

THE SCHOOL PERFORMANCE OF BOYS FROM RURAL SCHOOLS IN LOWER SILESIA IN THE LIGHT OF LEAD CONCENTRATION IN BLOOD

OSIĄGNIĘCIA SZKOLNE CHŁOPCÓW Z DOLNEGO ŚLĄSKA W ŚWIETLE STĘŻENIA OŁOWIU WE KRWI

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Abstract

Research conducted in many research centers all over the world indicate health threats resulting from the presence of lead in the blood gradually decreases to the permissible amount. Lead accumulation in a living organism results in adverse changes in different body systems, symptoms of which include various behavioral changes. They can be reflected in grades obtained by the child at school.

The aim of this paper was to establish whether the blood lead level diversify the boys in the respect of their school performance during consecutive years of primary education.

The amount of lead in blood of 94 boys at the age of 10 has been measured; subsequently, the group of subjects was divided into two subgroups; the first one (termed in this paper „L”) comprised students whose Pb-B level was lower than 6 µg/dl (4,846 µg/dl on average) and the second one (termed „H”) comprised boys whose blood level exceeded 6 µg/dl (9,256 µg/dl on average). Academic performance in the arts, scientific subjects, geography and natural science in respective groups was assessed. Said procedure was replicated in respective subgroups after a year when the subjects were 11 years old.

It was ascertained that the academic performance of the boys with higher blood lead levels deteriorated in scientific subjects and tended to worsen also in other school subject groups. Performance of the students

whose blood lead level was lower in the initial examination remained unchanged or improved.

Key words: heavy metals, school performance.

Streszczenie

Badania podejmowane w wielu ośrodkach naukowych na całym świecie, wskazujące na zagrożenia zdrowotne wynikające z obecności ołowiu we krwi, zaowocowały stopniowym obniżeniem dopuszczalnej zawartości tego metalu ciężkiego w organizmie. Konsekwencją jego kumulacji są bowiem niekorzystne zmiany obserwowane w układach wewnętrznych, których jednym z przejawów są m.in. różnego rodzaju zmiany behawioralne. Mogą one przekładać się na oceny uzyskiwane przez dziecko w szkole.

Celem niniejszej pracy było określenie czy poziom ołowiu we krwi różnicuje chłopców pod kątem ich osiągnięć szkolnych w kolejnych latach kształcenia w szkole podstawowej.

Wykonano pomiar zawartości ołowiu we krwi 94 chłopców 10-letnich, a następnie całą grupę badanych podzielono na dwie podgrupy; pierwszą (zwaną umownie „N”), w której znaleźli się uczniowie, których poziom Pb-B był mniejszy niż 6 µg/dl (średnio 4,84 µg/dl) i drugą (W) o zawartości ołowiu we krwi przekraczającej ten poziom (średnio 9,25 g/dl). W grupach tych oceniono osiągnięcia w nauce z przedmiotów

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humanistycznych, ścisłych oraz geograficzno-przyrodniczych. Procedurę tę w wyodrębnionych podgrupach powtórzono w kolejnym roku, a więc wśród 11-latków,

Wśród chłopców o wyższej zawartości ołowiu we krwi stwierdzono istotne obniżenie się wyników w nauce przedmiotów ścisłych oraz tendencję do obniżania

się ocen z pozostałych grup przedmiotów. Uczniowie, których poziom ołowiu we krwi był niższy w badaniu wyjściowym utrzymali lub podnieśli poziom swoich osiągnięć szkolnych.

