Ensuring Safe Food for Infants: The Importance of an Integrated Approach to Monitor and Reduce the Risks of Biological, Chemical, and Physical Hazards

Massimo Pettoello-Mantovani, MD, PhD[1,2], Julije Mestrovic, MD[1,3], Leyla Namazova-Baranova, MD, PhD[1,4], Ida Giardino, MD[5], Eli Somekh, MD[1,6], and Mehmet Vural, MD[1,7]

Despite a decrease in biological, chemical, and physical hazards in infant food owing to national and international control programs, the risks of hazards in infant food remain a global concern.[1] Raising consumer awareness on the consequences of unhealthy food consumption, and a growth of consciousness by the food industry of the importance of ensuring protection against contaminants in commercially available products, have limited the risk of food contaminants.[2,3] However, interventions applied across the food supply chain to inspect the presence of food contaminants and help to ensure a sustainable supply of nutritious safe food, are insufficient to provide an extensive and comprehensive protection.[3] Infant food safety in the economically advanced Western world is currently monitored by increasingly strict legal regulations; however, some countries still use banned substances in industrial food production owing to their poor economy and insufficient regulation.[4] The export and import exchange of commercial, often low-cost, infant food products, may raise serious risks for children's health despite the presence of standard control procedures and techniques, which may be insufficient or inadequate to detect a large variety of contaminants in food products.[3,4]

This commentary aims to increase awareness of the necessity to further decrease the risks of hazards of different nature in infants and children's food and to emphasize the importance of developing and constantly update integrated and effective systems for monitoring the presence of contaminants in infant food.[5]

Food Safety in a Globalized World

Food safety and protection of consumer's health are a major concern for many governments. Policies aim to prevent, mitigate, or eliminate risks at different stages of the food chain, while maintaining, providing, and supplying high-quality food to meet consumer demands.[2,4] Globalization involves trade liberalization, integration of production, and consumption and lifestyle patterns; this implies a widespread import, export, and distribution of a great variety of foodstuffs, including food for infants and children. Owing to increasing consumer demand for quality and transparency, larger scale food production, intensive food trade, and growing urbanization influencing production patterns of food, food safety has become a major priority in public health. Food safety and quality assurance involve trust, transparency, and harmonization of practices, which is a prerequisite for the development of efficient and reliable domestic and international trade. However, implementing efficient food safety control is a complex task owing to several factors, including the variety of products resulting from the diversity of raw materials, processing, packaging, and storage and to the different regulatory contexts and health surveillance systems between countries. Furthermore, the diversity and changes in consumer practices favor a constant evolution of products facilitated by agri-food innovations and advances in human health knowledge, which also contribute to the regulatory changes.[6]

EU	European Union

Potential Hazards in Food

Biological, chemical, or physical hazards may be introduced into the food supply at any time during harvesting, processing, transporting, preparing, storing, and serving food. Understanding the risks associated with each of these steps can significantly decrease the potential of foodborne illnesses. All can be avoided through an effective food safety management system.

Biological hazard occurs when food becomes contaminated by micro-organisms. Many micro-organisms are beneficial; however, in the right conditions, some may cause a foodborne illness.[7] Foodborne diseases can be caused by consuming food or water contaminated by pathogenic micro-organisms, which include bacteria and their toxins, fungi, viruses, and parasites.[8,9] Food can be contaminated

From the [1]European Paediatric Association/Union of National European Paediatric Societies and Associations (EPA/UNEPSA), Berlin, Germany; [2]Department of Pediatrics, Scientific Institute "Casa Sollievo della Sofferenza", University of Foggia, Foggia, Italy; [3]Department of Pediatrics, Medical School of Split, University Hospital of Split, Split, Croatia; [4]Russian Academy of Pediatrics, Department of Pediatrics, University of Moscow, Moscow, Russia; [5]Department of Biomedical Sciences, University of Foggia, Foggia, Italy; [6]Department of Pediatrics, Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel; and [7]Department of Pediatrics, Cerrahpasa Medical Faculty, University of Istanbul, Istanbul, Turkey

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both at the source as raw material and during food processing, storage, and distribution. Infected individuals or carriers of pathogens and the environment, through food contact surfaces and facilities, can spread micro-organisms to raw or processed food.

Food contaminants include environmental contaminants, food processing contaminants, unapproved adulterants, food additives, and migrants from packaging materials.[10] Typically, chemicals used for pest control or for cleaning and sanitizing food contact surfaces and food preparation equipment may contaminate food. Persistent organic pollutants are a common and dangerous group of chemical contaminants that persist in the environment, bioaccumulate through the food web, and pose a risk of causing adverse effects to human health and the environment (**Table I**; available at www.jpeds.com).[1]

A variety of extraneous materials in foodstuffs are hazardous to individuals, causing illness or injury. Foreign items can be unintentionally introduced to food products, or naturally occurring objects may fail to be separated along a food processing line and excluded from consumption (**Table II**; available at www.jpeds.com). Materials normally absent in food products include metal fragments in ground meat, bone chips, pieces of product packaging, stones, glass or wood fragments, insects or other filth, and personal items.[11] Furthermore, individuals may be exposed to metals and metal compounds as environmental pollutants from industrial or other human activities.[11] Heavy metals such as lead, arsenic, mercury, or cadmium, may be considered a potential contaminant. These substances are of concern owing to their toxicity, particularly in the case of a long-term intake, because they may accumulate in the body and cause organ damage, especially in susceptible groups, including young children.[11]

