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PRACA ORYGINALNA
ORIGINAL PAPER

Awareness of parents of preschool children about selected heavy metals in food

Świadomość rodziców dzieci w wieku przedszkolnym dotycząca wybranych metali ciężkich występujących w żywności

Magdalena Dolibóg[1], Weronika Osmala-Kurpiewska[2]

[1]Students' Scientific Club, Department of Environmental Health, Faculty of Public Health in Bytom, Medical University of Silesia, Katowice, Poland
[2]Department of Environmental Health, Faculty of Public Health in Bytom, Medical University of Silesia, Katowice, Poland

ABSTRACT

INTRODUCTION: Human activity has contributed to the widespread distribution of heavy metals in the natural environment. The effects of exposure to heavy metals may not become apparent until many years later. Understanding and understanding the health risks of heavy metals in food is essential to protect children's health. The study aimed to assess the level of knowledge about heavy metals, their occurrence in food, and the health risks to children from eating food contaminated with heavy metals.
MATERIAL AND METHODS: The research tool was the author's questionnaire, consisting of the "specification" part and closed questions, mainly of a single choice. The study group consisted of 100 parents of two kindergartens located in the Silesian voivodeship. The results of the survey questionnaire were developed in Microsoft Office Excel 2019. Statistica 13 (StatSoft) was used for statistical analysis (chi-square test) and statistical significance was assumed at the level of $\alpha = 0.05$.
RESULTS: Parents of preschool-age children are not aware of the associated risks of exposure to heavy metals. Most of the respondents did not read the general information on the presence of heavy metals in food products.
CONCLUSIONS: The awareness of preschool-age parents about selected heavy metals in food is low. It is recommended to implement educational activities to increase the level of parental knowledge about possible health consequences and ways to reduce the health risk resulting from exposure to heavy metals through food.

KEYWORDS

children, heavy metals, food, awareness, health risk, food route

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Address for correspondence: dr n. o zdr. Weronika Osmala-Kurpiewska, Zakład Zdrowia Środowiskowego, Wydział Zdrowia Publicznego w Bytomiu, Śląski Uniwersytet Medyczny w Katowicach, ul. Piekarska 18, 41-902 Bytom, tel. +48 32 397 65 29, e-mail: wosmala@sum.edu.pl

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STRESZCZENIE

WSTĘP: Działalność człowieka przyczyniła się do szerokiego rozpowszechnienia metali ciężkich w środowisku naturalnym. Skutki narażenia na metale ciężkie mogą się ujawnić dopiero po upływie wielu lat. Narażenie dzieci na metale ciężkie drogą pokarmową może stanowić istotne ryzyko zdrowotne, dlatego wiedza oraz postawy zdrowotne rodziców i opiekunów prawnych mają niebagatelne znaczenie w zakresie minimalizacji ryzyka zdrowotnego dzieci. Celem pracy była ocena poziomu wiedzy rodziców na temat metali ciężkich, ich występowania w żywności oraz zagrożeń dla zdrowia dzieci, wynikających ze spożywania żywności zanieczyszczonej metalami ciężkimi.
MATERIAŁ I METODY: Narzędzie badawcze stanowił autorski kwestionariusz ankiety, składający się z części „metryczka" oraz pytań zamkniętych, głównie jednokrotnego wyboru. Grupę badaną stanowiło 100 rodziców z dwóch placówek przedszkolnych zlokalizowanych na terenie województwa śląskiego. Wyniki kwestionariusza ankiety zostały opracowane w programie Microsoft Office Excel 2019. Za pomocą programu Statistica 13 (StatSoft) wykonano analizę statystyczną (test chi-kwadrat), a istotność statystyczną przyjęto na poziomie $\alpha = 0,05$.
WYNIKI: Rodzice dzieci w wieku przedszkolnym nie są świadomi zagrożeń związanych z ekspozycją na metale ciężkie. Większość respondentów nie zapoznawała się z informacjami ogólnymi na temat obecności metali ciężkich w produktach spożywczych.
WNIOSKI: Świadomość rodziców dzieci w wieku przedszkolnym dotycząca wybranych metali ciężkich występujących w żywności jest niska. Wskazane jest wdrożenie działań edukacyjnych w celu zwiększenia poziomu wiedzy rodziców na temat możliwych następstw zdrowotnych i sposobów zmniejszania ryzyka zdrowotnego wynikającego z narażenia na metale ciężkie drogą pokarmową.

