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Education, household wealth and blood pressure in Albania, Armenia, Azerbaijan and Ukraine: Findings from the Demographic Health Surveys, 2005–2009☆

Michael O. Harhay^{a,*}, Jason S. Harhay^b, and Meera M. Nair^a

^aUniversity of Pennsylvania, Philadelphia, PA 19104, USA

^bDrexel University, Philadelphia, PA 19104, USA

Abstract

Background—While socioeconomic gradients in cardiovascular disease have been well established in high-income countries, this relationship is not well understood in middle-income countries.

Methods—Data from Demographic Health Surveys collected in Albania (2008–09), Armenia (2005), Azerbaijan (2006) and Ukraine (2007) were used to estimate age-adjusted differences in systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse pressure (PP), hypertension (HTN), elevated blood pressure, and optimal blood pressure across a standardized wealth index, level of educational attainment, and urban versus rural residence.

Results—The wealthiest Albanian females had lower average SBP, DBP, PP (all $p < 0.01$) and HTN status (odds ratio [OR] = 0.3, CI: 0.2–0.5, $p < 0.001$) compared to the poorest; similar education gradients were also found. Such disparities also existed for Albanian men. Among Armenian women, urban (OR=1.4, 1.1–1.8, $p < 0.01$), more educated (OR = 0.7, CI: 0.6–0.9, $p < 0.01$), and wealthier (OR=1.8, 1.4–2.4, $p < 0.001$) women were more likely to have optimal blood pressure. Urban Armenian men were also more likely to have optimal blood pressure (OR=1.8, 1.2–2.9, $p < 0.01$). Wealthier and urban Azerbaijani had lower risk of elevated blood pressure and Azerbaijani women displayed strong wealth gradients with higher quintiles of wealth associated with lower continuous blood pressure measures. There were no socioeconomic gradients for Ukrainian males or females.

Conclusions—There is compelling evidence that wealth and education gradients affect the probability of HTN for women in Albania, Armenia, and Azerbaijan, and for men in Albania.

Keywords

Eastern Europe; Socioeconomic position; Hypertension; Demographic Health Surveys

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*Corresponding author at: Blockley Hall, Rm. 1214, 423 Guardian Drive, Philadelphia, PA 19104, USA. Tel: +1 215 878 6700; fax: +1 215 898 0611. mharhay@mail.med.upenn.edu (M.O. Harhay).

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Conflict of interests

None. We declare no potential personal, financial or academic conflicts of interest.

1. Introduction

Since the middle of the 19th century, countries in Northern Europe have experienced approximately a 50% increase in adult life expectancy, with a concomitant 90% decline in childhood mortality [1]. The epidemiologic transitions in these countries occurred as a result of economic development, improvements in sanitation, access to nutrition, and advances in medical technology [2,3]. As a result, populations survived long enough to develop cardiovascular disease (CVD), currently the number one cause of death and disability worldwide [2–6]. Wealthier countries in Northern and Western Europe, as well as the United States, Japan, and Australia were the first to experience increases in CVD, whereas similar trends have only more recently occurred in low- and middle-income countries [5–11]. However, a particular focus on CVD risk factors in low- and middle-income countries is of high importance, as the consequences of CVD disproportionately impact mortality in these populations. Indeed, while chronic diseases such as CVD, cancer, chronic respiratory diseases, and diabetes accounted for 60% (35 million) of all deaths worldwide in 2005, 80% of these deaths occurred in low- and middle-income countries [7].

Historically, the largest and lasting burden of CVD has fallen on the poorest and least educated citizens of countries that have undergone the epidemiological transition, as the wealthier and more educated had the advantage of increased access to medical care and pharmaceuticals that successfully modify the known risk factors for CVD [12–14]. Elevated blood pressure is one of these CVD risk factors (other examples include elevated blood glucose, cholesterol, and abdominal obesity). The relationship of blood pressure to CVD is independent of other CVD risk factors and while previous guidelines have identified stage I hypertension (HTN) as SBP/DBP of 140/90 millimeters of mercury (mm Hg) [15], many experts advocate lower blood pressure goals given evidence that above blood pressures of 115/75 mm Hg, CVD mortality doubles with each 20 mm Hg increment in SBP and 10 mm Hg increment in DBP for persons aged 40–49 [16]. Studies carried out in wealthy countries have consistently found a higher mean blood pressure and greater frequency of HTN among people of lower socioeconomic position (SEP) [17–19]. However, the empirical literature that exists on SEP and CVD in middle-income countries is sparse and conflicting on the link between SEP and CVD risk factors [9,17]. Given these uncertainties, there is a growing interest in country-specific research to identify patterns of CVD risk factors such as high blood pressure [20,21], particularly in low- and middle-income countries [10,22–24]. Therefore, understanding patterns of blood pressure in low- and middle-income countries, where mortality from chronic disease is particularly high, is the goal of this manuscript. We seek to contribute to the knowledge of the relationship between SEP and blood pressure by examining nationally representative survey data from Albania, Armenia, Azerbaijan and Ukraine [25]. These four middle-income countries (as defined by the World Bank) have not been included in other regional socioeconomic and health analyses [25–32]. We hypothesized, as described in high-income countries, that high blood pressure, an important modifiable CVD risk factor, exhibits an inverse gradient with SEP [12–14,17]. We also hypothesized, based on prior evidence, that lower SEP more strongly and adversely impacts women and urban inhabitants [4,8,12,13,17,33].

