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Review

Epidemiological studies on noise and blood pressure in children: Observations and suggestions

Katarina Paunović [a,*], Stephen Stansfeld [b], Charlotte Clark [b], Goran Belojević [a]

[a] Institute for Hygiene and Medical Ecology, School of Medicine, University of Belgrade, Belgrade, Serbia
[b] Centre of Psychiatry, Wolfson Institute of Preventive Medicine, Barts and The London School of Medicine and Dentistry, Queen Mary University of London, London, United Kingdom

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ABSTRACT

Objective: The goal of this review was to investigate methodological differences in studies on the effects of aircraft or road-traffic noise on blood pressure (BP) of urban children, emphasizing the similarities and differences in blood pressure measurements.
Methods: A literature search has identified eight peer-reviewed studies, four conference proceedings and one PhD thesis on the effects of aircraft or road-traffic noise on children's blood pressure published in English in the last 30 years. Most of the studies were cross-sectional, and four studies were longitudinal, with follow-up period from one to three years. The studies were analyzed according to the following methodological issues: study design, children's characteristics, noise exposure assessment and blood pressure measurements. The effects of noise on systolic and diastolic pressure were presented in detail.
Results: Studies on aircraft noise had more uniform methodology, indicating a slight tendency towards a positive relationship between aircraft noise exposure and BP in children. The studies on road-traffic noise were methodologically diverse, but compared to aircraft noise studies they showed a more uniform trend in the direction of a positive relationship with systolic BP. The time, place and number of BP measurements, as well as the devices and cuff sizes varied among the studies. Children's age, gender, body composition and ethnicity, and socio-economic status remain the greatest source of diversity in BP values.
Conclusions: The reviewed studies were methodologically diverse concerning noise exposure assessment, BP measurement, study design and control for confounders. In spite of this, they indicate a tendency toward positive association between noise exposure and children's blood pressure. We recommended strategies that might help researchers adopt similar procedures when measuring BP in future field studies.

Contents

Abbreviations: BP, blood pressure; SBP, systolic blood pressure; DBP, diastolic blood pressure; ABPM, ambulatory blood pressure monitoring; SES, socio-economic status.

* Corresponding author at: Institute for Hygiene and Medical Ecology, School of Medicine, Dr Subotica 8, 11000 Belgrade, Serbia. Tel.: +381 11 3612 762; fax: +381 11 2657 852.
E-mail address: paunkaya@gmail.com (K. Paunović).

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1. Introduction

Urban noise is known to increase the risk of arterial hypertension in adults (Babisch, 2006; Belojevic et al., 2008c; Bluhm et al., 2007; de Kluizenaar et al., 2007). A large number of studies have been conducted in the previous 30 years aiming to explore the relationship between noise and blood pressure in children, but their results have been inconsistent and even controversial.

The diversity in results between these studies on noise may be explained by differences in methodology (Stansfeld and Clark, 2009). One possible explanation is the noise exposure assessment; different sources of noise (aircraft vs. road-traffic noise), different times of exposure (daytime vs. night time vs. 24-hour exposure), and different settings of exposure (schools vs. residences) might bring about divergent results. Second, there might be a difference in the study designs and sample characteristics, such as the age of participating children, gender distribution, ethnicity, etc. Finally, the procedure of blood pressure (BP) measurements may be the source of the variability between the studies, making them ineffective in terms of clinical interpretation and prediction of blood pressure in adulthood.

Blood pressure measurement is not an integral part of a routine physical examination of children in many countries. Epidemiological studies, as well as clinical practice require standard measurement and examination procedures in order to make the results comparable and valid. The aim of this review is to explore methodological differences in blood pressure measurement procedure in epidemiological studies on noise and blood pressure in children, and to point out the most important issues that need to be addressed in the future studies.

2. Methods

This is a critical review of papers on the effects of aircraft and road-traffic noise on children's blood pressure published since 1980. Papers were identified by a literature search in Pub Med, Scopus and Google Scholar databases, using “aircraft”, “road-traffic”, “noise”, “blood pressure” and “children” as key words. Papers published in peer-reviewed journals, some conference proceedings and a PhD dissertation (available on the Internet) were included in this review. Papers which were not published in English, laboratory studies, and studies on classroom noise exposure were excluded from the analysis.

