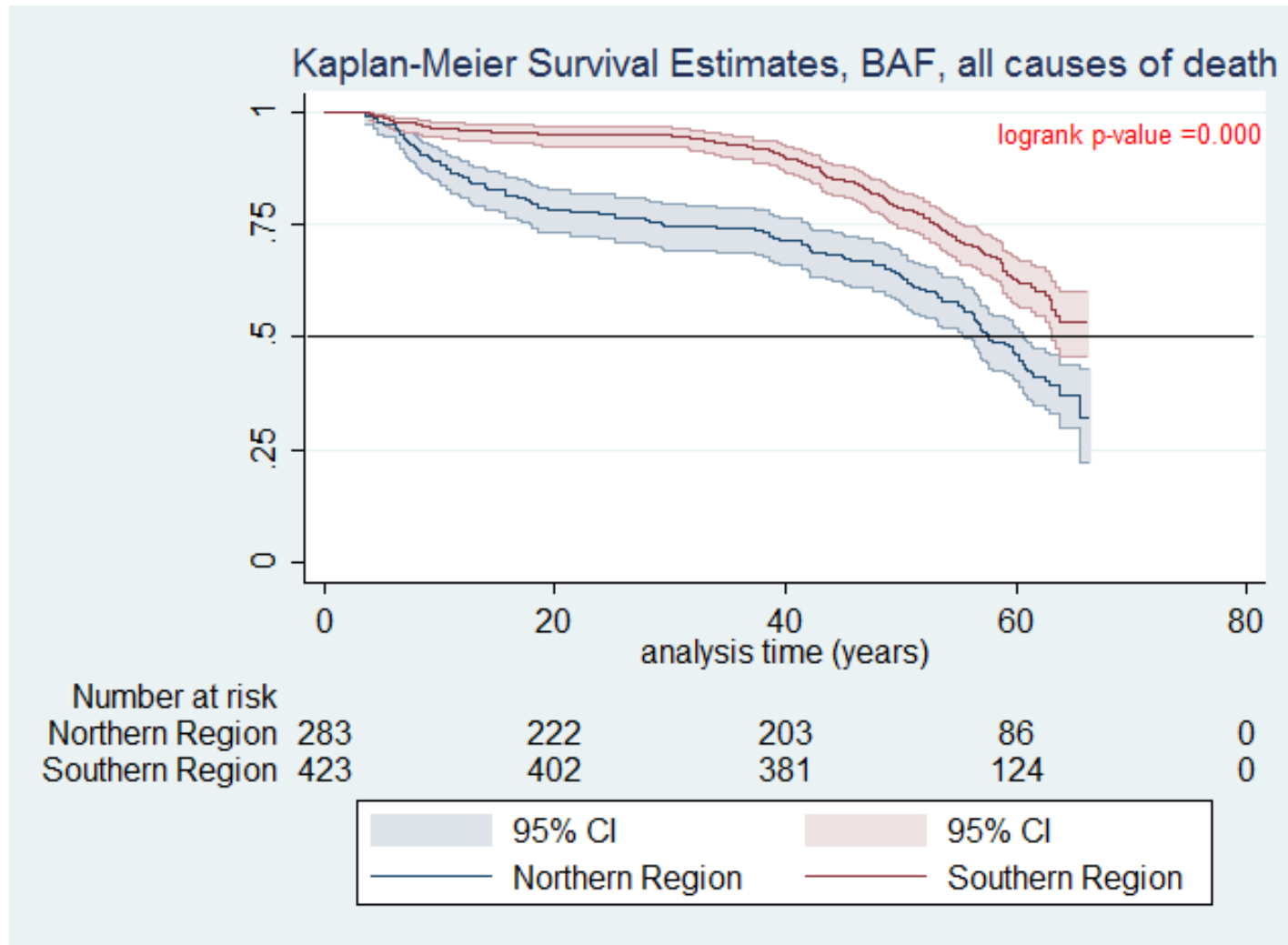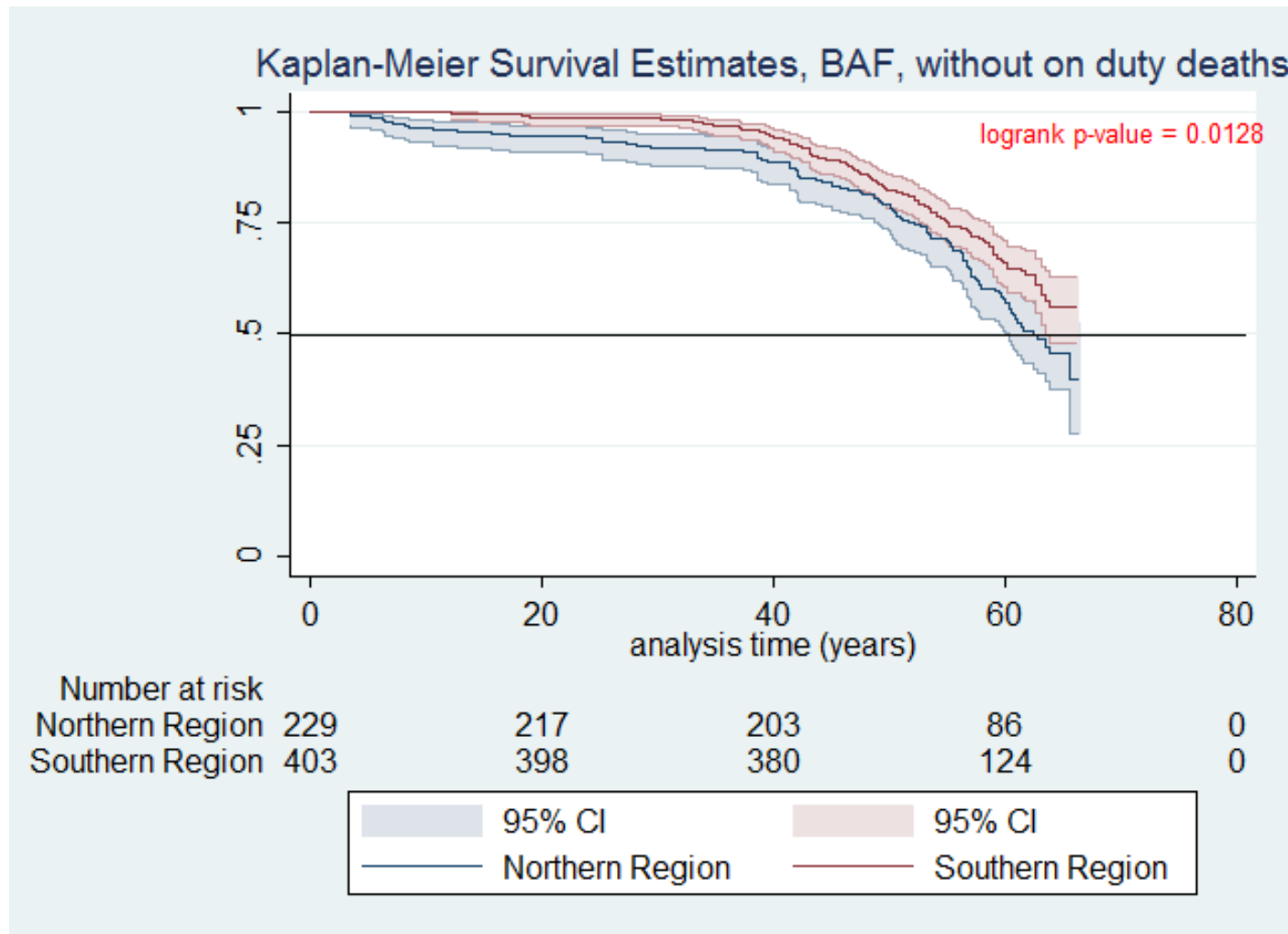

Source: DIRSA/Air Force Health Center.

The differences in the distribution of survivors by career are not as clear as the differences by place of birth. Figure 5 shows that the proportion of survivors among pilots from all causes of death reduces more rapidly in the first 20 years of observation, but it catches up the proportion of survivors among administrative offices by the year 56.20. In fact, there is a crossover point, after which the proportion of administrative officers alive become lower. Overall, the difference between the two survival curves is not statistically significant (p-value=0.268).

Not surprisingly, deaths on duty are responsible for shaping the survival curves by career. When we fit KM curves without on duty deaths by career (Figure 6), the difference between pilots and administrative workers becomes statistically