Blood pressure among rural Montenegrin children in relation to poverty and gender

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Background: Health inequalities may begin during childhood. The aim of this study was to investigate the main effect of poverty and its interactive effect with gender on children’s blood pressure. Methods: The study was performed in two elementary schools from a rural region near Podgorica, the capital of Montenegro. A questionnaire including questions on family monthly income, children’s physical activity and the consumption of junk food was self-administered by parents of 434 children (223 boys and 211 girls) aged 6–13 years. Children’s poverty level was assessed using the recommendations from the National Study on Poverty in Montenegro. Children’s body weight and height were measured and body mass index-for-age and age percentile was calculated. An oscillometric monitor was used for measurement of children’s resting blood pressure in school. Results: A two-factorial analysis of variance with body mass index percentile, physical activity and junk food as covariates showed an interaction of gender and poverty on children’s blood pressure, pointing to synergy between poverty and female gender, with statistical significance for raised diastolic pressure (F = 5.462; P = 0.021). Neither physical activity nor the consumption of junk food explained the interactive effect of poverty and gender on blood pressure. Conclusion: We show that poverty is linked to elevated blood pressure for girls but not boys, and this effect is statistically significant for diastolic pressure. The results are discussed in the light of gender differences in stress and coping that are endemic to poverty.

Introduction

High blood pressure is less frequently found among children compared with adults, possibly due to fewer environmental stressors, higher physical activity levels, lower prevalence of obesity, healthier lifestyle and infrequent paediatric screening. However, according to prevalence, essential hypertension should be considered a common chronic disease in children and adolescents. We briefly review data on the prevalence of hypertension among children and adolescents from large studies in different countries. Hansen et al. performed a study on more than 14,000 American children and adolescents (aged 3–18 years) and determined the prevalence of hypertension to be 3.6%. In another study with repeated measurements of blood pressure in 6790 adolescents (11–17 years) from the USA, prevalence of hypertension was 3.2%. Monyeki et al. disaggregated his data on hypertension by gender in 1884 rural children aged 6–13 years from South Africa, noting that 1.0–5.8% of the boys and 3.1–11.4% of the girls had hypertension. He also noted that obesity was intercorrelated with socioeconomic status (SES) and hypertension. Pavcivic et al. examined 3000 Serbian children (aged 7–16 years) during regular school days. Prevalence of arterial hypertension for all children was 0.93% and was the lowest in children aged 7–8 years (0.83%), and the highest in children aged 15–16 years (2.96%). Finally, in a study of 15612 school children (6–14 years) from Pescara province, Italy, the prevalence of hypertension was 11.1%.
Major risk factors for hypertension include age, male gender, African heritage, family history of hypertension, obesity, lack of physical activity, smoking and secondhand smoke, too much dietary sodium, too little dietary potassium, more than two alcohol drinks a day, sleep apnea and stress. An important and understudied contextual link between many of these risk factors and hypertension is SES during childhood. Periods of childhood and adolescence are usually described as ‘critical developmental periods’ with pronounced changes in hormones and neurotransmitter receptors and transporters and consequent behaviours that are important for the regulation of blood pressure. Because of structural disadvantages in the social and physical environment, low SES may have detrimental effects on blood pressure regulation during development, but also leading to deregulation of blood pressure in adulthood through cumulative effects. Children from lower SES families may have less access to healthy food and more fast food restaurants in the vicinity of their schools, compared with adolescents from high-income families. As a consequence of less access to safe environments for exercise and healthy food, low SES children often have inadequate physical activity and diet, with low consumption of vegetable and fruit and consumption of too many fried foods and soft drinks, leading to obesity. In lower SES communities, there may also be less social control over youth’s risky health behaviours such as smoking, drinking, low physical activity and unhealthy diets. Chronic stress is more common in low SES communities compared with high-income communities due to violence, less stable families and suboptimal physical environments (e.g. noise, crowding and substandard housing) with harmful effects on health. Repeated adaptation to stressors and allostatic load may affect the regulatory mechanisms of blood pressure and raise the risk of hypertension and other cardiovascular diseases.

