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ENVIRONMENTAL CONTAMINANTS AND THEIR SIGNIFICANCE FOR BREASTFEEDING IN THE CENTRAL ASIAN REPUBLICS

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EXECUTIVE SUMMARY

Breast milk contamination is an issue of concern among health professionals and the general population in the Central Asian Republics. Possible sources of contamination are agricultural pesticides, industrial chemicals, and radioactive materials. A review of the English literature and a limited review of the Russian literature on breast milk contamination in this area reveals a weakness in existing data. Published reports are not based on scientific analyses of breast milk samples. They often fail to specify the contaminant or provide details on the site. No information is available on infant outcomes from breast milk contaminants in the Central Asian Republics.

Previously unpublished data collected in three of the republics in 1988-89 provide useful information on substances found in breast milk samples from the area, including the range of concentration and the number of positive samples. In spite of the fact that DDT had been restricted in the former USSR, the presence of DDT and its metabolites suggests continuing use of this pesticide. The amount of toxicants found in breast milk in the Central Asian Republics is similar to amounts reported in breast milk from other areas of the world.

While most observers are aware of the potential risk of contamination through breast milk, there is less recognition of the importance of *in utero* exposure and direct exposure on infant outcomes. Sources that contribute to the mother's exposure may pose a greater risk to the fetus than to the breastfeeding child. Breast milk substitutes, water and food can be sources of contamination for young children. Drinking water is the major source of nitrate exposure for children.

For many substances, limiting breastfeeding is likely to have a small impact on the child's total body burden. For very stable, non-metabolized, fat-soluble materials like PCBs and DDT or its metabolites, breastfeeding may contribute disproportionately to the infant's exposure. However, studies conducted elsewhere report that chronic, low-level maternal exposures to environmental toxicants such as lead, nitrate, DDT, and PCBs have not resulted in measurable health effects in children who were exposed through breastfeeding.

There are several isolated cases in the world where high body burdens of chemicals have been found in infants, they were generally the result of maternal poisoning that occurred through acute exposure in the work place or accidental food contamination during processing activities. The greater concern than acute intoxicants, some believe, is the long-term carcinogenic effect of exposure to breast milk contaminants. Researchers using a model to estimate the potential cancer deaths from environmental chemicals in breast milk concluded that the lifetime risk of cancer mortality is significantly less than the loss of life due to deaths associated with bottle feeding.

While questions remain regarding the subtle and long-term impact of environmental contaminants on health outcomes, there is clear and documented evidence of the nutritional, immunological, contraceptive, and cost benefits from breastfeeding. A decline in breastfeeding rates in the Central Asian Republics would likely result in higher infant mortality and morbidity rates, and higher maternal fertility rates.

Based on current knowledge of risks and benefits, breastfeeding should be supported and encouraged by policy makers and health professionals in the Central Asian Republics. Health professionals and the

public should be informed of the advantages of breastfeeding and the risks associated with failure to breastfeed. Rigorous research is urgently needed to determine whether contaminants in breastmilk constitute a problem in the Central Asian Republics, and if so, the scope of the problem. Available evidence and models suggest that potential declines in breastfeeding associated with fear of contaminants constitute a much greater threat to infant health than do contaminants in breastmilk. Environmental rehabilitation efforts should get underway to reduce contaminants and the risk of exposure to infants and all members of society.

ENVIRONMENTAL CONTAMINANTS AND THEIR SIGNIFICANCE FOR BREASTFEEDING IN THE CENTRAL ASIAN REPUBLICS

INTRODUCTION

In recent years, considerable attention has been focused on the environmental damage associated with industrial and agricultural practices in the former Soviet Union. As a result of *glasnost* and a developing ecological movement, information about environmental problems and their potential consequences has appeared in both professional literature and the lay media. A recent book is devoted solely to the environmental problems of the former USSR (Feshbach and Friendly, 1992).

This attention to environmental issues has stimulated scientific concern, raised public awareness and, perhaps, contributed to changes in practices that were harmful to the environment and its inhabitants. However, since the available data are often inadequate for an accurate assessment, some of the information may have exaggerated certain environmental hazards and diverted attention from more familiar and possibly avoidable problems. To some extent, this seems to be the case in reports of breast milk contamination.