2. Methods

2.1. Data sources

Nationally representative surveys known as Demographic Health Surveys (DHS) conducted in Albania (2008–09) [34], Armenia (2005) [35], Azerbaijan (2006) [36] and Ukraine (2007) [37] were used for this analysis. ICF International conducts these surveys in many low- and middle-income countries in collaboration with national partners. Survey households are chosen using a 2-stage sampling process in which representative clusters are selected from a

national sampling frame and a random sample of households is selected within each cluster. In each household, women between 15 and 49 years of age who consent are interviewed. Though women are the primary focus of these surveys, DHS also collects data on males (15–49 years) in consented households. The informed consent process typically involves verbal consent from the participants, presumably because literacy rates are low in many of the regions in which the DHS are conducted. Response rates were greater than 90% in all surveys in this analysis (Table 1). This study was based on anonymous public use data with no identifiable information on the survey participants.

2.2. Measurement of the outcome variables

We examined hemodynamic indices found to have independent associations with CVD outcomes [38,39]. In each country, trained interviewers (including physicians and nurses) took blood pressure readings using a fully automatic, digital oscillometric blood pressure measuring device (Table 1). Three measurements of SBP and DBP were taken during the survey interview, with an interval of at least 10 minutes between measurements. The average of the three measurements was used to estimate the following outcomes: (1) continuous central hemodynamics: [a] SBP, [b] DBP, and [c] pulse pressure (PP) = SBP – DBP [40]; (2) pre-specified blood pressure cut-offs: [a] HTN (defined as SBP ≥ 140 mm Hg, DBP ≥ 90 mm Hg, or both) [15] and [b] elevated blood pressure (defined as SBP ≥ 130 mm Hg, DBP ≥ 85 mm Hg, or both), a level identified in the most recent harmonized definition of the Metabolic Syndrome as a CVD risk factor [41]; and (3) optimal blood pressure (defined as < 120/80 mm Hg) [15].

2.3. Measurement of socioeconomic indicators

Conceptually, an individual's SEP indicates their prestige and access to material or social resources [12,42,43]. No single measure of SEP is ideal for all studies and contexts [17,44]. Adult SEP is typically measured using educational attainment (years of schooling or highest level of school completed), income, occupation, residence (urban or rural) or marital status [45,46]. The key exposure variables in this study are: (1) three levels indicating the highest level of schooling the individual completed at the time of the survey: [a] no education or primary school only, [b] secondary/professional/or technical, and [c] university/higher education; (2) a standardized household wealth index indicating the poorest 20% to the wealthiest 20% in quintiles; and (3) rural dwelling (as compared to urban). The DHS defines urban areas as large cities (capital cities and cities with over one million population), small cities (population over 50,000), and towns (other urban areas). All locations that did not meet any of those three criteria were assumed to be rural.

The DHS wealth index is a standardized metric estimated to facilitate comparison of outcomes associated with income between different surveyed countries at different points in time [47]. The index treats wealth (or economic status) as an underlying unobserved dimension that can be estimated using latent variable techniques. In the DHS, it is assumed that the possession of observable or easily queried-about assets, services, and amenities is related to the relative economic position of the household in that survey country (WebTable 1). For example, the proportion of households in developing countries with a surface water source (e.g. lake, river or stream) is likely to decrease with increasing wealth, and the proportion of households with a television or a refrigerator is likely to increase with increasing wealth. Motorcycle ownership generally indicates mid levels of wealth, with poorer households likely to have no vehicles or bicycles, and wealthier households likely to have vehicles. The index is calculated by developing Z-scores for each indicator variable in WebTable 1 and conducting a principal components analysis on these Z-scores. For each household in each country, the values of the indicator variables are multiplied by the factor loadings and summed to produce a standardized household wealth index value with a mean

of zero and a standard deviation of one. This standardized score is then divided into quintiles [48]. As a result, the index is constructed using a country-specific distribution. Therefore, households that score low on this index are poor relative to households within the same country, though absolute poverty is not directly estimated by this index.

