Health equity surveillance:

Use of life tables defined

by the socioeconomic level of the community

Tim Miller[1]
Ulla Suulamo[2]

[1] El Centro Latinoamericano y Caribeño de Demografía (CELADE), División de Población de la Comisión Económica para América Latina y el Caribe (CEPAL). Paulo.Saad@cepal.org

[2] El Centro Latinoamericano y Caribeño de Demografía (CELADE), División de Población de la Comisión Económica para América Latina y el Caribe (CEPAL). Tim.Miller@cepal.org

1. Objective

There is an urgent need to establish health equity surveillance systems throughout the region. As a contribution to these efforts, we demonstrate the feasibility of geography-based estimates of health inequality using sub-regional geographic units. Traditionally, inequality in life expectancy has been measured across large geographic areas. For example, most governments publish estimates of life expectancy by region or by rural vs. urban areas. Our approach in this paper is to focus on smaller geographies – which should improve the accuracy of estimates of inequality because smaller geographic units are much more homogenous than large regions. We use Chile as a test case and construct life tables based on the socioeconomic characteristics of the comuna in which people live. Chile is divided into 346 comunas, a sub-regional political division. We measure health inequality in Chile by calculating life expectancy observed across five SES groups based on comuna characteristics. After first identifying that individuals in lower SES comunas live substantially shorter lives, our analysis then focuses on two questions. Which ages contribute most to this life expectancy gap? That is, at which ages do individuals living in lower SES comunas suffer the greatest disadvantage? And further, which causes of death contribute most to the gap?

2. Methods and sources

2a. Mortality data

We use publicly available death certificate data from the Chilean Ministry of Health. These data contain the age, sex and cause of death for decedents. Deaths are classified according to the International Classification of Diseases and Related Health Problems 10th Revision. In addition, the records contain information on the marital status, occupational status, and educational attainment of the individual. Information on place of residence (region and comuna) is also provided on the publicly available data set. We chose to define socioeconomic level by place of residence rather than by the educational attainment of the individual. Data on education attainment is of limited use in measuring inequality because it is uninformative for children, it is often unreliably recorded for adults, and its social meaning has changed over time as educational systems expanded. We overcome these difficulties by using the comuna as the social marker for inequality. Comunas are defined according to a socioeconomic index based on household data collected in the Chilean census of 2002. We rely on a SES index in widespread use in Chile developed by the Chilean National Institute of Statistics (INE, 2002). The number of deaths by age, sex, cause, and socioeconomic level of the comuna were derived from death registration data for the years 2001, 2002, and 2003. These 3 years were chosen so as to center our estimate of mortality rates on the year 2002 – a Census year.

2b. Population counts

Population counts were taken from the Chilean census of 2002. Using REDATAM, we accessed the census micro data for Chile and aggregated population counts by age group and sex for each comuna. We defined 19 age groups: 0, 1-4, 5-9,…, 85+. Using information from the INE index of socioeconomic status (SES) for each comuna, we divided the population into 5 groups according to SES ranking. Group 1 contained 10% of the population living in the highest SES comunas. There were 9 comunas in this highest SES group – all located in the capital city of Santiago. Group 2 contained 20% of the population (in 17 comunas); Group 3 contained 40% of the population (in 68 comunas); Group 4 contained 20% of the population (in 115 comunas). Finally, 10% of the population was found to be in the lowest SES Group 5 (in 132 comunas). While the highest SES group is comprised entirely of comunas from the capital, the other SES groups contain comunas spread throughout the country. Thus, these 5 SES groups provide a classification scheme quite different from a simple regional classification of Chile.

From the death registration data set, we calculated average deaths over the three-year interval of 2001, 2002, and 2003 for the 19 age groups, 2 sexes, and 5 SES groups. Dividing these deaths counts by the population as enumerated in the Chilean census gave us mortality rates by age and sex for each SES group – which formed the basis of our analysis. No adjustment was made to either the death counts nor the population counts for under-registration or under-enumeration. The 2002 Census was estimated to have an undercount of approximately 4% (Tacla, 2006). Death registration data is considered to be nearly complete in Chile -- less than 1% (Bay & Orellana, 2007). Therefore, our calculated mortality rates are likely to be overstated due to undercount of the population. This bias will be strongest for those population groups with the highest undercount. In the final version of the paper, we will evaluate the impact of such undercounts on observed differences in life expectancy. For this preliminary version we calculated infant mortality rates based on the census enumeration. We are in the process of revising these estimates based on information on births in each comuna for the 2000-2003 period.

