

**The puzzling SES gradients in adult health and mortality
of a Latin American population**

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Abstract (150 words)

Vast evidence has shown that poorer health and higher mortality in children are clearly associated with lower socioeconomic status of parents everywhere. In contrast, the evidence of a SES gradient in developing country adult health is scarce and conflicting. Particularly puzzling is the fact that subjective general health status measures have been found in some studies to have much larger SES gradients than more objectively measured health indicators. This paper further investigates this paradox using data from an ongoing longitudinal study of health and survival among elderly Costa Ricans (the CRELES study). We document varying SES gradients across a rich array of health indicators including subjective health, functional status, disease conditions, objective risk factors from blood and urine samples, and mortality data. In addition, we estimate SES gradients in key mediating environmental and behavior variables in order to elucidate what hypotheses may be most promising for further research.

The puzzling SES gradients in adult health and mortality of a Latin American population

Introduction

Vast evidence from demographic and health surveys has shown that poorer health and higher mortality in children are clearly associated with lower socioeconomic status of parents everywhere. In contrast, the evidence of a socioeconomic status (SES) gradient in the health of adults in developing countries is scarce and conflicting. Particularly puzzling is the fact that subjective general health status measures have been found in some studies to have much larger SES gradients than more objectively measured health indicators. Crimmins (2005) discussed some hypotheses that could help explain these patterns, but there has been little analysis regarding which hypotheses are consistent with observed data.

This paper further investigates this paradox using data from an ongoing longitudinal study of health and survival among elderly Costa Ricans (the CRELES study). CRELES has a rich array of health indicators including subjective health, functional status, disease conditions, objective risk factors from blood and urine samples, and mortality data. In addition, CRELES collected data on various pathways through which these SES effects might be mediated as they influence different types of health indicators. In this paper we both document varying SES gradients across a wide range of well-defined health indicators, and also estimate SES gradients in mediating environmental and behavior variables in order to elucidate what hypotheses may be most promising for further research.

Background

Analyses in developed countries have found SES and elderly health to be significantly positively correlated, though gradients appear smaller at older ages than at earlier ages (Crimmins, 2005). In developing countries there has been much less study of elderly health differentials, partly due to the paucity of appropriate data until recent years. Now available surveys in elderly populations in Asia and Latin America do indeed appear to also show substantially poorer self-assessed health among the low-educated (Zimmer et al., 2002; Palloni & McEniry, 2004). However, the SES gradient in less subjective indicators is much less consistent. In Asia, surveys such as in Taiwan have found unclear relationships between SES and indicators of functional health, and SES differentials appear to even reverse for life-threatening measurements. In contrast, Latin American surveys such as in Mexico find that the SES gradient persists for chronic conditions like diabetes, although with less strength than that observed in self-assessed health indicators. In both, Asian and Latin American studies, socioeconomic differentials are substantially lower than those observed in the USA (Zimmer et al., 2002; Palloni & McEniry, 2004).

When studying mortality indicators, SES differentials for older adults are again not well understood in developing countries. Recent studies have found that mortality by cardiovascular diseases and diabetes tends to be higher in the more developed areas of Costa Rica (Rosero-Bixby, 1996); similarly, a 17-year follow-up study in Costa Ricans showed no significant differences in survival by SES among elderly (Rosero-Bixby, et al., 2005).

Various hypotheses have been suggested to explain different dimensions of these SES patterns in health. Some authors attribute to selection effects the weakening of SES-differentials by age: i.e. mortality eliminates the frailest individuals at early ages in groups with lower SES (Crimmins, 2005). But selection effects cannot easily explain the contrasting relationships across different domains of objective and subjectively reported health. These puzzles could be partly due to systematic biases by SES in subjective self-reports, but they also may reflect true differences in SES gradients across different domains of health. For example, it could be that low SES is associated with demanding physical labor across the life course that manifests in self-reported pain and mobility problems, while middle and higher income is associated with developed country lifestyles that elevate cardiovascular risks for mortality, and high SES individuals are able to mitigate the effects of cardiovascular risks via access to medical care.

Data and methods

Data for this analysis come from the Costa Rican Study on Longevity and Healthy Aging (CRELES), an on-going longitudinal study of a nationally representative sample of about 9,000 adults born in 1945 or before and residing in Costa Rica in the year 2000, with over-sampling of the oldest old and with an in-depth longitudinal survey in a subsample of about 3,000 of them. For this analysis we use mortality data from a computer follow up of the sample from June 2000 to December 2005, as well as the data for the first wave of interviews, conducted from November 2004 to September 2006. The sample of 9,000 individuals was randomly selected from the 2000 census database after stratification by 5-year age groups. Sampling fractions ranged from 1.1% among those born in 1941-45 to 100% for the born before 1905. For the in depth longitudinal survey, a sub-sample of 60 “health areas” (out of 102 for the whole country) was taken with probability proportional to the population aged 60 and over. This sub-sample included more than 5,000 individuals. The sub-sample, which covers 59% of Costa Rican territory, yielded the following non-response rates: 19% of the individuals deceased by the contact date, 18% were not found in the field, 2% moved to other addresses, 2% rejected the interview, and 2% remained as pendant interviews after several visits (likely rejections). Among those interviewed, 95% of the participants provided blood sample, 92% collected urine, 91% had anthropometric measures, and 24% required a proxy to answer the questionnaire.

