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Research Article

Risk for Adolescent Health Due To Chemical Contamination of Food and Food Stock

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ABSTRACT

Based on the data on the volume of food consumption data according to the results of the actual nutrition study among the adolescents at the age of 15-17 they calculated the intake of chemical contaminants with local food products and food raw materials. They determined the main food products for adolescents, where chemical contaminants occur most frequently: fruits and vegetables, meat, grain, fish, drinks and milk. They determined the systems most susceptible to the total nonspecific effects at 95%: circulatory, cardiovascular, central nervous and reproductive systems. By the influence of imported products on functional systems they revealed circulatory system and the cardiovascular system. With combined intake of pollutants by food intake, the total hazard index for non-carcinogenic effect development by domestic products (HI) made 9.36 (95%), for imported products HI made 3.1 (95%).

Key words: chemical contaminants, regional exposure factors, adolescent health, non-carcinogenic risk, critical body systems.

INTRODUCTION

The problems associated with global food safety are an important healthcare issue. Within the framework of WHO, the Beijing Declaration on Food Safety adopted by the consensus of the International Forum on Food Safety "The Increase of Food Safety in the World Community" has determined the control over their safety as an essential public healthcare function that protects consumers against health risks created by biological, chemical and physical harmful factors associated with nutrition [1]. Food product safety measures should be based on current scientific evidence and ensure an adequate and an effective compliance with food safety legislation [2-6]. Chemical risk factors remain an important source of food related diseases. The evaluation should be based on internationally agreed principles and be conducted taking into account other factors, such as health benefits, socio-economic factors, ethical and environmental characteristics. As the means of food safety system improvement at the global level, it is necessary to use both positive and negative experiences of the countries with well-developed systems of such security. The diseases of food origin make a significant impact not only on health, but also on the development of many aspects of life. In particular, in the matters relating to the globalization of food trade and the development of international standards for these products promote the increase of awareness concerning the links between food safety and the export potential of developing countries. Therefore, nowadays the priority is the use of the method based on risk analysis, such as the system for risk analysis and critical control points and the development of the programs to monitor food and complete diet [1].In the EU, product security is based on three key elements: legislation, operational response system and standards. In Russia, the priority is the state policy trend in the sphere of population provision with healthy and nutritious food. As the part of RF Government Decree (May 17, 2010) 376-r "The Doctrine of Food Security", "The Fundamentals of RF State Policy in the field of population healthy nutrition during the period until 2020" (The Order of RF Government (25.10.2010) No. 1873-r "On the approval of RF state policy foundations in the field of healthy nutrition of the population for the period until 2020") [7-10]. The wide spread of chemical pollutants in nature, their accumulation in plant and animal organisms directly from the environment or through so-called food chains condition chemical contamination of food raw materials, food products and the entry of xenobiotics (most dangerous to human health) into a human body with food through the gastrointestinal tract [11]. As was noted in several publications, the implementation of national nutrition projects should be carried out taking into account the regional characteristics of the population diet (1-3). The definition of the risk, associated with chemical contamination of food products for the health of a sensitive group of people, particularly the teenagers of Kazan, is relevant and will continue to be the basis for the development of further prevention measures.

Objective Of The Study

The purpose of the study was to assess the effect of food product chemical composition on the health of adolescents in the city of Kazan for the period of 2004-2016.

Material And Methods

The average daily intake of the main food groups by the teenagers of Kazan was determined via the method of 24-hour (daily) nutrition reproduction [12] recommended by the Federal State Scientific Research Institute "Nutrition Research Institute" for these purposes. The assessment of food safety for adolescents was carried out in respect of meat, fish, milk, eggs, bread and flour products, sugar, vegetable oil and other oils, fruits, vegetables and beverages. The list of the main contaminants under study included nitrates, heavy metals and pesticides. In the course of the study, we calculated non-carcinogenic health risks for 15-17 year olds.

