Heavy Metal Concentration in Human Placenta from Southern Poland

K. Sawicka-Kapusta[1], G. Bydłoń[1], M. Zakrzewska[1], A. Nowicka-Połeć[1], M. Zadrożna[2], B. Nowak[2]

[1]Institute of Environmental Studies, Jagiellonian University, Gronostajowa 7, 30-387 Kraków, POLAND, **katarzyna.sawicka-kapusta@uj.edu.pl**
[2]Department of Pharmacobiology , Jagiellonian University, ul.Medyczna 9, 30-688 Kraków, POLAND

Abstract

The aim of this study was to assess the heavy metals concentration in full term human placenta collected from different polluted areas in southern Poland. Furthermore the study was designed to investigate environmental pollution impact on the accumulation of heavy metals in human placenta. Placentas from healthy women were collected from five different polluted areas in southern Poland: Legnica-Głogów Copper Region, Upper Silesia Industrial Region, Kraków agglomeration, Jastrzębie Zdrój city and Bieszczady Mountains as control. Newborn from Jastrzębie Zdrój and Upper Silesia were much lighter than those from Kraków and Bieszczady region. Highest cadmium concentration was notice in placenta from Legnica-Głogów region while highest lead was found in samples from Jastrzębie Zdrój. Smoking had the effect on lead concentration in placenta. In placenta from Jastrzębie Zdrój effect of sanple location was found. Lead and cadmium were mainly accumulated at the maternal side what indicate that human placenta appears to be the partial barrier for those metals.

Key words: Human placenta, heavy metals, environmental contaminants, placental barrier

Introduction

The potentially adverse effect of chemical substances on the fetus and newborn is of major concern in the medicine. In the second half of 20th century a number of drugs have been shown to be particularly toxic in immature and developing organisms Fetuses and newborn are more susceptible then adults animals and humans. The field of teratology has much expanded in the last 50 years, with the results that much knowledge has been acquired of the development of the fetus (Kacew and Reasor 1984, Nordberg et al. 2008). Drugs are not the only chemicals that can affect the fetuses and the newborn. During the last few decades numerous of different chemical substances, including the wide range of heavy metals, are present in the environment. They are present in air, water and soil as the result of human activity. Some of them are highly persistent and may enter the female organism through the food chain. Heavy metals as lead, cadmium, mercury, nickel and chromium can cross the placenta barrier, accumulate in fetus and caused severe disorders in developing organism. Most of the data regarding the negative effect of those metals on fetuses were received from animal studies mostly on rodents. Mammalian organisms are very similar so the result obtained from animals can be for some extend useable for human. Data on this field (both from animals and human) from Poland are very scarce (Zakrzewska 1988, Zadrożna 1996, Zadrożna et al. 1998, Zakrzewska et al. 2002. The aim of this study was to assess the heavy metals concentration in full term human placenta collected from different polluted areas in southern Poland. Furthermore the study was designed to investigate environmental pollution impact on the accumulation of heavy metals in human placenta.

Material and Methods

Full term placenta from healthy women from five different polluted areas from southern Poland were collected between year 1995 and 2007. First group consist from 20 samples were collected between 1995-1998 in Legnica-Głogów Copper Region (LGOM), second group (19 placenta) was sampled in 2000-2002 in Upper Silesia Industrial Region (GOP). Third group (20 placenta) were collected in Kraków agglomeration (Małopolska district) between 2000-2002. Fourth group (5 placenta) were taken in 2007 from hospital in Jastrzębie Zdrój city located in high industrial region in Silesia district (Table 1). Control group was from Bieszczady Mountains. From this region 25 samples were collected between 2000-2002. All samples were wet digested in mixture of HNO_3 and HClO4 (4:1) and the

concentration of heavy metals (Cd, Pb, Cu, Zn and Fe) was analysed using atomic absorption spectrophotometer PerkinElmer AAnalyst 800 with graphit furnace for Cd, Pb,Cu and with flame for Zn and Fe (Damek-Poprawa and Sawicka-Kapusta 2003). Additionally placenta from Jastrzębie Zdrój city were analysed for the same heavy metals in placentas layers (in relation to thickness of the placenta), anatomic segments of placenta (paracentral and central part) and placentas intended beams (designed from umbilical cord). Metal concentrations are presented in μg/g dry weight.

Results and discussion

Cadmium concentrations in placentas were low and ranged from 0.05 μg/g in women from Kraków agglomeration to 0.20 μg/g in placenta collected in Legnica-Głogów Copper Region (LGOM) (Table 2). No statistical significant differences from all investigated places were found. Low lead concentration was noticed in human placenta from Bieszczady Mountains and Upper Silesia Industrial Region (GOP), 0.06 and 0.03 μg/g respectively. The higher value (0.24 μg/g on average) was found in Kraków and LGOP regions. There are statistically different from those found in Bieszczady and in GOP. Statistically highest lead concentration (2.66 μg/g) from all others was found in women leaving in Jastrzębie Zdrój city (Table 2). No statistical differences in copper and iron concentrations in placenta samples between investigated areas were found. Zinc concentrations ranged from 47 μg/g in placenta from Bieszczady Mountains to 66 μg/g in samples from LGOM. This highest value was significantly different from results obtained for placentas from GOP, Bieszczady and Kraków regions (Table 2). Age and mothers occupation, pregnancy lenght, newborn sex and Apgar score, placenta vascularization and weight were not statistically different between investigated regions. Newborn from GOP and Jastrzębie Zdrój were much

Table 1. Characteristic of newborn from different polluted sites.