All the data and specimens in the study were collected at the participants’ homes, usually in two visits. In the first visit, participants provided informed consent and answered a 90-minute long questionnaire (including some mobility tests and two blood-pressure measures) as well as a 10-minute frequency of tracer food consumption questionnaire. In a second visit early the next day, fasting blood samples were collected by venipuncture: 1 EDTA tube (for 3-4 ml. of whole blood) and 2 serum separating tubes (SST), with a clot activator (for 10-12 ml. of blood, to obtain 4-6 ml. of serum). In this visit, the field team also picked up a cooler containing 12-hour overnight urine and took the anthropometric measures. All field data were collected using Personal Digital Assistants (PDAs), also known as palm computers, with software applications developed by CCP for this study.

Dependent variables

All biomarkers examined in this study come from the physical examination and blood and urine collection undertaken in the two home visits between 2004 and 2006. Dependent variables for various domains of health include:

- Ordinal self-rated general health status.
- Indices of activities of daily living (ADLs) and instrumental ADLS.
- Mobility: self-reported ability to walk various distances.
- Physical performance tests of walking, grip strength, etc.
- Reported clinical diagnoses of major diseases such as diabetes, cancer, heart disease, arthritis.
- Anthropometric measures of obesity.
- Measured blood pressure, cholesterol (total, HDL, total/HDL), diabetes control (HbA1c and fasting glucose), and other elements of allostatic load constructs (such as epinephrine, urinary cortisol, etc.).
- Mortality: as recorded in national death index match with year 2000 census records as per extensively validated procedure (with under-recording of deaths investigated through the household survey component).

In addition, we examine SES gradients in mediators such as:

- Preventive health care use: vaccinations for influenza and tetanus; screening for breast cancer, cervical cancer, prostate cancer.
- Medical treatment: undiagnosed, untreated, or uncontrolled diabetes or hypertension.
- Health insurance coverage: both current and detailed retrospective life history.
- Health behaviors: smoking and alcohol use and intensity; exercise frequency; grams of saturated fat and calorie intake in diet.
- Work history: one-digit industry and occupation coding of main lifetime employment.
- Early life health conditions: TB, polio, malaria, asthma, etc.

Explanatory variables

The primary explanatory variables of interest capture different dimensions of socioeconomic status:

- Education: respondent and parents.
- Wealth: index of current household assets; index of household economic well-being in childhood.
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For both education and wealth we will code life-course economic trajectories into categorical variables: SES low in childhood and low currently, SES low in childhood and high currently, and the residual high SES categories. In addition, models will control for demographics such as age, sex, marital status, and location.

Methods

A series of models will be estimated in order to summarize SES gradients across various measures. The general form of the model will be: $Health = f(SES | Demographics)$, as illustrated in Table 1. Functional forms will vary by dependent variable; for example, binary health variables will be analyzed using logistic regression, mortality will be estimated with hazard models, etc. Summary tables and graphs will be used to concisely present results in a manner that can be readily compared across models, such as in Table 1.

Finally, to better understand the content of self-reported health (SRH), we will estimate a hedonic-style model:

$SRH = f(ADLs, \text{mobility}, \text{physical performance}, \text{and reported clinical diagnoses})$.

The model is intended to suggest in an accounting-style which dimensions of health known to the respondent might have the largest influence on subjective self-reported health. Further adding SES to this last model could provide suggestive evidence on the extent to which SRH has unexplained partial correlations with SES that would be consistent with (although not proof of) self-reporting biases systematically related to SES.

Preliminary Results

International comparisons with the Costa Rican death rates in the CRELES sample are by themselves a challenge to the notion of an inevitable SES gradient. Costa Rican death rates are lower than in the USA and not very different than in Japan, especially at higher ages (Figure 1), in spite of the substantially lower SES of the Latin American population measured by any indicator, such as education, income or health expenditure. It is remarkable that a population with a per capita income that is one-fifth of the USA and per capita health expenditures that are one-tenth of the USA can have lower death rates than the USA.