SŁOWA KLUCZOWE

dzieci, metale ciężkie, żywność, świadomość, ryzyko zdrowotne, droga pokarmowa

INTRODUCTION

Heavy metals are elements with a density greater than 5 g/cm^3, which have been present on the Earth since the beginning of its existence and are an integral part of the crust [1,2,3]. Natural sources of heavy metals include mainly rock weathering and volcanic eruptions, but also forest fires, ocean evaporation, or soil formation processes [4,5]. The main anthropogenic sources of heavy metal emissions to the environment include industry, mining, metallurgy, and agricultural activities using pesticides and phosphorus fertilizers containing toxic elements. An important source of heavy metal emissions is the extraction of fossil fuels and combustion processes for energy purposes (Figure 1) [4,6].

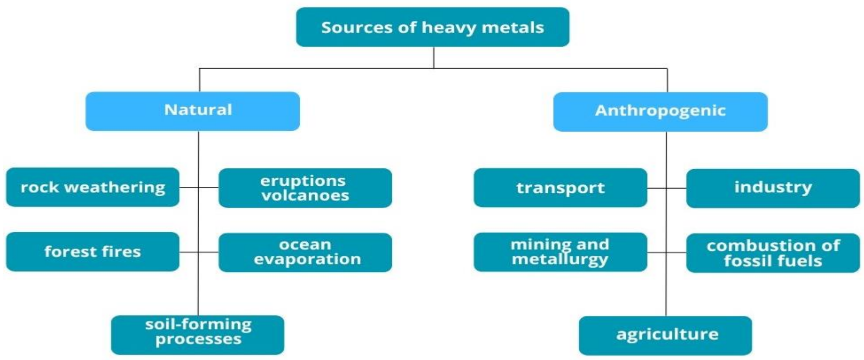

Fig. 1. Heavy metal sources and examples of their emission to the environment (own elaboration based on [4,5]).

Among heavy metals, some elements are necessary for the proper functioning of the human body, called trace elements. Their content should be balanced because improper amounts (deficiency and excess) can lead to negative health effects. An example of microelements that affect proper physiological processes in the human body are iron, zinc, and copper. Some elements do not perform biological functions in the human body and can cause negative health effects even at low concentrations. The most toxic heavy metals include cadmium, lead, and mercury, which enter the human body primarily through the consumption of foods contaminated with them, through the digestive tract [7,8].
Exposure to heavy metals through oral, dermal, respiratory, and non-dietary way is a significant risk factor for the health of adults and children, resulting, among others, from the durability of heavy metals in the environment and their ability to accumulate, as well as carcinogenic properties [3,9]. Due to their high levels of toxicity, lead, cadmium, and mercury are considered to pose significant public health challenges [10]. The study aimed to assess the level of parental knowledge of heavy metals, their presence in food, and

the health risks to children resulting from the consumption of heavy metals.