significant (p-value=0.007), with the proportion of survivors among pilots becoming larger than among administrative officers during most of the observation period: 50% of administrative officers deceased by time 59.76, whereas the median time for pilots did not happen by the end of the follow-up period.

Therefore, despite living in the same environment since very young ages, having similar lifestyles, income and access to health care, we still found mortality differentials among the subgroups of officers that arise from epidemiologic and socioeconomic conditions that are related to the place of birth. The type of career also plays a role, as pilots have higher risk of dying from on duty causes, but they appear to carry a health advantage for older ages, compared to administrative officers.

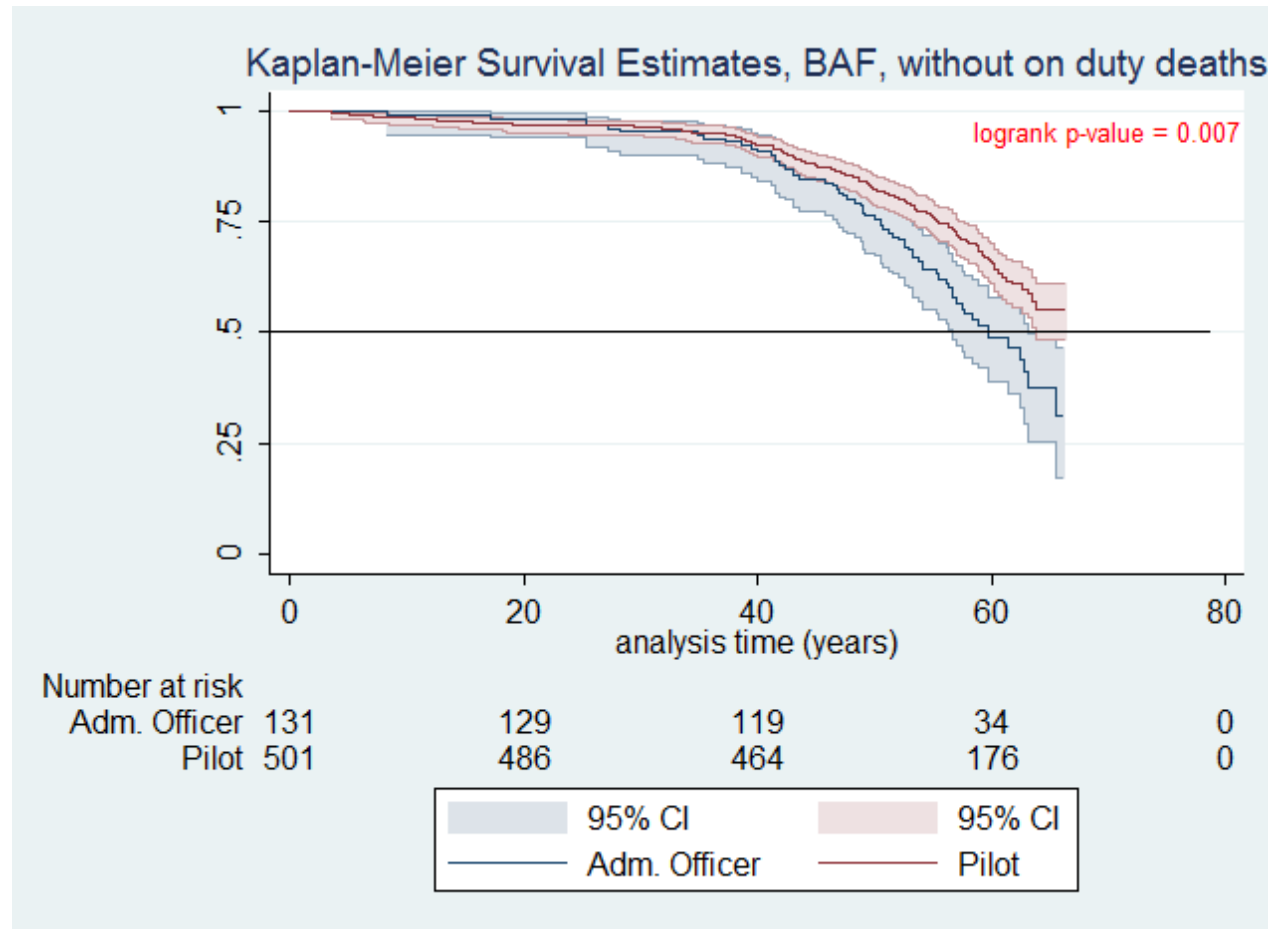**Figure 4.** Kaplan-Meier Survival Curve by region, BAF, without on duty deaths