To study the quality of food products, the research data of the laboratory of the Federal State-Funded Health Care Institution (FBHI) "Center for Hygiene and Epidemiology in the Republic of Tatarstan (Tatarstan)" and the data on consumption of the main product groups based on the results of sampling studies of the household budgets on the whole in the Republic of Tatarstan were used. The risk assessment was carried out according to the data of the Regional Information Fund (RIF) of social and hygienic monitoring and results of the research carried out on the basis of an accredited laboratory of the Federal State-Funded Healthcare Institution "The Center of Hygiene and Epidemiology in the Republic of Tatarstan" in keeping with Guidelines P 2.1.10.1920-04 [13].

Exposure calculations, contribution of each of the product groups to total exposure value were carried out according to the formulas (1) and (2)

$$\mathrm{Exp} = \frac{\sum_{i=1}^{N}(C_i M_i)}{B}, \qquad (1)$$

Where *Exp* is the value of pollutant exposure, mg/kg body weight/day (mg/kg body weight /week, mg/kg body weight); C_i *is the* pollutant content in the *i*-th product, mg/kg; M_i *is the* consumption of the *i*-th product, kg /day (kg /week, kg/year); *BW is* the human body weight, kg (standard value is 70 kg); *N is* the total amount of products included into the study.

The product contribution to the total value of pollutant exposure was calculated according to formula:

$$C_a = \frac{C_k M_k}{\sum_{i=1}^{N}(C_i M_i)}, \qquad (2)$$

where *Contr is the* contribution of the *k*-th product to the total exposure value; C_i *is* the pollutant content in the *i*-th product, mg/kg; M_i *is the* consumption of the *i*-th product, kg/day (kg/week, kg/year).

Non-carcinogenic risk (route of ingestion: per os) is assessed by calculating the hazard quotient (HQ):

HQ = I/RfD,

where I is an average daily dose substances by oral intake, mg/kg, RfD is a reference (safe) dose.

To assess the total effect of chemical substances, the total hazard index is used:

HI = HQ1 + HQ2 + ... + HQn,

where HQq, HQ2, HQn are the hazard quotients of the 1st ,2nd … n – th chemical substances. The calculation of HI is usually performed only for the substances, affecting the same body organs and systems. To assess the non-carcinogenic risk, the approach based on safe (reference) doses and total hazard indices (THI) was used. The study of the pollutants' toxicity was carried out on the basis of chronic daily ingestion of a substance (the peroral route). The confidence interval of indices, which we determined, was in the range of 95.0% correct prediction probability for the obtained data transfer on the general rural population of the Republic of Tatarstan. Statistical analysis of the obtained data was implemented operating system Windows 2010 with application of standard application program packages Excel 2010 and "истатистическаяпрограмма «STSS».

Results

During the consumption of food products, we calculated the data on the chemical contaminants that enter our body along with food. The analysis of the data on the content of toxic metals in the food products of local production did not reveal the excess of MPC. At that, they used the available data on food consumption, which also have their own uncertainty. In order to assess the risk and to calculate the probable dose of admission among the adolescents at the age of 15-17 years, they used the selective studies of diets. The performed assessment of non-carcinogenic risk has shown that the contamination of domestic food products is formed due to the effects of cadmium, mercury, lead, nitrites and nitrates. The systems most susceptible to total

nonspecific effects are the circulatory system (HI 95%) - 3.3; cardiovascular system with the hazard index (HI 95%) of 1.65; central nervous system (HI 95%) - 0.74; reproductive system (HI 95%) - 0.74. According to the influence of imported products on functional systems, the following data were revealed: circulatory system (HI 95%) - 1.02; cardiovascular system (HI 95%) - 0.85. With the combined intake of pollutants by alimentary way, the total risk index for the development of non-carcinogenic effects by domestic products was 9.36 (95%), for imported products - 3.1 (95%) (Table 1).

Table 1. Critical organs and systems based on non-carcinogenic risk evaluation results during the receipt of chemicals with domestic and imported food products.