There is heterogeneity in the results of the studies on the relation between SES and blood pressure. In a cross-sectional study on 1,535 African school children and adolescents, the only significant risk factor for arterial hypertension was SES. In a study on 13,500 adolescents from the National Longitudinal Study of Adolescent Health (USA), lower SES placed adolescents at risk for higher systolic and diastolic blood pressure. However, in the US National Health and Nutrition Examination Surveys conducted from 1999 to 2008, no significant differences in systolic blood pressure were observed between lowest- and highest-income background children and adolescents, regardless of gender. Little is known about gender differences in cardiovascular risk factors, such as blood pressure, and SES. In one American study, women who grew up under adverse economic conditions were the most likely to experience elevated risk for heart attack. This was not the case for men. In a large national Canadian study, women living in areas of high neighbourhood deprivation were 10% more likely to report having hypertension compared with men living in similar environments. No similar studies in children have been undertaken so far. It is important from a public health perspective to clarify whether societal action against poverty in childhood would have different counter-hypertension effect in females and males.

The present study is a part of a national project ‘Investigation of child obesity and poverty in Montenegro – clinical, pathophysiological, biochemical and preventive aspects’. Poverty is a potentially major public health problem in Montenegro, as it is estimated that 6.1% of adults and 10% of children live in poverty, with the highest rates of poverty in rural areas. This is the first investigation in Montenegro on the relation between poverty and blood pressure in children. We focused on the possibility of a moderating role of gender in this relationship. We also investigated whether poverty main or interactive effects can be explained in part by diet and physical activity.

**Methods**

**Sample**

A cross-sectional study of elementary school children from grades II to VII was performed in the rural area Zeta, near Podgorica. There are only two elementary schools in this area. Sampling frame consisted of all children from grades II to VII from these two schools (228 and 756 children, respectively). A 55% sample (540 children) was randomly selected with a probability proportional to school size (125 from the smaller school and 415 from the larger one).

Parents were asked permission for their children to be recruited for the study. Parents and children were informed that blood pressure, body mass and body height would be measured. To avoid response bias, poverty as the investigation subject was not mentioned. Of 540 letters delivered, positive answers were obtained from 434 families (response rate = 80.3%). As blood pressure measurement is not a regular part of paediatric examination, we assumed that all parents were equally interested in this investigation and that non-responsiveness was randomly distributed. The final sample included 223 boys (51%) and 211 girls (49%) aged from 6 to 13 years (mean ± SD = 9.3 ± 1.6 years).

**Questionnaire**

A parental questionnaire included information on SES. Based on monthly family income in EUR and the number of adults and children in the family, socio-economic level (poverty) was assessed using the recommendations from a National Study on Poverty in Montenegro. For example, the cutoff points of monthly income of families with two adults are as follows: 304 (one child), 355 (two), 406 (three), 457 (four), 507 (five), 558 (six) and 609 (seven). With valid data on SES, there were 404 children, of which there were 193 (48%) children below the level of poverty and 211 (52%) above that level.

Children’s physical activity was checked with a question: ‘Over a typical or usual week on how many days is your child physically active for a total of at least 60 min per day?’

The questionnaire also included a question on the frequency of consumption of junk food such as sugary carbonated beverages, candy, sweet desserts and fried fast food (Never, Rarely, Sometimes, Frequently and Always).

**Anthropometric measurements**

Body weight of barefoot children in light clothes was measured on a digital scale accurate to 0.1 kg. Body height was measured with a stadiometer accurate to 0.5 cm. Body mass index (BMI) was calculated dividing body weight in kilograms by body height in squared metres. BMI-for-gender-and-age percentile was calculated using software available on the website of the Centers for Disease Control and Prevention (http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html).

**Blood pressure measurement**

An Omron HEM 907 XL oscillometric monitor was used for measurement of blood pressure. The measurement was performed in school between noon and 3:00 p.m. in a quiet room, in a sitting position and on a non-dominant arm, after a rest of 5 min. Three measurements with a 1-min interval were performed after calibration of the measuring system, using an appropriate cuff size (child: 2–19 cm; small adult: 17–25 cm). Mean values of systolic and diastolic pressures were calculated.
Statistical analysis

Pearson correlation was used to check for the relationship between the main variables used in this study. Two-factorial analysis of variance (ANOVA) was performed with gender and poverty as main factors; BMI percentile, physical activity and junk food as covariates and blood pressure as a dependent variable.

Results

Correlations of the main variables indicate that BMI percentile was significantly related to both systolic and diastolic blood pressure. However, BMI percentile was not significantly related to poverty. Poverty was negatively related to children’s age (table 1).