2c. Life table calculations

We calculated 10 abridged life tables for Chile: one for each of the 5 SES levels, for men and for women. Using these life tables, we assess the life expectancy gap between the highest SES level and all other SES levels. Our first step in the analysis was to apply the Arriaga (1984) method in order to decompose this gap in life expectancy into the contributions of differences in mortality risk at each age. We also examined the relative mortality risks at each age across SES groups. Finally, we examine causes of death to better understand the source of these observed differences in mortality risk.

3. Key Findings

3a. World record life expectancy in the “Bubble”

In 2002, ten percent of the Chilean population lived in the highest SES group of comunas. Our results show that the population residing in these 9 comunas in the capital enjoyed a significant advantage compared to the rest of Chile due to their low mortality risks at all ages which was reflected in their higher life expectancies. Life expectancy among women in this group was 83.0 years – 3 years greater than the rest of Chile. For men, this advantage in life expectancy was even greater at 3.7 years – a life expectancy of 77.4. To put this into a global context, Chile as a nation ranked 25th in the world in female life expectancy in 2002. But life expectancy of women living in the highest SES group of comunas in Chile would have ranked second in the world – tied with France. For male life expectancy in 2002, Chile as a nation ranked

32nd in the world at 74.6 – just behind the United States. But the life expectancy of men in the highest SES comunas in Chile would have ranked 6th in the world – tied with Australia. Thus, a small but sizable group of the Chilean population (10%) had one of the highest life expectancies in the world for both men and women in 2002.

3b. The rest of Chile

One surprising finding was the lack of a socioeconomic gradient in life expectancy amongst the lower SES groups – representing 70% of the Chilean population. As seen in Figure 1a, life expectancies among women in the 3 lowest SES groups (comprising 40%, 20%, and 10% of the population) were strikingly similar: 80.0, 79.9, and 80.0 years. Figure 1b shows similar results for men: 73.7, 73.7, and 73.8 years. We did observe notable differences in mortality risks at specific ages between the SES groups—however these differences were not large enough to cause a difference in life expectancy. One possible explanation for this finding is that the level of socioeconomic heterogeneity within comunas is high. Therefore, the average socioeconomic level of a comuna is not an accurate reflection of the socioeconomic level of the neighborhood in which people live. Evidence in support of this hypothesis is seen in the distribution of households within comunas. According to INE's SES index, even wealthy comunas have poor neighborhoods within them and vice versa. Another possible explanation is that in terms of health, Chile is comprised of essentially two groups: an elite consisting of the top 10% of the population and everyone else.

Figure 1a

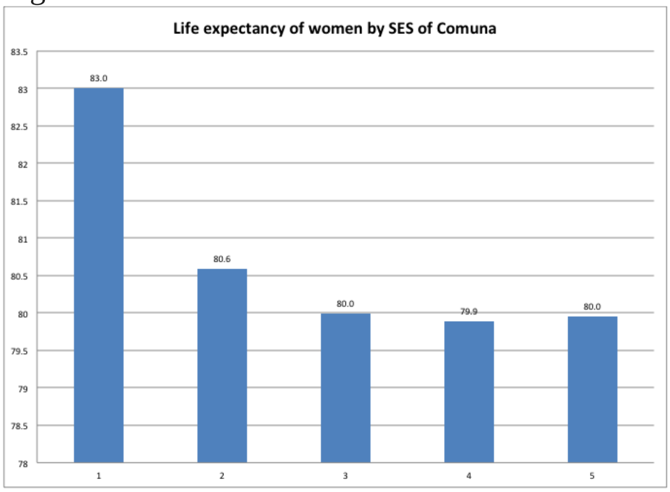
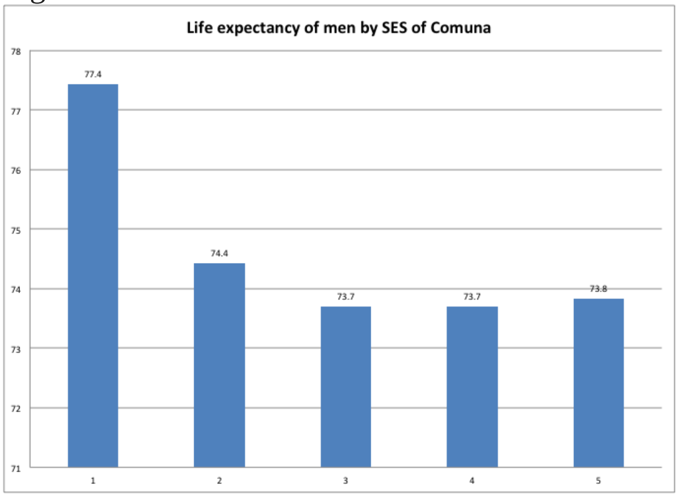