Critical organs and systems	Domestic products		Imported products	
	Me	95 %	Me	95 %
Blood	1,04	3,3	0,37	1,02
Kidneys	0,10	0,58	0,03	0,13
Hormones	0,10	0,58	0,03	0,13
Skin	0,02	-	-	-
CNS	0,19	0,74	0,07	0,21
NS	0,14	0,5	0,06	0,16
CVS	0,41	1,65	0,3	0,85
Immune system	0,04	0,23	0,007	0,05
Reproductive system	0,19	0,74	0,07	0,21
Development	0,14	0,5	0,06	0,16
Biochemistry	0,14	0,5	0,06	0,16
Cancer	-	0,001	-	-
HI	2,55	9,36	1,09	3,12

During the evaluation of the non-carcinogenic risk, they revealed the percentage of each contaminant consumed with food. A significant contribution is made by 41.95% (Me) and 29.4% (95%) nitrites, as well as nitrates - 35.7% (Me) and 42.4% (95%). The following results were obtained for the products of the imported production: the leading ones are the nitrates with the values of 75.4% at the median level and 74% (95%), lead - 17% (Me) and 14.3% (95%). The main substances developing the total hazard index were cadmium, lead and mercury. The first place was occupied by lead, the share of which was 12.6% (Me) and 12.9% (95%), the second position was occupied by cadmium 5.54% (Me) and 9.04% (95%) and mercury - 3.92 (Me) and 6.11 (95%), respectively (Table 2).

Table 2. The share of each contaminant in food from the total hazard index (HI).

Contaminants	Domestic products		Imported products	
	Me (%)	95 (%)	Me(%)	95 (%)
Cadmium	5,54	9,04	5,77	6,95
Arsenic	0,16	-	-	-
Mercury	3,92	6,11	1,79	4,53
Lead	12,67	12,92	17,01	14,31
Nitrites	41,95	29,47	-	-
Nitrates	35,73	42,41	75,41	74,19
Benzapyrene	-	0,02	-	-
TOTAL	100	100	100	100

Conclusion

When lead enters a body, the abnormalities of reproductive processes, the central nervous system activity, gastrointestinal tract, cardiovascular and excretory system may take place, the formation of kidney adenoma and adenocarcinoma can occur

[14].Cadmium, like lead, disturbs the activity of kidneys, the sexual and nervous system with an increased intake; it promotes the destruction in bone tissue [14, 15]. Mercury compounds are highly toxic for adolescents: the metabolism is disrupted, degenerative processes develop in the parenchymal organs (liver, kidneys, endocrine glands) [16].Similarly, lead, supplied with food, can reduce the ability of junior schoolchildren to learn at school, the attention and the memorizing educational material, it can hamper the level of intellectual development [17]. According to our calculations, the largest contribution of contaminants to the exposure for imported products is performed by the following types of products: fish, fruits and vegetables, meat and meat products. While among the domestic products vegetable crops, fish, grain and meat are the main ones. Milk and dairy products (35.9%), grain (49.5%), fish, non-fish products of fisheries (19%) make the largest contribution to the mercury exposition. The maximum amount of cadmium comes from the following products: fish and fish products (23.3%), grain (48.8%), fruit and vegetable products (11%).At the same time, such products as milk and dairy products refer not only to socially important goods of mass consumption, but also occupy a special place in the structure of school meals due to digestibility and an exceptional nutrition. Therefore, it is important to reduce the contamination of the dairy products in the Republic of Tatarstan to the minimum [18].

Discussion

The main contribution to the non-carcinogenic risk from food contamination is formed among adolescents due to the effects of nitrates (35%), lead (12%) and nitrites (41%). They revealed a direct relationship between the content of nitrates in foods and the diseases of the digestive system organs among children [19].According to our calculations, the groups with the largest contribution to the exposure of contaminants for imported products are represented by fruits and vegetables, fish, meat and meat products. Whereas the exposure of contaminants for domestic products is represented by vegetables, fish, grain and meat. With the combined intake of pollutants by the alimentary method, the total hazard index of non-carcinogenic effect development was 9.36 (95%) for domestic production, 3.1 (95%) for imported products (HI). The hazard index of more than one (unacceptable level) was obtained from the cardiovascular system and blood during the period of 2004-2016. The study of the increasing chemical load on the body of adolescents has shown that the use of standard values in the methodology of risk assessment leads to the underestimation of the actual risk for adolescent health.

