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Short Communication

Socioeconomic status, life expectancy and mortality in a universal healthcare setting: An individual-level analysis of > 6 million Catalan residents

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ABSTRACT

We evaluated the association between individual-level socioeconomic status (SES), life expectancy, and mortality, in adult men and women from the general population living in Catalonia, a universal healthcare coverage setting. We used the Catalan Health Surveillance System database, which includes individual-level information on sociodemographic characteristics and mortality for all residents of Catalonia (Spain). We categorized individuals as high, medium, low or very low SES based on annual personal income and welfare receipt. We used 2016 mortality data to estimate life expectancy at age 18, and the probability of death by age, sex and SES categories. We followed a total of 6,027,424 Catalan residents in 2016. Men and women of very low SES had 12.0 and 9.4 years lower life expectancy compared to men and women of high SES, respectively. Low SES was also strongly associated with mortality in both men and women of any age. In the entire adult population of Catalonia, despite the availability of universal, high quality healthcare coverage, low SES is associated with lower life expectancy and higher mortality. Solutions to these large inequalities may combine tailored health promotion and management interventions, with solutions coming from outside of the health sector.

1. Introduction

Socioeconomic status (SES) is a powerful determinant of health (Mackenbach et al., 2018). In many contexts and research designs, higher SES (income (Chetty et al., 2016), education (Zajacova and Lawrence, 2018), and occupational class (Toch-Marquardt et al., 2014; van Rossum et al., 2000)) have been associated with reduced morbidity and higher life expectancy (Mackenbach et al., 2018; Chetty et al., 2016; Zajacova and Lawrence, 2018; Toch-Marquardt et al., 2014; van Rossum et al., 2000). These associations were initially attributed to differential health care coverage, as a number of the studies were conducted in the US (Adler and Newman, 2002). However, studies conducted in countries with universal National Health Systems such as the UK have shown similar gradients (Aldabe et al., 2011).

A number of studies looking at the SES-life expectancy or mortality association have been conducted using cross-sectional or cohort

Abbreviations: CHSS, Catalan Health Surveillance System; CI, confidence interval; OR, odds ratio; SES, socioeconomic status

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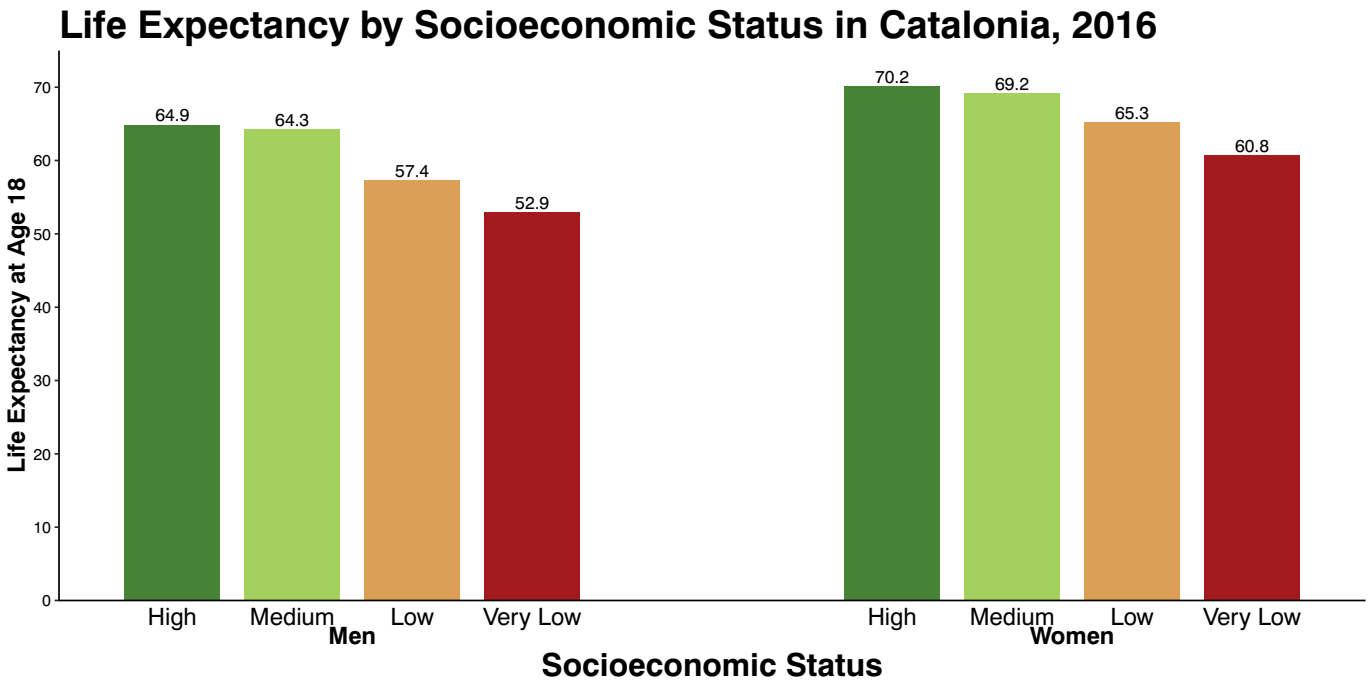