Source: DIRSA/Air Force Health Center

Figure 5. Kaplan-Meier Survival Curves by Careers, BAF, all causes of death
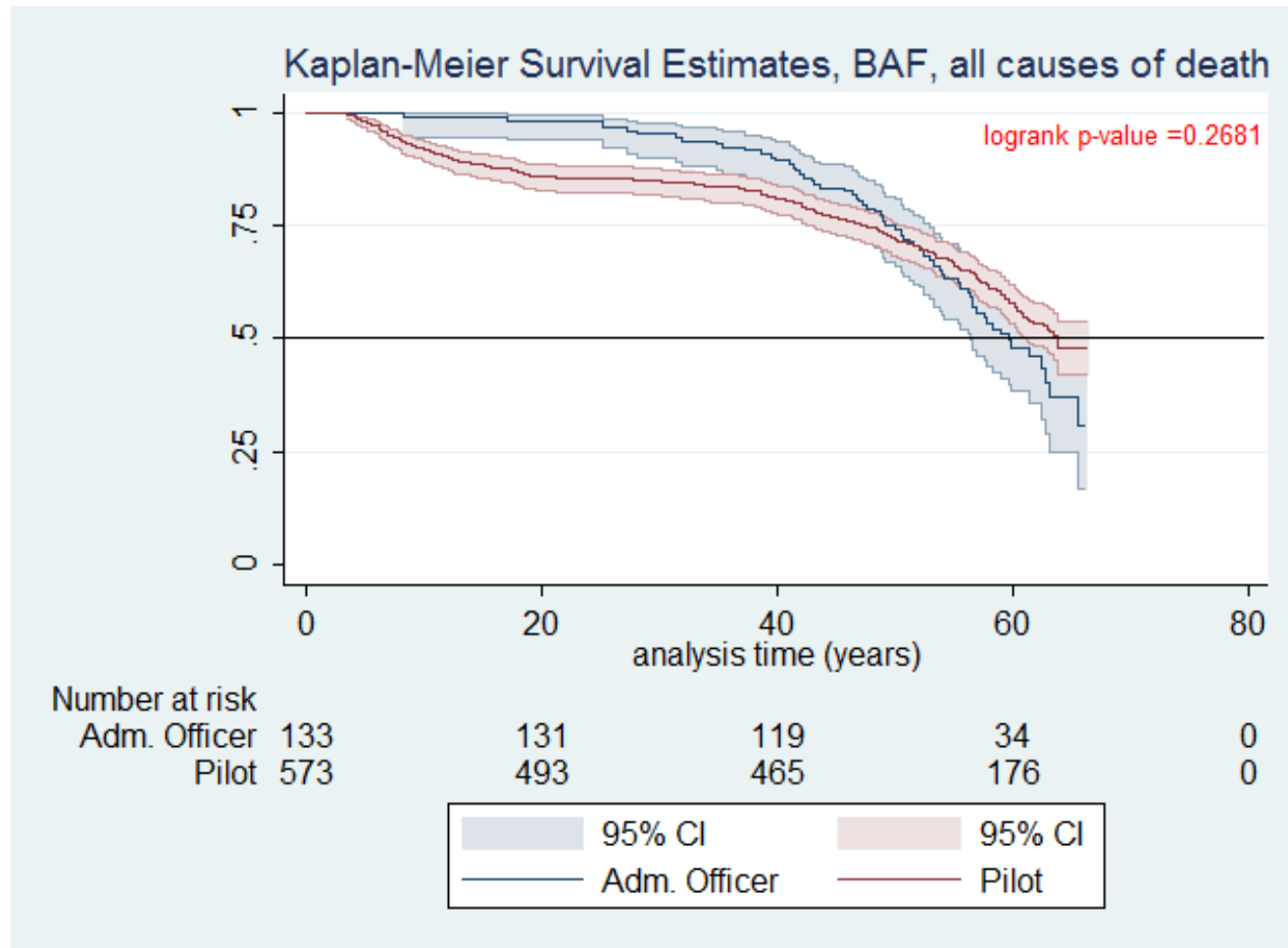
Source: DIRSA/Air Force Health Center.

Figure 6. Kaplan-Meier Survival Curve by Careers, BAF, without on duty deaths

Source: DIRSA/Air Force Health Center

MORTALITY DIFFERENTIALS BY AGE

In the second part of our analysis, we examine age specific mortality rates fitting Poisson regression models. Table 2 presents the results for the first model that accounts only for age (Model 1).

Using the coefficients in Model 1 we predicted age-specific mortality rates for the BAF cohort and compared them with the mortality rates for the other populations: Sweden, Chile, France, Japan and Brazil (Figure 7). The concentration of on duty deaths at younger ages makes the death rates higher at age groups 15-24 and 25-34 in the BAF cohorts than in any other population. Of course, the difference is biased upwards since members of the BAF cohorts experienced these mortality rates about 40 to 60 years ago, while for the other population death rates are for the year 2000. The age-specific mortality rates are still higher for the BAF officers than in the Brazilian cohort, suggesting that the risk of dying on duty was not trivial, despite the fact that Brazil was not on war during this time. After the age of 55, the mortality rates for BAF officers become comparable and even lower than those for populations known for experiencing the lowest mortality levels in the world. These results suggest a high degree of health selection among BAF officers in Brazil.