Effects of exposure to selected heavy metals

Lead (*Pb*)

The health consequences of exposure to lead can result from acute exposure (when taking a significant concentration in a short period of time) or chronic exposure as a result of the accumulation of this element within the body [11]. Exposure of children to this element results from direct ingestion of lead--contaminated food and water. The highest accumulation of this element is found in vegetables – mainly root vegetables, such as carrots or parsley [12]. Up to 50–70% of lead can be absorbed into the child's body, while in adults the absorption of this element in the same way is 5–10% [13]. Inhalation exposure to lead, including smoking, is also significant [11,14,15]. The literature indicates that lead can contribute to decreased concentration, increased irritability, and dementia by affecting the central nervous system (CNS). Convulsions, headaches, coma, and even death may occur at high lead concentrations [15]. Exposure to lead in childhood may be associated with impaired cognitive functions and a lower intelligence quotient (IQ), which may not become apparent until adulthood [16]. Currently, there is no safe dose of lead. The International Agency for Cancer Research (IARC) classified this element in Group 2B as "possibly carcinogenic to humans" [17,18].

Cadmium (*Cd*)

The oral route is considered to be the main route of exposure in non-smokers and people who are not occupationally exposed to this element [19]. Exposure to cadmium may also result from the absorption of this element through the skin and during inhalation – by inhalation [20]. Food products in which significant concentrations of cadmium are determined include rice, potatoes, wheat, and leafy vegetables. This element accumulates in the human body, especially in parenchymal organs such as the liver and kidneys, which are also the organs that remove this element. The health hazard that can be caused by exposure to cadmium is also evidenced by the fact that IARC has classified this element as a human carcinogen, group 1 [21]. Exposure to cadmium may already be in the foetus, as this element penetrates the placental barrier and easily reaches the foetus [22]. Exposure to cadmium can contribute to kidney damage [23]. It also affects the formation of free radicals [24]. Exposure to this element can also contribute to an increased risk of cardiovascular disease [10]. In the literature, the health effects of cadmium are also considered in the context of the effects on reproduction and the immune system [25].

Mercury (*Hg*)

Mercury occurs in three forms: elemental, organic, and inorganic, which differ in their properties and degree of toxicity [10]. The World Health Organization (WHO) has placed mercury on the list of 10 chemicals with the greatest impact on public health [26]. In turn, IARC classified methylmercury as a possible carcinogen (Group 2B), and inorganic compounds as a Group 3 agent – not classifiable in terms of carcinogenicity for humans [27]. The main route of exposure to mercury is ingestion, which results from the consumption of fish and seafood contaminated with this element. This is related to the release of this element into the environment and the possibility of the transformation by microorganisms into methylmercury, which bioaccumulates and biomagnifies in water systems. The highest concentrations of this element are found in large predatory fish such as tuna, swordfish, and mackerel [28]. Mercury can accumulate in the kidneys, liver, and especially in the brain, leading to various health effects, including the cardiovascular system, reproductive disorders, and neurological. Children are more susceptible to the toxic effects of mercury than adults, due to greater sensitivity in the early stages of brain development. The neurotoxic effects of methylmercury may contribute to the occurrence of neurobehavioral disorders in children, manifested by cognitive deficits, reduced motor skills, learning, and memory [29].

Children as an example of a group particularly sensitive to heavy metals

In addition to children, groups that are particularly sensitive to the effects of heavy metals include pregnant and lactating women and the elderly [30]. Attention should be paid to the behavioral development of children, who learn about their environment through touch, often putting their hands in their mouths and touching and objects that may be contaminated with heavy metals [31]. This route of exposure is referred to as non-nutritional and can also occur during physical activity on playgrounds and sports fields through ingestion of contaminated airborne dust particles [9]. The risk of exposure also exists indoors because children spend time in different places than adults. One example is playing on the floor, where children may be exposed to heavy metals with dust from the house [32]. Children's shorter height is also important, particularly in the context of heavy metal exposure by inhalation – the respiratory tract is closer to the ground, which means that children can inhale more pollutants. This is also related to the respiratory rate per minute, which is much higher in children than in adults [33,34]. The phenomenon of distorted appetite, i.e. deliberate consumption of non-food substances (e.g. soil), may occur in the child population [11,14,35].

