Mortality Advantages: An Analysis Using Data on Brazilian Air Force Officers

Vanessa di Lego (Cedeplar/UFMG)
Cássio Turra (Cedeplar/UFMG)
Cibele Cesar (ICEX/UFMG)

ABSTRACT

Examining the mortality patterns of selected population subgroups are of great elucidative value not only for the wealthiest nations, but also for the highest heterogeneous societies, since it remains unclear the extent to which the unequal distribution of social and economic conditions lead to adult mortality differentials in those populations. Hence, mortality estimates for selected groups in these countries, even if represent a small fraction of the population, can reveal how the numerous pathways linking mortality with several well-established factors operate in unfavorable socioeconomic settings. We used longitudinal mortality data from 1947 to 1960 (n=706, 66 years follow-up), for a highly selected Brazilian group, the Air Force officers (BAF), in order to test two main hypotheses: (1) mortality levels for BAF officers are lower than for the average Brazilian; (2) mortality differentials due to distinct socioeconomic backgrounds are offset by their long-lasting exposure to a privileged health setting. Our results not only confirmed a survival advantage of BAF officers when compared to the average Brazilian male in 2000, but also that BAF life expectancy is comparable to those in low mortality countries, such as Sweden, France and Japan in 2000. We found that place of birth had no statistically significant association with BAF mortality and so officers who were born in the more developed regions of Brazil presented no survival advantage relative to those who were born in the less developed regions, indicating that despite coming from different socioeconomic settings during childhood, it did not affect their mortality differentials.

1. 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 increasing longevity. Earlier research has shown for a large and heterogeneous list of countries, survival advantages associated with higher income, higher educational attainment, better occupational status (Cutler and Lleras-Muney 2008; Christensen and Johnson 1995), gender (Crimmins and Saito 2001; Case and Paxson 2005; Norris K. and Nissenson A., 2008), race (Elo and Preston 1994; David and Selina 2009) and marital status (Zick and Smith 1991; Goldman, 1993; Waite and Gallagher 2000; Rahman 1991), just to mention a few of the most well-know factors. Sometimes, the mortality rates among population groups look 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; Elo et al. 2004), as well as the lower mortality rates among foreign-born groups in Europe, including the Turkish in German and Mediterranean in France compared to the native born (Razum 2002; Darmon 2003).

Some other studies have examined the survival advantages of population subgroups that represent significantly smaller but selected fractions of the populations, including certain learned societies and religious groups. In a recent study, 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. Also, 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 psychosocial factors, such as autonomy, active cognitive reasoning and control at work and in life (Marmot et al. 1998). Scholars have also compared mortality among religious groups and the whole population. 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), which appears to be related to 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).

Examining the mortality patterns of selected population subgroups are of great elucidative value not only for the wealthiest nations, but also for the highest heterogeneous societies. First, because it remains (surprisingly) unclear the extent to which the unequal distribution of social and economic conditions lead to adult mortality differentials in those populations. In many countries, including Brazil, despite the long lasting effort to produce reliable mortality estimates, most of the information available is still for the total population by age, sex and geographic areas. Furthermore, mortality estimates for selected groups in these countries, even if represent a small fraction of the population, can reveal how the numerous pathways linking mortality with several well-established factors operate in unfavorable socioeconomic settings.

In this article, we benefit from reliable longitudinal 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 group, other factors are still associated with their survival. For that purpose, we obtained information from 706 male officers who enrolled in the Brazilian Air Force (BAF) 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 military is a population subgroup that have attracted growing attention from demographers interested on learning more on survival under extreme conditions, as well as the factors responsible for lower mortality rates over the life cycle. Although it is reasonable to assume that members of the military are healthier than the average citizen is somewhat surprising that they experience lower mortality than most 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. 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. In addition, 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. In addition, married servicemen were more likely to be involved in hostile incidents than single servicemen (Ozcan 2012). The main explanation for these patterns is the occupational profile and the demands of military duties, especially during conflict, across different racial, marital and gender groups. 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).

In our study, we examine the magnitude of the mortality advantage of the Brazilian Air Force Officers compared to the total Brazilian population and to the populations living in low mortality countries. Brazilian women engaged in military duties only in 1991, as administrative officers, 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 the importance of sex differentials in mortality, somewhat limiting our analysis. Nevertheless, 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 the end of period study. By understanding their possibly privileged survival relative to Brazilian males, we expect to improve our knowledge on male life expectation in a developing country scenario (Rosero-Bixby 2008).

