

## **Noise at school independently raises the odds for hypertension in children and adolescents**

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### **ABSTRACT**

Community noise is a strong stressor that might affect the regulatory mechanisms of blood pressure in children. The aim of this study was to investigate the prevalence of hypertension among urban schoolchildren and adolescents and its possible relationship with exposure to community noise. A cross-sectional study was performed on 632 schoolchildren and adolescents (278 boys; 44%), aged 11-15 years from the center of Belgrade. Noise (Leq) was measured in front of schools in two daily intervals and on the streets where children lived in one evening period and in two night intervals. Children's resting blood pressure was measured with sphygmomanometer in a school setting. Hypertension was defined as systolic and/or diastolic pressure that is at or above the 95th percentile in relation to child's gender, age and height. The prevalence of hypertension was 4.6% (29 cases). In a multiple regression analysis body mass index percentile and noise at school (per dB Leq) were significant predictors of children's hypertension (odds ratio /95% confidence interval/ = 1.067 / 1.038-1.097/  $p < 0.001$  and 1.072 /1.001-1.149/  $p = 0.048$ , respectively).

### **INTRODUCTION**

Public health importance of childhood hypertension (CH) derives from the fact that CH is closely related to hypertension in adulthood [1]. Hypertension is a major risk factor for premature disability and mortality, because it substantially contributes to the burden of heart disease, cerebral insult and renal failure [2]. The prevalence of CH is estimated to be between 3% and 5% but it is rising throughout the world [3]. There are no national data on the prevalence of CH in Serbia, but a study on 7-14 old children from Belgrade showed that high systolic pressure was present in 4.7% of boys and 5.3% of girls, while high diastolic blood pressure was found in 5.6% of boys and in 4.8% of girls [4].

Major risk factors for CH are obesity, waist circumference and dietary salt intake [5]. The relation has also been found between rural environment and CH probably due to higher rates of poverty, poorer diet, and lack of access to recreational opportunities for physical activity [6]. Among environmental factors, noise is a potential stressor that might affect the regulation of blood pressure in children through the stimulation of hypothalamic-pituitary-adrenal axis, the reticular formation and sympathetic nervous system [7]. Recent meta analysis of the previous researches on the relationship between road traffic noise and children's blood pressure has found an average 0.48 mmHg increase in systolic blood pressure and 0.22mmHg in diastolic blood pressure per 5dB increase in road traffic noise at school/kindergarten and 0.20mmHg increase in systolic blood pressure and 0.03mmHg in diastolic blood pressure per 5dB increase in road traffic noise at home [8].

In this study we use for the first time CH as a dependent variable in the noise-children's blood pressure relationship. The aim of our investigation was to establish the prevalence of hypertension among schoolchildren and its possible relationship with the exposure to road traffic noise at children's homes and schools.

## **METHODS**

### **Study Sample**

The children for this study were recruited from six elementary schools, grades V to VIII, from a central municipality of Belgrade. The approval for participating in the study was asked through 950 parental letters and obtained for 637 children (67%). After applying the exclusion criteria (diabetes mellitus and/or renal diseases; five children) the final sample included 632 children aged 11-15 years (278 boys; 44%). All the children lived on the present address for at least one year.

### **Noise Measurements**

We measured road-traffic noise with a Hand-Held Noise Level Analyzer "Bruel&Kjaer" type 2250 according to International Standard Organization regulation [9]. As all the children attended school in the first shift, the measurements were performed in front of schools in two daily intervals (between 9 a.m. and 11 a.m. and between noon and 2 p.m.). Other measuring sites were in the middle of the streets where children lived, in one daily interval (between 6 p.m. and 8 p.m.) and in two night intervals (between 10 p.m. and midnight and between midnight and 2 a.m.). Each noise recording lasted 15 minutes. From the obtained Leq levels a daytime Leq was calculated for each school and a composite evening-night Leq for each street.

### **Questionnaire**

Parents completed the questionnaire providing socio-demographic data (child's age, gender, period of residence on the present address, maternal education /coded as 1-elementary school; 2-secondary school; 3-university/, perceived family income /coded as 1-insufficient; 2-sufficient; 3-more than sufficient/, parental hypertension based on antihypertensive therapy, presence of child diseases related to hypertension (diabetes mellitus and renal diseases). Parents also provided information on the orientation their child's room toward a busy street and about the child's involvement in physical activities outside the school (number of trainings per week).

## **Anthropometrics**

Anthropometric measurements on children were performed in the morning, in light clothes and barefoot. Body weight was measured on a digital scale accurate to 0.1 kg. A stadiometer accurate to 0.5 cm was used for the body height measuring. Body mass index-for-age percentile was calculated using a software available at the website of the Center for Disease Control and Prevention [10].

## **Blood Pressure Measurement**

A mercury sphygmomanometer with two cuff sizes (7.5 cm x 19.5 cm and 11 cm x 27 cm) was used for the measuring of children's blood pressure. We chose a quiet room in the school and each child was in a sitting position having rest for 15 minutes. Two measurements were performed on the right arm with five minute interval. If the difference between the measured systolic and/or diastolic pressure was larger than 5 mmHg a third measurement was performed. Mean values of systolic and diastolic pressure were calculated. Child hypertension is defined as an average systolic and/or diastolic pressure that is greater than or equal to the 95<sup>th</sup> percentile for sex, age and height [11].