Figure 1b



3c. Shorter lives of low SES groups mainly due to higher mortality risks at older ages

The lower life expectancy of the low SES groups was a result of facing higher mortality risk at all ages. But which ages contributed most to this gap? Using the Arriaga decomposition, we analyzed the life expectancy gap across SES groups for men and for women (see Table 1 below). Looking at the difference of 3.05 years in female life expectancy between the highest SES group and the lowest SES group, we find that for women the vast majority of the gap in life expectancy (78% of the gap) is due to mortality differences beyond the age of 40. In fact, half of the gap is due to mortality differences at ages 60 and older. Thus, the shorter lives of women in lower SES comunas is mainly due to higher mortality risks faced in old age. For men, these mortality differences in later life are also the most important reason for a gap in life expectancy (accounting for 50% of the gap). However, we also see the important impact of differences in mortality across SES groups among young men ages 20-34 – which accounts for about one-third of the observed gap in life expectancy.

Table 1. Contribution of differences in mortality rates for each age group to the life expectancy gap relative to the highest SES group (SES 1).

Women					
	Contribution of Age Group (in years)				
	0-19	20-39	40-59	60+	Total
SES 2	0.12	0.12	0.43	1.75	2.41
SES 3	0.22	0.14	0.59	2.06	3.00
SES 4	0.28	0.15	0.70	1.99	3.11
SES 5	0.34	0.33	0.75	1.63	3.05
Men					
	Contribution of Age Group (in years)				
	0-19	20-39	40-59	60+	Total
SES 2	0.20	0.38	0.76	1.67	3.00
SES 3	0.30	0.65	1.02	1.77	3.74
SES 4	0.40	0.85	1.09	1.39	3.73
SES 5	0.53	1.27	1.30	0.50	3.60

3d. Causes of death

Figure 2a compares age-specific mortality risks for women by SES group compared to the highest SES group. Women in the lower SES groups face mortality risks that are about 50% greater compared to the highest SES group. We see a particularly big difference in risk among young women in reproductive ages: 15 to 29. In particular, the risk levels of women in the lowest SES group are more than twice as great as those experienced in the highest SES group. Examining the cause of death among this age group of women, we found the largest difference in risk was due to external causes: mainly accidents and self-harm (Figure 3a). In the case of men (Figure 2b), we see a much stronger SES gradient among young men ages 15 to 29 – with the risk level in the lowest SES group reaching triple that of the highest SES group for young men ages 20-24. Examining causes of death among the age group 15 to 29 (Figure 3b), we find --similarly to the case of women-- that these excess deaths are primarily from accidents and self-harm.

Among the older population, we find that the main difference is attributed to ill-defined and unknown causes of death (Figures 4a & 4b). This is likely to be a reflection of poor access to health services. This lack of information on the causes of death greatly limits our ability to interpret the causes of the excess mortality risk of lower SES groups. However, we do note that among those deaths that could be classified, the gap between the highest and lowest SES groups is explained by different causes for men and for women. Among men, we see that external causes are the leading cause of excess mortality. Among women, we find that respiratory system diseases are the leading cause of excess mortality.