Fig. 1. Life expectancy at age 18, by sex and SES, in Catalonia, 2016.
The x axis represents categories of SES, and the y axis represents life expectancy, in years, at age 18.
Abbreviations: SES = socioeconomic status.

research designs (Braveman et al., 2010), or in census-based mortality registries (Mackenbach et al., 2018; Mackenbach et al., 2016; Mackenbach et al., 2008; Steingrímsdóttir et al., 2012). Studies based on research cohorts or surveys have issues with selection bias, if participants of lower SES strata die before being included in the study, or have a lower probability of being included (Weisskopf et al., 2015; Chaix et al., 2011), biasing associations towards the null.

Analyses of the SES-health association using linkage to population-based healthcare databases can help identify potential contributing factors to this association. Moreover, these analyses can also help identifying specific population sub-groups with limited access to health-promoting resources, increased exposure to health-harming factors, or where public health or medical interventions are not being as effective. Reducing these socioeconomic inequalities is an explicit objective of the Spanish Ministry of Health (Comisión para Reducir las Desigualdades Sociales en Salud en España, 2012), and integrating the study of these inequalities into the healthcare system can help in their alleviation (Institute of Medicine, 2014).

In order to inform these efforts, we leveraged data from > 6 million people living in Catalonia. The objective of this study was to evaluate the association between individual-level SES, life expectancy and mortality of adult men and women from the general population living in a universal healthcare coverage setting.

2. Methods

We used the Catalan Health Surveillance System (CCHS) database from Catalonia (Spain), a region in which all citizens are granted universal healthcare coverage. The CCHS includes detailed, individual-level information on sociodemographic characteristics, medical diagnoses (coded using the International Classification of Diseases, 9th Edition, Clinical Modification) and mortality, among others, for all residents of Catalonia (N = 7,496,276 as of 2016). The study period was defined between January 1st, 2016 and December 31st, 2016. Individuals were included if they were alive and 18 years of age or older as of January 1st, 2016, as SES data is only available for individuals aged 18 or above. There were no exclusion criteria beyond the age restriction.

The exposure of interest was SES, proxied by an indicator of annual individual income and receipt of welfare assistance. The CCHS database collects and updates data on annual income (categorized as < 18,000, 18,000–100,000, and > 100,000 euros/year) and on receipt of welfare support from the Catalan government. We defined 4 individual-level SES categories: "high SES" (annual income > 100,000 euros/year); "medium SES" (18,000–100,000 euros/year); "low SES" (< 18,000 euros/year); and "very low SES" (individuals receiving welfare support from the government). These categories are based on the income groups that determine drug copayments nationally. Both working-age and retired individuals were included in this classification. Age, sex, and date of death are recorded in the database for all Catalan residents.