Table 2. Poisson Regression Estimates by Age only

| Estimates Model I(Age)						
Paramater	**Estimate**	**Std. Error**	**z value**	**Pr(>|z|)**	**95% Conf.Interval**	
Constant	-5.3599	0.2132	-25.1400	0.0000	-5.7778	-4.9421
Age						
15 to 24	-					
25 to 34	0.4683	0.2566	1.820	0.068	-0.0347	0.9713
35 to 44	-0.7406	0.3419	-2.170	0.030	-1.4107	-0.0706
45 to 54	-0.2664	0.3015	-0.880	0.377	-0.8574	0.3245
54 to 64	0.6548	0.2543	2.570	0.010	0.1563	1.1533
65 to 74	1.4305	0.2366	6.050	0.000	0.9668	1.8942
75 to 79	2.1402	0.2510	8.530	0.000	1.6483	2.6321

Figure 7. Age-specific male mortality rates, Sweden (2000), Chile (2000), France (2000), Japan (2000), Brazil (2000), Brazil cohort and BAF (cohort)
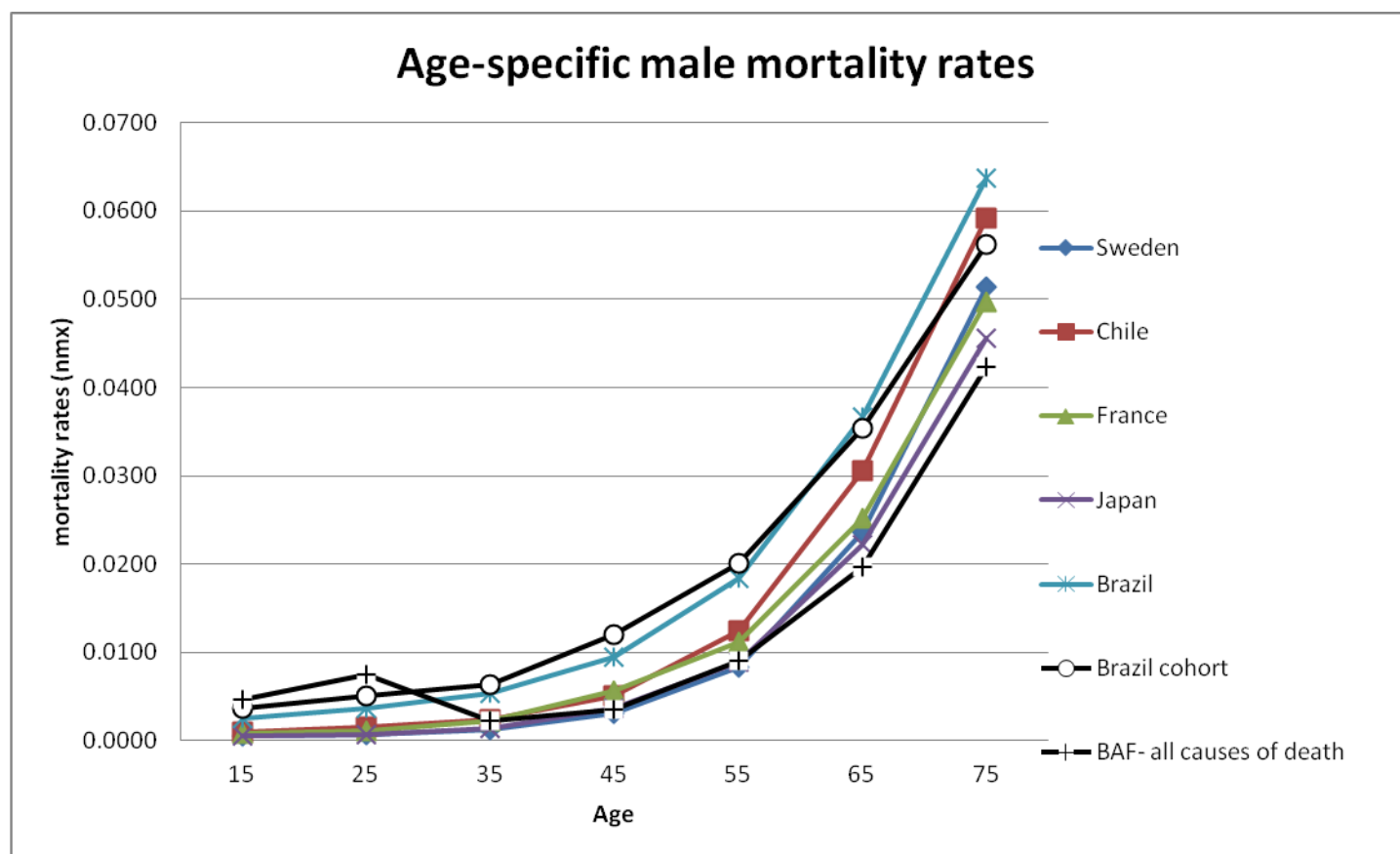
Source: DIRSA. HMD/Human Mortality Database, available at http://www.mortality.org/. IBGE/Instituto Brasileiro de Geografia e Estatística, male life tables available at http://www.ibge.gov.br/ .

In order to get a better understanding of differences in mortality patterns across the populations compared in our analysis, we also estimated mortality ratios for ages 45 and above assuming the age specific mortality rates for Sweden as the standard. The closer the ratio is to the value of one, the closer the mortality of that given population in a certain age group is to Sweden's mortality rate. As shown in Figure 8 the mortality rates for BAF officers, regardless if deaths on duty are included in the analysis or not, present a mortality pattern that it is very close to the one for the Swedish. The same is true for Japan (2000). For France (2000) and Chile (2000) mortality levels are somewhat larger at ages 45 to 64, but become more similar at the older age groups. More striking are the results for Brazil (2000) and for the Brazilian cohort born in 1935, There is clearly a downward mortality pattern, characterized by much higher mortality levels at younger adult ages, that gradually reduces towards Swedish levels at older ages. These results confirm earlier analyses that have shown a distinct pattern of mortality among Brazilian adults (Turra, 2009; Paes, 2005). While we cannot provide a definitive explanation for these differences, the mortality estimates for the BAF officers, which were based on high quality data, suggest that the mortality pattern for the Brazilian population may be data artifact, particularly the effect of age misreporting at older ages in Brazil (Preston, Elo and Stewart, 1999). Of course, the distinct mortality patterns for the Brazilian total populations may also indicate compositional effects from risk heterogeneity by age. But in that case, the mortality selection should be strong enough to make the mean risk move that fast towards the Swedish and BAF levels at ages 75 and above. The differences in mortality patterns affect the estimates of the truncated life expectancy at age 80. Not surprising, given the results discussed before, life expectancy by age for the BAF officers is very similar to life expectancy by age for the Swedish males in 2000 (Table 3). Consistently, Brazilians (both in the year 2000 and from the 1935 cohort) have much lower life expectancy at age 45 (respectively, 25.68 and 25.91 years of life) than BAF officers (30.25). At age 75 the difference between BAF cohorts and the 1935 Brazilian cohort is inverted, reflecting the distinct pattern of mortality in the Brazilian total population.