In the context of health and proper development, providing the right amount of nutrients in the diet is of great importance. This can be a significant health risk for children because they consume more food per unit of body weight than adults [36]. Children have a different stomach pH than adults. It is 6 to 8 in premature infants and 2.3 to 3.6 in term infants. Children between the ages of 1 and 2 years reach the stomach pH of adults, which is 1.4 to 2.0. Children also have a faster metabolism and inactive enzymes responsible for neutralizing toxins in the body [37,38].

MATERIAL AND METHODS

A total of 100 respondents (parents) whose children attended kindergarten participated in the study. The study was conducted from December 2022 to February 2023. The participation of all the respondents was voluntary after giving oral consent. The research tool was an original questionnaire consisting of closed single-choice metric and questions. In the "metrics" section, there are questions about gender, age, education, and place of residence of parents. The results of the survey questionnaire were developed in Microsoft Office Excel 2019 and presented in the form of tables and figures. Furthermore, statistical analysis (chi-square test) was performed in the study using Statistica 13 (StatSoft), and statistical significance was assumed at the level of $\alpha = 0.05$.

RESULTS

Among all parents surveyed, 74% were women, while men accounted for 26%. 47% of the respondents indicated that secondary and higher education was theirs, while the remaining 6% of the respondents had vocational education. None of the respondents indicated the level of their education as primary or secondary school. 88% of the respondents were professionally active, while 10% of the respondents were unemployed. The largest group among all surveyed parents (45 people), that is 45% of all respondents, were people aged 33–39. There were 44 respondents aged 25–32 years (44%), and the smallest group (11 people) was represented by parents over 40 years of age. Most of the parents who participated in the survey (47%) believed that children were more likely to be exposed to heavy metals in food than adults. At the same time, up to 70% of parents knew that children are exposed to heavy metals only through food. As many as 87% of the respondents believed that the condition/quality of the environment affects the content of heavy metals in food. When asked what percentage of absorbed lead enters the child's body through the digestive tract, only 10% of the respondents gave the correct answer that lead is absorbed in 50––70%. Parents showed a low level of knowledge when asked about the health effects that can occur in children as a result of exposure to lead. 51% of parents indicated headaches and 44% of respondents indicated irritation of the digestive system. Only 5% of the parents knew the correct answer, lowered IQ. We asked parents how they handle vegetables before giving them to children for consumption. 74% of parents apply good practise, washing and peeling vegetables. 19% of the respondents wash vegetables, but do not peel them, and the remaining 7% of people do not wash vegetables, but peel them. None of the parents replied that they did not wash or peel vegetables. When parents were asked which mercury system was the most toxic to them, 57% of them replied that it affected the nervous system. Other people indicated the endocrine system (31%), the immune system (9%), and the urinary system (3%; Table I).

Respondents were asked to determine the frequency of consumption of selected food products by their children. According to the answers to parents' questions about the food products, the most consumed by their children was wheat bread, eaten daily by 38 children and 5 to 6 times a week by 33 children (Table II).

Table I. Respondents' responses on selected heavy metals

Questions asked	Parent responses n = 100 (100%)
1	2
1. Do you think that children are more exposed to heavy metals through food than adults?	
yes	47 (47%)
no	17 (17%)
I don't know	36 (36%)
2. In your opinion, is the oral route the only way to expose children to heavy metals?	
yes	5 (5%)
no	70 (70%)
I don't know	25 (25%)