A two-factorial ANOVA showed an interaction of gender and poverty on blood pressure when controlled for BMI percentile. For girls but not boys, poverty is linked to elevated blood pressure, with statistical significance for diastolic pressure ($F = 6.621; P = 0.010$; figures 1 and 2).

Including children’s physical activity and consumption of junk food as covariates in two-factorial ANOVA did not significantly change the effects of gender and poverty either on systolic ($F = 1.791; P = 0.191$) or diastolic ($F = 6.332; P = 0.012$) blood pressure.

Post hoc univariate ANOVA performed separately for boys and girls, and controlling for BMI percentile, physical activity and junk food, showed that the effects of poverty on systolic pressure were not statistically significant in either gender ($F = 0.255; P = 0.614$ for boys and $F = 2.646; P = 0.10$ for girls). However, the effect of poverty on diastolic pressure was significant for girls ($F = 5.462; P = 0.021$), but not for boys ($F = 1.835; P = 0.177$).

Discussion

In the first large-scale systematic study of blood pressure among children in Montenegro, we uncovered an interaction between gender and poverty on blood pressure in children. For girls but not boys, poverty is linked to elevated blood pressure. The effect of poverty on blood pressure in boys is actually in the opposite of expected direction, although not statistically significant.

A 48% poverty level in the investigated sample of rural children is about five times higher than the percentage of poor children in the entire country of Montenegro, but consistent with population statistics for rural areas in Montenegro.21

Among major risk factors for hypertension, we controlled for children’s age and BMI in factorial analysis. Further inclusion of physical activity and consumption of junk food as covariates in statistical analysis did not explain the effect of gender/poverty interaction on children’s systolic and diastolic blood pressure.

Our finding of female gender and poverty synergy on blood pressure in youth is congruent with the results of a recent study

Table 1 Correlation between the main variables investigated in the study ($N = 434$)

<table>
<thead>
<tr>
<th>Variable</th>
<th>% or Mean (SD)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Poverty</td>
<td>47.7%</td>
<td>1</td>
<td>0.040</td>
<td>0.062</td>
<td>0.003</td>
<td>0.013</td>
<td>-0.109*</td>
</tr>
<tr>
<td>2. Systolic pressure</td>
<td>111.6 (10.8)b</td>
<td>0.040</td>
<td>1</td>
<td>0.622**</td>
<td>0.260**</td>
<td>0.084</td>
<td>0.217**</td>
</tr>
<tr>
<td>3. Diastolic pressure</td>
<td>68.9 (9.7)b</td>
<td>0.062</td>
<td>0.622**</td>
<td>1</td>
<td>0.106*</td>
<td>0.172**</td>
<td>0.013</td>
</tr>
<tr>
<td>4. BMI percentile</td>
<td>58.7 (29.4)b</td>
<td>0.003</td>
<td>0.260**</td>
<td>0.106*</td>
<td>1</td>
<td>-0.115*</td>
<td>-0.055</td>
</tr>
<tr>
<td>5. Gender (0 = male)</td>
<td>51.0%</td>
<td>0.013</td>
<td>0.084</td>
<td>0.172**</td>
<td>-0.115*</td>
<td>1</td>
<td>0.035</td>
</tr>
<tr>
<td>6. Age (years)</td>
<td>9.3 (1.6)b</td>
<td>-0.109*</td>
<td>0.217**</td>
<td>0.013</td>
<td>-0.055</td>
<td>.035</td>
<td>1</td>
</tr>
</tbody>
</table>

*P < 0.05 (two-tailed); **P < 0.01 (two-tailed); a %; b Mean (SD).

Figure 1 Estimated marginal means of mean systolic pressure in boys and girls in relation to poverty (mm Hg) and controlling for BMI percentile

Figure 2 Estimated marginal means of mean diastolic pressure in boys and girls in relation to poverty (mm Hg) and controlling for BMI percentile
with American adults, showing that women from low SES are more likely to report having hypertension than men living in similar conditions. In another retrospective study of the relationship between SES in childhood, and health status at the age of 50 years, it was shown that self-assessed SES in childhood in the USA was significantly associated with the appearance of cardiovascular disease among women, but not among men. In a study performed in the UK, greater effects of non-work-based stressors were found for women than for men. Among African American adults, low SES women had significantly more hypertension than higher SES women, but not among men. Winkleby et al. showed that low SES was related to 7% higher incidence of cardiovascular diseases in women compared with men.