Figure 8. Mortality Ratios between each country's rate and Sweden's rate as pattern.
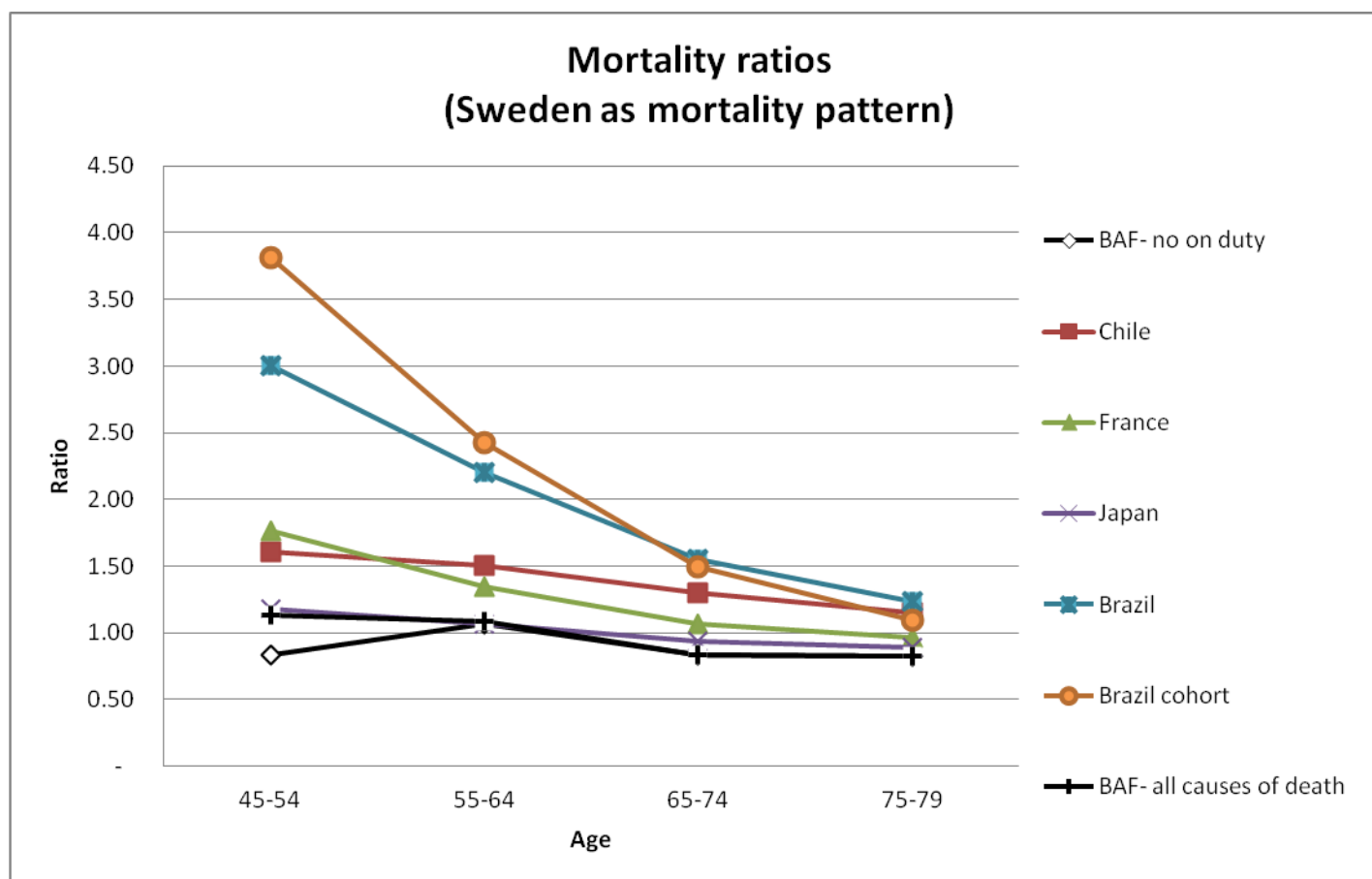
Source: DIRSA. HMD/Human Mortality Database, available at http://www.mortality.org/. IBGE/Instituto Brasileiro de Geografia e Estatística, male life tables available at http://www.ibge.gov.br/

Table 3. Male life expectancies for BAF, Sweden, Brazil and Brazil cohort

	Male Life Expectancies			
Age	BAF	Sweden	Brazil	Brazil cohort
45	30.25	30.43	25.68	25.91
55	21.16	21.22	17.85	18.58
65	12.67	12.57	10.73	11.60
75	4.33	4.46	4.04	4.38

Source: HMD/ Human Mortality Database, available at http://www.mortality.org/ .IBGE/ Instituto Brasileiro de Geografia e Estatística, male life tables available at http://www.ibge.gov.br/ . DIRSA/Air Force Healh Center

While a BAF officer expects to live another 30.25 years at age 45, an average Brazilian expects to live 25.68 years according to period life table (year 2000) and 25.91 years, when considering the cohort data.

One should be careful when comparing our estimates with those from other populations since our sample is small and there is large statistical uncertainty. Table 4 shows the predicted death rates using the lower and upper bounds for the 95% confidence interval. The ratio of mortality rates in the upper bound to mortality rates in the lower bound can be as high as 8 for the age group 35-44 and as low as 2.29 for the age group 15-24. We also fit Poisson models to assess the joint effects of age, region of birth and career on death rates. Our multivariate analyses account for all deaths. All estimates were performed in STATA (Statacorp, 2005).

Given the concentration of deaths on duty at younger ages, it is not surprising that the mortality rate for the age group 25-34 is approximately 61% higher (1-exp(0.4683) than the mortality rate for the age group 15-24, although the coefficient is only marginally significant (Model 1, Table 2). Further, the mortality rate for the age group 75-79 is eight times (exp(2.14)) higher than the one for the omitted age group (15-24), which is also expected since most of deaths occur at those ages.