Furthermore, we use the information on place of birth 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. Both mechanisms may affect adult mortality positively or negatively. Other authors have shown how different exogenous influences on childhood can affect adult mortality, including economic recessions, climate change and starvation periods (Bengtsson 2000; Van den Berg 2007; Van den Berg 2009; Doblhammer 2003). On the other hand, there is also evidence that mid-life factors, such as behavior related to tobacco and alcohol abuse and sedentary life styles, may mitigate or intensify the influence of earlier life events on old age mortality (Kannisto 1997; Kannisto 1994). Since the group of military officers studied here enrolled in the Brazilian Air Force 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. However, because the BAF employs a very restrictive selection process to choose officers and later, offers an extremely controlled environment that includes overwhelmingly good health, nutritional and
physical structures, we hypothesize that the working environment may offset the effects of being born in more or less developed regions.

2. THE MILITARY AS AN INSTITUTION IN BRAZIL

Some features of the Brazilian military institution and the time period here considered are important to account for when analyzing this group, since they are fundamental in understanding the characteristics of our cohort study. First, an important cultural aspect of the military institution and one that particularly makes it different from other social settings is that it is a “totalizing” social environment (Simmel 1972). Which means, as Castro (1990; 2000) shows, that individuality in the military is not encouraged, their social circles are more restricted and their social ties are more homogenous. In addition, more traditional familistic values are stressed, with officers marrying at relatively young ages, preferably with members of other known military families. 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). This standardized setting is a crucial element in efficiently coping with military training and duty, which often involves risky and stressful situations, since it is considered to provide a more predictable guide to behavior.

Second, the period considered in this study hosted important historic changes, which had an impact on the institution. Castro’s research 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). Between 1940 and 1960 the military were accepted and respected in the highest social segments. However, after the 1964 military coup, the prestige of the military declined before the civil society. Parallel to that, other ongoing movements starting in the end of the 60’s, such as the feminist revolution, exposed social structures that conflicted with some of the traditional aspects of society, as well with those of the military profession. The increase in
women empowerment, labor force participation and education levels progressively affected the marriage market for the military, as women started to question why female occupation outside the household was unacceptable for an officer’s spouse. With all those changes taken together, by the 90’s, the military had already lost its former prestige before the civil society (Castro 1990). Hence, we study a cohort which was exposed to a period of many social and political changes, composed of individuals who entered the Air Force from the 1940’s until the 1960’s, both from traditional higher classes and the bourgeoisie, but also from the working class. 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 characteristics of these officers 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.

3. DATA AND METHODS

3.1. Data

The data for this study come from an electronic database of the Air Force pension fund system (Brazilian Air Force Health Center/DIRSA). The database contains information on officers who are still alive and retired, officers who already deceased but whose families receive survival benefits, and officers who died on duty (casualties) and did not support any designated beneficiary in the BAF pension plan. We were not able to retrieve information for a minority group of officers composed of deceased 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 keep track of them. Since the BAF pension system demands utmost control due to government legal accountability issues, 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

---

1 The Director of the Center, Brig. Gen. Jorge Marones de Gusmão, granted and formally approved access to the military records.
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 careeral 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).

3.2 Variables

In order 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). Information on deaths was available for two groups of causes of deaths: deaths during military service (casualties) and other remaining causes of death. For analyzing the possible effect of childhood conditions we obtained information on place of birth as of the enrollment 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. In addition, candidates at that time chose upon their application if they wanted to follow a career on aviation or on administrative affairs, so we were able to collect information on these two types of career. Once enrolled, officers could be dismissed or opt to leave, but their choice of career was fixed and could not change throughout their training or thereafter.

3.3 Analytical approach

To estimate mortality levels among BAF officers, we first predicted age-specific death rates based on the coefficients of Poisson modeling that controls only for age. We then compared the age specific death rates for the BAF officers with male death rates for Brazil and a selected
number of countries, which are known for their low levels of mortality and high quality mortality data. We not only compared mortality rates, but also the estimated truncated life expectancy at age 80 for all populations being considered in the analysis.

