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## ABSTRACT

The impact of environmental pollution on public health is currently a major research challenge. This holds true for air pollution, an area where scientific knowledge has advanced significantly in recent times, but also for noise pollution that characterizes the urban spaces in which most of the population is concentrated. In fact, industrial and technological progress has transformed the standard of human life on the Planet. The most diverse motor vehicles invaded the space in which the inhabitants of most cities are born, grow and study. Smoke and noise contaminate the daily lives of people exposing their health novel risks. The population morbidity and mortality increase as consequence of these environmental damages. Scientific studies on the subject have focused on the adult range. As childhood and adolescence are decisive steps for adequate growth and differentiation of the human brain, the impact of air and noise pollution on the health of children and adolescents needs to be better understood. Those studies will provide the fundamental requirements for the adoption of preventive measures necessary for the adequate promotion of the physical, mental and social well-being of the new generations. The focus of this article is on noise pollution during childhood.

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# The Impact of Urban Sound Pollution on Children Health

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*The impact of environmental pollution on public health is currently a major research challenge. This holds true for air pollution, an area where scientific knowledge has advanced significantly in recent times, but also for noise pollution that characterizes the urban spaces in which most of the population is concentrated. In fact, industrial and technological progress has transformed the standard of human life on the Planet. The most diverse motor vehicles invaded the space in which the inhabitants of most cities are born, grow and study. Smoke and noise contaminate the daily lives of people exposing their health novel risks. The population morbidity and mortality increase as consequence of these environmental damages. Scientific studies on the subject have focused on the adult range. As childhood and adolescence are decisive steps for adequate growth and differentiation of the human brain, the impact of air and noise pollution on the health of children and adolescents needs to be better understood. Those studies will provide the fundamental requirements for the adoption of preventive measures necessary for the adequate promotion of the physical, mental and social well-being of the new generations. The focus of this article is on noise pollution during childhood.*

**Keywords:** sound pollution, urban traffic noise, intrauterine sound pollution, classroom pollution, noise impact on students.

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## I. INTRODUCTION

Child development is very complex. Neuroscience and epigenetics have produced well-founded evidence in this regard. The almost complete growth and differentiation of the brain occurs in the first six years of life, named as first childhood<sup>1</sup>. For this reason, trauma at this stage of life may produce sequelae that have long-term impact in physical, mental and social well-being<sup>2</sup>. In addition, the maximal cognitive ability of a human being will only be achieved if the brain, in this development stage, is supplied by optimal nutritional, socio-affective and ecological conditions. Based on current the scientific evidence, it can be stated that the healthy childhood is the foundation of citizenship<sup>3</sup>. However, it is evident that more research is necessary to ascertain the impact of environmental factors on the child's health. An example is the growing noise and atmospheric pollution in urban centers, caused by the heavy traffic of motor vehicles. Smoke and noise exceed acceptable limits, affecting people's well-being. According to the data released by the World Health Organization, the highest world mortality rate is no longer caused by the communicable diseases<sup>4</sup>. Of notice, the mortality resulting from environmental pollution is growing in many countries. Thus, the effects of noise pollution in childhood must be further investigated, as this time-window is likely to be the most detrimental.

## II. OBJECTIVE

The aim of this article is to consolidate the evidence that the environmental noise pollution can have an impact on children's growth and development, with sequelae in adult life. It is a

search for solid evidence that may guide the establishment of preventive measures able to protect the human being in the development phase of his personality.

### III. METHODS

The study is based on the review of scientific articles on the topic, published in the last 10 years, in several countries. The selection parameters of the bibliographic sources used prioritize longitudinal, transversal studies and revisions. Primary point is the emphasis on the age range of childhood. Articles that disclose research involving only the adult population were thus excluded. Among the requirements are the respective year of publication, the type of research carried out, the characteristics of the urban space evaluated, the noise pollution index produced, the size of the sample analyzed, the degree of exposure to the pollutant and the intensity and diversity of the impacts on the health of children and adolescents. For all this, the articles that clearly describe the research data, their consistent statistical evaluation and the exclusion of confounding variables were included. As the greatest differentiation of the brain occurs in the first six years of life, there is a prevalence of articles that evidence damages caused by sound pollution on the child's physical growth, mental development and cognitive ability, as well as on disorders that drag on indefinitely. For the comprehensive analysis of these researches published in the last decade, the consistent interpretative and conceptual correlation between the various contents approached was adopted as consistent scientific evidence of the studied theme. These are the five items that summarize the results of this review.