cd. tab. I

1	2
3. Have you ever heard about the possible health effects of exposure to heavy metals (e.g. cadmium, lead, mercury) through food?	
yes	66 (66%)
no	20 (20%)
I don't know	14 (14%)
4. In your opinion, does the quality/condition of the environment influence the concentration of heavy metals in foods derived from it?	
yes	87 (87%)
no	0 (0%)
I don't know	13 (13%)
5. In your opinion, what percentage of ingested lead (Pb) enters the child's body through the digestive tract?	
up to 5%	11 (11%)
10–20%	44 (44%)
30–40%	35 (35%)
50–70%	10 (10%)
6. Which of the following health effects do you think children may experience as a result of lead exposure?	
headache	51 (51%)
lowered intelligence quotient (IQ)	5 (5%)
irritation of the digestive system	44 (44%)
7. Which vegetables do you think contain the most heavy metals?	
in leafy vegetables (e.g. spinach, lettuce)	35 (35%)
in fruit vegetables (e.g. cucumber, tomato)	12 (12%)
in root vegetables (e.g. carrot, parsley)	53 (53%)
8. How do you handle vegetables before your child eats them?	
I wash but don't peel	19 (19%)
I don't wash but peel	7 (7%)
I wash and peel them	74 (74%)
I don't wash and I don't peel	0 (0%)
9. How does your child most often eat vegetables?	
raw	36 (36%)
in juices	11 (11%)
in soups	42 (42%)
steamed	2 (2%)
another (mousses)	2 (2%)
boiled	7 (7%)
10. Which group of foods do you think accumulates the most mercury (Hg)?	
in meat	10 (10%)
in fruit	8 (8%)
in vegetables	5 (5%)
in fish	77 (77%)
in milk and milk products	0 (0%)
in cereal products	0 (0%)
11. Which system in the human body do you think mercury is most toxic to?	
endocrine system	31 (31%)
immune system	9 (9%)
nervous system	57 (57%)
urinary system	3 (3%)

cd. tab. I

1	2
12. Would you like to participate in a training/lecture on the health effects and possibilities of reducing the health risk resulting from exposure to heavy metals in food?	
yes	41 (41%)
no	33 (33%)
I don't know	26 (26%)

Table II. Frequency of consumption of selected food products by children in response

Food product	Every day	5–6 times a week	3–4 times a week	1–2 times per week	1–2 times per month	Does not eat
Carrot	3	8	36	29	21	3
Parsley	1	5	16	34	23	21
Lettuce	6	11	6	22	24	31
Cabbage	1	6	10	21	26	36
Wheat bread	38	33	10	9	6	4
Tuna	0	0	0	1	13	86
Baltic herring	0	0	0	0	14	86
King mackerel	0	0	0	0	24	76

Statistical analysis was performed in the study, taking into account the level of education of parents of preschool-age children and the answers to questions about the toxic effects of mercury on individual systems in the human body, and the answers to the question about the effects of exposure to lead. For this purpose, an empirical distribution was determined. The results of the chi-square test did not show a correlation between education and the answer to the question of the toxic effects of mercury on individual systems in the human body ($p > 0.05$; Table III). In turn, the results of the chi-square test showed a relationship between education and the answer to the question of the effects of exposure to lead ($p < 0.05$). The Cramer coefficient $V = 0.23$ shows a weak correlation between the characteristics examined (Table IV).

Table III. Chi-square test results for variables: education and respondents' answers to the question about the toxic effects of mercury on individual systems in the human body

Statistics	Statistics: Education vs. mercury toxicity		
	chi-square	df	p
chi-square Pearson	3,595869	df = 6	p = 0,73117
chi-square NW	4,243588	df = 6	p = 0,64375
Fi	0,1896278		
Contingency coefficient	0,1863077		
V Craméra	0,1340871		
Spearman's R rank	0,0911812	t = 0,90642	p = 0,36694

Table IV. Results of the chi-square test for variables: education and answers to the question about the effects of exposure to lead

Statistics	Statistics: Education vs. effect of lead exposure		
	chi-square	df	p
chi-square Pearson	10,62613	df = 4	p = 0,03110
chi-square NW	12,66783	df = 4	p = 0,01302
Fi	0,3259774		
Contingency coefficient	0,3099265		
V Craméra	0,2305009		
Spearman's R rank	-0,011111	t = -0,1100	p = 0,91264

DISCUSSION

Upper Silesia is the most polluted region in Poland and, according to the WHO, one of the most polluted regions in Europe [9,39,40]. Intensive and long-lasting industrial activity in the Silesian voivodeship, mainly related to the mining and processing of non-ferrous metals, contributed to heavy metal pollution [9]. For this reason, the study was conducted among parents of preschool children attending kindergartens located in the Silesian voivodeship.

