Sex and SES paradox in health status and mortality among elderly populations

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Abstract

Adult males have higher mortality than females, while, paradoxically, health status indicators often show the contrary: males are better off than females. Mortality indicators are hard, indisputable data. Health indicators, however, are often based on "soft" data, dependent on definitions, interpretations, and subjective self-reports. Based on panel data for elderly Mexicans (MHAS study) and biomarkers for elderly Costa Ricans (CRELES), we conclude that self-reported health indicators may be misleading. The sex gap showing elderly women with poorer health than men is to some extent a spurious result of differential age structure, survival selection, and sex-bias in self-reports. The paper also explores whether the large socioeconomic gap in self-reported health suffers similar problems as the sex gap. Elderly Costa Ricans do not show the inverse gradient in health by socioeconomic status (SES) for important biomarkers. This finding contradicts the results obtained when using self reported indicators.

Introduction

In this paper we investigate the well-known paradox existing in data for adult and elderly populations: while everywhere there is over-mortality for males, health status indicators are usually much better for males than females. Mortality indicators can be considered "hard", clear-cut data. We can say that they are indisputable. Health status indicators, in contrast, are often based on "soft" data, dependent on definitions, interpretations and subjective self-reports. Is this paradox real or just a result of biases in data on health status? If it were real, then the paradox would mean that elderly females enjoy live longer but with a lower quality, which is an inequity that should be corrected as feminists and gender-approach literature proclaim. But if the paradox is originated in bad survey data, people would be making wrong inferences and taking bad decisions. Furthermore, if sex-differentials in health status are biased, socioeconomic and other differentials may also be so. As a matter of fact, Costa Rican old age mortality data do not show the expected socioeconomic gradient (more educated or richer individuals do not show lower mortality), and some self-reported, survey data show substantially better health indicators for the affluent or more educated (Rosero-Bixby, 2005; Rosero-Bixby, Dow, & Lacle, 2005). In this paper we also explore whether socioeconomic differentials in health are afflicted by similar problems as the sex-gap.

Comparative studies for four Asian countries (Zimmer, Natividad, Ofstead, & Lin, 2002), and seven Latin American cities (Wong, Pelaez, & Palloni, 2005; Menendez et al., 2005) show clear advantage of elderly males over females in self-assessed health status, performing activities of daily living (ADL), and chronic conditions with the exception of some life-threatening conditions that are more prevalent among men. However, a study of elderly Taiwanese show that the health sex-gap disappears or becomes less consistent when measured by objectively biomarkers (Goldman et al., 2004). It is important to mention that all these evidences come from cross-sectional data.

One possible explanation for the sex paradox is that females have higher prevalence of debilitating conditions, while males have higher prevalence of life-threatening conditions (Zimmer et al. 2002). The paradox may also be originated in confounding effects of third variables, selection effects, or just sex-biased responses. The most common confounding effect comes from the age structure, which is older for elderly females than that for males. This confounding element can --and should-- be easily controlled for. Second, the selection bias may come from the fact that in surveys we are dealing with just survivors; usually, the rare male survivor could be healthier than the more common female survivor. Third, females may simply be more aware of diseases and bad health that males, either because the former have the social responsibility for health in their families, so, they pay more attention or are in closer contact with health providers, or males may try to hide disease or poor health on the premises that those are signs of weakness, which men should not exhibit them.

Differential in both health and mortality by socioeconomic status (SES) at older ages are less clear and rarely studied because of the lack of proper information. In general terms, SES differentials tend to be smaller at older ages than at earlier ages (Crimmins, 2005). Surveys in Asia and Latin America show substantially poorer self-assessed health among the low-educated (Zimmer et al., 2002; Palloni & McEniry, 2004). These studies show that the SES differential is less clear in Asia for ADL indicators and it reverses for life-threatening measurements, whereas in Latin America the SES gradient persists for ADLs and chronic conditions like diabetes, although with less strength than that observed in self-assessed health indicators. In both, Asia and Latin America, socioeconomic differentials are substantially lower than those observed in the USA (Zimmer et al., 2002; Palloni & McEniry, 2004). However, SES differentials for adult and old age mortality are less known 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)

Some authors attribute to selection effects the weakening of sex-differentials by age: i.e. mortality eliminates the frailest individuals at early ages in groups with lower SES (Crimmings, 2005). Other authors attribute to differential access to health care the finding that life-threatening conditions are less prevalent in lower SES groups Zimmer (2002).