Słowa kluczowe: metale ciężkie, osiągnięcia szkolne

Introduction

The problem of elevated lead concentration in blood and its impact on various aspects of child's development was frequently discussed in the subject literature [i.a. 1–5]. Incidence of adverse changes in the musculoskeletal, digestive, respiratory systems – and particularly in the nervous system [i.a. 6, 7] was indicated. The primary origin of these changes was past exposure of the person under study to heavy metals, either as a result of residing in unfavorable environment, in the vicinity of main transportation routes, or due to direct contact with polluted waste [5, 8]. The consequences of such exposure to various areas of a developing organ and its functioning are of interest to scientists of various disciplines. Taking into consideration the perspective connected with school education, the problem appears to be significant regarding microdamage in brain tissue, described as minimal brain damage, which can cause various neurobehavioral changes [1]. Research conducted in different parts of the world is mainly focused on negative impact of lead in blood on intelligence quotient; much more rarely it is focused on children's school performance [i.a. 9–12]. These surveys seem to be of utmost importance when their social aspect is taken into account. Also the possibility to take the results into consideration in the student care at school, and to perceive school achievements and failures in the context of his/her environment. While analyzing the factors responsible for student's success and failures, one can distinguish a group of factors connected with the child (e.g. intelligence), his/her school environment (e.g. teaching staff), and the living environment (e.g. the socio-economic status of the family) [13]. In the light of a negative influence of lead on cognitive functions it seems important that changes in students' school performance should be monitored.

A question whether there is a connection between blood lead level and students' academic performance which can be viewed as a derivative of intelligence [14], has arisen. The question becomes more important in the light of some surveys which indicated that students who were faced with high blood lead concentration in childhood had more often problems with graduating from high school, in contrast with children whose Pb-B in childhood was right [15–17]. Therefore, the aim of this paper

was to estimate whether students whose lead concentration in blood differed in consecutive years resulted in different outcome in their studies.

Material and Methods

The research on which the present work was based has been conducted in selected rural schools in Lower Silesia, schools located in the immediate vicinity of large industrial plants (smelters). The selection of schools was not incidental; the selection took into account location in similar distance from the cities (Legnica and Głogów), similar infrastructure and demographic structure of the village in which the school was placed, as well as a stable and experienced teaching staff. Families of the scrutinized students presented similar socio-economic status as they were all employed in neighboring plants processing heavy metals (Głogów and Legnica) smelters.

Cooperation with the Foundation for the Children of the Copper Basin in Legnica, provided information in 2005 on full blood lead levels of 122 boys at the age of 10. The markings were conducted using the method of absorptive atomic spectroscopy with electrothermal atomization in the Laboratory of Heavy Metals Toxicology which belongs to the Foundation. Their school performance was estimated on the basis of analysis of school documentation (grade sheets), considering final grades in the arts (Polish, foreign language, history), scientific subjects (mathematics, computer science) and geography and natural science. The study procedure was replicated after a year, when the group of boys decreased to 94 as a result of some boys changing the place of residence or not having measurement of blood lead level taken again. Only results from 94 boys have been analyzed.

The base for breaking the group up into two subgroups was the lead concentration in blood. The boundary was set at the value of 6 µg/dl. Those students whose lead level was below the boundary value fall into the group of low Pb-B level (so called group „L”) and those whose lead level exceeded the value – to the group which will further be termed as group „H” (comprising subjects with higher Pb-B levels). The average blood lead levels of students from both groups differed statistically significantly; boys 10 or 11 years old (Table I).

The significance of differences between average results in the subgroups of students was estimated by the use of analysis of variance, and further lost significant differences (LSD Fisher test), most often used to examine other tests. Calculations were performed in the Laboratory of Biostructure Research at the University School of Physical Education in Wrocław by the use of software package Statistica, version 8.0.

Results

The average blood lead level of students in group L was insignificantly higher at the age of 11 in relation to the level recorded in the previous year (Table I). The inter-year change concerning the boys with high lead level was statistically significant; the average amount of Pb-B exceeded 10 µg/dl. It is noteworthy that in both cases the blood lead level was higher in the group of 11-year-old boys in com-

parison with the same group examined in the previous year.

The school performance in the arts did not significantly differentiate students (Table I). It covers the initial level, namely students from groups L and H examined at the age of 10, as well as the level recorded a year later. However, the tendency for stabilization of the results in group L became evident, whereas the results regarding school performance in the second year of research in the group of students with high Pb-B level decreased in terms of absolute value.

Similar change along with age was recorded in scientific school subjects. The difference in the arts comprising of the initial and secondary examination the grades of students from groups L and H do not differ significantly, but in the group of students with high lead concentration the deterioration of academic performance in the scientific subjects is statistically significant.