Table 4. BAF Age-Specific Mortality Rates

BAF Age-Specific Mortality Rates			
	nmx	95% Confidence Interval	
Age	Median	Lower	Upper
15	0.0047	0.0031	0.0071
25	0.0075	0.0030	0.0189
35	0.0022	0.0008	0.0067
45	0.0036	0.0013	0.0099
55	0.0090	0.0036	0.0226
65	0.0197	0.0081	0.0475
75	0.0400	0.0161	0.0993

Also, consistent with the findings from the KM estimates, we found that place of birth is a significant predictor of survival among BAF officers. The individuals who were born in the Sourthen states have death rates that are 55% (1-exp(0.55076)) lower than individuals born in the Northern states (Model 2, Table 6). The survival advantage of officers from the south does not change after we control for career (Model 3, Table 7). Finally, as already suggested by the log-rank test, military career was not significant in our multivariate analysis.

Table 5. Male Mortality Rates and Ratios (Sweden as the Standard)

Age	BAF		Chile		France		Japan		Brazil		Brazil Cohort	
	RATE	RATIO	RATE	RATIO	RATE	RATIO	RATE	RATIO	RATE	RATIO	RATE	RATIO
45	0.003	0.831	0.005	1.607	0.006	1.768	0.004	1.177	0.010	3.007	0.012	3.814
55	0.009	1.069	0.012	1.501	0.011	1.348	0.009	1.071	0.018	2.207	0.020	2.426
65	0.020	0.832	0.031	1.298	0.025	1.065	0.022	0.941	0.037	1.556	0.035	1.499
75	0.042	0.824	0.059	1.153	0.050	0.967	0.046	0.887	0.064	1.239	0.056	1.094

Source: HMD/ Human Mortality Database, available at http://www.mortality.org/ .IBGE/ Instituto Brasileiro de Geografia e Estatística, male life tables available at http://www.ibge.gov.br/ . DIRSA/Air Force Healh Center.

Table 6. Poisson Regression Estimates by Age and Region

Paramater	Estimate	Std. Error	z value	Pr(>|z|)	95% Conf.Interval	
Estimates Model II(Age+Region)						
Constant	-5.0508	0.2194	-23.0200	0.0000	-5.4808	-4.6207
Age						
15 to 24	-					
24 to 34	0.4826	0.2567	1.8800	0.0600	-0.0204	0.9856
35 to 44	-0.7147	0.3419	-2.0900	0.0370	-1.3848	-0.0445
45 to 54	-0.2348	0.3016	-0.7800	0.4360	-0.8259	0.3563
55 to 64	0.6853	0.2544	2.6900	0.0070	0.1866	1.1839
65 to 74	1.4583	0.2367	6.1600	0.0000	0.9944	1.9221
75 to 79	2.1351	0.2510	8.5100	0.0000	1.6432	2.6271
Region						
Northern	-					
Southern	-0.5839	0.1136	-5.1400	0.0000	-0.8065	-0.3613

Table 7. Poisson Regression Estimates by Age, Region and Occupation (Career)

Paramater	Estimate	Std. Error	z value	Pr(>|z|)	95% Conf.Interval	
Estimates Model III(Age+Region+Occupation)						
Constant	-5.064045	0.2207	-22.9500	0.0000	-5.4966	-4.6315
Age						
15 to 24	-					
25 to 34	0.4787	0.2567	1.8600	0.0620	-0.0245	0.9819
35 to 44	-0.7194	0.3420	-2.1000	0.0350	-1.3898	-0.0491
45 to 54	-0.2392	0.3017	-0.7900	0.4280	-0.8305	0.3521
55 to 64	0.6810	0.2545	2.6800	0.0070	0.1822	1.1799
65 to 74	1.4548	0.2367	6.1500	0.0000	0.9908	1.9188
75 to 79	2.1314	0.2511	8.4900	0.0000	1.6392	2.6235
Region						
Northern	-					
Southern	-0.5834	0.1136	-5.1400	0.0000	-0.8060	-0.3607
Ocupation						
Pilot	-					
Adm	0.0807	0.1388	0.5800	0.5610	-0.1912	0.3527

DISCUSSION

In this study we examined mortality estimates for the cohort of Brazilian Air Force officers who enrolled in the military between years 1947 and 1960. The BAF officers is a selected group of Brazilian men who has been exposed to a healthy and well structured setting since the moment they enroll in the military institution. Therefore, were brought forth two main hypotheses for our study: (1) BAF officers experience lower mortality levels than the average Brazilian male, but have risks of dying that are comparable to the populations living in countries with much lower mortality levels; (2) factors that typically affect adult mortality such as different socioeconomic backgrounds are offset in the Air Force population subgroup by the long-lasting exposure to a privileged setting.

The results confirm a survival advantage of BAF officers when compared to the average Brazilian male in 2000 as well as men from the 1935 Brazilian birth cohort. However, contrary to the findings from earlier studies that looked at the influence of mid-life conditions over survival (Kaden, 2013), (Kannisto, 1997), we showed that place of birth had a statistically significant impact on BAF mortality throughout the follow-up period. Officers who were born in the more developed regions of Brazil had lower mortality relative to those who were born in the less developed regions, despite living in similar socioeconomic settings after enrolling in the military service.

Certainly the mortality differentials we are measuring between ages 15 and 79 reflects the combination of several effects, including i) differences in early life conditions; ii) compositional effects from the selection of officers during enrolment and iii) the impact of providing similar health and socioeconomic conditions during the military life. While it is possible that life in the Air Force mitigated substantially the existing SES and health differences during childhood and at enrollment, it has not eliminated them completely.

Although we cannot test for each of these effects with our current data, it seems reasonable to suppose that birthplace is a good proxy for early life conditions. Therefore, our results provide evidence in favor of previous studies that have shown that early life events have

'scarring' affects on adult mortality, despite noteworthy positive changes during an individual's life course. Even if one invests heavily on health, education and nutrition at relatively young ages and continuously does so throughout his life, adverse conditions during infancy and childhood or on mother's health during pregnancy might still have significant impacts on mortality at later ages.