2.4. Statistical analysis

Statistical analyses were performed with Stata for Mac 12.1 (StataCorp) using sample weights that accounted for the complex sampling design and non-response, as recommended by the DHS statistics manual [47]. $p < 0.05$ was accepted as significant. Linear regression models were used to examine associations between the household wealth index and educational attainment with each individual's (continuous) measures of SBP, DBP, and PP. Logistic regression analyses quantified the magnitude of the association, using odds ratios (ORs) for being hypertensive, having elevated blood pressure, and optimal blood pressure across levels of SEP. All regression models were age-adjusted, as blood pressure is positively associated with age, and estimated separately by gender in each country.

Examination of the underlying household wealth index suggested an urban bias, likely since publicly provided services (electricity, piped water, sewers) are not available in many rural areas and some assets depend on having electricity, piped water, etc. Thus, the results in the tables represent patterns using the DHS household wealth index of the national population as a whole. The bi-modality of the national distributions (not shown) is due to the combination of the two unimodal distributions of the rural and urban areas. To examine the slope of the SEP gradients in urban and rural survey respondents separately an urban- and rural-household wealth index was estimated using the national-level wealth scores as they were originally generated, dividing them separately into quintiles in urban and rural areas [49]. Age-adjusted logistic regression with an interaction term between (1a) the quintile in the urban or rural specific household wealth distribution or (1b) educational attainment and (2) a dummy variable for urban dwelling was used to estimate predicted probabilities of HTN, elevated blood pressure as defined by the Metabolic Syndrome, and optimal blood pressure. Due to low sample sizes, males and females were estimated together to improve the uncertainty intervals of the predicted probabilities.

3. Results

Table 1 shows the characteristics of the four study countries. WebFigs. 1 and 2 depict the unadjusted distribution of SBP, DBP and PP by wealth index and educational attainment, stratified by gender and country. For ease of interpretation, the results for each country are discussed separately. For reference, WebTables 2 and 3 display the age-adjusted differences of SBP, DBP and PP by the three SEP measures. Tables 2–4 contain the results, in ORs, of the SEP gradients in HTN, elevated blood pressure (as defined by the Metabolic Syndrome), and optimal blood pressure, respectively. Figs. 1–3 display the urban and rural wealth and education gradients in HTN, elevated blood pressure, and optimal blood pressure, respectively.

3.1. National results

3.1.1. Albania—The wealthiest females in Albania had a lower average SBP (−4.8 mm Hg, CI: −6.7, −2.9, $p < 0.001$), DBP (−2.2 mm Hg, CI: −3.5, −0.9, $p < 0.01$), and PP (−2.6 mm Hg, CI: −4.0, −1.3, $p < 0.001$) compared to the poorest. Similarly, the least educated females had a higher average SBP (5.5 mm Hg, CI: 3.8, 7.3, $p < 0.001$), DBP (1.9 mm Hg, CI: 0.8, 3.1, $p < 0.01$), and PP (3.6 mm Hg, CI: 2.5, 4.8, $p < 0.001$) when compared to the most educated females. Wealthier, more educated, and urban women were also much more likely

to have optimal blood pressure ($p^{\text{trend}} < 0.05$ for all) and less likely to have elevated blood pressure or be hypertensive ($p < 0.001$ for both).

There were no statistically significant differences in education or wealth among males when examining continuous blood pressure measures or the ORs of having optimal blood pressure or elevated blood pressure. However, the wealthiest 20% of men in Albania were much less likely to be hypertensive compared to the poorest 20% (OR = 0.5, CI: 0.4, 0.7, $p < 0.001$). Additionally, urban males were less likely to be hypertensive than rural males (OR = 0.7, CI: 0.5, 0.8, $p < 0.001$). Similarly, lower education was associated with a higher probability of being hypertensive ($p^{\text{trend}} < 0.01$).

3.1.2. Armenia—Among Armenian women, the most educated were more likely to have optimal blood pressure (OR = 0.7, CI: 0.6, 0.9, $p < 0.01$) and the least likely to have elevated blood pressure or stage 1 HTN ($p < 0.001$ for both). Urban women were also more likely to have optimal blood pressure (OR = 1.4, CI: 1.1, 1.8, $p < 0.01$), as were the wealthiest women (OR = 1.8, CI: 1.4, 2.4, $p < 0.001$). There was a graded association of lower SBP, PP, odds of elevated blood pressure, and stage 1 HTN with greater wealth ($p^{\text{trend}} < 0.01$).

There was limited evidence of SEP differences among Armenian men. Exceptions included an average 8.0 mm Hg higher DBP (CI: 2.7, 13.2, $p < 0.01$) among the least educated compared to the most educated and much higher OR = 1.8 (CI: 1.2, 2.9, $p < 0.01$) of having optimal blood pressure for urban males compared to their rural counterparts. Urban males were also less likely to be at risk for elevated blood pressure (OR = 0.7, CI: 0.4, 1.0, $p < 0.05$).