Table I. Statistical characterization and LSD test of examined parameters in 10 and 11 year old boys. Significant differences $p < 0,05$ were highlighted in bold.

Tabela I. Charakterystyka statystyczna badanych parametrów u 10 i 11-letnich chłopców. Różnice istotne zaznaczono z $p < 0,05$.

Parameter		Group L n = 35		p	Group H n = 59		p	Difference Group L-H	
		Age (years)			Age (years)			Age (years)	
		10	11		10	11		10	11
Blood Lead Level	x	4,84	5,07	0,8380	9,25	10,54	0,0364	0,0000	0,0000
	s	1,12	0,72		3,12	3,28			
The Arts	x	3,71	3,72	0,9818	3,47	3,26	0,2873	0,3882	0,0946
	s	1,10	1,01		0,92	1,07			
Scientific Subjects	x	3,43	3,47	0,9253	3,50	3,00	0,0286	0,8315	0,1492
	s	1,16	1,25		1,17	1,19			
Geography and Natural Science	x	3,79	3,77	0,9571	3,70	3,36	0,0896	0,7814	0,1567
	s	0,85	1,27		0,93	1,11			

Similar change connected with age in the school performance takes place in the area of geography and natural science, which confirms the previous observations. Older students obtain lower grades in these subjects, although the decrease is more evident in the performance of students from group H, whereas it is negligible in group L. The change, although statistically insignificant, indicates the emerging similar tendency for every of the school subject groups described, i.e. the arts, scientific subjects, geography and natural science (Table I).

Discussion

Dynamic changes which have been taking place during the last twenty years in Poland have drawn attention of the researchers representing various disciplines of science to the phenomena which had previously been inconspicuously presented in the scientific literature. Information that impact of industrial pollution is measurable in developing organisms has rather been avoided and suppressed during the period preceding socio-economic and political events instigated in 1989; progress was

a priority, regardless of its negative effect on the population. Thus, data indicating changes regarding the awareness of adverse effects of high lead concentration in blood are precious. The changes did not only relate to knowledge, but also affect the young population inhabiting endangered areas. These areas included Legnica – Głogów Copper Region; in the last twenty years blood lead levels of children residing in the region decreased from 11 µg/dl to below 4 µg/dl. The followed changes became crucial for the whole of the population, as low Pb-B level include changes in intellectual ability [7]. Intellectual ability consequently affects grades obtained by students at school, although some other factors also play a vital role in the academic performance. Said factors include socio-economic status of the family [18, 19], parents education [20], and living conditions [14]. On top of that academic performance is also influenced by heavy metal pollution level. In case of children from rural areas the pollution level was relatively high because they are in the immediate vicinity of a smelter in Legnica and Głogów [21].

Changes regarding grades in respective groups of students with low and high Pb-B levels may imply that high lead levels at younger age can be of importance to the grades obtained in subsequent stages of education. Despite the fact that the decrease in the level of knowledge and skills which was statistically significant occurred only with regard to scientific subjects in the group of boys with higher blood lead levels, a consistent decreasing tendency has been observed in the record of grades in other school subjects. A similar negative tendency was observed in the research of Canfield and al. (2003); they analyzed the results whose children Pb-B did not exceed 10 µg/dl. The problem of significant deterioration of grades in scientific subjects seems to be critical, as in the contemporary technical world achievements in these disciplines ensure attractive jobs and high social status in the future [22].

The above information draws attention to students' living environment, sharing responsibility for the lead concentration in child's blood. It can be, thus, assumed that the demand for safe blood lead level should not exceed 2 µg/dl or should equal zero [5]; even low Pb-B content (i.e. below 10 µg/dl) is threatening for a growing child and its cognitive functions.

Conclusion

1. It was assumed that students with higher blood lead levels in the initial examination performed statistically significantly worse in scientific subjects; also, decreasing tendency in academic per-

formance in the arts, geography and natural science was observed.

2. It is justified that the pedagogical care and the analysis of student's school performance should take into account the environmental factor such as elevated lead concentration in blood.

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