Life expectancy at age 18 was calculated using life tables separately for men and women for each SES category. To evaluate the associations between SES and all-cause mortality, we calculated age-adjusted mortality (using the age distribution of the overall population of Catalonia as the standard population) by SES and sex, and calculated mortality differences and their 95% confidence intervals (CI). We also ran a logistic regression model with mortality as the outcome and SES as the exposure, adjusted for age (in years). This model was stratified by age (< 65, ≥65 years) and sex (men, women), yielding 4 age-sex strata. All statistical analyses were performed using R version 3.2. The study was approved by the ethics committee of the Institut d'Investigació Biomédica de Bellvitge (IDIBELL), and conformed to the Declaration of Helsinki.

3. Results

We studied a total of 6,027,424 Catalan adults 18 years of age or older and alive as of January 1st, 2016. This included 2,367,802 (39%) men and 2,311,424 (38%) women < 65 years of age, and 575,463 (10%) men and 772,735 (13%) women ≥65 years of age. The low income stratum was the most frequent (N = 3,949,038; 66%), followed by medium income (1,777,651; 29%) and very low (246,773; 4%). The

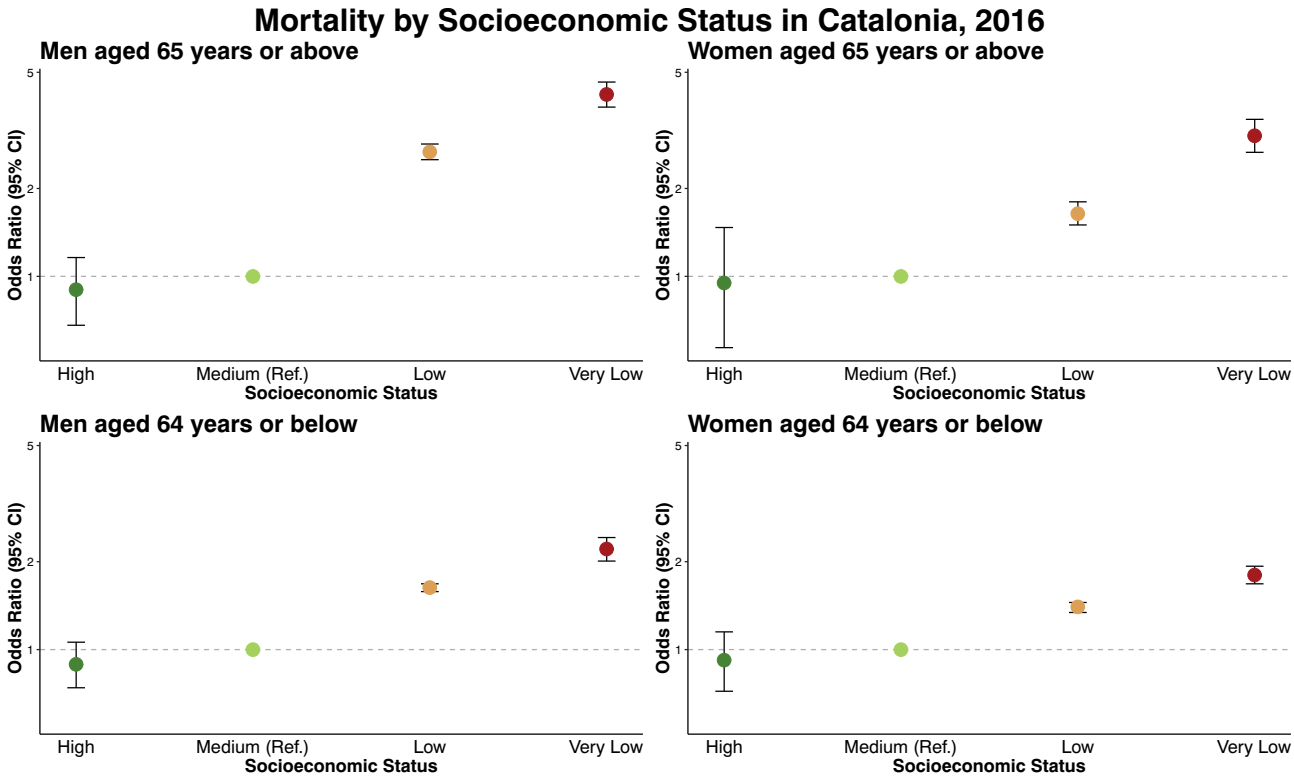

Fig. 2. SES and all-cause mortality, in Catalonia, 2016.
Results are presented as odds ratios from the logistic regression models (y axis in the log scale). Analyses were adjusted for age. Medium income was set as the reference category.
Abbreviations: CI = confidence interval; Ref. = reference; SES = socioeconomic status.

high income group was the least frequent (53,962, 1%).

Lower SES (both low and very low SES) was associated with lower life expectancy among both men and women (Fig. 1). In men, compared to individuals in the high SES group, the life expectancy of individuals with very low SES was 12 years shorter (18.5% decrease). In women, compared to individuals in the high SES group, the life expectancy of those with very low SES was 9.4 years shorter (13.4% decrease).