In the Central Asian Republics (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan), most women initiate breastfeeding with initiation rates ranging between 80 and 90 percent. Health personnel have expressed concern about environmental contaminants in breast milk. There has been discussion of discouraging breastfeeding in highly polluted areas and providing breast milk substitutes. At the same time, there is concern about the effect of lower breastfeeding rates on infant morbidity and fertility. Health officials in all five republics report declining rates of breastfeeding initiation and duration (Welsby, 1993).

This paper looks at both concerns: the possible impact of breast milk contaminants on infant health and the potential effect of declining breastfeeding rates. Sources consulted were reports in the English literature on environmental and breast milk contamination in the Central Asian Republics, a limited evaluation of the Russian literature on the subject[1], unpublished data collected in the Central Asian Republics, and reports of breast milk contamination in other areas of the world.

A review of the English and Russian literature demonstrates the limitations of existing data. Assertions of breast milk contamination in the Central Asian Republics are not based on scientific analyses of breast milk samples. Reports lack specificity and numerical data. For example, many authors and reporters write in generalities, referring to "pesticides," "minerals," or "salts" as major environmental problems. When specific compounds were identified as contaminants in certain areas, there were rarely any detailed descriptions of the site. Furthermore, it is unclear whether these reports of environmental contaminants were based on assumptions or actual measurements.

The review also found that the connection between environmental contamination and illness was asserted without scientific substantiation. The environmental science literature, which covers the contamination of sites, tended to be separate from the literature describing health conditions.

[1] The Russian articles consulted are cited at the end of the reference list.

Recognizing the limitations of the published data, an attempt was made to identify other sources of information. With the help of physician Susan Welsby, a Wellstart consultant in Moscow, and the cooperation of several major scientific organizations in the Central Asian Republics[2], Wellstart International was able to obtain data based on actual analysis of contaminants in breast milk, cow's milk, and some food items from the Central Asian Republics. These previously unpublished data provide a firmer foundation for assessing the risks of breastfeeding and bottle feeding in the Central Asian Republics.

This paper begins with a literature review of environmental and breast milk contaminants in the Central Asian Republics and a discussion of their potential effect on infant health and development. This review is followed by a discussion of implications for public policy.

ENVIRONMENTAL CONTAMINANTS IN THE CENTRAL ASIAN REPUBLICS

The four most frequently cited sources of environmental contaminants in the Central Asian Republics are agricultural pesticides, industrial chemicals, radioactive materials, and human waste. Contaminants from any of these sources can affect the health and development of children. With the exception of human waste, they are all potential vehicles for breast milk contamination.

For female agricultural laborers in the Central Asian Republics, agricultural production could be a significant source of their exposure to contaminants. Pesticides, herbicides and fertilizers are used in cotton production[3], the primary agricultural activity in the Central Asian Republics. Although there has been little industrial development in the Central Asian Republics, the possible toxic effect of exposure to industrial processes cannot be overlooked. In the few cases in the world reporting toxicity through breast milk, industrial exposures or poisonings were identified as the source of contamination. Prevention of such poisonings is largely dependent on the development and enforcement of health standards in the work place.

In addition to occupational risks, women are exposed to contaminants in their home and surroundings. Orchan Makhmudov, director of the Republican Scientific Research Institute for Pediatrics in Tashkent, Uzbekistan, reported that the breast milk of women living down wind of the Tajik Aluminum Works had fluorine contents four times above the acceptable norm (Welsby, 1993). The environment can be polluted by radioactive materials. Poorly monitored hazardous waste disposal sites are located in the Central Asian Republics. Potential household hazards include contaminated food and water and household

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[2] The Institutions and the people who provided data include: Dr. Turegeldy Shurmanov, Director of the Almaty Scientific Research Institute on Regional Nutrition Problems; Dr. Viktor Radzinsky, Director of the Turkmenistan Republican Institute for Maternal and Child Health Protection; Dr. Kafan Subanbaev, Deputy Minister of Health for Kyrgyzstan; and E.M. Butaev, Chief of the laboratory of the Scientific Research Institute of Pediatrics of the Ministry of Health of Uzbekistan; and researchers: Sh.A. Bakanov, Botagoz Kadirsizova, V.I. Korolkova, B.Zh. Kusainovam, Dr. Murat Kuzhukeev, Satbek Musabekov, P.S. Nikov, Stanislav Peotrovsky, Gulnara Semenova, R.M. Smailova, Sh.S. Tazhibayev, G.S. Trepak, Y.S. Turdiev, V.A. Uzbekov, Dr. Vigdorovich; and translators: Dr. Bauyrzhan Amirov and Dr. Murat Kuzhukeev.