The list of countries in our analysis 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.

About 60% of the deaths of the 1947-1960 BAF cohorts occurred between the years 1995 and 2013. Therefore, 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, and compared to the military mortality estimates.

In the second part of our analysis, we examined the association of place of birth with survival among the individuals of the BAF cohort, controlling for career. We looked at two groups of causes of death, casualties and other causes, through a competing risks framework. The standard approach for survival analysis has been the non-parametric Kaplan-Meier estimator. However, it has been proven as an inappropriate estimator in a competing risks setting, since it overestimates the incidence rates of a particular cause when in presence of other causes (for details, see Klein et al 2001). To avoid that issue, we first look at the survival trajectory of the BAF cohort by estimating the cause-specific cumulative incidence function. CIF is a useful non-parametric summary curve for analyzing the competing risks data, which provides the cause-specific hazards in presence of other causes. CIF is defined as: $F_k(t) = \int_0^t \overline{F}(s -) \lambda_k(s) ds$, with

\[
\overline{F} = \exp \{- \sum_{k=1}^K \int_0^t \lambda_k(s) ds\},
\]

and represents the probability that an event of type $k$ has occurred by time $t$. In a competing risks setting, there is an underlying hazard $\lambda_k^*$ that corresponds to the cause-specific cumulative incidence function, also denominated the subdistribution hazard. This
underlying hazard, called sub-hazard \( (\lambda_k^*) \), corresponds to the cause-specific cumulative incidence function via \( \overline{F} = \exp \left\{ - \sum_{k=1}^{K} \int_0^t \lambda_k^*(s) ds \right\} \).

After describing the survival curves for cohort of BAF officers, we modeled the underlying hazard through the proportional hazards model for the subdistribution (FG), proposed by Fine and Grey (1999). The FG model is very similar to Cox regression model, with the difference that the former applies to the sub-hazard underlying the cumulative incidence function (CIF) and creates different weights to the population under risk. Since our concern is not specifically with modeling the cause-specific hazards, but understanding if our covariate place of birth is associated to cause-specific hazards, the FG approach is more appropriate than the Cox regression. One disadvantage of using the FG approach is the difficulty in interpreting its results. However, this approach is convenient and useful when the direction and not the magnitude of the effect is sufficient for the study, since the sign of the coefficients indicate the direction of the effects. Hence, the coefficients are not interpreted in terms of their quantity, but in terms of their sign.

4. RESULTS

Table 1 shows the distribution of cohort members according to survival status and the variables used in our analysis. The results show that 44% of the cohort is alive by June 30th, year 2013. Among all deaths, one fourth occurred on duty. When we analyze the differences by place of birth, we found that 56% of officers who were born on the Northern region of Brazil were deceased by the end of the follow-up period, compared to only 36% among those who were born on the Southern region. Also, among the deceased, 13% died from casualties in the Southern region, compared to 34% in the Northern region. As for career, 43% of pilots died by the end of the study period, compared to 50% of the administrative officers. Not surprising, most of deaths from casualties were concentrated among pilots (97%).
Table 1: Descriptive Characteristics, by Region of Birth, Career and Causes of Death

<table>
<thead>
<tr>
<th>Variables</th>
<th>Number enrolled</th>
<th>Alive</th>
<th>Deceased</th>
<th>Proportion of deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Casualties</td>
<td>Other causes</td>
</tr>
<tr>
<td>Total</td>
<td>706</td>
<td>395</td>
<td>74</td>
<td>237</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern</td>
<td>283</td>
<td>124</td>
<td>54</td>
<td>105</td>
</tr>
<tr>
<td>Southern</td>
<td>423</td>
<td>271</td>
<td>20</td>
<td>132</td>
</tr>
<tr>
<td>Career</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pilot</td>
<td>573</td>
<td>328</td>
<td>72</td>
<td>173</td>
</tr>
<tr>
<td>Adm. Officer</td>
<td>133</td>
<td>67</td>
<td>2</td>
<td>64</td>
</tr>
</tbody>
</table>

4.1 Mortality differentials by age

In order to analyze mortality differentials by age we first estimated age-specific mortality rates by fitting Poisson regression models accounting only for age. Afterwards, we used the coefficients of that model to predict age-specific mortality rates for the BAF cohort and so compare them with the mortality rates for the other populations: Sweden, Chile, France, Japan and Brazil (Figure 1). The concentration of on duty deaths at younger ages makes the death rates higher at age groups 15-24 and 25-34 among BAF officers than in any other population. This is true even when we compare the BAF age-specific mortality rates with those for the 1935 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 the populations that are known for experiencing the lowest mortality levels in the world. These results suggest a high degree of health selection among BAF officers in Brazil.

