Effect of individual lifestyle choices on the cause and timing of death and their impact on aggregate population measures

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1 Background and Aims

Research focusing on inequality in mortality finds that social norms are connected to lifestyle factors, and together, these can help explain an individual's mortality risk. In a simplified framework, societal conditions are understood to shape downstream determinants such as health-related behaviors and life styles, which then are more directly associated with health outcomes and mortality risks [2]. Although there is an extensive body of research on the effects of behavioral causes and life style factors, such as diet and tobacco smoking [i.e. 3, 7], on particular health outcomes and age-specific mortality risk, little research has directly linked these behaviors to cause-specific mortality.

A theoretical link between population dynamics and patterns of disease and disabilities was posited by Abdel Omran in 1971. In his "Theory of Epidemiological Transition," he proposed that changes in the causes of death distribution and related disease patterns are the main forces that drive population aging and other changes in various social contexts. He argues that 20th century gains in life expectancy were made possible by the eradication and containment of deadly infectious diseases. According to his essay, we had reached the "The Age of Degenerative and Man-Made Diseases [6]." Given that many of these causes can be directly related to risky behaviors, how would the elimination of any of these individual behaviors influence the mortality schedule on a population level? Several preventable causes of death still contribute significantly to premature mortality. In Spain, diabetes had an age- and sex-adjusted prevalence rate of 13.8% in 2002, a daily smoking prevalence of 34% in ages 15-64 in 2017, and over the last ten years, roughly ten percent of the population has been found to consume alcohol daily [1, 9].

Ultimately, this analysis seeks to first identify the mortality differences in preventable and non-preventable deaths, then explain how individuals' life style choices and social background interact and influence their mortality trajectory. However, we also hope to better understand the dynamics of population aging and the compression of morbidity in the context of preventable disease and lifestyle factors. That is to say, we aim to discover how the elimination of a risky behavior (alcohol, diet, etc. related) within the entire population can change such factors as life expectancy and lifespan inequality.

2 Linked individual level data: Spanish National Health Survey and National Statistics of Population Movement

The data used in this analysis comes from two distinct individual level sources that have been linked by the National Institute of Statistics for the purpose of this study. The Spanish National Health Survey (Encuesta de Salud) is a roughly biannual nationally representative study that asks 0.08% of the Spanish population, drawn at the household level, about factors related to all aspects of health, such as diet, alcohol and tobacco use, cancer and medical history, and use of medical services [5]. Our analysis uses two distinct survey time points (in 2011/12 and 2014), which together, contain 43,816 individual participants. These participants have been linked by the Spanish National Institute of Statistics (Instituto Nacional de Estadistica) to both the National Death Registry (Estadística de defunciones, Movimiento natural de la población) and the National Civil Register (Padrón). This linkage allows us to know if an individual has died within the follow up period (to 2017), if they have left the country (out-migrated/right censored), or if they are still in the exposure population. For individuals that have died, the linkage provides information about age at, and date and cause of death according to ICD-10.

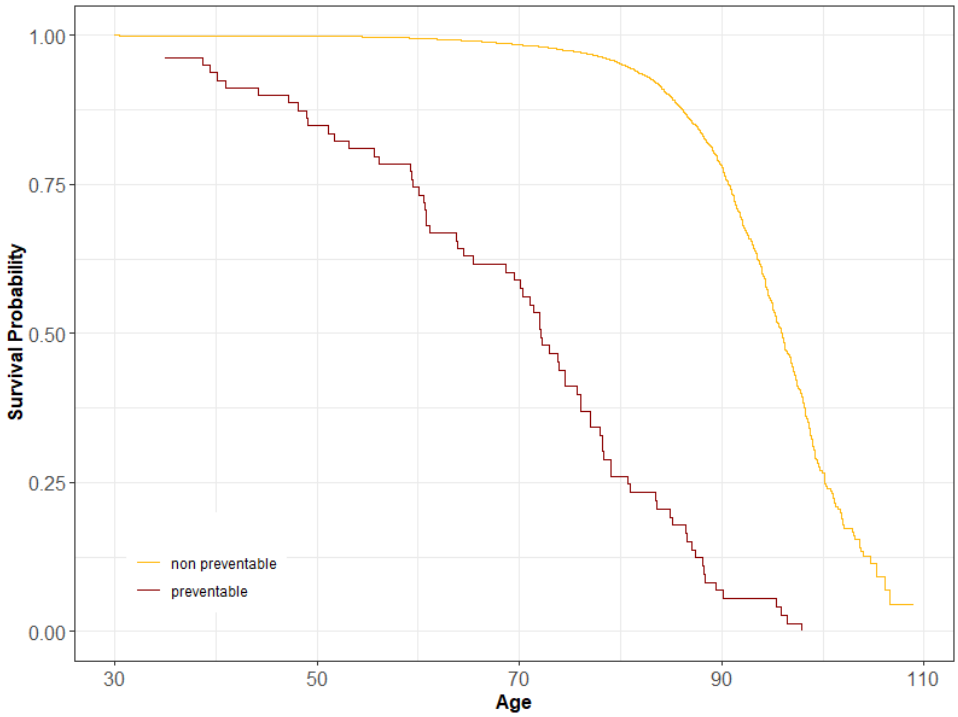

Figure 1: Non-parametric Kaplan Meier survival probability between preventable and all other deaths