[3] Ekstrom and Akerblom (1990) list pesticides that have been used on cotton crops in various part of the world. The list includes: carbendazim, DDT, diuron, DSMA, fluometuron, methyloxyethyl mercury, monocrotophos, MSMA, phosalone, and trifluralin. These authors list monocrotophos as highly hazardous (WHO classification), DDT and phosalone as moderately hazardous, and DSMA as slightly hazardous.

Pesticides used in cereal, dairy, and meat production in Northern Kazakhstan (Almaty Scientific Research Institute on Regional Nutrition Problems/WHO Collaborating Centre for Nutrition, 1986 Annual Report) include "metaphos, carbophos, chlorinephos, cyodrine, coral, trolen, TCM-3 (trichlorinemetaphos-3), 2,4 dichlorinephenol, DDT, alpha and gamma hexachlorinecyclohexanes, heptachlorine, and aldrine."

pesticides. Due to cumulative, continuous exposure, household pesticides may contribute disproportionately to contamination levels in the body.

Tables 1 A-D provide a list of substances used in the former Soviet Union that could pollute the water, air, soil or food. The list, which is not exhaustive, does serve to demonstrate that there are many substances that may raise concerns about environmental contamination. In general, there are few published data indicating that these substances have, in fact, contaminated the environment of the Central Asian Republics.

The large number of substances in this partial list makes it difficult to evaluate their importance as toxicants. The array of chemicals used in industrial societies is very broad. Many chemicals are fat soluble and would, theoretically, accumulate in human adipose tissue[4]. However, reports from other countries indicate that few have proven to be significant human contaminants. It should be noted, though, that not all fat-soluble chemicals have been studied.

BREAST MILK CONTAMINANTS IN THE CENTRAL ASIAN REPUBLICS

The extent to which environmental contaminants are present in the breast milk of women in the Central Asian Republics is unclear. Published information is limited as well as dated. Previous studies on breast milk contaminants of women in the former USSR mention DDT, DDE, and methylene chloride (Jensen, 1983).

Table 2 shows that these substances are only a few of the ones that have been reported in breast milk studies in other parts of the world. This table does not provide information on the quantitative significance of these substances; however, it does indicate that many materials have been documented to enter breast milk. The failure to identify a wider range of contaminants in breast milk in the Central Asian Republics undoubtedly reflects the paucity of studies rather than the absence of other substances in milk.

Recent unpublished data, presented in Tables 3 to 8, expand the list of substances found in some breast milk samples in the Central Asian Republics. The data, collected in 1988-89, are from studies of human milk donated by healthy, lactating women attending maternal and child health centers in different regions of Tajikistan, Turkmenistan and Kazakhstan[5]. Improvements in analytic techniques, rather than the presence of new contaminants, may account for the longer list. Although the number of "positive samples" for certain pesticides may appear high, the sensitivity of the assays that were used is not stated. In some cases, very low quantities were detected, indicating that a sensitive method was used.

The studies checked for DDT, several of its metabolites, and other pesticides and herbicides. Of the substances studied, three were not found in any samples (aldrin, propanide or "PRPD," and celtan). Tables 3 to 8 show the range of concentration and the number or percentage of positive samples.

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[4] In general, the majority of organic materials listed are fat soluble. Minerals are unlikely to be fat soluble unless bound in an organic form, such as methyl mercury. Reference works detailing chemical and known biological properties of these substances are available to assist in evaluating the hazardousness of specific materials.

[5] For other data, sample selection and other details were not provided.

A few general conclusions can be drawn from the data. First, the presence of DDT and its metabolites DDD and DDE in a large portion of samples in the areas of study in Turkmenistan, Tajikistan, and Kazakhstan suggests that DDT continues to be used. The use of DDT was restricted in the former Soviet Union. Secondly, the use of pesticides may vary substantially in different regions, locales and households. Tables 4 to 7 show that pesticides appeared in breast milk samples from certain areas of Kazakhstan but not in others. Substances ranged widely in concentration (10 to 20 fold). Some substances were found in the breast milk of a small portion of women. High levels in individual women may indicate that they used fewer precautions during pesticide use.