New survey data on health status among elderly in developing countries come from cross-sectional designs and include more objective health indicators like biomarkers, which allow more valid assessments on sex and SES differentials in health. Currently, there are two important sources of longitudinal data: a Mexican survey (MHAS project) and a Costa Rican survey (CRELES project), which are useful to refine measurement on health status and to validate more traditional indicators. This paper uses data from both surveys in order to overcome cross-sectional indicators on prevalence and to assess health indicators based on biomarkers.

By using transitions from longitudinal studies, instead of just prevalences, one can assess the volatility of data and also remove biases that stay fixed over time. If, for example, a health indicator has two components: (1) a true health status varying over time *H(t)*, and (2) a bias or error *E* fixed on time, the growth rate *rh* in a health status, computed from observations at times t_0 and t_1, will be free of the bias *E,* and it will measure only health status (its actual change) as follows:

$$rh = \frac{H(t_0)E}{H(t_1)E} - 1 = \frac{H(t_0)}{H(t_1)} - 1$$

By using biomarkers, one can check if sex and SES differentials persist. These indicators permit also to validate self-reported data on specific conditions such as diabetes or high blood pressure. Biomarkers allow also identifying cultural biases in reporting own health status that vary systematically by sex or socioeconomic status.

Data and methods

Study population

Data for this study come primarily from the Mexican Health and Aging Study (MHAS), which is a prospective panel in a nationally representative sample of about 8,000 individuals born before 1951 and interviewed during 2001 and 2003. This paper uses information on self-assessed health ("Would you say your health is excellent, very good, good, fair or poor?"), mortality, age, sex and education from data files available at the study's web page (MHAS, 2005).

The second data set used in this study comes from the Costa Rican Study on Longevity and Healthy Aging (CRELES). This is a panel study of a nationally representative sample of 3,000 adults aged 60 and over, with over-sampling of the older old. For this analysis, a sub-sample of 1,800 individuals was available from this on-going study. For this subsample, data collection entailed physical assessments (anthropometric measures), blood specimens, and a 12-hour (overnight) urine collections, which together yielded information on the biomarkers considered in this paper.

Measures

Two unconditional transition probabilities (called "rates" for simplicity) are considered to measure self-assessed health category "fair and poor health", which were computed for individuals with information for the two waves in the Mexican study:

1. *Deterioration rate* = proportion of individuals with "poor or fair" health in wave 2 and with "good to excellent health" in wave 1.

2. *Improvement rate* = proportion of individuals with "good to excellent health" health in wave 2 and with "poor or fair health" in wave 1

To assess mortality selection effects between waves, individuals who died before o during the second wave were included in the category "poor or fair health" in the second wave, keeping their reported status in wave 1.

The biomarkers include 16 measures: systolic and diastolic pressures (indices of cardiovascular activity); waist-to-hip ratio (index of metabolism and adipose tissue deposition); serum HDL cholesterol, ratio of total to HDL serum cholesterol (indices of risk for cardiovascular disease); urinary epinephrine and norepinephrine (measures of SNS activity); etc. Table 1 reports the cut-off values for each biomarker, the number of individuals included in their assessment and the percentage of population at risk.

Results

In Table 3, using data from the two-wave Mexican survey we can observe the well-known pattern of poorer self reported health for women: 18% of women reported "poor" health compared to 13% reported by males. During the second wave, carried out 2 years later, the sex differential is 20% for females against 15% for males. Thus, the likelihood of reporting poor health is more than 30% higher for women.

After controlling for age, as expected, the sex gap narrows from 23% in the first wave to 9% in the second (the age adjusted percentage were computed assuming a rectangular age structure, i.e., with the same population in each 5-year age group). A second adjustment takes care of mortality selection bias (those who died between the two waves are included in the group of "poor health" in the second wave). This adjustment corrects the death selection bias occurred in the two years between waves. The adjustment, which is relevant only for the second wave estimate, makes the sex gap to disappear. In fact, the percentages for males and females are 27.0 % and 27.6%, respectively. It seems that the entire sex gap in self reported health is result of the female older age structure and the selection bias due to higher male mortality.

In the same Table we can see the growth rate for poor-health individuals; females exhibit lower rates: poor-health males increase by 24%, while females did by about 10% (age-adjusted indicators). Thus, health deterioration seems to occur faster in males than females for this longitudinal study.