The importance of this problem is demonstrated by the concentrations of toxic heavy metals measured also in playgrounds where children spend their free time. An example of a town with significant soil contamination with cadmium and lead is Księża Góra in Radzionków. The highest concentration of cadmium found in soil samples from playgrounds and sports fields in this were 15.28 mg/kg and 41.22 mg/kg. In turn, the highest concentration of lead was also determined in samples from playgrounds and sports fields in Radzionków were 856.24 mg/kg and 656.16 mg/kg [9]. If we compare the results of these toxic heavy metals with the values specified in the Ordinance of the Minister of the Environment of September 1, 2016, the permissible values of heavy metals such as cadmium and lead in recreational areas are: 2 mg/kg dry matter and 200 mg/kg dry matter, respectively [41]. Not only soils of recreational areas are contaminated with heavy metals, but also soils where local crops are grown, where significant concentrations of heavy metals are also found [42]. The level of heavy metal contamination in vegetables is influenced by, among other things: soil parameters, such as its pH, the content of trace elements in the soil, the content of heavy metals in mineral fertilizers and the doses of fertilizers used, the country and region of cultivation or transport [43].

Due to the toxicity of heavy metals and the possibility of their accumulation in the body, it is necessary to assess the impact of a polluted environment on human health. One of the methods is the use of biomonitoring, i.e. the control of heavy metals in the bodies of residents of areas polluted with toxic elements, based on the analysis of the concentrations of individual elements in hair, nails, blood, urine, bones and teeth [30]. The metal burden in children's bodies remains consistently high, as confirmed by studies conducted in many regions of the world. According to the United Nations International Children's Emergency Fund (UNICEF), 1 in 3 children worldwide (up to 800 million) have blood lead levels at or above 5.0 μg/dl, a level that requires regional and global intervention [44,45].