3.1.3. Azerbaijan—There was limited evidence of SEP disparities among Azerbaijani men, though the wealthiest (OR = 0.6, CI: 0.4, 0.9, $p < 0.05$) and urban (OR = 0.7, CI: 0.5, 0.9, $p < 0.01$) men were less likely to have elevated blood pressure. Azerbaijani women displayed strong wealth gradients with each wealthier quintile displaying lower (i.e. more optimal) blood pressure measures. The wealthiest females had a lower average SBP (−4.2 mm Hg, CI: −5.4, −3.1, $p < 0.001$), DBP (−2.6 mm Hg, CI: −3.7, −1.4, $p < 0.001$), and PP (−1.7 mm Hg, CI: −2.5, −0.9, $p < 0.001$) compared to the poorest. Urban females were also much less likely to have HTN (OR = 0.6, CI: 0.5, 0.7, $p < 0.001$). Further, there was a graded and statistically significant decrease in the risk for elevated blood pressure (a Metabolic Syndrome component) and an increase in the likelihood of having optimal blood pressure with each increasing quintile of household wealth ($p^{\text{trend}} < 0.001$). Additionally, urban women were less likely to have HTN ($p < 0.001$) and elevated blood pressure ($p < 0.001$), and more likely to have optimal blood pressure ($p < 0.001$) than their rural counterparts.

3.1.4. Ukraine—There were no statistically or clinically significant differences across any of the three SEP measures for any blood pressure outcome for either gender in the Ukraine.

3.2. Differences in urban and rural wealth and education gradients

Figs. 1–3 represent the predicted probabilities of HTN, elevated blood pressure, and optimal blood pressure among the rural (solid gray) and urban (black dash) populations within each country. The wealth gradients were estimated using a wealth quintile calculated for each rural and urban cohort separately. In all four countries the education gradients follow similar trends across the three levels of educational attainment. The exceptions are the increased likelihood of optimal blood pressure outcomes and lower likelihood of stage I HTN with greater educational attainment among urban Armenians. In Albania, the wealth gradient for HTN among urban dwellers is graded and separates from the flat rural gradient, while the other countries overlap at almost every quintile (Fig. 1). Similar, less pronounced patterns

emerge when examining differences in elevated blood pressure (Fig. 2) and optimal blood pressure (Fig. 3), with the exception of Armenia. In Armenia, the urban wealth gradients are strong and positively associated with optimal levels of blood pressure, whereas in the rural setting the gradient is essentially flat.

4. Discussion

The consequences of CVD in less wealthy countries may be greater in terms of morbidity and mortality [7], and therefore the identification of pathways and mechanisms of CVD in these countries is of value for a variety of public health endeavors. This manuscript addresses this subject in four previously unstudied middle-income countries. The published estimates for the DHS in the four study countries suggested that, on average, one in five individuals had blood pressure readings that would define them as hypertensive. As a comparison, the prevalence of HTN among adults in the United States is 29% (almost one in three) [50]. While there has not been an economic evaluation of the consequences of HTN in the study countries, these findings may be placed in the context of other countries in which the economic burden of HTN has been studied. In 2010 alone, blood pressure disorders were estimated to have cost the United States \$93.5 billion in health care services, medications, and missed days of work [51].

Understanding population trends of blood pressure control will improve the identification, diagnosis and treatment of blood pressure conditions by enabling targeted public health campaigns. Education about the adverse consequences of HTN and the promotion of blood pressure measurement and screening, particularly aimed at the less educated, financially disenfranchised, and female sub-populations should be an important focus of national health programs. Also, evidence of more pronounced SEP patterns of CVD risk among urban as compared to rural residents [4,52] could justify targeted health interventions designed to maximally impact groups of people living in close proximity (i.e. urban poor).

Blood pressure disorders are uniquely treatable cardiovascular risk factors, and the first step in treating abnormal blood pressure is awareness by individuals of their condition and its implications. Therefore, lack of access to education may explain some of the SEP patterns we have observed in attaining optimal blood pressure control. Individual health knowledge appears to be a major hurdle for HTN control in each study country. In Albania, 79% of women and 90% of men who were identified as hypertensive were unaware of their condition [34]. Only 3% of women and 1% of men were aware of their HTN, were treating it, and were optimally controlling their blood pressure. In Armenia, four out of five hypertensive women and men were unaware of their condition (82 and 81%, respectively) [35]. In Azerbaijan, only 44% of hypertensive women reported that they were aware of their condition. The majority of hypertensive Azerbaijani men (86%) were unaware of their condition [36]. In the Ukraine, 51% of hypertensive women and 77% of hypertensive men were unaware of their condition [37]. As HTN is a treatable condition, education about the lifestyle and nutritional choices that improve blood pressure is critically important to the vast numbers of hypertensive citizens in each country that are unaware of their condition. Given the evidence of SEP gradients in blood pressure control, designing health interventions specifically for people of lower educational attainment and wealth is likely an important strategy. Our findings suggest a need for national educational campaigns that address disparities in health knowledge and literacy as a critical component of addressing CVD risk.