	Sites	N	Mean	SE	Range
Mother's age (years)	GOP	19	**26**	1	17 - 39
	LGOM	20	**26**	1	19 - 37
	Kraków	25	**25**	1	20 - 32
	Jastrzębie Zdrój	5	**34**	2	30 - 41
	Bieszczady	25	**28**	1	19 - 38
Body weight (g)	GOP	19	**3107** [1]	109	2100 - 3730
	LGOM	20	**3445** [1,2]	125	2600 - 4750
	Kraków	20	**3561** [2]	85	3050 - 4720
	Jastrzębie Zdrój	5	**3010** [1]	205	2600 -3700
	Bieszczady	25	**3616** [2]	106	2750 - 5150
Body lenght (cm)	GOP	19	**53** [1]	0,6	48 - 57
	LGOM	20	**55** [1,2]	0,7	49 - 60
	Kraków	20	**54** [1,2]	0,7	43 - 60
	Jastrzębie Zdrój	5	**54** [1,2]	0,9	52 - 57
	Bieszczady	25	**56** [2]	0,2	38 - 41

1,2 - different numbers indicates statistically important differences between investigated areas ($p < 0,05$)

Table 2. Heavy metal concetrations in human placenta from different contaminated sites.

	Sites	N	Mean	SE	Range
Cd	GOP	19	**0,06**	0,01	0,00 – 0,20
	LGOM	20	**0,2**	0,12	0,02 – 2,53
	Kraków	20	**0,05**	0,00	0,02 – 0,1
	Jastrzębie Zdrój	5	**0,06**	0,01	0,02 – 0,11
	Bieszczady	25	**0,09**	0,01	0,00 – 0,30
Pb	GOP	19	**0,03** [a]	0,01	0,00 – 0,20
	LGOM	20	**0,24** [b]	0,09	0,01 – 1,53
	Kraków	20	**0,23** [b]	0,10	0,00 – 1,60
	Jastrzębie Zdrój	5	**2,66** [c]	0,77	0,95 – 5,39
	Bieszczady	25	**0,06** [a]	0,01	0,01 – 0,24
Cu	GOP	19	**4,9**	0,5	0,6 – 8,7
	LGOM	20	**4,5**	0,2	3,4 – 6,0
	Kraków	20	**4,4**	0,3	2,7 – 6,7
	Jastrzębie Zdrój	5	**5,2**	0,3	3,2 – 7,4
	Bieszczady	25	**4,6**	0,2	3,5 – 6,7
Zn	GOP	19	**50** [a,b]	3	20 – 37
	LGOM	20	**66** [a]	5	35 – 111
	Kraków	20	**51** [b]	3	33 – 81
	Jastrzębie Zdrój	5	**58** [a]	5	29 – 123
	Bieszczady	25	**47** [b]	2	27 – 67
Fe	GOP	19	**902**	262	10 – 4852
	LGOM	20	**1081**	343	228 – 7485
	Kraków	20	**1089**	192	26 – 3222
	Jastrzębie Zdrój	5	**1069**	299	43 - 1593
	Bieszczady	25	**975**	159	4 – 3841

a,b - different letters indicates statistically important differences between investigated areas ($p < 0,05$)

lighter than those from Bieszczady and Kraków regions (Table 1). It could be effect of contaminated environment (steel heavy industry regions) on pregnant women. Smoking had an effect on Pb concentration in placentas from GOP region - placentas of smoking mothers had higher lead mean value than sample from non-smoking mothers. In human placentas from Jastrzębie Zdrój city the effect of samples location was found. Essential metals were homogenously distributed in components of the placenta. Toxic metals (cadmium and lead) were mainly accumulated at the maternal side of placenta, what indicate that human placenta appears to be the partial barrier for those elements and protect fetus again intoxication. But data we received come only from five placentas so material we investigated was too small.

Conclusion

Our surveys showed that human placenta is not close barrier, as some amount of lead and cadmium can cross it. In case of those two metals it is know that they could be fetotoxic and caused malformation in the offspring.

Acknowledgements

The authors thank the financial supports providing from Institute of Environmental Studies, Jagiellonian University.

References

Damek-Poprawa M, Sawicka-Kapusta K. Damage of the liver, kidney and testis with reference to burden of havy metals in yellow-necked mice from areas around steelworks and zinc smelters in Poland. Toxicology 2003: 186: 1-10.

Kacew S, Reasor M.J.Toxicology and the newborn. Elsevier, Amsterdam, New York, Oxford 1984.

Nordberg G.F, Fowler B.A, Nordberg M, Frieberg L.T. Handbook on the toxicology of metals. Third edition. Elsevier, Amsterdam, Boston, Heidelberg, London, New york, Oxford, Paris, San Diego, San Francisko, Sigapore, Sydney, Tokyo, 2008.

Zadrożna M. The effect of environmental xenobiotics onhistoenzymatic characteristics of human placentae collected in Silesian Copper Minning Territory. Folia Morphologica 1996:4: 464-466.

Zadrożna M, Zamorska L, Nechay O, Niweliński J. Compensatory morphochemical modifications development in human placentae in the Carpathian Mountains affected by xenobiotics. Proccedings Latvian Academy of Sciences 1998;52: 175-180.

Zakrzewska M. Effect of lead on postnatal development of the bank vole (Clethrionomys glareolus) Archives of Environmental Contamination and Toxicology 1988; 17: 365-371.

Zakrzewska M, Białońska D, Sawicka-Kapusta K. Cadmium accumulation in fetus and placenta of bank vole (Clethrionomys glareolus, Schreber 1780) Bulletin of Envionmental Conamination and Toxicology 2002; 69: 829-834.