FOOD PATTERNS AND CHEMICAL CONTAMINATION OF BABY FOOD

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Studying nutrition patterns in children remains relevant for analysis of nutritional status in the population, including children. Child nutrition is considered the environmental factor that eventually defines the child's health status and life expectancy. The large scale commercial market of adapted and partially adapted milk formulas for bottle feeding usually encourages mothers to refuse to breastfeed and transfer their babies to bottle feeding, which could be unsafe for the child. Supplementary and complementary foods could contain various foreign substances, which could increase chemical load on the growing child's body by means of the consumed food products. The study was aimed to assess nutrition patterns in infants based on the questionnaire survey of 600 mothers in various healthcare institutions and to evaluate chemical contamination of the products for bottle feeding/supplementary feeding of infants, as well as of complementary foods based on the data acquired by the Federal Information Fund for Social and Hygienic Monitoring of the Russian Federation in 65 federal subjects in 2012–2017. The data obtained were processed using the Microsoft Word 2010 and Microsoft Excel 2010 software. It has been found that 37.3% infants are breastfed, 62.7% of infants are bottle-fed or supplemented. In 74.7% of cases complementary foods are introduced at the age of 4–6 months. Fruit and vegetable products are most commonly used as first complementary foods, after which cereal foods (cereal mixes) and canned meat are introduced. These types of food products have the highest concentrations of heavy metals (lead, cadmium, arsenic, mercury).

Ключевые слова: химическая контаминация, токсичные элементы, детское питание, структура питания, грудное вскармливание, продукты прикорма

Keywords: chemicals, toxic elements, baby food, food pattern, breastfeeding, complementary feeding products

Compliance with ethical standards: the study was approved by the Ethics Committee of Pirogov Russian National Research Medical University (protocol No. 15 dated December 14, 2015).

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СТРУКТУРА ПИТАНИЯ И ХИМИЧЕСКАЯ КОНТАМИНАЦИЯ ПРОДУКТОВ ПИТАНИЯ ДЛЯ ДЕТЕЙ РАННЕГО ВОЗРАСТА

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Для анализа качества питания населения, в том числе детского, остается актуальным изучение структуры питания детей. Питание детей — это фактор окружающей среды, который в дальнейшем определяет состояние здоровья и продолжительность жизни детей. Появление на рынке большого количества адаптированных и частично адаптированных молочных смесей для искусственного вскармливания способствует тому, что часто матери отказываются от грудного вскармливания и переходят на искусственное вскармливание, что может быть небезразлично для детского организма. Продукты докорма и прикорма могут содержать различные чужеродные вещества, что будет увеличивать химическую нагрузку на растущий детский организм через продукты питания. Целью исследования явилось: изучение структуры питания детей первого года жизни по данным анкетирования 600 матерей в различных ЛПУ; оценка химической контаминации продуктов для искусственного вскармливания/докармливания и прикорма на первом году жизни по данным федерального информационного фонда социально-гигиенического мониторинга Российской Федерации (ФИФ СГМ РФ) по 65 субъектам за 2012–2017 гг. Полученные данные обрабатывались с использованием компьютерных программ «Microsoft Word 2010» и «Microsoft Excel 2010». Установлено, что 37,3% детей первого года жизни находятся на грудном вскармливании, 62,7% детей получают искусственное вскармливание/докармливание. Возраст введения прикорма в 74,7% случаев — это 4–6-й месяц первого года жизни. В качестве первого прикорма чаще используются фруктовые и овощные продукты, далее вводят злаковые продукты (каши) и мясные консервы. Эти же виды продуктов имеют самые высокие показатели по содержанию тяжелых металлов (свинец, кадмий, мышьяк, ртуть).