Figure 2a

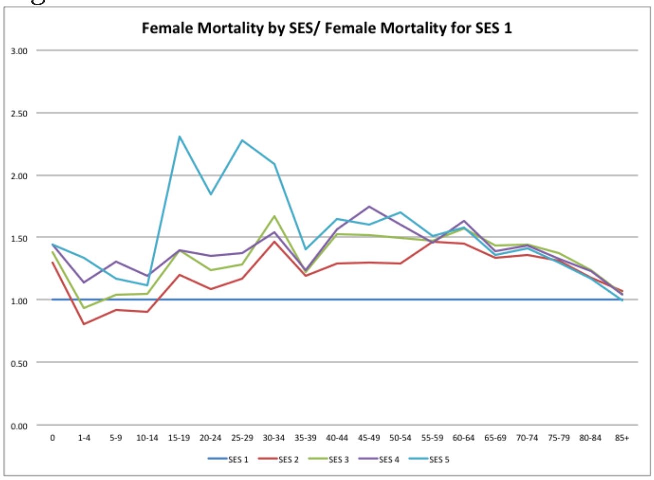


Figure 2b

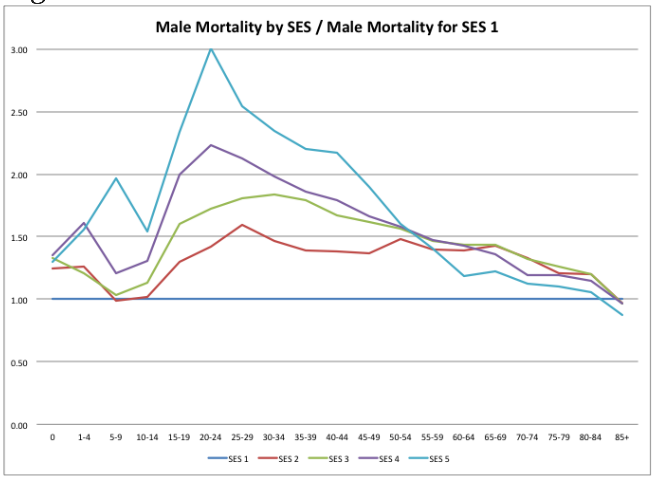


Figure 3a

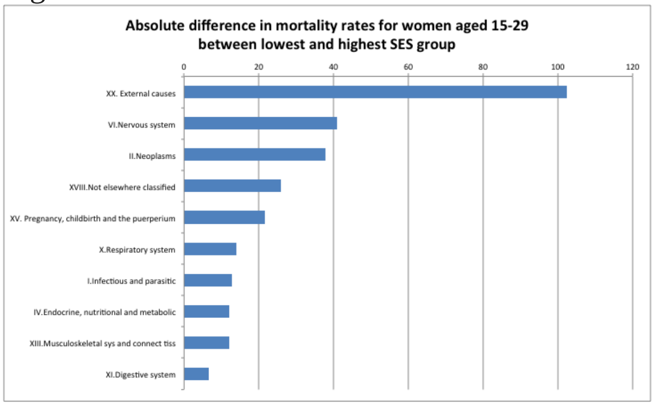


Figure 3b

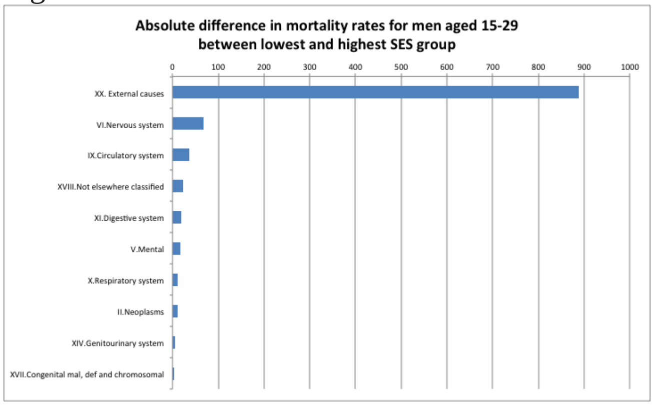


Figure 4a

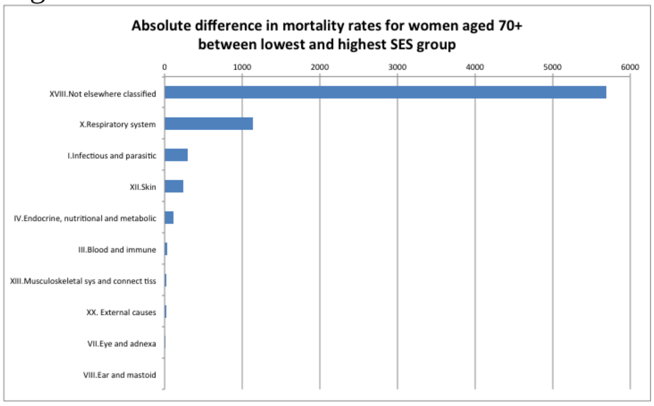
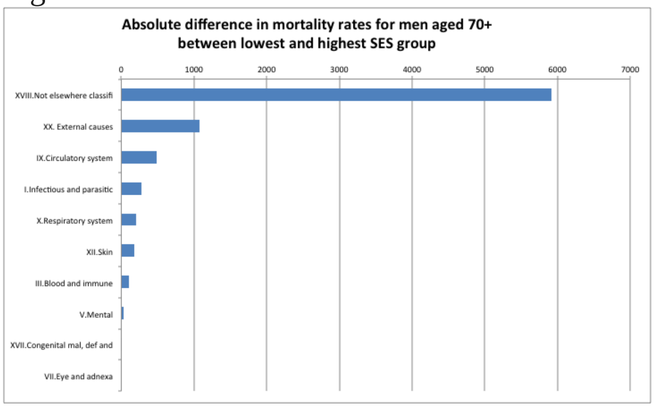


Figure 4b



3e. Mortality crossover observed.

In general, we observe the expected pattern: a gradient in mortality risks across the 5 SES groups – as SES level increases, mortality rates fall. However, it is worth commenting on one notable exception to the expected pattern as seen in Figure 2b. Ten percent of Chilean men reside in the lowest SES comunas. This group of men has higher mortality rates than the other SES groups for most ages. Interestingly, at the older ages (above age 50) the mortality rates of this most disadvantaged group fall below that of all the other low SES groups and approach the mortality levels observed among the most advantaged group. How are we to interpret this improvement in relative mortality risks at older ages? One explanation might be poor data quality among these older men in the lowest SES group. Age misstatement can bias mortality estimates downward (Preston, Elo, and Stewart, 1997). As noted earlier, census undercounts of this group would also bias mortality estimates downward. However, if the bias caused by these errors were small, it is possible that we are observing a selection effect. This older cohort of men might be more robust than the other SES groups because the frailer members of this cohort have already died as a result of the high mortality the cohort experienced earlier in life. This type of mortality crossover has been extensively studied in the US population where black mortality rates are higher than white mortality rates up until the oldest ages (85+). (For a recent analysis and review, see Fenelon, 2013). Further investigation of this phenomenon is certainly warranted, beginning with a review of the data quality for this SES group.

4. Conclusions

Our results demonstrate the feasibility of using publicly available death registration data combined with census data to derive life table for different socioeconomic groups within a country. The death registration data and census micro data are readily available for many countries in the region. While the particular SES index used for classifying comunas is unique to Chile, most countries will have similar indices. Or lacking that information, an SES index could be readily constructed from the census micro data. Therefore, it would be relatively straightforward to replicate these results in many countries throughout the region in order to establish a regional system for quantifying national health inequalities based on life tables. Furthermore, the approach allows examination of the specific ages and specific causes of death in which these SES groups are at their most severe disadvantage.

However, we note several disadvantages to this approach. While it is straightforward to calculate the differences in risks from specific causes of death, the analysis is hampered by the quality of the data. As we saw in the case of Chile, the main cause of excess deaths among the elderly in the lower SES groups were ill-defined and unknown causes. While this fact does provide general evidence on the lack of access to health systems among this population, it greatly limits our understanding of the specific disease processes underlying the large difference in mortality risks between SES groups seen in these older ages.