### IV. RESULTS

Five important scientific evidences emanate from the content of the articles evaluated and fulfill the objectives of the researched topic:

1 - The detriment effects of noise pollution on children's health should be further disseminated.

A proof of this argument validity comes from a research study performed in Turkey through a questionnaire applied to parents of children in educational phase. The aim was to verify the population's awareness about the effects of the environment aggressive factors on the child and adolescent health. Most participants were married and had a high schooling level. One of the formulated questions was if they knew that continuous exposure to noise pollution is a hearing loss risk for their children. The responses were: 82.9% knew; 14.3 percent had no idea; and 2.8% disagreed. Among the environmental risks addressed, noise pollution was the least known by the parents<sup>5</sup>.

2 - Childhood is the postnatal period in which the brain grows and matures physiologically.

Childhood is the irreplaceable moment for the highest cognitive potential of the individual<sup>6</sup>. Therefore, the child should be protected of any environmental pollution that may compromise his/her cognitive potential. Sound pollution is one of the most harmful factors for development, although less recognized as such. The assessments in school settings prove the relevance of the topic. A study performed in South Korea analyzed the performance of elementary and middle school students in two cities. The mapping of the noise level from the urban traffic in the residential areas of students was done. The noise sensitivity was evaluated according to a Likert scale<sup>6</sup> and related to the student's behavioral disorders list. The data analysis proved that the higher sensitivity to noise, greater their behavioral disturbances, especially those of internalization and externalization. In addition, in the low-income group there is a greater noise sensitivity and a higher rate of behavioral disorders<sup>7</sup>.

3 - The school's location can be harmful to students.

This relationship of the location of the school (namely if it is within an area with air and noise

polluters) and the impact on students is confirmed by a research done in Canada. It was found that 16% of public elementary schools in that country are less than 75 meters from road with high traffic<sup>8</sup>. Given that sound pollution is a harmful reality for the health of children, it was shown that this context was detrimental with an increased risk of low cognitive. Another assessment of the environmental noise pollution impact on child development was made in Denmark. The data derives from the Danish National Birth Cohort that focuses on the evaluation of children behavioral problems at 7 years of age and is linked with the information about their history since the conception. The indicators of urban traffic noise in the respective residential neighborhoods were used as reference for the analysis. It was found that an average increase of 10 decibels of child exposure to traffic noise, weighted by time from birth to 7 years of age, produced a 7% increase in the total distress index and a 5% increase in hyperactivity/attention deficit index and a 5% increase in the rates of abnormal behavioral problems and subscales of peer relationship problems. It is clear the noise pollution of urban traffic can cause behavioral disorders such as attention deficit and hyperactivity<sup>9</sup>.

A research conducted in Norway investigated also the likelihood of a link between in utero exposure to traffic noise and increased frequency of attention deficit. The parental information about their childcare was associated with traffic noise patterns. The cause-effect relationship between exposure to traffic noise during pregnancy and attention deficit was analyzed in the age groups of 3 to 8 years; and in the range of complete 8 years old. In the evaluated children, there was an increase in the index of attention deficit related to the noise from the urban traffic, to which they were exposed. It has been proved that noise pollution from urban traffic increases the frequency of attention deficit in children, an impact that also occurs in intrauterine life<sup>10</sup>.

4 - In addition to the polluting noise that comes from outside of the schools, one needs to consider the internal noise, typical of the classroom.