In order to get a better understanding of the 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 2 the mortality rates for BAF officers, regardless if deaths from casualties 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 for these two sets of estimates, characterized by much higher mortality levels at younger adult ages gradually reducing towards Swedish levels at older ages. These findings confirm earlier analyses that have shown a distinct pattern of mortality among adults in Brazil (Turra 2009; Paes 2005), which is probably caused by age misreporting at older ages. These results could also be indicating compositional effects from risk heterogeneity by age in the total population. However, the simple fact that the much flatter mortality pattern for the BAF officers is based on high quality information, offers another piece of evidence of the presence of data artifact at older ages in the national population (Preston, Elo and Stewart 1999).
Figure 1. Age-specific male mortality rates, Sweden (2000), Chile (2000), France (2000), Japan (2000), Brazil (2000), 19 Brazilian cohort and BAF officers

Figure 2. Mortality ratios Chile (2000), France (2000), Japan (2000), Brazil (2000), Brazil cohort and BAF (cohort), with Sweden (2000) as pattern.

The mortality differences translate into variations of the truncated life expectancy at age 80 across the populations. Not surprisingly, 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 2). 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 (and probably biased) pattern of mortality in the Brazilian total population.
The mortality differences translate into variations of the life expectancy across the populations. Not surprisingly, given the results discussed before, life expectancy at any age for the BAF officers is very similar to the one for the Swedish males in the year 2000 (Table 2). Consistently, Brazilians (both the year 2000 estimates and the 1935 birth cohort estimates) 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 becomes inverted, reflecting the distinct (and probably biased) pattern of mortality in the Brazilian total population.

Table 2. Male life expectancies for BAF, Sweden, Brazil 2000 and 1935 Brazilian cohort

<table>
<thead>
<tr>
<th>Age</th>
<th>BAF</th>
<th>Sweden</th>
<th>Brazil</th>
<th>Brazil cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>30.25</td>
<td>30.43</td>
<td>25.68</td>
<td>25.91</td>
</tr>
<tr>
<td>55</td>
<td>21.16</td>
<td>21.22</td>
<td>17.85</td>
<td>18.58</td>
</tr>
<tr>
<td>65</td>
<td>12.67</td>
<td>12.57</td>
<td>10.73</td>
<td>11.60</td>
</tr>
<tr>
<td>75</td>
<td>4.33</td>
<td>4.46</td>
<td>4.04</td>
<td>4.38</td>
</tr>
</tbody>
</table>

However, one should be careful when comparing BAF estimates with those from other populations since the number of cases is small and there is large statistical uncertainty. Figure 3 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.

**Figure 3. Predicted BAF cohort death rates using the lower and upper bounds for the 95% confidence interval**

Source: DIRSA/Air Force Health Center.

### 4.2 Mortality and place of birth among BAF officers

In this section, we examine the association between place of birth and military mortality in Brazil. To do that, we first look at survival trajectories through non-parametric cumulative incidence functions. Figure 4 shows the curves by other causes of death and casualties,
respectively, with the corresponding 95% confidence intervals and p-values for significance test between the curves. The CIF by other causes of death indicates that the pattern of mortality by region of birth is similar. The incidence curve looks lower in the southern region, especially in the first 30 years of follow-up, but the statistical test did not show any statistical difference. The median follow-up time is also similar in the two regions: 50.53 years for the northern region and 49.37 for the southern region. When looking to casualties, however, the incidence of death is significantly higher for the northern region. The median time of follow-up was 10.78 years for officers born in the southern region compared to only 7.48 years for those form the northern states.

**Figure 4. Cumulative Incidence Functions by regions of birth and causes of death**

![Cumulative Incidence Functions](image)

Source: DIRSA/Air Force Health Center.