Data from a study of the Taldy-Kagan and Almaty areas of Kazakhstan offer a comparison of contaminants in breast milk, cow's milk or water in samples collected during the same time period (Table 7). The analyses tested for more pesticides than previous studies. In the Taldy-Kagan samples, many different pesticide residues were identified. Most of these residues were found in both breast milk and water, although in some samples the level of concentrations was very low. Data on breast milk from the Almaty area showed somewhat fewer pesticides. For those pesticides found in breast milk in both Taldy-Kagan and Almaty, concentrations tended to be higher in breast milk samples from Almaty. In another study in Kazakhstan of pesticides in breast milk and cow's milk, contamination levels were much higher in cow's milk (Tables 6 and 11).

INFANT EXPOSURE AND ASSOCIATED RISKS

Exposure to Environmental Contaminants

Infant exposure to environmental contaminants can occur in utero, through breast milk, or by direct exposure. Theoretical estimates of exposure to toxic substances often overestimate the contribution of breast milk for two reasons. First, the duration of breastfeeding may be much less than assumed. Second, supplementary foods may substantially reduce breastmilk intake as well as contribute significantly to the baby's intake of pesticides (Tables 7, 8, 10, 11).

While most observers are aware of the potential risk of contamination through breast milk, there is less recognition of the importance of *in utero* exposure and direct exposure on infant outcomes. In situations where the concentration of environmental contaminants is high in breast milk, sources that contribute to the mother's exposure may pose a greater risk to the more vulnerable fetus than to the breastfeeding child. Increased maternal infertility, stillbirths, malformations and fetal growth retardation (low birth weight) are some of the possible prenatal manifestations of maternal (or for some outcomes, paternal) contamination.

Postnatally, the infant can be directly exposed to contaminated air, food, or water in the surrounding environment. In some areas of the Central Asian Republics, lack of proper sewage treatment facilities results in widespread contamination of water supplies. Drinking water and breastmilk substitutes prepared with this water can be a source of infant exposure to contaminants.

Drinking water is the major source of nitrate exposure for children. Water standards for nitrate (<45ppm) "appear adequate for protection against methemoglobinemia," but much higher levels are present in water in some areas of the former Soviet Union (Fan et al., 1987). High levels of nitrate in water are of greatest concern for infants and young children who get proportionately more of their total nitrate intake from water. Adult exposure is primarily through consumption of vegetables contaminated by fertilizers. Nitrates do not appear to concentrate in breast milk; milk levels parallel plasma levels.

Breastfeeding may protect infants from excess nitrates because it reduces water consumption, but available data are too limited to prove this hypothesis.

For many substances, limiting breastfeeding is likely to have a small impact on the child's total body burden. However, for very stable, non-metabolized, fat-soluble materials like PCBs and DDT or its metabolites, breastfeeding may contribute disproportionately to the infant's exposure. PCB use is largely limited to specific industrial applications where it is enclosed. DDT is now withdrawn or severely restricted in most countries, including the former USSR. (Jensen, 1983)

Potential Infant Outcomes

When high body burdens of chemicals are found in infants, they are generally the result of maternal poisonings from chemical exposure in the work place, manufacturing accidents, or accidental food contamination during processing activities. Listed below are associations that have been made between maternal poisonings and infant outcomes.

- *Mercury*: poorer cognitive function
- *Copper, lead, or cadmium*: stillbirth
- *Pesticides or radiation*: low birth weight
- *PCBs*: skin rash and discoloration, lethargy, and joint pain in the infant
- *Tetrachlorodibenzodioxin (TCDD)*: malignant neoplasm 20 or more years after exposure.

Reported effects of general environmental exposures are fewer. While environmental contaminants may not result in overt poisoning, they could contribute to disease and disability in widespread yet subtle ways. Below are specific associations cited in the literature.

- *Lead*: reduced IQ and attention deficits in children
- *DDT*: decreased lactation duration
- *Maternal dioxin*: altered newborn thyroid metabolism and an increased incidence of hemorrhagic disease
- *PCBs*: low birth weight
- *Nitrates*: methemoglobinemia (a condition that reduces the oxygen carrying capacity of the blood).