Age-adjusted mortality was higher in men of very low and low SES as compared to men of medium SES (1044.1 [95% CI 923.4, 1164.7], and 605.4 [95% CI 574.8, 636.1], respectively), and lower in men of high SES (−82.1 [95% CI −182.4, 64.2]) (see Supplementary Fig. 1). A similar association, of lower magnitude, was seen in women (548.5 [95% CI 485.7, 611.2], and 250.1 [95% CI 226.6, 273.7], for very low and low SES as compared to medium SES, respectively, and −59.1 [95% CI −182.4, 64.2] for high SES as compared to medium SES) (see Supplementary Fig. 1). In the age-adjusted regression analyses, lower SES was strongly associated with a higher odds of all-cause death in all age-sex groups (Fig. 2). For the comparison low versus medium income, the odds ratio (OR) ranged from 1.40 (95% CI 1.34, 1.45) in women ≥65 years of age, to 2.67 (95% CI 2.51, 2.84) in men < 65 years of age. For the comparison very low versus medium income, the OR ranged from 1.80 (95% CI 1.68, 1.93) in women ≥65 years of age, to 4.20 (95% CI 3.80, 4.63) in men < 65 years of age.

4. Discussion

In a study of 6 million people including the entire adult population of Catalonia and using individual-level income data, we found a strong social patterning of life expectancy and mortality. Men and women in the lowest SES group had 12 and 9 years lower life expectancy, respectively, at age 18 than those in the highest SES group. Moreover, the lower the SES, the higher the odds of death, independent of age and sex.

Our findings showing a social patterning of life expectancy and mortality are consistent with previous reports. A study by Regidor et al. using the entire Spanish census and measures of household wealth (proxied by floor space and car ownership) also found that people of lower SES have higher mortality (Regidor et al., 2016). Interestingly, those differences declined during the economic recession of 2008 onwards (Regidor et al., 2016). A pooled study of 27 European countries found consistently higher mortality in people of lower educational attainment (Mackenbach et al., 2018). In the US, a study by Chetty et al. found that people in the lowest percentile of SES had a life expectancy 14.6 and 10.1 years lower (respectively in men and women) as compared to those in the highest percentile (Chetty et al., 2016).