The transition rates shown in Table 2 confirm the results discussed above. First, females seem to be more volatility on this regard, that is, more women enter and leave the poor health state, but the net health deterioration rate is about the same for both sexes. However, after adjusting for the age structure, the net health deterioration rate among women is about half that for men: 1.6 and 3.1, respectively.

The story is somewhat different with the Costa Rican data on biomarkers, which are age-adjusted with a rectangular age structure. Figure 1, panel A, shows that self reported poor or fair health is larger for females and women report more problems than men when performing activities of daily living (ADLs) and instrumental ADLs (IADL). Substantially higher number of women, compared to men, report to have been diagnosed high blood pressure, high cholesterol, arthritis, diabetes, respiratory problems and osteoporosis. Only when reporting myocardial infarct, and stroke there is no sex gap. No self reported indicator shows higher morbidity for males.

Interestingly, many of the biomarkers confirm that women may have higher morbidity (panel B in Figure 1). That is the case for high blood pressure, total cholesterol, triglycerides, body mass index, and tests on physical performance and grip strength. However, there are some biomarkers in which males exhibit higher risk: serum creatinine, HDL cholesterol, and waist/hip ratio.

However, these results from biomarkers are not conclusive regarding the sex paradox studied here. Well documented higher mortality of men relative to women (although the sex gap in Costa Rica is substantially smaller than in other populations) contrast with the many age-adjusted biomarkers that show women may be at higher risk of poor health and, consequently, death. It is possible, however, that part of this phenomenon come from the

selection of the fittest effect, which we will be able to control in part with panel data. It may also be that women are, indeed, doing poorly in many biomarkers, but those biomarkers in which women are doing better (HDL cholesterol, serum creatinine, and waist/hip ratio) are the ones that count the most for their survival.

Now, we can take a closer look at two conditions --diabetes and high blood pressure (HBP) -- comparing to self report (MD diagnoses) and biomarkers. Actually, biomarkers allow us to assess only the negative predictive value of self-reports, i.e., those that report themselves free of the condition but biomarkers show this is not the case. False-positive reports, instead, cannot be detected since an apparent discrepancy with biomarkers can be explained by the fact they are taking medicine and keeping the condition under control. In Table 4 we identify those individuals free of the condition mentioned (according to both self report and biomarker), those who have the condition (self report) but keep it under control (negative biomarker), those not controlling the condition but knowing they have it, and those with "hidden" condition since biomarkers show they are sick but they did not know that.

For diabetes, we have two biomarkers: fasting glucose (≥126 mg/dL) and glycosylated hemoglobine (HbA1c ≥ 6.5%). The second measures glucose metabolism in the last 3 months; thus, it may have a superior predictive value. Fasting glucose may vary because of temporary conditions or because subjects did not fast (even though they reported fasting). For HBP our "biomarker" is the average of two readings during the 1.5-hour long interview (diastolic BP > 90 OR systolic BP > 140).

Women are more likely of having both diabetes and HBP, but men are more likely to be in the dark about having these health conditions. For example, 36% (age adjusted) of males in the sample did not report having HBP but our two readings suggested they have it, compared to 26% of women. These results confirm that women may be more aware than men of their health condition. In other words, men are more likely to under-report morbidity.

Biomarkers also allow us to check early findings showing that among Costa Rican elderly there is no a socioeconomic gradient in mortality and this gradient may be contrary to the expected direction of the relationship: the more affluent or better educated individuals will show a better health. Figure 2 shows that in Costa Rica, as everywhere, less educated individuals are substantially more likely to self report poor-fair health, as well as to report they need more help performing ADLs and IADLs (note these figures are age-adjusted). However, biomarkers provide a much more complex picture. For a couple of biomarkers, the low-educated are at higher risk: high systolic BP and urine creatinine. For many biomarkers, differences are too small to be significant.

But there are several biomarkers showing that low-educated individuals are at lowest risk: triglycerides, HDL cholesterol, fasting glucose, body mass index, and the ratio total/HDL cholesterol. It may be that among elderly Costa Ricans, those in low socioeconomic status do not necessarily have higher morbidity, which is coherent with early results regarding mortality.