One possible explanation for the gender × poverty interaction on blood pressure could be gender differences in coping with community stressors. Perhaps girls are more sensitive to childhood conditions than boys, and women are more prone to distress related to material deprivation compared with men. Low SES is closely related to exposure to multiple sources of stress in the home, school and community, and the lower a person's SES, the lower the individual’s reserve capacity and ability to cope with stress. Female cardiovascular health may be more dependent on the protective influence of residential stability and social network supports compared with males. Both of these social factors are associated with poverty. Several studies have confirmed that females and males do differ in their reactions to material deprivation. In a study on Danish adolescents, girls reported more perceived stress than boys, and lower SES and lower parental education were associated with higher stress levels. A 2-year follow-up study on a cohort of 15-year-old American adolescents revealed that a very low SES was related to higher internalizing symptom levels in girls compared with boys. A study on 1160 adults from a deprived neighbourhood in Denmark showed higher levels of stress among women compared with men. As a response to chronic and pervasive stress endemic to environment of poverty, increased activity in the hypothalamic pituitary adrenal axis, high allostatic load and wear and tear of the body may be expected, causing less efficient regulatory mechanisms of blood pressure. Similarly to the studies from Denmark and USA, perhaps poverty is more stressful for girls than for boys in Montenegro, resulting in adverse cardiovascular consequences only for females.

More pronounced effect of poverty on diastolic blood pressure than on systolic blood pressure in girls may be explained by sex differences in cardiovascular reactivity to stressors. In an experimental exposure to stressful effect of video games and cigarette smoking, females were higher on diastolic pressure reactivity on both stressors than males.

Investigation of the contribution of SES to the emergence of early irregularities of blood pressure has implications for societal action and health policies aimed at controlling the burden of hypertension in adulthood. Establishing the strength of the relation between modifiable SES factors and blood pressure irregularities in youth may be helpful in designing adequate interventions. There are positive experiences of school-based prevention interventions in lowering the prevalence of high blood pressure in youth. If it turns out that these gender differences in susceptibility to poverty are robust, then interventions for low-income boys and girls may need to be adjusted according to gender.

Given our ideas about the possible reasons for gender differences in SES and blood pressure, an important limitation of our study is the lack of a stress questionnaire to explain the gender differences in the effects of poverty on blood pressure. Smoking and drinking were not controlled for in the analyses, as data obtained from parents would not be reliable. However, it might be expected that regular smoking and drinking are very rare in Montenegrin children aged 6–13. As power analysis was not performed, there is a possibility of too small sample size. However, the fact that we detected SES effects in girls only suggests that sufficient statistical power is present in purdah. Further, ambulatory blood pressure measurement, which provides a better representation of daily experiences in relation to the cardiovascular system, was not possible in the present field investigation in Montenegro. In the future, we hope to study a larger population of children and youth in Montenegro, utilizing ambulatory monitoring techniques integrated with experience sampling methodology so we can track momentary shifts in stress throughout the daily lives of children and youth.

In conclusion, we show gender differences in the association between poverty and blood pressure in children from a rural region of Montenegro, where poverty apparently is affecting near one-half of the children. For girls but not boys, poverty is linked to elevated blood pressure, and this effect is statistically significant for diastolic pressure. The results are discussed in the light of gender differences in stress and coping that are endemic to poverty.

Acknowledgements

The authors are grateful to Dr Katarina Paunovic from the Institute of Hygiene and Medical Ecology, Faculty of Medicine, University of Belgrade, for revising the manuscript and for useful suggestions.

Funding

Montenegrin Ministry of Science, Contract No. 01-1366/2012.

Conflicts of interest: None declared.

Key points

- Poverty is linked to elevated blood pressure for girls but not boys, and this effect is statistically significant for diastolic pressure.
- Societal action and health policies aimed at controlling the burden of hypertension in adulthood should include measures against poverty in childhood.
- It may be expected that societal action against poverty in childhood would have more pronounced counter-hypertension effect in females compared with males.

References

8. Thawornchaits P, de Loose F, Reid CM, et al. Thai Cohort Study Team. Health risk factors and the incidence of hypertension: 4-year prospective findings from