Ключевые слова: химическая контаминация, токсичные элементы, детское питание, структура питания, грудное вскармливание, продукты прикорма

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Breastfeeding period, breast milk substitution and introducing complementary foods are the major issues of the infant development. The extent to which these processes would be chemically safe for the child is reflected in the extent of the favorable effects on the child health. The optimized and balanced child nutrition since birth would make it possible to reduce the risk of disease and increase the percentage of healthy children [1–6]. In the early XX century the majority of infants were breastfed (according to the WHO, 70–80%), however, in the early XXI century the majority of infants are bottle-fed, and the breastfeeding rate has reduced to 30–50%. The Decade of Childhood project has been announced in the Russian Federation (2018–2027): one of the priorities of the national policy is wide promotion and support of breastfeeding. Transferring the child to bottle feeding results in the altered metabolism, immune status, and, therefore, the increased risk of allergy, gastrointestinal disorders, and alimentary-dependent diseases [7–9]. The presence of chemical contaminants, such

Table 1. Levels of baby food heavy metal contamination, average values for 2012–2017, Russian Federation

№	Group of food products	Average concentration, mg/kg M ± м
1	Food products for complementary feeding: foods made of fruit and vegetables, canned fruits and vegetables	0.0213 +/- 0.0021
2	Cereal food	0.0199 +/- 0.0012
2a	Instant cereal mixes	0.0195 +/- 0.0014
2b	Cereal mixes, groats and flour that require cooking	0.0178 +/- 0.0020
2c	Instant baby biscuits	0.0367 +/- 0.0073
3	Canned meat, fish and plant food	0.0195 +/- 0.0019
3a	Canned meat and meat with vegetables	0.0194 +/- 0.0021
3b	Canned fish and fish with vegetables	0.0210 +/- 0.0043
4	Cottage cheese and curd products	0.0124 +/- 0.0011
5	Dairy products	0.0098 +/- 0.001
5a	Dairy products (except for milk formulas)	0.0105 +/- 0.0022
5b	Adapted and partially adapted milk formulas	0.0094 +/- 0.001
6	Liquid fermented dairy products	0.0076 +/- 0.0005

as heavy metal (lead, cadmium, arsenic, mercury) salts, even in the concentrations not exceeding the maximum permissible levels, affect the health of children [10–16]. The study was aimed to assess food patterns in infants: define the percentage of the breastfed and bottle-fed babies, assess the terms of introducing complementary foods during the first year of live, evaluate chemical contamination of the products for bottle feeding/supplementary feeding, and complementary foods.

METHODS

The socio-hygienic study (questionnaire survey of 600 respondents) was conducted. The research object and the number of observations were as follows: a total of 500 mothers in health-care institutions of Moscow and 100 mothers in health-care institutions of Shakhty (Rostov region) were interviewed. Healthcare institutions to be included were selected randomly based on a survey. Examination was carried out only with the consent of the interviewed person. The questionnaire survey was voluntary and anonymous. The study did not endanger the subjects and infringe their rights in accordance with the principles of biomedical ethics approved by the Declaration of Helsinki of the World Medical Association (2000). Each of the respondents was invited to answer 39 questions. The total number of survey units was 23,400. Studying food patterns in infants was the subject of the study. Questions were clustered as follows: type of feeding, breastfeeding duration, initiation of complementary feeding and the type of consumed food products, quantity, introduction and types of complementary foods. We also assessed the indicators of the heavy metal (lead, cadmium, arsenic, mercury) chemical contamination of baby food obtained in the Russian Federation in 2012–2017. The data provided by the Federal Information Fund for Social and Hygienic Monitoring were analyzed (form 18, Information on the Sanitary Conditions in the Subjects of the Russian Federation).

Statistical processing involving the use of parametric methods was performed in the constructed databases. The average concentrations (and their errors) of toxic elements in the contaminated samples of baby food obtained in the Russian Federation in the years 2012–2017 were calculated. Student's t-test was used for evaluation of significant differences. We compared the data on baby food contamination with the data on food products used for bottle feeding and foods most commonly used for complementary feeding.