Few scientific studies have investigated the knowledge of parents of preschool children about the presence of heavy metals in food, but parents' attitudes towards health may influence children's eating habits and choices at an early stage in their lives [46,47]. In our study, most parents surveyed had heard about the potential health effects of exposure to heavy metals through food. When asked: "Do you think that children are more exposed to heavy metals through food than adults?", only 47% gave the correct answer – yes. This knowledge is important because heavy metals pose a significant threat to the health of children, who consume more food per unit of body weight than adults [36]. In addition, vegetables, such as carrots, are often a major part of their diet. Research conducted by Gut et al. [8] showed that even the method of preparing carrots for consumption affects the level of oral exposure of the person consuming them, among other things. For cadmium – the highest cadmium content was found in parts discarded during preparation for consumption (e.g. peel and pomace), therefore carrots should be peeled to minimize the health risk. Our own study showed that it is the food most often consumed by children (3–4 times a week). Carrots, as a root vegetable, are characterized by the highest accumulation of lead next to parsley [12]. In our study, the vast majority of parents (74%), when asked how they handled vegetables before eating tchem. In a study by Shim and Lee [48] examining parental knowledge, behaviors, and concerns about chemical hazards in food, 96% of mothers surveyed (N = 352) also washed fruits and vegetables under running water before eating them. This practice is important in minimizing exposure to heavy metals through the digestive tract. According to some sources, abandoning this practice could contribute to an increase in average lead consumption of up to 130% [49]. In the study by Szefczyk-Polowczyk and Respondek [50] parents of children aged 4–6 years were asked which is the main route by which heavy metals can enter the child's body. 20% of parents with primary/vocational education stated that the main route of heavy metal intake was through the skin. Only 3% of people with the same level of education gave the correct answer regarding the digestive system. In the parents' own survey, 66% of respondents said that they had heard about possible adverse health effects of exposure to heavy metals (e.g. cadmium, lead, mercury) through food. The remainder had not heard of such effects (20%) and could not give a clear answer (14%). Research in recent years has shown that preschool children are the most sensitive [47]. In our study, respondents were also asked about possible health effects in children as a result of lead exposure. The research conducted showed a significant lack of knowledge among the parents surveyed. Only 5% of the respondents with higher education mentioned a decrease in IQ as a possible health effect in children as a result of lead exposure. Parents were also unaware that up to 50–70% of ingested lead enters the child's body through food – only 10% of parents gave the correct answer [13]. On the other hand, when asked which system in the human body mercury is most toxic to, 57% of respondents gave the correct answer, indicating the nervous system. A similar question: "What health effects are associated with exposure to heavy metals?" was asked to respondents participating in the study by Szefczyk-Polowczyk and Respondek [50]. Respondents with primary/vocational education first mentioned respiratory disorders (62%), then headaches (53%), and thirdly disorders of the nervous system (52%). The next most commonly reported effects were anemia (31%) and lower IQ (9%). In our own study, the respondents had to give any answer, while in the study by Szefczyk-Polowczyk and Respondek [50] there were additional answer options, such as “I have no knowledge on this subject”, which was chosen by 17% of the respondents, and “none of the mentioned answers is correct” – the variant chosen by 2% of the respondents. Parents with higher education were more knowledgeable and answered the same question that heavy metals may contribute to nervous system disorders (75%). In our own study, parents also showed a low level of knowledge when answering the question about the time of manifestation of health effects due to dietary exposure to cadmium during childhood. Only 36% of respondents gave the correct answer, indicating adolescence or adulthood [35]. In their own work, respondents correctly identified the food in which most mercury accumulates (fish; 77% of respondents). The study shows that the vast majority of children did not eat fish. In the case of tuna and Baltic herring, this was 86 children, and in the case of king mackerel, 76 children.

When assessing parents’ knowledge of the health effects of exposure to heavy metals, it is worth including basic questions in the survey questionnaire, such as: What are heavy metals? This was not included in our study. Perhaps a better choice would be to ask about general awareness and hygiene habits when preparing food (e.g. washing and peeling vegetables) and to limit questions on specialised knowledge (e.g. percentage of lead absorbed by the digestive system). If such questions are to be asked, it is worth including an ‘I don’t know’ option to check the actual level of knowledge rather than random guessing. Perhaps a good direction would be to investigate parents’ general awareness and perception of the health risks of heavy metal exposure, not only through food, but also through the respiratory tract, non-dietary sources and the skin. In the case of the latter, such a risk should not be ignored in the child population. Research by Chen et al. [44] shows that clothing may be a potential factor for metal exposure in children. However, the available information on the content of heavy metals in children’s clothing is extremely limited and the associated health risks remain poorly understood.

As the results of our own research show, there is a need to improve the awareness of parents of preschool children about heavy metals in food. The role of parents cannot be overemphasized in teaching children good habits that can help reduce health risks from exposure to heavy metals. The most effective methods of providing parents with basic knowledge in this area are still being explored. One of these may be for parents to work with pediatricians, as they are considered the most appropriate people to communicate with about children’s health risks [50]. On the other hand, the Internet can be an important source of information about environmental health hazards. According to some paediatricians, the Internet should be a tool for communicating information about threats as well as prevention methods and programmes [51].

Research on similar topics, which has been scarce so far, could help to raise parents’ awareness of the topic of this paper. Therefore, there is a need to undertake comprehensive educational activities on dietary exposure to heavy metals.

CONCLUSIONS

The awareness of preschool-age parents about selected heavy metals in food needs to be increased. Parents said they had heard about possible adverse health effects from exposure to heavy metals, but they could not identify the health effects associated with children’s exposure to lead, cadmium and mercury. It is recommended to implement educational activities to increase the level of knowledge of parents of preschool children about possible health consequences and ways to reduce the health risk resulting from exposure to heavy metals through food.