3 Methods

We first group the individuals into those who are still in the exposure population, those who have left, and those who died, separated into both preventable and non-preventable causes as identified by Eurostat [4]. These largely include infectious diseases, accidents, drug, alcohol, and smoking related mortality, and at some ages, causes related to diabetes. Many of these diseases are directly related to lifestyle choices that can be identified in the National Health Survey.

Following these groups, we were able to asses overall mortality differences between the preventable and non-preventable causes using a Kaplan-Meier estimator, as seen in figure 1. In order to asses relative mortality risk according to identified life style choices in the Survey, we plan to use the flexible parametric proportional-hazards model proposed by Parmar and Royston, which implements natural cubic splines to smooth the baseline hazard and provides an extension to deal with non-proportionality, which is a concern in our dataset [8]. Using the demographic and social variables (e.g. educational level) in the Encuesta, we can isolate the effect related to behavior.

After identifying these relative mortality risks and how the lifestyle habits of an individual affect this, we attempt to understand how relative behavioral changes in the habits of the population can impact the overall mortality structure of the population. We plan to create lifetables using the death and exposure data, then preform analyses to examine how eliminating specific preventable causes and/or lifestyle habits can potentially impact such factors as life expectancy, lifespan disparity, the compression of mortality, and other factors related to age-specific death rates and the age-at-death distribution.

4 Preliminary Results and Outlook

An initial analysis examining the survival curves of preventable and non-preventable causes of death reveals a much lower survival probability across all ages to those who died of preventable causes (see figure 1). Subsequent analyses will identify the specific lifestyle characteristics, after controlling for additional demographic, social, and economic variables, that contribute to an individual's relative risk of death to a preventable cause.

Following the analysis that will indicate the behaviors which correlate the highest to preventable (ergo, premature) deaths, additional calculations will help to understand how the elimination of these behaviors from the entire population may impact life expectancy and other aggregate demographic measures. Understanding

that these risky behaviors are likely *not* limited to those who die prematurely, we still expect that our results, as calculated from cause-deleted life tables, will show that Spain's already high life expectancy could be further increased by the elimination of some individual behaviors, leading to better overall population health. The results are expected to highlight specific practices in the population that government officials and other policy actors can target in campaigns to increase public health and awareness.

References

[1] (2017). *Encuesta sobre Alcohol y otras Drogas en España (EDADES), 1995-2017*.

[2] Braveman, P. (2014). What are health disparities and health equity? we need to be clear. *Public health reports (Washington, D.C. : 1974)*, 129 Suppl 2(Suppl 2):5–8.

[3] Haveman-Nies, A., de Groot, L. C. P., Burema, J., Cruz, J. A. A., Osler, M., and van Staveren, W. A. (2002). Dietary quality and lifestyle factors in relation to 10-year mortality in older europeans: the seneca study. *American journal of epidemiology*, 156(10):962–968.

[4] Kossarova, L., Holland, W., Nolte, E., and McKee, M. (2009). Measuring "avoidable" mortality. *Research Note. European Observatory on the Social Situation*.

[5] Ministerio de Sanidad, C. y. B. S. (2011,2012,2014). Encuesta nacional de salud.

[6] Omran, A. R. (2005). The epidemiologic transition: a theory of the epidemiology of population change. *The Milbank Quarterly*, 83(4):731–757.

[7] Preston, S. H., Glei, D. A., and Wilmoth, J. R. (2011). Contribution of smoking to international differences in life expectancy. *International differences in mortality at older ages: Dimensions and sources*, pages 105–31.

[8] Royston, P. and Parmar, M. K. (2002). Flexible parametric proportional-hazards and proportional-odds models for censored survival data, with application to prognostic modelling and estimation of treatment effects. *Statistics in medicine*, 21(15):2175–2197.

[9] Soriguer, F., Goday, A., Bosch-Comas, A., Bordiú, E., Calle-Pascual, A., Carmena, R., Casamitjana, R., Castaño, L., Castell, C., Catalá, M., et al. (2012). Prevalence of diabetes mellitus and impaired glucose regulation in spain: the di@ bet. es study. *Diabetologia*, 55(1):88–93.