Socioeconomic status and mortality in Moscow: A role for biomarkers?

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Abstract

Low socioeconomic status has consistently been linked to poor health and elevated mortality risk, though the physiological mechanisms behind this relationship are not well understood. These health disparities are especially large in Russia, where the recent mortality crisis disproportionately affected low-SES individuals.

In this study, I assess whether a number of biomarkers predict subsequent mortality among older adults in Moscow, and whether these factors explain the SES-mortality link. Using data from the survey on Stress, Aging, and Health in Russia, I examine biomarkers related to inflammation, neuroendocrine function, heart rate variability, and cardiovascular risk.

Background

Low socioeconomic status (SES) has consistently been linked to poor health outcomes and greater mortality risk. This association has been found in different time periods, in locations around the world, in both genders, in all ages, across the entire range of SES, and for most health conditions (Adams et al. 2004; Phelan et al. 2004; Cutler, Deaton, and Lleras-Muney 2006).

Health disparities by SES are especially troubling in Russia, where disparities are particularly large (Shkolnikov et al. 1998). Between the 1960s and 1990s, mortality rates increased in Russia, representing a dramatic departure from the global trend of decreasing mortality rates (Shkolnikov et al. 2004). This mortality crisis disproportionally affected the least educated groups, which experienced decreases in life expectancy, particularly among men (Shkolnikov et al. 2006; Shkolnikov et al. 2004).
For SES to affect physical health and disease, it must ultimately act on some physiological process (Steptoe and Marmot 2002), but these pathways are not well understood. In this study, I examine socioeconomic disparities in mortality among older adults in Moscow, Russia, determining whether baseline biomarkers can partially explain the SES-mortality link. I examine biomarkers related to inflammation, neuroendocrine function, heart rate variability, and traditional markers of cardiovascular risk.

Data and method

The survey on Stress, Aging, and Health in Russia (SAHR) focuses on Moscow residents aged 55 and older. The study consists of a baseline survey fielded 2006-2009, with a follow-up survey wave conducted in 2009-2011, and mortality follow-up planned through 2016 (Shkolnikova et al., 2009). The sample (n=1800) is largely drawn from seven existing epidemiological cohorts in Moscow; prior studies of these cohorts began between the 1970s and 1990s. To ensure more recent immigrants to Moscow are represented in the SAHR sample, a small additional group is drawn from medical registers. The baseline survey collected numerous biomarkers from a venous blood sample.

Variables

I use educational attainment as a measure of SES, categorized as follows. Lower education includes elementary education and incomplete secondary education (with or without vocational education). Secondary education includes completed secondary education (with or without vocational education), and incomplete higher education. Higher education includes completed higher education and above.

Inflammation is measured as a count of the following measures for which an individual falls into a high-risk category: C-reactive protein, interleukin-6, and fibrinogen. Of these three measures, a clinical high-risk cut-point exists only for C-reactive protein: respondents with C-reactive protein > 3mg/L are considered high risk (Alley et al. 2006). Because there is no such established cut-point for interleukin-6 and fibrinogen, I classify respondents in the top sex-specific quintile of these measures as high risk. This potential range of this inflammation index is 0-3. The neuroendocrine index [0-4] is a count of the four neuroendocrine measures for which a respondent falls into the high-risk category. High risk is categorized as follows: 1) dehydroepiandrosterone sulfate (DHEAS) in lowest sex-specific quintile, 2) cortisol in highest sex-specific quintile, 3) epinephrine in highest or lowest sex-specific decile, 4) norepinephrine in highest sex-specific quintile. The heart rate index [0-4] is a count of the four heart rate markers for which a respondent falls into the high-risk category. High risk is categorized as follows: 1) mean heart rate in the highest sex-specific quintile, 2) ratio of mean daytime heartrate to mean nighttime heartrate in the lowest sex-specific quintile, 3) standard deviation of the normal-to-normal beat-to-beat intervals < 100 ms, 4) square root of mean of sum of squares of differences between normal-to-normal intervals in the highest or lowest sex-specific quintile. The cardiovascular index [0-9] is a count of the nine cardiovascular risk factors for which a respondent falls into the high-risk category. High risk is categorized as follows: 1) systolic blood pressure > 140 mmHG, 2) diastolic blood pressure > 90 mmHG, 3) total cholesterol >= 240 mg/dL, 4) high-density lipoprotein < 40 mg/dL, 5) triglycerides >= 200 mg/dL, 6) glycosylated hemoglobin > 6.5%, 7) homeostasis model assessment-estimated insulin resistance index >= 3.78 for men, >=4.16 for women, 8) BMI < 18.5 or > 30 9) waist circumference > 102 cm for men, >88 for women.