In summary, we have found evidence of household wealth, education and urban/rural gradients in continuous blood pressure measures and in the levels that define stage I HTN, elevated blood pressure, and optimal blood pressure in Albania, Armenia, and Azerbaijan.

We did not find similar gradients in the Ukraine. The difference in gradients observed between the study countries may be explained if access to health care or quality of education is not consistently associated with SEP in certain countries, but these details are not easily elucidated in the current analysis. The overall prevalence for stage I HTN is high in all of the study populations (Table 1), and it is of concern that awareness of the condition remains low. We also confirmed, consistent with findings in the existing literature on obesity and SEP, that the SEP and blood pressure gradients we observed were more pronounced among women than men. However, this persistent finding in the CVD literature remains to be fully understood [33,53].

4.1. Limitations

To facilitate cross-country comparisons and to align with other published DHS and SEP analyses [54,55] and a recent call for standardization in reporting and monitoring blood pressure globally [11], we limited adjustment of our models only to age and rural or urban residence. Additionally, the data is cross-sectional. As a result we cannot make inferences on casual relationships based on the results. However, the motivation of this analysis was to describe the distribution of blood pressure based on SEP in each country rather than to ascertain the causal effects of SEP on blood pressure. Also, in this study we focused on the level of educational attainment, rather than the marginal effects of the number of years of schooling (which may have provided more granular information). There is also potential variation in the quality of education between regions and countries, which is important when considering international comparisons. Small sample sizes in the highest and lowest levels of educational attainment limited statistical comparisons by gender and place of residence. There is also potential measurement error due to differing levels of training of the staff that took blood pressure measurements for each survey, though the blood pressure devices were fully automatic. Additionally, our analysis was restricted to young and middle-aged men and women, and evidence of gradients for vascular pathologies might not emerge until a population ages. We also had imperfect data on self-reported use of blood pressure medication across all of our samples. However, if we assume that the use of medication is higher among the wealthier or normally distributed across SEP levels, the interpretation of our results would not change. We could not examine potential disparities in access to and use of medications in our analyses due to data limitations. Additionally, our analysis might have been strengthened if we were able to adjust for confounding by the body mass index (BMI) of the survey participants, but this information was lacking for most subjects. Finally, access to a larger battery of general biomarkers would have permitted us to estimate more comprehensive composite risk scores for CVD [56,57]. Yet, blood pressure measures, both continuous and based on the cut-offs we have examined, are central to the risk assignment algorithms that estimate the Framingham Heart Risk Scores [58], the Reynolds Risk Score for CVD [56,57] and the Metabolic Syndrome [41]. Also, given the known increase in CVD risk with even modest increases in blood pressure [16], identifying subtle blood pressure trends that put certain populations at greater risk for CVD over time represents an important public health endeavor.

5. Conclusions

A more precise understanding of how socioeconomic advantages and disadvantages influence the pathophysiological processes underlying CVD may highlight novel approaches for the prevention of CVD across different settings and populations [42,59,60]. Our study adds additional evidence regarding the evolving distribution of blood pressure in four middle-income countries. The variation in gradients observed between the different countries may speak to differences in baseline education or access to care within each country, though more details on country-specific differences are not available given the

limitations of data used in the current analysis. Future studies could examine more detailed and country-specific factors that play a role in the emergence of socioeconomic gradients in elevated blood pressure and CVD, and indeed such studies are necessary to guide the efforts of targeted CVD intervention and prevention campaigns.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Learning points

- Cardiovascular disease (CVD) is the leading cause of adult mortality in low- and middle-income countries but data on the prevalence of cardiovascular risk factors such as HTN are scarce in these countries.
- Information on and identification of high risk groups in middle-income countries are important for public health forecasts of CVD and targeted prevention policies; this study examined blood pressure patterns across strata of socioeconomic status in four middle-income Eastern European countries and neighboring Commonwealth of Independent States (CIS): Albania, Armenia, Azerbaijan and Ukraine.
- There is compelling evidence that wealth and education gradients affect the probability of HTN for women in Albania, Armenia, and Azerbaijan, and for men in Albania.
- Blood pressure disorders are uniquely treatable CVD risk factors, and the first step in treating abnormal blood pressure is awareness by individuals of their condition and its implications. Therefore lack of access to education may explain some of the SEP patterns we have observed in attaining optimal blood pressure control. Individual health knowledge appears to be a major hurdle for HTN control in each study country.
- The variation in gradients observed between the different countries may speak to differences in baseline education or access to care within each country, though more details on country-specific differences are not available given the limitations of data used in the current analysis. Future studies could examine more detailed and country-specific factors that play a role in the emergence of socioeconomic gradients in elevated blood pressure and CVD.