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References

1. Beijing Declaration on Food Safety adopted by the consensus of the International Forum on Food Safety "Food Safety Improvement in the World Community" http://origin.who.int/foodsafety/fs_management/Beijing_decl_ru.pdf
2. WHO Global Strategy for Food Safety. - WHO, 2003. - 33 p.
3. Tetiana Chorna, Dmytro Yanushkevych , Vita Afanasieva Modern Aspects of Safety Assessment of Foodstuff Traektoriâ Nauki Path of Science. 2018. Vol. 4, No 4. pp. 4001- 4012
4. Ghose Bishwajit, Razib Barmon, Sharmistha Ghosh. Reviewing the status of agricultural production in bangladesh from a food security perspective Russian. Journal of Agricultural and Socio-Economic Sciences, 1(25) pp. 19-27
5. Zaitseva N.V., May I.V., Sychik S.I., Fedorenko E.V., Shevchuk L.M. The analysis of the legal and methodological basis of risk-oriented supervision of products circulated at the consumer market: tasks and development prospects in the Eurasian Economic Union. Health risk analysis. 2017. №4. pp. 4-22.
6. Ivanov V.P., Vasilieva Oksana Vladimirovna, Polonikov A.V. Scientific-methodological bases of risk assessment for public health at complex ecology-hygienic study of territories. Ecology of a man. 2012. № 11. pp. 11-19.
7. The doctrine of food security in Russian Federation (approved by the Decree of RF President (January 30, 2010) No. 120).
8. Fundamentals of RF state policy in the field of population healthy nutrition until 2020 (approved by Russian Federation Government Decree No. 1873-r issued on October 25, 2010).
9. The decree of RF Government (25.10.2010) No. 1873-r "On the approval of RF state policy foundations in the field of population healthy nutrition during the period until 2020"
10. The order of RF Ministry of Health and Social Development (The Ministry of Health and Social Development of Russia) (August 2, 2010) N 593 "On the approval of recommendations on rational norms for the consumption of food products that meet modern requirements for healthy eating." Moscow.
11. Fetter V.V. Risk assessment of chemical contamination of food products and food raw materials to public health. Health risk analysis. 2013. № 4. pp. 54-63.

12. Methodical recommendations for the estimation of food amount consumed by the method of 24-hour (daily) reproduction of meal / A.N. Martincik, A.K. Baturin, A.I. Feoktistova, I.V. Svyahovskaya: (26.02.1996) No. C1-19/14-17. M.: RF Ministry of Health, 1996. 24 p.
13. Guidelines for public health risk evaluation during the exposition to pollutant chemicals. - Moscow: Federal Center of the State Sanitary and Epidemiological Supervision of the Ministry of Health of Russia, 2004. - 143 p. (62)
14. Zabashta N.N., Kulpina N.V., Rieger A.N. Nitrates-nitrites are an agroecological aspect of meat raw material obtaining, intended for the development of baby food products on meat basis. The collection of scientific works of the North Caucasian Research Institute of Animal Husbandry. 2015; 4: 70-80.
15. Skripnikov Yu.G., Barabanov I.V. The methods of oxymethylfurfural level reduction in carrot puree for the manufacture of baby food. The bulletin of the Michurin State Agrarian University. 2013; (1): 82-3.
16. Setko A.G., Kuznetsova E.I., Fateeva T.A., Setko I.M. The features of food product contamination consumed by the children of the industrial city. Population health and habitat. 2011; (9): 21-5. 1
17. Istomin A.V., Eliseev Yu.Yu., Eliseeva Yu.V. The conditionality of the risks to health among children by the chemical contamination of food products in the region. ZNiSO. 2014. №2 (251). pp. 1-4.
18. Klepikov O.V., Hatuaev R.O., Istomin A.V., Rumyantseva L.A. Regional features of population nutrition and health risks associated with chemical contamination of food products. Hygiene and sanitation. 2016. № 11.
19. Pivovarov Yu.P., Milushkina O.Yu., Tikhonova Julia Leonidovna, Aksenova O.I., Kalinovskaya M.V. The pollution of baby food in RF by chemical products. Hygiene and sanitation. 2016. № 8. pp. 707-711
20. Unguryanu T.N. Hygienic assessment of food product quality in the city of Novodvinsk. Ecology of a man. 2010. № 12. pp. 10-17.