To put our findings into context, the life expectancy of men in the highest SES group in Catalonia is above that of Switzerland (highest life expectancy at age 18), while the life expectancy in the lowest SES group in Catalonia is similar to that of Rwanda or El Salvador (United Nations, 2017). In women, the highest SES group has a life expectancy above that of Japan, while the lowest SES group has a life expectancy similar to Sri Lanka or Honduras (United Nations, 2017), two countries with the world's lowest life expectancies. These differences, while striking, have also been reported in the US, where the lowest strata of SES has a life expectancy similar to Pakistan or Sudan (Deaton, 2016).

This study has several strengths. First, the very large size of the study population maximized statistical power and the precision of the regression estimates. Second, the universality of the Catalan healthcare system and of the CCHS database reduces concerns for selection bias and increases generalizability. Third, our measure of SES is individual rather than contextual, providing for better measurement and stronger inferences, and avoiding or at least minimizing exposure misclassification.

This study also has limitations that are worth discussing. The measurement of SES, while individual-level, may be prone to a degree

of measurement error. Since this measure is based on official social security data, jobs in the informal economy are not captured. However, workers in the informal economy tend to be of lower SES and would therefore be correctly categorized in the lowest SES category as they will not be reporting any income. Moreover, income is measured at the individual level, and is unavailable at the household level (except in people below 18 years of age), leading to some potential misclassification of individuals as lower SES if they do not report income while someone in the household does report income. This effect may be especially salient in women, with lower labor participation in Spain. Nevertheless, our analysis did not find differences in the associations between SES and mortality by gender. Given that income is only available at the individual level in individuals aged 18 or above, we could only calculate life expectancy at age 18, potentially obscuring differences in causes of death common in the younger population (Remes et al., 2010). Moreover, we were restricted to using the income categories associated with the drug copayment system in Spain, and could not disaggregate categories further, which could also be obscuring steeper gradients.

Last, immigrants become sick and return to their countries of origin, a phenomenon known as the "salmon effect" when studying the migrant paradox (Turra and Elo, 2008), which may bias estimates of mortality in this subpopulation. Nonetheless, most of these migrants tend to be of lower SES (Borrell et al., 2008), and we would therefore be underestimating mortality in the lower SES group, a sub-group for which we already found increased mortality, meaning that this bias would be, if anything, conservative.

Our findings have important implications. SES inequalities in life expectancy and mortality may emerge from differential exposure (i.e., unequal distribution of risk factors), or differential susceptibility (unequal effect of risk factors) (Diderichsen et al., 2018; Diderichsen et al., 2001). For example, for cardiovascular disease, the most common cause of death in Spain (Soriano et al., 2018), differential exposure involves a higher burden of risk factors such as obesity (Devaux and Sassi, 2013), diabetes (Bilal et al., 2018; Espelt et al., 2012), hypertension (Banegas et al., 2002), or smoking (Bilal et al., 2016) in people of lower SES. On the other hand, differential susceptibility would entail a stronger effect of these risk factors on mortality in people of lower SES, which could be due, for example, to differential use of healthcare resources (Diderichsen et al., 2018). In a previous study, we showed that life expectancy at age 50 was decreased in people of lower SES, both in the general population and in those with prevalent chronic heart failure (Cainzos-Achirica et al., 2019). However, the gradient was much stronger in people with chronic heart failure, indicating a potential for an interaction between SES and chronic conditions (Cainzos-Achirica et al., 2019). Characterization of marked differences by SES in terms of burden of lower life expectancy and mortality in a setting in which universal healthcare coverage is in place, should be used to inform political agendas, in which the protection of highly vulnerable groups such as low SES individuals should be a priority, with a focus on both reducing the burden of risk factors and minimizing differential susceptibility by SES (e.g., tailoring the management of chronic diseases).

5. Conclusions

Our study of the entire adult population of Catalonia has shown that, despite the availability of universal, high quality healthcare coverage, low SES individuals have much lower life expectancy and higher mortality. Solutions to these large inequalities may combine tailored health promotion and management interventions, with solutions coming from outside of the health sector.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ypmed.2019.03.005.

Conflicts of interest

The authors declare they have no conflict of interest.

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