RESULTS

It has been found that 37.3% of infants are breastfed, 62.7% of infants are bottle-fed or supplemented. A total of 7.8% of infants are exclusively bottle-fed from birth. At six months, 44.3% of infants are exclusively breastfed. In Moscow bottle feeding prevails (30.5% of infants are breastfed, 69.5% of infants are bottle-fed or supplemented). In Shakhty (Rostov region), breastfeeding prevails (51.2% of infants are breastfed, 48.8% of infants are bottle-fed or supplemented). In bottle-fed infants, 59.4% of respondents use only the imported adapted milk formulas, and 15.9% of respondents use the domestically-produced foods. In the remainder of cases (24.7%) both imported and domestically-produced adapted milk formulas are used. It has been shown that in 74.7% of cases mothers start introducing complementary foods at 4–6 months of age (as is recommended by pediatricians). However, in 14.5% of cases complementary foods are introduced to infants under four months of age, and in 10.8% of cases these are introduced to infants older than six months. More than a third of mothers (33.9%) introduce fruit as a complementary food. In second place are the fruit and vegetable complementary foods (21.3%), in third place are cereal mixes (16.3%), in fourth place is vegetable puree (11.3%), which is followed by cottage cheese (2.9%), fermented dairy products (2.3%) and dairy products (1.4%). The remaining 10.6% of respondents have noted that they have introduced food products of two groups simultaneously: fruit and cereal mixes, vegetables and cereal mixes, fruit and fermented dairy products.

According to 28.4% of mothers, vegetables are the most common second complementary foods to be introduced. In second place are cereal mixes (22%), and in third place are fruit and vegetable food products noted by 21.8% of mothers. Canned meat and meat with vegetables are the most common third complementary foods (46.3%). In second place are cereal mixes (cereal food) (27%), and in third place are dairy and fermented dairy products noted by 10.5% of mothers. Based on the data acquired in 2012–2017, provided by the Federal Information Fund for Social and Hygienic Monitoring of the Russian Federation, the average concentrations of 9,566 baby

Table 2. The baby food average portion size, g (M ± m)

Group of food products	Average portion size, g (M ± m)			
	1–3 months	4–6 months	7–9 months	10–12 months
Canned meat, fish Food products for complementary feeding: foods made of fruit and vegetables, canned fruits and vegetables	–	98.3 ± 3.8	137.1 ± 5.4	218.2 ± 6.6
Cereal food	–	61.3 ± 2.3	142.6 ± 7.5	207.7 ± 6.8
Instant cereal mixes	–	51.5 ± 2.1	103.8 ± 6.8	119.5 ± 3.3
Cereal mixes, groats and flour that require cooking	–	–	25.7 ± 3.8	66.8 ± 3.5
Instant baby biscuits	–	9.8 ± 1.1	13.1 ± 1.1	21.4 ± 3.3
Canned meat, fish and plant food	–	–	32.3 ± 5.6	53.4 ± 8.5
Canned meat and meat with vegetables	–	–	32.3 ± 5.6	40.5 ± 7.3
Canned fish and fish with vegetables	–	–	–	12.9 ± 2.8
Cottage cheese and curd products	–	–	36.4 ± 2.3	48.5 ± 4.1
Dairy products	758.5 ± 13.8	807.4 ± 18.4	730.5 ± 20.5	643.1 ± 26.2
Dairy products (except for milk formulas)	–	–	–	115.7 ± 8.1
Adapted and partially adapted milk formulas	758.5 ± 13.8	807.4 ± 18.4	730.5 ± 20.5	527.4 ± 29.7
Liquid fermented dairy products	–	–	119.6 ± 10.7	226.3 ± 14.1

food samples contaminated with heavy metals (lead, cadmium, arsenic, mercury) were analyzed (Table 1).

The maximum concentrations of toxic elements were found in the fruit and vegetable complementary foods (0.0213 ± 0.0021 mg/kg M ± м), instant cereal mixes (0.0195 ± 0.0014 mg/kg M ± м), canned meat and meat with vegetables (0.0194 ± 0.0021 mg/kg M ± м). Adapted and partially adapted milk formulas had lower concentrations of toxic elements (0.0094 ± 0.001 mg/kg M ± м). In the majority of cases, the listed above domestically-produced food products had higher levels of heavy metal contamination compared to imported products based on the concentrations in the studied samples.