Conclusion

The results obtained show that self-reported health indicators may be misleading. First, the sex gap showing elderly women with poorer health than men may be spurious and a result of differential age structure, survival selection, and sex-bias in self-reports. Second, the large

socioeconomic gap in self-reported health may also be spurious. Third, elderly Costa Ricans do not show the inverse gradient in health by socioeconomic status for many important biomarkers, as they did not show it in mortality risks.

Table 1. Cut-off points to define at risk biomarkers in the CRELES study, 2006

Biomarker	Cut-point at risk	(N)	Percent at risk	
			Observed	Weighted
High Diastolic Pressure (mmHg)	≥90	(1,808)	20	22
High Systolic Pressure (mmHg)	≥140	(1,808)	48	45
High Glycated Hemoglobin (%)	≥6.5	(1,494)	9	11
Body Mass Index	>30	(1,628)	16	19
Triglycerides (mg/dl)	≥150	(1,536)	40	43
HDL Cholesterol (mg/dl)	≤40	(1,533)	29	31
Total Cholesterol	>250	(1,536)	21	24
High total/HDL cholesterol ratio	≥5,92	(1,533)	18	20
High Urinary excretion of epinephrine (ug/g creatinine)	≥4,99	(1,314)	47	46
High Urinary excretion of nor-epinephrine (ug/g creatinine)	≥48	(1,357)	22	20
High Waist / Hip Ratio	≥1.0	(1,668)	24	24
Low Creatinine clearence (mg/dl)	≤44,64	(1,409)	17	11
Serum Creatinine	≤0.5, ≥1.2	(1,537)	39	35
Fasting Glucose	≥126	(1,537)	16	18
Grip Strength	≤33	(1,639)	25	16
Low best Peak Flow (L/min)	≤300	(1,736)	74	67

Table 2. Proportion of self reporting poor health conditions.
MHAS waves 1 and 2 and growth rate (percentages)

Wave & indicator	Sex			Education		
	Male	Female	Fem/Mal	Low	High	Low/High
(N)	(3,241)	(4,163)		(4,423)	(2,976)	
(N with deaths)	(3,393)	(4,324)		(4,651)	(3,061)	
Wave 1						
Observed	13.3%	18.2%	1.37	20.5%	9.5%	2.14
Age adjusted	16.6%	20.4%	1.23	22.0%	12.7%	1.73
Wave 2						
Observed	15.3%	20.2%	1.32	22.8%	11.1%	2.07
Age adjusted	20.6%	22.4%	1.09	25.0%	15.0%	1.67
Death & age adjusted	27.0%	27.6%	1.02	31.0%	22.1%	1.40
Growth rate						
Observed	15.6%	11.1%	0.71	11.6%	15.8%	0.73
Age adjusted	23.8%	9.5%	0.40	13.8%	17.8%	0.78

Table 3. Transition rates for self reported poor health status.
MHAS waves 1 and 2 and growth rate (percentages)

Rate type	Sex			Education		
	Male	Female	Fem/male	Low	High	Low/high
(N)	(3,393)	(4,324)		(4,651)	(3,061)	
Deterioration rate						
Observed	8.07	9.88	1.22	12.71	6.89	1.84
Age adjusted	10.84	9.97	0.92	13.50	8.02	1.68
Death & age adjusted	15.17	13.65	0.90	18.16	14.36	1.26
Improvement rate						
Observed	6.40	8.15	1.27	10.45	5.42	1.93
Age adjusted	7.72	8.37	1.08	10.70	5.94	1.80
Death & age adjusted	7.72	8.37	1.08	10.70	5.94	1.80
Net deterioration rate*						
Observed	1.67	1.73	1.04	2.26	1.47	1.54
Age adjusted	3.12	1.60	0.51	2.80	2.08	1.35
Death & age adjusted	7.45	5.28	0.71	7.46	8.42	0.89

* Deterioration minus improvement in health status

Table 4. Age adjusted percent distributions of diabetic and high blood pressure conditions, self reported and biomarkers. CRELES