In total, thirteen studies were identified; eight were published as papers, four as conference proceedings and one as a PhD dissertation. One study was dealing with the effects of both aircraft and road-traffic noises and was therefore listed and reviewed in both sections. Among seven studies on aircraft noise, four were papers from peer-reviewed journals, two were proceedings and one was a thesis. Among seven studies on road-traffic noise, five originated from peer-reviewed manuscripts and two from conference proceedings.

3. Results

The studies on the effects of noise on blood pressure of children were divided into two groups for convenience: studies on aircraft-noise and studies on road-traffic noise. The differences in research methodology of the studies on aircraft noise and road-traffic are presented in Tables 1 and 3; the results on children's systolic (SBP) and diastolic blood pressure (DBP) are summarized in Tables 2 and 4.

4. Aircraft noise studies

The methodology of the studies on aircraft noise on blood pressure is presented in Table 1. Three out of seven studies were cross-sectional (Cohen et al., 1980; Morrell et al., 1998; van Kempen et al., 2006); four were longitudinal, with the follow-up period of one year (Cohen et al., 1981), two years (Evans et al., 1998) and two to three years (Morrell et al., 2000;; Morrell, 2003). A longitudinal study of Cohen et al. (1981) included a cross-sectional study on noise abatement measures. Generally, the methodology of these aircraft noise studies was fairly uniform (Table 1). The participating children were of similar age, ranging from 8 to 12 years. Children's weight and height were measured and statistically controlled for in almost all of the studies. Nearly all studies were able to control for ethnicity, and most of them have controlled for family history of hypertension.

Noise exposure assessment varied across these studies. Noise levels were measured or modeled for the exposure at schools and/or residences. Some studies relied on daytime levels, others to 24-hour noise levels, or to monthly averaged noise levels (Table 1).

The studies were consistent concerning the use of automatic procedures of blood pressure measurement. However, cuff size was only specified in one study. The total number of BP measurements ranged from two to eight, and only two studies had repeated measurement the following day. The first BP measurement was excluded from the calculation in all the studies except for one. Time of BP measurement was specified only in two studies, but the place of BP measurement was described in the majority of the studies (Table 1)

The outcomes of the studies are presented in Table 2. At a first glance, the results of the studies on aircraft noise looked alike and reported a tendency toward positive correlation between noise exposure and systolic blood pressure (SBP). On the other hand, the relationship between the two was statistically significant in three studies only (Table 2). Among cross-sectional studies, Cohen et al. (1980) showed that children from noisy schools had significantly higher SBP than children from quiet schools. However, when children were categorized according to type of classroom (noisy, abated or quiet), Cohen et al. (1981) reported that children in noisy classrooms had numerically the highest systolic BP, followed by children in abated and quiet classrooms, but the differences were not statistically significant. The RANCH study was conducted in the UK and in the Netherlands and has shown that children exposed to aircraft noise at home during the daytime had significantly higher systolic pressure in comparison to children from quiet homes (van Kempen et al., 2006). Furthermore, although the pooled data showed an increase in SBP in relation to children's exposure to noise at night-time, a decrease in systolic BP was reported in the UK subsample (van Kempen et al., 2006). The relationship between noise exposure at schools/residences and systolic pressure was significant in the Dutch sample, but not significant in the UK sample of this study (Table 2). A third cross-sectional study showed a negative and non-significant relationship between aircraft noise levels at school or residences and children's SBP (Morrell et al., 1998).

Among longitudinal studies, two studies showed a significant increase in systolic pressure two years after the opening of a new airport in Munich (Evans et al., 1998) or a non-significant increase of systolic BP after opening of a new runway in Sydney (Morrell, 2003). The other two studies have reported no association between aircraft noise and SBP (Cohen et al., 1981; Morrell et al., 2000).

The effects of aircraft noise on diastolic blood pressure were also similar in the presented studies (Table 2). Almost all of them reported