Given that we collected data for officers enrolled from 1947 to 1960, most of them joined the Brazilian Air Force in moments of transitional processes and the creation of important research aviation centers and factories in the Southeast Brazil, as mentioned before. Those centers and factories probably attracted more individuals from those particular areas interested on training in engineering. If so, it is possible that the selection of individuals born in the Southern states with stronger background than those in the Northern states reinforced potential effects from early life conditions on mortality later in life. An extension of this study should include other BAF cohorts in order to test if the settlement of the institution during the 1940s and 1950s make the mortality differences within the BAF more pronounced.

This research also points to the importance of studying more closely male mortality (Yates, 2008; Hayward, 1997; Rosero-Bixby, 2008). Studies that focus on women mortality and health are often more numerous because women live longer and mortality data for them are of better quality. In this context, one contribution of our study is to improve our understanding of adult mortality in Brazil. Our mortality estimates for BAF officers indicate the current lower bounds for male mortality in Brazil, and learning about mortality limits is important in a very unequal country. In addition, mortality data, particularly at older ages, are defective. Although our sample is small, information about age at death is substantially better in the BAF database than in the other traditional mortality datasets in Brazil. Therefore, when examining the mortality of population subgroups with high quality mortality data, such as the case of BAF officers, one may help demographers identify potential errors in the mortality functions estimated for the entire country. Indeed, as we pointed out in this study, the mortality patterns above age 45 in Brazil look very different from those of other populations with more reliable mortality data, including the officers of the Brazilian Air Force, which suggests that more attention should be paid to the accuracy of mortality estimates at old ages.

Finally, our study points to the contribution of analyzing levels and patterns of mortality in subgroups, where the possibility of taking a closer look into a population's survival characteristics may lead us to interesting and surprising results. Demography has been traditionally focusing on large datasets and nations of peoples, which is also of great importance and allows us to generalize patterns and more accurately establish trends. However, analyzing more specific groups can also bring light into the complex and often obscure field of mortality.

REFERENCES

Abraido-Lanza et al., (1999). The Latino mortality paradox: A test of the "salmon bias" and healthy migrant hypotheses. *American Journal of Public Health.* 89(10)1543-1548.

Aérea, Força Aérea (2013). Available at http://www.afa.aer.mil.br/. Dowload on 15/04/2013.

Agresti, A. (2002). Categorical Data Analysis. Ed. John Wiley. New York. Edition 2.

Andrade, R. P. (Ed.). (1976). *A construção aeronáutica no Brasil 1910-1976*. São Paulo: Brasiliense.

Andreev, E. M., D. Jdanov, V.M. Shkolnikov, and D.A. Leon. . (2011). Long-term trends in the longevity of scientific elites: Evidence from the British and the Russian academies of science. *Population Studies-a Journal of Demography, 65*, 319-334.

Bengtsson, T., and Lindstrom, M. (2000). Childhood misery and disease in later life: the effects on mortality in old age of hazards experienced in early life, southern Sweden, 1760-1894. *Population Studies, 54*, 263–277.

Bertazzo, R. P. (2003). *A Crise da Indústria Brasileira Aeronáutica:1945-1968.* Bacharel, UFJF, Juiz de Fora.

Boscarino, J. A. (1997). Diseases Among Men 20 Years After Exposure to Severe Stress: Implications for Clinical Research and Medical Care. *Psychosomatic Medicine 59*, 605–614.

Boscarino, J. A. (2006b). Posttraumatic Stress Disorder and Mortality Among U.S. Army Veterans 30 Years After Military Service. *Annals of Epidemiology 16*, 248–256.

Breslow,L. and Enstrom, J. E. (2008). Lifestyle and reduced mortality among active California Mormons, 1980–2004. Preventive Medicine. 46, 133-136.

Buzzell, E. and. Preston, S. H. (2007). Mortality of American Troops in the Iraq War. *Population and Development Review, 33*, 555–566.

Case, A. and Paxson, C. (2005). Sex Differences in Morbidity and Mortality. *Demography*. 42. Number 2, 189-214.

Castro, C. (2000). Interviewing the Brazilian military: reflections on a research experience. XI International Oral History Conference. Istanbul, Turkey: International Oral History Association University

Castro, C. (Ed.). (1990). *O Espírito Militar. Um Estudo de Antropologia Social na Academia Militar das Agulhas Negras*. Rio de Janeiro: Jorge Zahar.

Costa, D. (2003). Understanding Mid-Life and Older Age Mortality Declines: Evidence from Union Army Veterans. *Journal of Econometrics, 112*, 175-192.

Costa, D. (2004). The Measure of Man and Older Age Mortality: Evidence from the Gould Sample. *Journal of Economic History, Working Paper No. 8843. Vol. 1*(64), 1-23.

Costa, D., Fogel, R. (1997). A Theory of Technophysio Evolution, with Some Implications for Forecasting Population, Health Care Costs, and Pension Costs. *Demography, 34*, 49-66.

Clipp, E.C., and Elder, G.H. (1996). The aging veteran of World War II: Psychiatric and life course insights. In P.E. Ruskin & J.A. Talbott (Eds.), *Aging and Posttraumatic Stress Disorder* (pp.19-51).

Cutler, D. M. and Lleras-Muney, A. (2010). Understanding differences in health behaviors by education. Journal of Health Economics. 29,1-28.

Davison, E. H., Pless, A.P., Gugliucci, M.R., King, L.A., King, D.W., Salgado, D.M., et al. (2006). Late-life emergence of early-life trauma: The phenomenon of late-onset stress symptomatology among aging combat veterans. *Research on Aging 28*: 84-114.

Doblhammer, G. and R. (2003). Seasonal mortality in Denmark: the role of sex and age. *Demographic Research, 9*, 197-222.

Elo, I., Preston, S. H and Stewart, Q. (1999). Effects of Age Misreporting on Mortality Estimates at Older Ages. *Population Studies, 53*, 165-177

Elo, I. and Preston, S.H. (1992). Effects of early-life condition on adult mortality: A review. *Population index*. 58, 186-222

Eschbach, R. and Markides, K.S. (2004). Evaluation of mortality data for older Mexican Americans: Implications for the Hispanic paradox. *American Journal Of Epidemiology*. 159(7), 707-715

Fogel, R. W. (2004). Health, Nutrition, and Economic Growth. *Economic Development and Cultural Change, 52*(3), 643.

Hayward, M.D., and Gorman, B.K. (2004). The long arm of childhood: The influence of early-life social conditions on men's mortality. *Demography*. 41, 87-107.