The results of the FG models confirm the CIF findings (Table 3). First, there is no significantly statistical difference by place of birth when we look at mortality by other causes. Interestingly, when we control for career type, the incidence of death from other causes is lower
among pilots than for administrative officers (p<0.001), maybe suggesting they are positively selected for health. On the other hand, being born in the Northern region is positively associated with the incidence of death from casualties, as shown by the CIF. Controlling for career type reveals that most of the excess mortality from casualties in the Northern region is due to the larger presence of pilots there, who of course are exposed to higher risks of dying on duty than administrative officers.

Table 3. Fine and Grey Models for Regions of Birth and Career, by Causes of Death

<table>
<thead>
<tr>
<th>Models</th>
<th>Sub-hazards</th>
<th>Models</th>
<th>Sub-hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region of birth</td>
<td></td>
<td>Region of birth</td>
<td></td>
</tr>
<tr>
<td>Southern</td>
<td>-</td>
<td>Southern</td>
<td>-</td>
</tr>
<tr>
<td>Northern</td>
<td>0.1272</td>
<td>Northern</td>
<td>1.4596***</td>
</tr>
<tr>
<td>Region of birth + Career</td>
<td></td>
<td>Region of birth + Career</td>
<td></td>
</tr>
<tr>
<td>Southern</td>
<td>-</td>
<td>Southern</td>
<td>-</td>
</tr>
<tr>
<td>Northern</td>
<td>0.1417</td>
<td>Northern</td>
<td>1.4596***</td>
</tr>
<tr>
<td>Adm.</td>
<td>-</td>
<td>Adm.</td>
<td>-</td>
</tr>
<tr>
<td>Pilot</td>
<td>(-0.6390)***</td>
<td>Pilot</td>
<td>2.1867**</td>
</tr>
</tbody>
</table>

Note: FG results presente in sub-hazards. FG coefficients do not quantify effects, they only give direction of effect. Pilot for other causes the coefficient is -0.639, for example, indicating effect of decrease, highly significant.

*p < .05; **p < .01; ***p < .001
5. 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 males who have been exposed to a healthy and well structured setting since the moment they enroll in the military institution. We tested two main hypotheses: (1) BAF officers experience lower mortality levels than the average Brazilian male; (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.

Our results confirmed 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. We showed that BAF life expectancy is comparable to those in low mortality countries, such as Sweden, France and Japan in 2000. Since BAF estimates are based on follow-up data, collected since 1947, BAF mortality is probably even more selective compared to the low mortality populations than the results showed in this article.

The results also confirmed findings from earlier studies that looked at the influence of mid-life conditions over survival (Kaden 2013; Kannisto 1997). We found that place of birth had no statistically significant association with BAF mortality throughout the follow-up period when considering other causes of death. Hence, officers who were born in the more developed regions of Brazil presented no survival advantage relative to those who were born in the less developed regions, indicating that despite coming from different socioeconomic settings during childhood, there is no sign of “scarring effects” (Preston, 1998) among individuals born in the northern region. Both the selection of officers during enrolment and the impact of providing similar health and socioeconomic conditions during enrolment may explain these results. It is well known that the military institutions in Brazil make strong efforts to continuously provide nutrition, healthcare, income and all other types of support starting since officers join the forces. Also, standardized experiences, as we have mentioned previously (Castro, 2000), is a crucial element in efficiently coping with military training and duty, which often involves risky and stressful situations.
Another important aspect is the time period of analysis and the particular cohort that we are considering in this study. The officers enrolled from 1947 to 1960 joined the Brazilian Air Force in moments of transitional processes and the creation of aviation centers and factories in Brazil (for more details, see INCAER 1991). Thus, an extension of this study should include other late BAF cohorts in order to investigate if the same mortality differentials and patterns are found.

This research also points to the importance of studying more closely male mortality (Yates, 2008; Hayward, 1997; Rosero-Bixby, 2008). Despite being an important limitation of our work to not include women, 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 male adult mortality in Brazil. Our mortality estimates for BAF officers probably indicate the current lower bounds for male mortality in Brazil; 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, our data are accurate, longitudinal and contains information about age at death in a substantially better way than in the other traditional mortality datasets in Brazil. 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 in the whole country.
REFERENCES


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


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