Groups	**Total**	Male	Female	**Total**	Male	Female
Diabetic	*Fasting glucose >=126*			*Glyc. hemoglobine >= 6.5*		
(N)	**(1486)**	(694)	(792)	**(1495)**	(692)	(803)
No diabetic*	**75.7**	79.7	72.3	**80.7**	84.7	77.2
Controlled	**8.0**	6.5	9.3	**10.3**	8.8	11.6
Uncontrolled	**10.2**	7.9	12.2	**7.8**	5.5	9.8
Hidden	**6.1**	5.9	6.3	**1.3**	1.1	1.4
Total	**100.0**	100.0	100.0	**100.0**	100.0	100.0
High blood pressure						
Diastolic > 90 OR Systolic >140						
(N)	**(1808)**	(839)	(969)			
No HBP*	**31.1**	36.4	26.4			
Controlled	**19.4**	17.9	20.7			
Uncontrolled	**27.3**	21.2	32.5			
Hidden	**22.3**	24.5	20.4			
Total	**100.0**	100.0	100.0			

* No reported MD diagnose nor biomarker

Figure 1. Percent diseased or at risk by sex, self-reported and biomarker indicators. CRELES

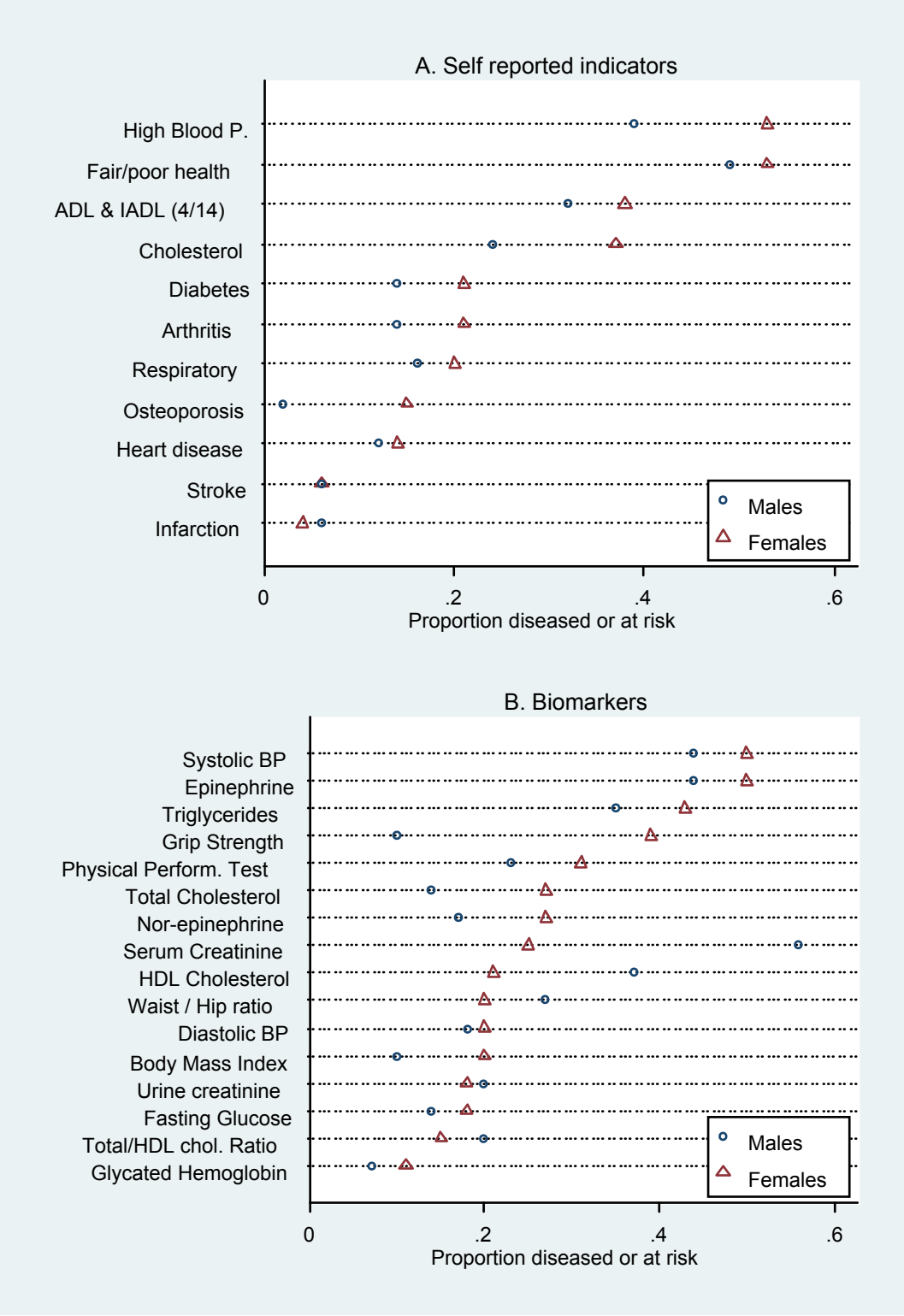
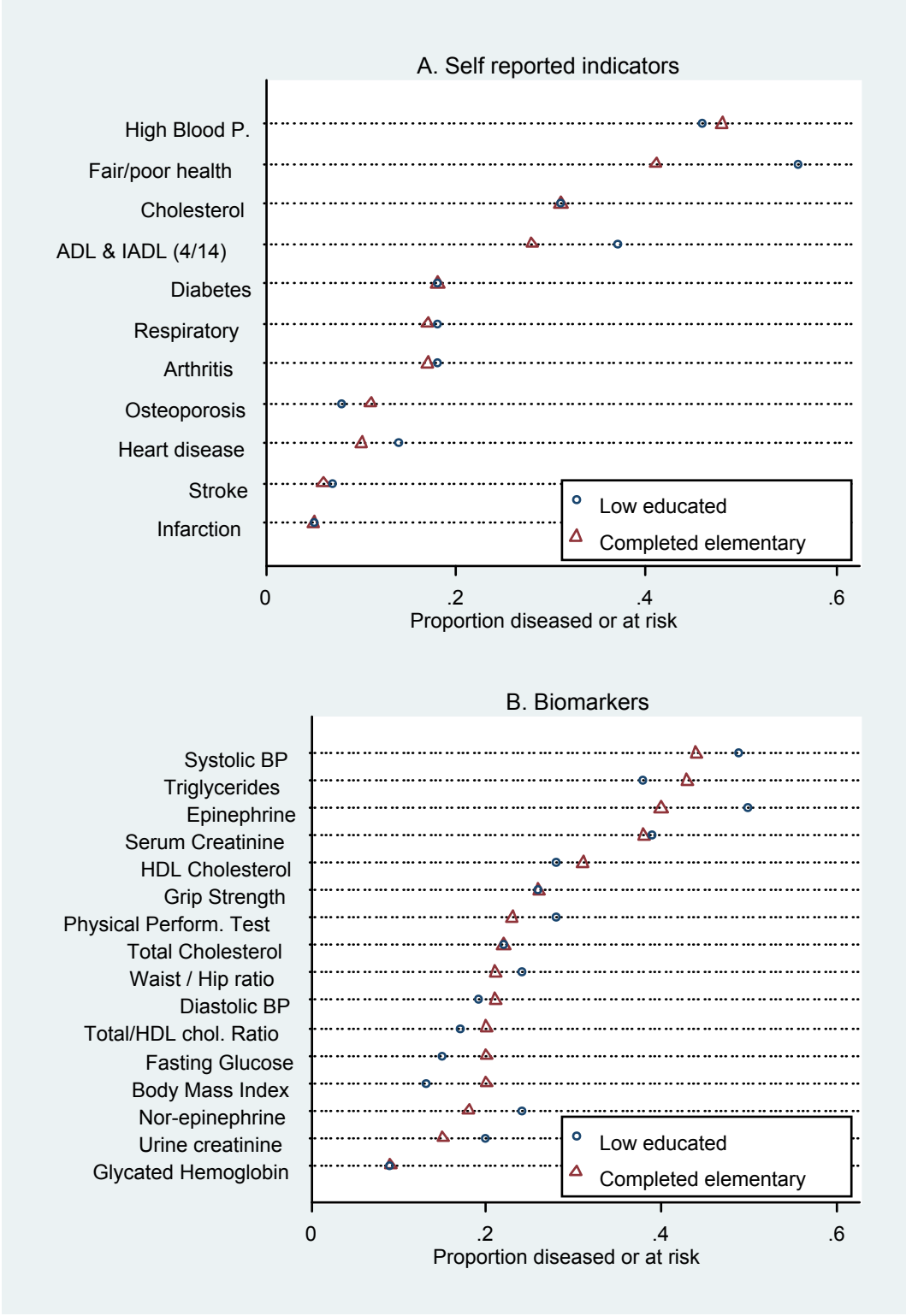


Figure 2. Percent diseased or at risk by education, self-reported and biomarker indicators. CRELES



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