We assessed food patterns based on the average amounts of basic food products consumed by the bottle-fed/supplemented infants (Table 2).

The average contamination levels of the adapted and partially adapted milk formulas are 1.5–2.3 lower than the average concentrations in complementary foods. However, it is these products that are used as a main food product (as an only food product in infants under 3–4 of age) for bottle-fed infants. Therefore, regular consumption of these products can result in the significant chemical load on the child's body. At the same time, we have to keep in mind that it is fruit and vegetable food products that are used as first complementary foods starting from the fourth month of life (on average). Cereal mixes (cereal foods) are the most common second complementary foods, after which meat products are introduced, including canned baby food. Despite the lowest concentrations of heavy metals, fermented dairy products rank second in the amount of food taken in the second half of the first year.

DISCUSSION

The findings are generally consistent with the results obtained by Rosstat, UNICEF, and the regions of the Russian Federation, being no more than 15% lower. According to Rosstat, in 2017, 43.2% of infants aged 3–6 months and 40.4% of infants aged 6–12 months were breastfed [17–19]. According to UNICEF, in 2018 41% of infants consumed breast milk only during the first six months of life. The higher the economic health, the lower is the rate of breastfeeding [20]. The minimum age at which complementary foods could be first introduced is four months. The optimum age of introducing first complementary foods to a healthy baby is 5–6 months or the age of eruption of first incisors. According to the World Health Assembly resolutions No. 54.2 dated May 18, 2002 and No. 59.13 dated May 4, 2006, in the exclusively breastfed children, first complementary foods should be introduced at the age of six months. Currently, introduction of such complementary foods as vegetable puree or cereal mixes is preferable. It is recommended to introduce meat starting from the age of six months, while in the past it was recommended to introduce meat at the age of seven months or later. It is best to introduce fruit puree during the second half of the first year, and not to use it as a first complementary food. It is recommended to introduce fish not earlier than at the age of eight months [17–19]. When studying children in St. Petersburg, the age of the first complementary food introduction was defined, 5–5.5 months [21]. Similar data were obtained by the authors when performing a questionnaire survey in various regions of the Russian Federation (Astrakhan region, Republic of Bashkortostan, Republic of Tatarstan, Udmurt Republic) [22–24].

Food products, including baby food, have been assessed in various regions of the Russian Federation (Arkhangelsk region, Primorsky Krai, Orenburg region, Saratov region). The priority contaminants (heavy metals) have been found in such food products as dairy products, fruit and vegetable products, meat items, which confirms the results of our analysis of baby food contamination [25–30].

CONCLUSION

The issue of breastfeeding remains relevant due to the fact that only 37.3% of infants consume breast milk in the first year of life. Preventive work in maternity clinics and women's consultation clinics in the form of information kits, leaflets and short booklets, and volunteer work with puerperants would make it possible to increase the number of breastfed babies. This is fully in line with the goal of increasing the abundance of the exclusively breastfed children under six months of age to 50%, stated by both Russian Government within the framework of the Decade of Childhood project and the world community (WHO).

The issues of the complementary food introduction age (a quarter of mothers introduce complementary foods before or after the optimum age) and the type of first complementary

food remain relevant: mothers most often introduce fruit-based products as first complementary foods, while pediatricians recommend to start with vegetable foods or cereal mixes.

Fruit and vegetable complementary foods in the form of the ready for use canned puree, which are most often used as first complementary foods by mothers, are the main contributors to heavy metal contamination. However, such dairy products as the adapted and partially adapted milk formulas play a significant part in the baby food heavy metal contamination due to high consumption as an alternative or supplement to breastfeeding.

The findings dictate the need to apply the measures to improve breastfeeding rate and reduce consumption of the ready to use baby food contaminated with heavy metals in favor of increasing consumption of the self-cooked baby food in infants. Such measures and recommendations would contribute to maintaining the child's health, optimum growth, development, and functional state, as well as to prevention of child morbidity.

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