Fig. 1. Urban (dashed) and rural (gray) hypertension gradients (SBP 140 mm Hg, DBP 90 mm Hg, or both). 1A: Urban and rural household wealth gradients. 1B: Urban and rural education gradients. Footnote: Demographic Health Surveys conducted in Albania [34], Armenia [35], Azerbaijan [36] and Ukraine [37]. Gradients were estimated using predicted probabilities from country specific logistic regressions.

Fig. 2. Urban (dashed) and rural (gray) gradients of elevated blood pressure (SBP $\geq$ 130 mm Hg, DBP $\geq$ 85 mm Hg, or both). 2A: Urban and rural household wealth gradients. 2B: Urban and rural education gradients. Footnote: Demographic Health Surveys conducted in Albania [34], Armenia [35], Azerbaijan [36] and Ukraine [37]. Gradients were estimated using predicted probabilities from country specific logistic regressions.

Fig. 3. Urban (dashed) and rural (gray) gradients of optimal blood pressure ($< 120/80$ mm Hg). 3A: Urban and rural household wealth gradients. 3B: Urban and rural education gradients. Footnote: Demographic Health Surveys conducted in Albania [34], Armenia [35], Azerbaijan [36] and Ukraine [37]. Gradients were estimated using predicted probabilities from country specific logistic regressions.

Table 1

Survey characteristics.

World Bank classification	Albania		Armenia		Azerbaijan		Ukraine	
	Upper middle-income		Lower middle-income		Upper middle-income		Lower middle-income	
Male cardiovascular disease mortality rate (2008) ^a	469		709		655		772	
Female cardiovascular disease mortality rate (2008) ^a	417		388		583		441	
Sample characteristics								
Year	2008–09		2005		2006		2007	
Citation	[32]		[33]		[34]		[35]	
Sampling plan	2-stage cluster, not self-weighting		2-stage cluster		2-stage cluster, not self-weighting, autonomous Republic of Nakhichevan excluded		2-stage cluster	
Response rate (max = 100%)	96.0%		92.8%		95.5%		95.1%	
Blood pressure device used								
	Omron HEM-711ac		Samsung model HD-503		Riester Model richampion, No.1715		LifeSource UA-787EJ	
	N	Mean or %	SD	N	Mean or %	SD	N	Mean or %
Age	6472	31.9	11.0	7552	31.3	10.6	10958	31.7
% female		56%			84%			77%
Years of education (avg)		5.3	2.4		3.8	1.4		6.1
SBP (avg)		129.1	12.4		127.4	16.7		121.2
DBP (avg)		82.5	8.3		78.7	12.2		76.3
Pulse pressure		46.6	9.8		48.7	11.6		44.9
% hypertensive (females) ^b		20.0%			21.7%			16.4%
% hypertensive (males) ^b		27.6%			27.3%			16.6%

Notes: SBP = systolic blood pressure; DBP = diastolic blood pressure; pulse pressure = SBP – DBP.

^aMortality rate per 100,000.

^bPublished DHS prevalence using SBP 140 and DBP 90 or reported use of anti-hypertensive medication in Albania [34], Armenia [35], Azerbaijan [36] and Ukraine [37].

Table 2

Country and gender specific odds ratios of hypertension (SBP 140 mm Hg, DBP 90 mm Hg, or both) based on measures of socioeconomic position.