Hayward, M. D., Pienta, A.M., and McLaughlin, D.K. (1997). Inequality in men's mortality: The socioeconomic status gradient and geographic context. *J Health Soc Behav, 38*, 313-330.

INCAER (Ed.). (1991). *História Geral da Aeronáutica* (Vol. 3).

IBGE. Instituto Brasileiro de Geografia e Estatística (2000). Tábuas Completas de Mortalidade 2000. Available at http://www.ibge.gov.br/home/estatistica/populacao/. (download on 23/10/2013)

Kahn and Costa, D. (2010). Health, Wartime Stress, and Unit Cohesion: Evidence From UnionArmy Veterans. *Demography, 47*(Number 1), 45-66.

Kannisto (Producer). (1994). Development of oldest-old mortality. *1950-1990 (Odense University Press, Odense, Denmark)*. Available on http://www.demogr.mpg.de/.

Kannisto, V., Christensen, K. and Vaupel, JW. (1997). No increased mortality later in life for cohorts born during famine. *American Journal of Epidemiology, 145*, 987-994.

Kennedy, McDonald and Biddle. (2006). The Healthy Immigrant Effect and Immigrant Selection: Evidence from Four Countries. SEDAP Research Paper No. 164

Khlat, D. (2003). Is there a Mediterranean migrants mortality paradox in Europe? *International Journal of Epidemiology, 32*(6), 1115-1118.

MacIntyre NR, M. R., Oberman A, Harlan WR, Graybiel A, Johnson E. (1978). Longevity in military pilots: 37-year followup of the Navy's "1000 aviators". *Aviat Space Environ Med, 49*(9), 1120-1122.

McDonald, J.T.and Kennedy, S.(2004). Insights into the 'healthy immigrant effect': health status and health service use of immigrants to Canada. Social Science & Medicine. 59(8)1613-1627.

McMichael , A.J. (1976). Standardized mortality ratios and the "healthy worker effect": Scratching beneath the surface. *J Occup Med.* 18,165-168.

Marmot et al. (1998). Contribution of Psychosocial factors to Socioeconomic Differences in Healths. *Milbank Quarterly, 76*(3), 403-448.

Markides, K.S.and Eschbach, K. (2005). Aging, migration, and mortality: Current status of research on the Hispanic paradox. *Journals of Gerontology Series B-Psychological Sciences And Social Sciences.* 60, 68-75

Mclaughlin, N. et al., (2008). An Evaluation of the Effect of Military Service on Mortality: Quantifying the Healthy Soldier Effect. *Ann Epidemiol, 18*, 928–936.
NIOSH, (1996). National Mortality Profile of Active Duty Personnel in the U.S. Armed Forces: 1980-1993.

Ozcan, S. (2012). Casualty Profile of the United States Army in Afghanistan and Iraq. Monterrey, California. Ministry of Defense.Thesis.

Paes, N. A. (2005). Avaliação da cobertura dos registros de óbitos dos Estados brasileiros em 2000. *Revista de Saúde Pública, 39*(6), 882-890.

Palloni, A. and Arias, E. (2004). Paradox Lost: Explaining the Hispanic Adult Mortality Advantage. *Demography*. 41, 385-415

Palloni, A.and Morenoff J.D. (2001). Interpreting the paradoxical in the Hispanic paradox - Demographic and epidemiologic approaches. *Population Health and Aging*. 140-174.

Preston, Guillot and Heuveline. (2001). Demography: Measuring and Modeling Population Processes. Oxford. Blackwell Publishers

Preston Hill and Drevenstedt (1998). Childhood conditions that predict survival to advanced ages among African-Americans. *Social Science & Medicine*. 47,1231-1246

Razum, O. and Twardella, D. (2002). Viewpoint: Time travel with Oliver Twist - Towards an explanation for a paradoxically low mortality among recent immigrants. *Tropical Medicine & International Health 7*(1), 4-10.

Rosero-Bixby, L. (2008). The Exceptionally High Life Expectancy of Costa Rican Nonagenarians. *Demography, 45*(3), 673–691.

Sastry, N. (2004). Trends in Socioeconomic Inequalities in Mortality in Developing Countries: The Case of Child Survival in Sao Paulo, Brazil. *Demography*. 41(3)443-464

Shah et al., (2009). Healthy worker effect phenomenon. *Indian J Occup Environ Med, 13*, 77-79.

Spiro, A., Chatterjee, S., King, L.A., King, D.W., and Davison, E.H. . (2009). Research on Aging Military Veterans: lifespan Implications of Military Service. *PTSD Research Quarterly, 20*(3), 1-9.

Spiro, A., Schnurr, P.P., and Aldwin, C.M. . (1997). A life-span perspective on the effects of military service. *Journal of Geriatric Psychiatry and Neurology, 30*, 91-128.

Statacorp. (2005). Stata Statistical Software: Release 9.0. *College Station, TX: Stata Corporation*.

The Human Mortality Database (HMD). University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org or www.humanmortality.de (data downloaded on 17/12/2013) from http://www.mortality.org/ or www.humanmortality.de

Turra, C. and Gomes., M. (2009). The number of centenarians in Brazil: Indirect estimates based on death certificates *Demographic Research, 20*(20), 495-502.

Turra, C. and Elo, I. (2007). Socioeconomic Differences in mortality among U.S Adults: Insights into the Hispanic Paradox. *Journal of Gerontology Social Sciences.* 52(B)S184-S192

Van den Berg, G. D., Christensen, K. (2009). Exogenous determinants of early-life conditions, and mortality later in life. *Social Science & Medicine, 68*, 1591-1598.

Van den Berg, G. J., Lindeboom, M., and Lopez, M. (2007). Inequality in individual mortality and economic conditions earlier in life. *Working paper VU University Amsterdam.*

Yates, L. B., Djousse, L., Kurth, T., Buring, Julie E.,Gaziano, M. (2008). Exceptional Longevity in Men: Modifiable Factors Associated With Survival and Function to Age 90 Years. *Arch Intern Med., 168*(3), 284-290.

Kaden and Winkler-Dworak (2013). The Longevity of Academicians: Evidence from the Saxonian Academy of Sciences and Humanities in Leipzig. *VID Working Paper 03/2013*