In the classroom the clearest perception of speech is not the general or background noise type. In this context, the most relevant element is the relationship between speech and noise. Following recommendations, the maximum noise in a classroom should be 40 decibels. Furthermore, the ratio between speech and noise should be maintained above 10 decibels for children with normal hearing, taking into account the fact that it is possible the presence of children with hearing loss in the classroom. In fact, the most favorable scenario would be the room noise background of 40 decibels and the speech of the teacher with the normal voice of 65 decibels<sup>11</sup>. This technical standard was not used for the noise assessment studies in the classroom of some countries. Nevertheless, the noise index was above the maximum standard values. The sound school space pollution requires a preventive initiative with the aim to provide the healthy environment conditions for the children and adolescent school learning.

5 - Further research confirms the broad spectrum of the negative noise pollution repercussions on the children and adolescents' health.

The emphasis has been placed on the impact of urban traffic noise, which continues to increase in most countries<sup>12</sup>. The obesity is an example. It is a disease that can cause health damage in all age groups. In addition, stress is among the obesity predisposing factors. This evidence is found for the adult population. There is little research on this subject regarding the child. Based on data from a longitudinal study performed in Norway, it became clear that exposure of the pregnant woman to noise pollution from urban traffic may cause impairment to fetal growth with low birth weight neonates. Children who were exposed to this kind of stress in prenatal life were born with a risk of increasing their body weight during childhood. They reached a high body mass index

(BMI) at 8 years of age if exposed to the same modality of pollution sound in their daily life<sup>13</sup>.

An important hypothesis is based on research carried out in Scandinavia. There is a clear evidence that exposure to traffic noise and air pollution increase the susceptibility to viral infections, the main triggering agent for febrile convulsions. Analysis of the data obtained in a large national cohort shows that the higher is the exposure index for both environmental polluters, the greater is the risk of febrile convulsions for the exposed population<sup>14</sup>.

In the adult stage, one of the negative repercussions of noise pollution on health is the risk of arterial hypertension, which is more pronounced in cases of nocturnal noise pollution, as occurs in spaces close to airports and urban traffic. It has already been shown that environmental noise increases the levels of catecholamines. A study of children's health in South Korea demonstrates that the noise pollution by the urban traffic can impair the ability to interpret reading as well as reduce memory in the long run. It was also found that chronic exposure of children to noise pollution can increase blood pressure, triggering the prehypertensive phase. These findings included children even in the pre-school phase<sup>16</sup>.

## V. DISCUSSION

The scientific articles selected for the systematic review performed fulfill the requirements defined by the methodology adopted. Significant data from national cohorts including the age group of infancy and adolescence provide the necessary robustness to the interpretations proceeded. Another significant feature is the fact that the data analyzed show the reality of different countries. Respecting the cultural and environmental differences, which could be confusing variables, the impact researched refers to the effect of urban sound pollution produced by motor vehicles across the planet, generating increasing and equal pollution. The statistical bases of the revised

articles comply with the scientific principles appropriate to the confirmation of the hypotheses formulated. It is consolidated the clear hypothesis that the urban sound pollution, produced by the motor vehicle fleets, becomes a cause of multiple disturbances that harm the health of children and adolescents. On the other hand, some of the scientific studies reviewed show that the noise pollution of school and educational environments reduces the cognitive potential of the human being in the formation phase of his personality. To reinforce the validity of the cause and effect relationships established, the number of articles selected for the present review was not higher because scientific research on the subject has been concentrated in adults. Childhood is the period of the most complex differentiation of the structure and brain function of the human being. Therefore, it is the age group in which studies on the impact of environmental pollution need to prevail. In summary, the data from the analyzed articles support the scientific evidence identified in its review. They provide the basis for preventive measures to be adopted with the aim of improving the quality of the urban environment in favor of health and education of the new generations.

## VI. CONCLUSION

The above described studies that noise pollution, especially from urban traffic, is an environmental component that endangers the health of population. It impairs the cognitive ability in the school life stage and generates frequent disturbances in childhood, such as attention deficit and hyperactivity. Human exposure to this kind of pollutant can begin in intrauterine life, when noise pollution dominates the pregnant woman's environment. One of the risks, highlighted in this review, is the obesity that affects children daily exposed to noise since prenatal life.

In conclusion, without preventive actions that can protect children of the exposition to the described

risks, the damage for the human society can be difficult to revert.

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