Author’s contribution

Study design – M. Dolibóg, W. Osmala-Kurpiewska
Data collection – M. Dolibóg
Data interpretation – M. Dolibóg
Statistical analysis – W. Osmala-Kurpiewska
Manuscript preparation – W. Osmala-Kurpiewska
Literature research – M. Dolibóg

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SURVEY QUESTIONNAIRE

Gender: □ female □ male

Parents' ages (in years): …………………………………………....

Education: □ primary □ middle school □ vocational □ secondary □ higher

Domicile: □ village □ city up to 100 thousand inhabitants □ city with over 100 thousand residents

Status of the profession: □ student □ working □ unemployed □ pensioner □ other, *what?* ……………………

Gender of the child: □ female □ male

Date of birth of the child: |_|_|- |_|_| - |_|_|_|_|

day month year

1. Do you think that children are more exposed to heavy metals through food than adults?

□ yes □ no □ I don't know

2. In your opinion, is the oral route the only way to expose children to heavy metals?

□ yes □ no □ I don't know

3. Do you think that heavy metals have only negative effects on health?

□ yes □ no □ I don't know

4. Have you ever heard about the possible health effects of exposure to heavy metals (e.g. cadmium, lead, mercury) through food?

□ yes □ no □ I don't know

5. In your opinion, does the quality/condition of the environment influence the concentration of heavy metals in foods derived from it?

□ yes □ no □ I don't know

6. Have you ever read general information on the presence of heavy metals in food? (websites, scientific articles)

□ yes □ no

7. Do you check the country or region of origin of food before you buy it?

□ yes □ no □ I don't know

8. In your opinion, which group of foods contains the most toxic heavy metals, such as cadmium (Cd) or lead (Pb)?

□ in meat □ in fruit □ in vegetables □ in fish □ in milk and milk products □ in cereal products

9. In your opinion, what percentage of ingested lead (Pb) enters the child's body through the digestive tract?

□ up to 5% □ 10–20% □ 30–40% □ 50–70%

10. Which of the following health effects do you think children may experience as a result of lead exposure?

□ headache □ lowered intelligence quotient (IQ) □ irritation of the digestive system

11. Which vegetables do you think contain the most heavy metals?

□ in leafy vegetables (e.g. spinach, lettuce) □ in fruit vegetables (e.g. cucumber, tomato) □ in root vegetables (e.g. carrot, parsley)

12. How do you handle vegetables before your child eats them?

□ I wash but don't peel □ I don't wash but peel □ I wash and peel them □ I don't wash and I don't peel

13. How does your child most often eat vegetables?

□ raw □ in juices □ in soups □ steamed □ other, *what kind?*……………………

14. How long do you think the health effects of oral exposure to cadmium in childhood may take to become apparent?

□ up to several weeks after exposure □ up to several months after exposure □ during adolescence or adulthood

15. Which group of foods do you think accumulates the most mercury (Hg)?

□ in meat □ in fruit □ in vegetables □ in fish □ in milk and milk products □ in cereal products

16. What percentage of ingested mercury in organic form (methylmercury) do you think can be absorbed in the gastrointestinal tract?

□ ≤ 45% □ 50–70% □ 75–90% □ > 95%

17. Which system in the human body do you think mercury is most toxic to?

□ endocrine system □ immune system □ nervous system □ urinary system

18. Please indicate how often your child eats selected foods

Food product	Does not eat	1–2 times per month	1–2 times per week	3–4 times a week	5–6 times a week	Every day
Carrot						
Parsley						
Lettuce						
Cabbage						
Wheat bread						
Tuna						
Baltic herring						
King mackerel						

19. Would you like to participate in a training/lecture on the health effects and possibilities of reducing the health risk resulting from exposure to heavy metals in food?

□ yes □ no □ I don't know