		Albania		Armenia		Azerbaijan		Ukraine	
Males									
N		2869		1207		2551		5110	
Socioeconomic status	Model	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Poorest 20%		Reference		Reference		Reference		Reference	
Poorer	(1) Household wealth index	0.9	[0.7,1.3]	1.0	[0.6,1.6]	1.2	[0.8,1.8]	0.8	[0.6,1.1]
Middle		0.9	[0.7,1.3]	1.0	[0.6,1.7]	1.3	[0.9,1.9]	0.9	[0.6,1.4]
Richer		0.8	[0.6,1.1]	0.8	[0.5,1.3]	0.7	[0.4,1.1]	1.2	[0.8,1.8]
Richest 20%		0.5***	[0.4,0.7]	1.1	[0.7,1.8]	0.7	[0.4,1.2]	0.8	[0.5,1.2]
Rural	(2) Place of residence	Reference		Reference		Reference		Reference	
Urban		0.7***	[0.5,0.8]	0.9	[0.6,1.3]	0.8	[0.6,1.1]	1.0	[0.7,1.4]
Primary/no	(3) Educational attainment	2.0**	[1.3,3.1]	1.8	[0.3,11.4]	5.1*	[1.4,18.6]	1.4	[0.1,14.5]
Secondary		1.6*	[1.1,2.3]	1.1	[0.7,1.6]	1.0	[0.7,1.4]	1.3	[1.0,1.6]
Higher		Reference		Reference		Reference		Reference	
Females									
N		3603		6338		8407		5692	
Poorest 20%		Reference		Reference		Reference		Reference	
Poorer	(1) Household wealth index	0.7	[0.4,1.0]	1.1	[0.9,1.5]	0.8*	[0.6,1.0]	0.9	[0.7,1.2]
Middle		0.7	[0.5,1.0]	0.9	[0.7,1.2]	0.7	[0.5,1.0]	1.1	[0.8,1.5]
Richer		0.6**	[0.5,0.9]	0.7*	[0.5,1.0]	0.5***	[0.4,0.7]	0.9	[0.6,1.3]
Richest 20%		0.3***	[0.2,0.5]	0.6**	[0.4,0.8]	0.4***	[0.3,0.5]	0.9	[0.7,1.3]
Rural	(2) Place of residence	Reference		Reference		Reference		Reference	
Urban		0.5***	[0.4,0.7]	0.8	[0.6,1.0]	0.6***	[0.5,0.7]	0.8	[0.6,1.0]
Primary/no	(3) Educational attainment	3.5***	[2.2,5.5]	3.6*	[1.3,10.2]	1.9*	[1.2,3.2]	2.2	[0.7,6.5]
Secondary		2.4***	[1.5,3.7]	1.5***	[1.2,2.0]	1.5**	[1.1,1.9]	1.2*	[1.0,1.5]
Higher		Reference		Reference		Reference		Reference	

Note: For both males and females, odds ratios (OR) were estimated from three separate models that included the primary socioeconomic variable and a continuous age variable. Data are from the Demographic Health Surveys conducted in Albania [34], Armenia [35], Azerbaijan [36] and Ukraine [37]. Exponentiated coefficients are shown. 95% confidence intervals [CIs] are in brackets.

* p<0.05,
 ** p<0.01,
 *** p<0.001.

Country and gender specific odds ratios of elevated blood pressure (SBP 130 mm Hg, DBP 85 mm Hg, or both) based on measures of socioeconomic position.

Table 3

		Albania		Armenia		Azerbaijan		Ukraine	
Males									
N		2869		1207		2551		5110	
Socioeconomic status	Model	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Poorest 20%		Reference		Reference		Reference		Reference	
Poorer	(1) Household wealth index	1.1	[0.8,1.7]	0.7	[0.4,1.1]	0.7	[0.5,1.2]	1.0	[0.7,1.3]
Middle		1.2	[0.8,1.7]	0.8	[0.5,1.3]	0.9	[0.6,1.3]	1.2	[0.8,1.7]
Richer		1.4	[1.0,2.0]	0.6	[0.4,1.0]	0.5**	[0.3,0.8]	1.1	[0.7,1.7]
Richest 20%		1.4	[0.9,2.1]	0.7	[0.4,1.1]	0.6*	[0.4,0.9]	0.8	[0.5,1.1]
Rural	(2) Place of residence	Reference		Reference		Reference		Reference	
Urban		1.2	[0.9,1.5]	0.7*	[0.4,1.0]	0.7**	[0.5,0.9]	1.0	[0.7,1.3]
Primary/no	(3) Educational attainment	1.0	[0.6,1.5]	3.8	[0.5,30.7]	2.5	[0.7,8.6]	0.4	[0.0,4.4]
Secondary		0.8	[0.5,1.1]	1.1	[0.8,1.7]	1.0	[0.8,1.4]	1.2	[1.0,1.5]
Higher		Reference		Reference		Reference		Reference	
Females									
N		3603		6338		8407		5692	
Poorest 20%		Reference		Reference		Reference		Reference	
Poorer	(1) Household wealth index	0.8	[0.6,1.1]	1.1	[0.9,1.4]	0.8	[0.7,1.0]	1.0	[0.8,1.2]
Middle		0.9	[0.7,1.3]	1.0	[0.7,1.2]	0.8**	[0.6,0.9]	1.1	[0.8,1.4]
Richer		0.8	[0.6,1.1]	0.7*	[0.5,0.9]	0.6***	[0.5,0.8]	0.9	[0.7,1.3]
Richest 20%		0.5***	[0.3,0.6]	0.5***	[0.4,0.7]	0.5***	[0.4,0.6]	1.0	[0.8,1.3]
Rural	(2) Place of residence	Reference		Reference		Reference		Reference	
Urban		0.6***	[0.5,0.8]	0.7**	[0.6,0.9]	0.6***	[0.5,0.8]	0.9	[0.7,1.1]
Primary/no	(3) Educational attainment	2.6***	[1.9,3.6]	5.8***	[2.5,13.9]	1.5	[0.9,2.5]	1.3	[0.4,4.6]
Secondary		2.0***	[1.5,2.7]	1.5***	[1.2,1.9]	1.2	[1.0,1.5]	1.2*	[1.0,1.4]