Empirical strategy

Limiting the sample to respondents with non-missing information on demographic characteristics (age, sex) and biomarkers yields a sample of 1,557.

I use proportional hazard Gompertz models of age-specific mortality through the end of 2011. I use Gompertz models because the Gompertz hazard function has been shown to be a good approximation of mortality among older adults (Horiuchi and Coale, 1982).

Preliminary results

Descriptive statistics of my analytic sample are shown in Table 1 for the full sample, and separately by sex.

Table 2 shows Gompertz hazard models of mortality by December 31, 2011. Model 1 includes only years of education, while subsequent models add potential biological mediators of the education-mortality relationship. The cardiovascular index (Model 3) is not independently associated with mortality; the inflammation index (Model 4) is most strongly predictive of future mortality. The coefficient on education attenuates slightly when each index is sequentially included in the model; when all four indexes are included (Model 2 and 7), the coefficient on education attenuates slightly more, and retains only marginal significance ($p = 0.054$). Model 7 allows the comparison of all four indexes together. While the association with mortality for each index is slightly weaker in this joint model, the neuroendocrine, inflammation, and heart rate indexes remain significantly associated with subsequent mortality.

Conclusion

My preliminary results suggest that inflammation, neuroendocrine function, and heart rate may mediate the relationship between education and mortality among older adults in Moscow. Inflammation is the most strongly related to mortality. Future work should work to clarify the relationship between education, inflammation, and mortality.

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Tables

Table 1: Descriptive statistics

	Full sample			Male			Female		
	Mean/ Prop.	SD	Med.	Mean/ Prop.	SD	Med.	Mean/ Prop.	SD	Med.
Demographic characteristics									
Male (%)	45%	--	--	100%	--	--	0%	--	--
Age	67.9	7.5	68.0	68.6	8.0	68.0	67.3	7.0	67.0
Education, completed years	14.0	3.5	15.0	13.9	3.8	15.0	14.1	3.3	15.0
Education: lower (%)	11.0%	--	--	13.9%	--	--	8.6%	--	--
Education: secondary (%)	39.6%	--	--	39.0%	--	--	40.1%	--	--
Education: higher (%)	49.5%	--	--	47.2%	--	--	51.4%	--	--
Mortality									
Died by 31 December 2011 (%)	8.2%	--	--	12.0%	--	--	4.9%	--	--
Died of cardiovascular cause by 31 December 2011 (%)	4.9%	--	--	7.8%	--	--	2.6%	--	--
Biomarkers									
Full index (possible range: 0-20)	4.7	2.6	4.0	4.5	2.6	4.0	4.8	2.6	5.0
Cardiovascular index (possible range: 0-9)	2.5	1.8	2.0	2.4	1.8	2.0	2.6	1.8	2.0
Heart rate index (possible range: 0-4)	0.7	0.9	0.0	0.7	1.0	0.0	0.7	0.9	0.0
Neuroendocrine index (possible range: 0-4)	0.8	0.9	1.0	0.8	0.9	1.0	0.8	0.8	1.0
Inflammation index (possible range: 0-3)	0.7	0.8	0.0	0.7	0.8	0.0	0.7	0.9	1.0
N	1,557			706			851		

Table 2:

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Education, years	0.93	(0.89, 0.97)	0.96	(0.91, 1.00)	0.94	(0.89, 0.98)	0.95	(0.91, 0.99)	0.94	(0.90, 0.98)	0.93	(0.89, 0.97)	0.96	(0.91, 1.00)
Biomarkers														
Full index			1.22	(1.15, 1.30)										
Cardiovascular index					1.07	(0.97, 1.19)							1.00	(0.90, 1.11)
Inflammation index							1.68	(1.41, 2.01)					1.63	(1.36, 1.96)
Heart rate index									1.59	(1.38, 1.83)			1.55	(1.35, 1.79)
Neuroendocrine index											1.23	(1.03, 1.47)	1.22	(1.02, 1.46)
Male	2.27	(1.56, 3.29)	2.52	(1.74, 3.65)	2.34	(1.61, 3.39)	2.38	(1.64, 3.45)	2.24	(1.55, 3.25)	2.30	(1.59, 3.33)	2.36	(1.62, 3.44)
N	1,557		1,557		1,557		1,557		1,557		1,557		1,557	
Model Chi squared	29.59		66.60		31.45		61.73		65.12		34.71		97.68	