Another weakness of the approach concerns the validity of the particular SES index chosen for classifying the comunas. We chose an index developed by the Chilean National Statistical Office (INE, 2002), but there are other indices available. These alternative indices are similar to that of INE in that they are based on household level data such as type of housing, education of household head, etc. It would be worthwhile to calculate an alternative set of life tables by SES using these other indices in order to evaluate the extent to which different SES classification schemes influence our results.

Finally, we note that considerable SES heterogeneity exists within comunas – albeit less than that observed at the regional level. Data at the level of neighborhoods or census blocks would be considerably more homogeneous with respect to standards of living (SES) than comunas. Exposure to health risks, access to health care, and a host of other factors that ultimately determine mortality are likely to be better measured by neighborhood characteristics rather than those of comunas. The main advantage of the approach used in this paper is that comuna-level characteristics are available in the publicly released version of the death certificate database. This makes our analysis using administrative division data easy to replicate throughout the region. We expect that an analysis based on neighborhoods in which people live would yield a more accurate assessment of national health inequalities. This approach has been successfully demonstrated in the analysis of SES gradients in life expectancy in the state of California, United States (Clarke, C. et al. 2010).

The type of analysis presented in this paper opens another interesting line of investigation: focusing on comunas themselves rather than aggregations of comunas based on socio-economic status. The main difficulty presented would be the uncertainty and bias introduced in estimates for small comunas. Recent research (Scherbov & Ediev, 2011) into minimum population sizes for accurate estimates of life expectancy based on simulations indicate that populations greater than 80,000 would be needed to establish 95% confidence interval less than 2 years (that is, e0 +/- 1 year). According to the Chilean census of 2002, 57 of the 343 comunas exceeded this minimum size. A next step in our investigation will be to construct life tables for each of these 57 comunas, which represent 65% of the Chilean population. These represent mainly urban areas in Chile and exclude the very poorest, rural comunas. It would be possible to extend that analysis by grouping together the adjacent, smaller rural comunas in order to reach a sufficiently large population to insure a relatively small confidence interval.

Our main conclusion from this analysis of publicly available death registration data combined with census micro data provides a good "first look" at national inequality in health. We recommend the analysis be replicated in other countries in the region as an important first step in developing a regional health equity surveillance system. An important second step would be to further disaggregate the data by using neighborhood level (census block) characteristics. This should be feasible in most countries but will require the additional effort of special tabulations of national death registration data conducted by the national statistical offices. Data on neighborhood residence are collected but not publicly released because individuals can be readily identified based on data on age, sex, cause of death, and neighborhood. Data would need to be reported by aggregations of neighborhoods according to socioeconomic status in order to preserve the confidentiality of the individual death records.

5. References

Arriaga, E. 1984. Measuring and explaining the change in life expectancies. *Demography* 21(1), pp. 83–96.

Bay, G. y Orellana, H. 2007. La calidad de las estadísticas vitales en América Latina. (Versión preliminar para discusión). Documento preparado para el taller de expertos en el uso de estadísticas vitales: alcances y limitaciones. Santiago, Chile, diciembre, 2007.

CELADE. Database/Population Census/Chile/2002. www.cepal.org/redatam. Accessed January 10, 2014.

Clarke, C. et al. 2010. Racial and social class gradients in life expectancy in contemporary California. *Social Science & Medicine* 70(9), pp. 1373–1380.

Chile. Instituto Nacional de Estadísticas. 2002. *Metodologia Clasificacion Socioeconomica de los Hogares Chilenos*.

Fenelon 2013. An examination of the black/white differences in the rate of age-related mortality increase. *Demographic Research* 29 (17), pp. 441-472.

Scherbov, S. & Ediev, D. 2011. Significance of life table estimates for small populations: Simulation-based study of standard errors. *Demographic Research* 24 (22), pp. 527-550.

Tacla, O. 2006. La omisión censal en América Latina, 1950-2000. *Serie Población y Desarrollo* No. 65 (LC/L.2475-P), Santiago de Chile, CEPAL.