		Albania		Armenia		Azerbaijan		Ukraine	
Males									
N		2869		1207		2551		5110	
Socioeconomic status		OR		OR		OR		OR	
Higher		Reference		Reference		Reference		Reference	
Model		95% CI		95% CI		95% CI		95% CI	

Note: For both males and females, odds ratios (OR) were estimated from three separate models that included the primary socioeconomic variable and a continuous age variable. Data are from the Demographic Health Surveys conducted in Albania [34], Armenia [35], Azerbaijan [36] and Ukraine [37]. Exponentiated coefficients are shown. 95% confidence intervals [CIs] are in brackets.

* p<0.05,
** p<0.01,
*** p<0.001.

Country and gender specific odds ratios of optimal blood pressure (120/80 mm Hg) based on measures of socioeconomic position.

Table 4

		Albania		Armenia		Azerbaijan		Ukraine	
Males									
N		2869		1207		2551		5110	
Socioeconomic status	Model	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Poorest 20%		Reference		Reference		Reference		Reference	
Poorer	(1) Household wealth index	1.1	[0.6,2.2]	0.9	[0.5,1.7]	0.9	[0.6,1.2]	0.9	[0.6,1.3]
Middle		1.0	[0.5,1.9]	1.0	[0.6,1.8]	0.8	[0.6,1.1]	0.9	[0.6,1.4]
Richer		0.6	[0.3,1.2]	1.2	[0.6,2.3]	1.3	[0.9,1.9]	1.0	[0.6,1.6]
Richest 20%		0.6	[0.3,1.0]	1.7	[1.0,3.1]	1.5	[0.9,2.5]	1.2	[0.7,1.8]
Rural	(2) Place of residence	Reference		Reference		Reference		Reference	
Urban		0.7	[0.5,1.0]	1.8**	[1.2,2.9]	1.2	[0.8,1.7]	1.0	[0.7,1.3]
Primary/no	(3) Educational attainment	1.6	[0.8,3.2]	-	-	0.6	[0.2,2.0]	2.0	[0.2,24.8]
Secondary		1.7	[0.9,3.1]	0.9	[0.6,1.4]	1.1	[0.7,1.6]	1.1	[0.9,1.4]
Higher		Reference		Reference		Reference		Reference	
Females									
N		3603		6338		8407		5692	
Poorest 20%		Reference		Reference		Reference		Reference	
Poorer	(1) Household wealth index	1.2	[0.8,1.9]	0.9	[0.7,1.2]	1.2**	[1.1,1.5]	0.9	[0.8,1.2]
Middle		1.1	[0.8,1.6]	1.1	[0.8,1.4]	1.3**	[1.1,1.6]	0.9	[0.7,1.2]
Richer		1.4	[1.0,2.0]	1.4*	[1.1,1.9]	1.7***	[1.4,2.2]	1.1	[0.8,1.3]
Richest 20%		1.8**	[1.2,2.8]	1.8***	[1.4,2.4]	1.7***	[1.3,2.0]	1.1	[0.9,1.4]
Rural	(2) Place of residence	Reference		Reference		Reference		Reference	
Urban		1.3*	[1.0,1.7]	1.4**	[1.1,1.8]	1.4***	[1.2,1.7]	1.1	[1.0,1.4]
Primary/no	(3) Educational attainment	0.5***	[0.4,0.7]	0.4	[0.2,1.2]	0.7	[0.4,1.0]	1.8	[0.6,5.9]
Secondary		0.6***	[0.4,0.8]	0.7**	[0.6,0.9]	0.8*	[0.7,1.0]	0.9	[0.8,1.0]
Higher		Reference		Reference		Reference		Reference	

Note: For both males and females, odds ratios (OR) were estimated from three separate models that included the primary socioeconomic variable and a continuous age variable. Data are from the Demographic Health Surveys conducted in Albania [34], Armenia [35], Azerbaijan [36] and Ukraine [37]. Exponentiated coefficients are shown. 95% confidence intervals [CIs] are in brackets.

* p<0.05,
 ** p<0.01,
 *** p<0.001.