The Importance of Developing an Integrated Approach to Food Safety Monitoring

Improving risk assessment and monitoring of food safety, including the use of big data, is important. Effective control programs are required to plan integrated approaches along the entire food chain for detecting, assessing, and mitigating relevant pathogens and other contaminant hazards.[12] That implies the development of efficient food safety control systems, supported by reliable authentication and traceability approaches. Effective control systems should be implemented across the entire food chain, focusing on the combination of hazard monitoring and control options. To overcome the complexity and the diversity of food chains, tools, databases, procedures, and operating models, need to be integrated in a user-friendly and upgradable decision support system for identification, detection, ranking, and control of hazards and risk assessment. A reliable and effective integrated approach is based on the involvement and contribution of different disciplines competent but not limited to risk assessment, food technology, predictive toxicology, residue chemistry, predictive microbiology, child health, data science, and knowledge engineering. The integrated approaches should collect and combine pertinent knowledge and data from the entire food chain, taking into account the diversity of biological, chemical, and physical hazards. Finally, the different criteria contributing to risk ranking should consider and include the public health impact, community perception of the risks, diversity of local cultures, and a rigorous selection of the different sources of information.[12]

In 2020, the European Paediatric Association, Union of National European Paediatric Societies and Associations working group on nutrition joined forces with a consortium of 19 European research centers, coordinated by the French National Research Institute for Agriculture, Food and the Environment, to develop a research program called safe food for infants, supported by the European Union (EU).[13,14] This EU-funded project aims to improve risk-based food safety management of biohazards. To achieve these goals, the consortium is developing procedures to enhance top-down and bottom-up hazard control by combining management options within the frame of the EU Horizon 2020 research and innovation program.[14] In view of the food safety challenges in the monitoring and detecting of contamination in food supplies, whether by accident or fraud, the consortium is developing decision support systems to enhance safety controls along the food chain. Focusing on the potential risks raised by the major international channels of infant food trade, the program is also establishing educational and knowledge transfer activities to foster harmonization of good practices. Global collaboration in the area of food safety and control is of great strategic importance, and the EU program includes cooperation with public health authorities of governments around the world.[15]

Conclusions

Owing to increasing populations and global threats, the integrity and safety of global food chains are at risk. In many countries, simply getting enough to eat can be an issue, with poor quality food often contaminated with hazardous agents, whereas in developed countries the pressure to deliver cheap, affordable food may affect quality and safety.[16]

The fate of nations is determined by what they eat, and pediatricians are on the front line to contain the risks of food hazards.[7,17] They can play a key role if they will actively cooperate and integrate their efforts with governments and local, state, federal, and global public health institutions and agencies, to ensure that infants and children have access to good and safe food. *EPA-UNEPSA thanks the European Commission for its support in the area of child safety. EPA-UNEPSA is a partner of the European Union's Horizon 2020 research and innovation program n.861917.* ■

Reprint requests: Massimo Pettoello-Mantovani, MD, PhD, Department of Pediatrics, Scientific Institute "Casa Sollievo della Sofferenza", University of Foggia, Foggia, Italy. E-mail: mpm@unifg.it

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Table I. Summary of most common persistent organic pollutants: Associated contaminated food and health hazards

Persistent organic pollutants	Contaminated food	Possible hazards
Polyaromatic hydrocarbons	Dairy products, grain, flour and bran, rice, fruit and vegetables, oyster, water	Mutagenicity/carcinogenicity, DNA damage, oxidative stress, impaired male fertility, respiratory diseases, cognitive dysfunction among children and cancer (breast cancer)
Organochlorine pesticide	Eggs, dairy products, meat and meat products, rice, fruit and vegetables, honey, oil, fish, mussel, water	Neurologic symptoms, endocrine disruption, infertility and fetal malformation, diabetes, cancer (breast cancer, testicular, prostate and kidney cancer), reproductive problems, cardiovascular problems, high blood pressure, glucose intolerance and obesity
Polychlorinated biphenyls	Eggs, dairy products, meat and meat products, rice, fruit and vegetables, oil, fish, mussel, water	Endocrine disruption, neurologic disorders, liver injury, diabetes, cancer (breast, prostate, testicular, kidney, ovarian and uterine), cardiovascular problems and obesity
Polybrominated diphenyl ethers	Fish, mussels	Reproductive problems, cancer (testicular), diabetes, obesity and cardiovascular problems
Perfluorinated compounds	Eggs, fish, water	Breast cancer
Hexabromocyclododecanes	Eggs, oil, fish	Endocrine disruption, reproductive problems and behavioral disorders
Polychlorinated naphthalenes	Meat and meat products	Cancers
Dioxins/furans	Eggs, dairy products, meat and meat products, oil, fish,	Language delay, disturbances in mental and motor development, cancer, diabetes, endocrine disruption, high blood pressure, glucose intolerance, and cardiovascular problems

Table II. Common sources of physical hazards in food

Glass	Light bulbs, glass containers and glass food containers
Metal	Fragments from equipment such as splinters, blades, needles, utensils, staples, etc
Plastic	Material used for packaging, fragments of utensils used for cleaning equipment
Stones	Incorporated in field crops, such as peas and beans, during harvesting
Wood	Splinters from wood structures and wooden pallets used to store or transport ingredients or food products
Natural components of food	Hard or sharp parts of a food (eg, shells in nut products)
Metallic contaminants	Natural and anthropogenic sources of heavy metal contamination include agricultural activities, such as pesticide and herbicide application, contaminated irrigation water, municipal waste used for fertilization and mineral fertilizer containing traces of heavy metals