The puzzle of differential SES gradients across health measures is clearly illustrated in Table 1. Self-reported health status in CRELES has a strong positive relationship with both respondent education and current wealth. However, this relationship disappears when examining mortality, with preliminary analysis suggesting perhaps slightly worse mortality at higher education levels in this age group (We discard that this originate in differential age misreporting since all birth dates are well documented with an identity card). Even more striking, metabolic syndrome (a composite measure of obesity, hypertension, high cholesterol, and elevated fasting blood sugar) clearly worsens with higher wealth. When further disaggregating into individual biomarkers there is no clear pattern of positive or negative gradients with SES, as shown by preliminary results in Figure 2. There are a number of indicators, however, that do suggest better health among the low SES respondents, such as fasting glucose and body mass index.

Discussion

In order to make progress in solving the puzzle of differential SES gradients by health indicator it will be important to investigate how various indicators along the pathway are related to SES. This requires both detailed measurement of health indicators with different underlying causes, as well as data on individuals' environmental constraints and behaviors. The CRELES survey provides a promising opportunity to describe these patterns in a single dataset, which will then allow better judgment of which hypotheses are consistent with the data, in preparation for future work of a more causal nature.

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Table 1. SES gradient in three indicators of health. Costa Rica circa 2004

SES groups	Mortality		Regular/bad SRH		Metabolic syndrome	
	RR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Residence						
Metro San Jose	1.00	Ref.	1.00	Ref.	1.00	Ref.
Other urban	1.09	(0.99 - 1.21)	1.32	(1.05 - 1.66)	0.81	(0.64 - 1.02)
Rural	1.07	(0.95 - 1.20)	1.71	(1.34 - 2.19)	0.76	(0.59 - 0.98)
Education						
Below secondary	1.00	Ref.	1.00	Ref.	1.00	Ref.
Secondary & +	1.16	(1.01 - 1.32)	0.39	(0.29 - 0.52)	0.85	(0.65 - 1.12)
Wealth stratum						
Low	1.00	Ref.	1.00	Ref.	1.00	Ref.
Middle	1.10	(0.99 - 1.23)	0.73	(0.59 - 0.91)	1.52	(1.20 - 1.91)
High	1.04	(0.93 - 1.16)	0.68	(0.54 - 0.86)	1.31	(1.02 - 1.67)

RR = Rate ratio. OR = Odds ratio

RR and OR estimated with Cox and logistic regression models, respectively, controlling the effects of age, sex, marital status, recent migration, and residency in a nursing house.

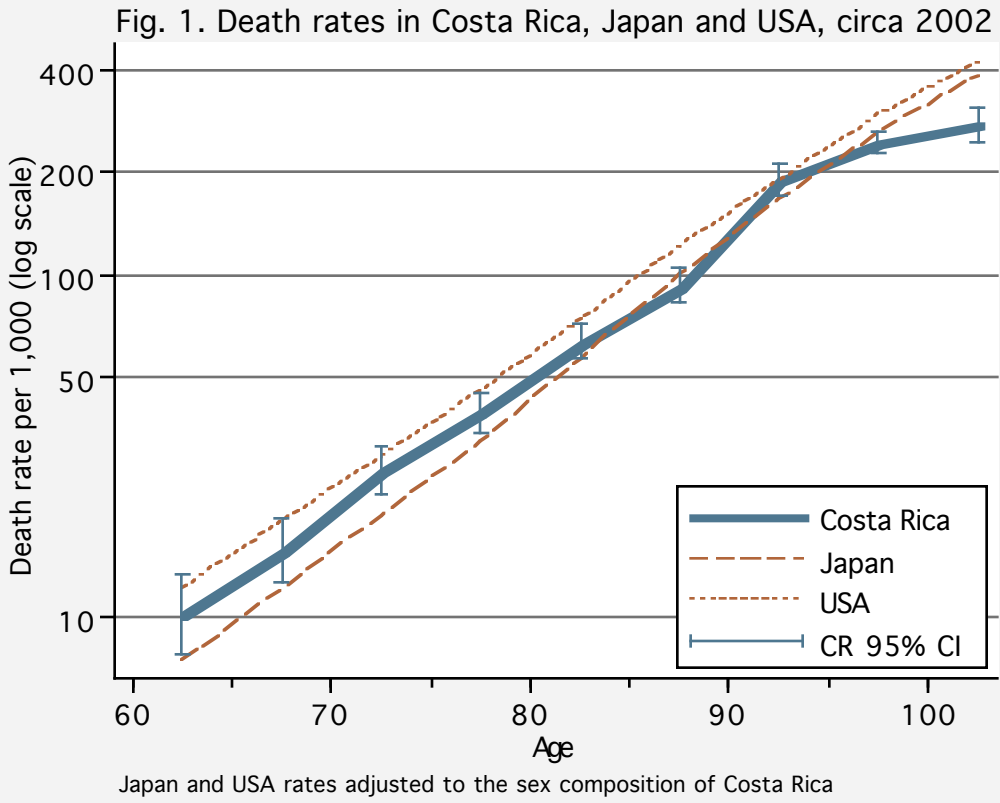


Fig. 2. Education differences in selected biomarkers