## **Statistical Analysis**

An univariate logistic regression was used to test the association between the relevant variables from the questionnaire and child hypertension. Based on the results of univariate logistic regression, variables significantly related to hypertension were included in a multiple regression model. We adopted the level of alpha error to be less than 0.05.

## **RESULTS**

Analysis of the children's sociodemographic data showed that the majority of mothers and fathers were employed (84% and 91%, respectively) and with a university level of education (60% and 56%, respectively). For 18% of the families monthly income was insufficient to cover basic needs. Most of the children lived with both parents (83%). The average period of residence on the present address was 13 years and the average apartment area per tenant was satisfactory (18.8 m<sup>2</sup>).

The results of noise measurements showed that Leq<sub>day</sub> outdoor levels at schools ranged from 55.0-72.3 dB (A) with the mean and SD levels of 64.6±7.0 dB (A). Leq<sub>evening-night</sub> levels on the streets where children lived ranged from 51.9-83.7 dB (A) and the average values were 64.8±7.8 dB (A).

There were 29 children (4.6%) hypertension (16 boys and 13 girls). In an univariate logistic regression analysis we investigated the effect of several independent variables on the onset of hypertension in children (Table 1). Significant positive relation with CH was found for child BMI percentile and noise level at school.

**Table 1:** Univariate logistic regression with childhood hypertension as a dependent variable and some relevant factors for children's blood pressure as independent variables

Independent Variable	Odds Ratio	95% Confidence Interval	p
Gender (male=1; female=2)	0.624	0.295-1.321	0.218
Age (per month)	1.017	0.990-1.045	0.223
Residence on the present address (per year)	1.009	0.975-1.045	0.600
Child's bedroom facing the busy street (no=0; yes=1)	0.909	0.430-1.923	0.803
Paternal hypertension (no=0; yes=1)	0.563	0.232-1.364	0.203
Maternal hypertension (no=0; yes=1)	1.394	0.310-5.807	0.694
Child's physical trainings (number per week)	1.066	0.719-1.581	0.751
BMI percentile	1.067	1.038-1.096	<0.001
Leq <sub>school</sub> (per dB)	1.071	1.002-1.144	0.042
Leq <sub>evening-night</sub> (per dB)	1.029	0.973-1.089	0.319

In a multiple regression analysis (Table 2) noise level at school independently raised the odds for CH by 7.2% per dB, when controlled for child BMI percentile.

**Table 2:** Multiple logistic regression with childhood hypertension as a dependent variable and children's BMI percentile and noise level at school as independent factors

Independent Variable	Odds Ratio	95% Confidence Interval	p
BMI percentile	1.067	1.038-1.097	<0.001
Leq <sub>school</sub> (per dB)	1.072	1.001-1.149	0.048

## DISCUSSION

In this first study on the relationship between road traffic noise and CH we show that there is an independent effect of noise at school on the increase of odds for CH by 7.2% per dB. The effect size is much higher compared to the relationship between road traffic noise and hypertension in adults /7% per 10 dB/ [12]. This is probably the consequence of a small number of cases of CH in our study.

Noise levels children are exposed to are rather high and typical for the center of Belgrade. According to Serbian regulations the noise limit of 45 dB Leq<sub>evening-night</sub> is exceeded by 20 dB on average in front of children's homes (A), while the average Leq at schools is 15 dB higher than the noise limit of 50 dB [13].

The results of meta analysis of previous studies on noise-CH relationship [8] are indicative of road traffic noise around schools having a larger disrupting effect on the regulation of blood

pressure than noise around children's homes. In our study on schoolchildren aged 11-15 years from Belgrade we showed that systolic pressure was raised by 4,5 mmHg per 10 dB increase of Leq at school [14]. In another study that we also carried out in Belgrade, on schoolchildren aged 7-11 years, both systolic and diastolic pressure were significantly and positively related to Leq in front of schools ( $B=0.57$  and  $0.11$ , respectively /per dB/) [15]. These findings may be explained by a synergistic stressful effect of noise exposure at schools and children's mental efforts during educational process. Noise at schools affects children's mental performance and lower achievements in schools may be an additional stressor for children [16,17]. The two basic types of auditory distraction when children are exposed to noise in classrooms during cognitive processes are interruption of processes and interference between processes [17]. Based on the WHO Burden of Disease from Environmental Noise Project the effects of noise on cognitive performance are ranked at the fourth place for children aged 7 to 19 years in the Europe A region with 45,036 disability adjusted life years lost each year, as compared to 903,000 years for sleep disturbance, 654,000 for noise annoyance and 61,000 years for ischemic heart disease [17].

The limitation of our study is that we did not control dietary factors and particularly salt intake which is a major risk factor for CH [5]. Another limitation is that the establishment of CH was based on two or three consecutive measurements and not on 24h ambulatory blood pressure measurement which is a gold standard for CH diagnosis [12].

Further studies on larger samples of children are needed to test the hypothesis raised in this study on the relationship between community noise and CH.

## CONCLUSION

In this cross-sectional study we show that road-traffic noise at school may be significantly related to CH. If these findings were proved in future studies, noise counter-measures in a school environment might be protective for children's cardiovascular health.

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