For most toxicants, the values found in breast milk in the Central Asian Republics are similar to values reported in breast milk from other areas of the world (Table 9). The U.S. Committee on Pesticides in the Diets of Infants and Children found no major study demonstrating that pesticide concentrations had led to adverse health outcomes in children exposed through breastfeeding (National Research Council, 1993). At present, information on infant outcomes from breast milk contaminants is not available in the Central Asian Republics. Until such reports are available, information from studies in other areas of the world on infant exposure to environmental contaminants and health outcomes can help to inform policy decisions.

To date, chronic, low-level maternal exposures to environmental toxicants such as lead, nitrate, DDT, and PCBs have not resulted in measurable health effects in children who were exposed through breastfeeding. Of these environmental toxicants, only lead has been clearly implicated for affecting cognitive function and behavior in children who have been exposed to common environmental levels of contamination. None of the several well-controlled studies on the subject has identified breast milk as the source of this contamination. Even though the total exposure to PCBs is greater during breastfeeding, it is believed that prenatal exposure is largely responsible for associations between PCB exposure and functional outcomes. (Rogan, 1986)

In cases where breast milk contaminants have been associated with negative health outcomes, exposure was *acute* as a result of maternal poisoning. A greater risk, some believe, is the long-term, carcinogenic effect of exposure to breast milk contaminants. Below is a summary of the literature on accidental poisoning of infants through breast milk and the long-term effects on cancer outcomes.

Accidental Poisonings

Jensen (1983) summarizes several cases of accidental poisonings that occurred in various parts of the world. In one case, a mother was acutely exposed to perchloroethylene while visiting a dry cleaning facility. As a result, her breastfed child developed jaundice and abnormal liver function. Symptoms disappeared when breastfeeding was temporarily suspended.

In the early 1900s, several of the infants born to a woman employed in the lead industry died. Contaminated breast milk was implicated (but not demonstrated) as the cause of death. In 1933, infant lead poisoning was traced to maternal use of a contaminated toilet powder. It should be noted that the lead content of human milk is normally lower than the lead content of milk formulas (Jensen, 1983) but can be raised by chronic, high exposure. In general, blood lead levels are higher in formula-fed infants.

The literature mentions several other unique cases of accidental poisonings. In Turkey, grain intended for planting was treated with HCB (hexachlorobenzene). This treated grain was made into flour. Infant fatalities were reported among lactating women who had consumed the flour. HCB is now banned in many countries.

Food was also the source of breast milk contamination in another study. During the manufacturing process, PCB (polychlorinated biphenyl) contaminated the rice oil. PCB poisonings ("Yusho" disease) resulted in various skin and nail abnormalities and other symptoms in breastfed infants and infants exposed in utero. Adverse long-term effects on reproductive function have been observed in monkeys exposed to PCB.

In another incident, occurring several decades ago in Michigan, PBBs (polybrominated biphenyls) accidentally contaminated animal feed and created a major public concern about breastfeeding. No clinical effects, however, were demonstrated during the childhood of infants who had been exposed through breast milk.

Cancer Outcomes

Since several fat soluble environmental contaminants are carcinogens, many observers are concerned that exposure will subject breastfed children increased cancer rates during their lifetime. Long-term studies of breastfed and bottle-fed children, which could refute these fears, are not available. However, estimates by Rogan *et al* (1991) of potential cancer deaths from environmental chemicals in breast milk suggest that the lifetime risk of cancer mortality is less significant than the loss of life due to deaths associated with bottle feeding

Rogan *et al* synthesized current knowledge to estimate cancer deaths resulting from potential breast milk exposure to environmental toxicants. They compared these estimates with the estimates of life lost due to bottle feeding under relatively ideal conditions. Using data reported in the literature, they estimated the effects of six toxicants (DDE, dieldrin, heptachlor epoxide, oxychlordane, PCBs, TCDD). The 90th percentile values for all of these toxicants were assumed to be present in breast milk from the same woman. Milk intake was based on full breastfeeding (700g/day) for 9 months. Comparative death rates among bottle-fed and breastfed infants were based on mortality data from England. Carcinogenicity of the six listed breast milk contaminants was estimated from animal data[6]. Death was assumed to result shortly after onset of cancer, generally in adulthood.

Each of these assumptions is "conservative," tending to give maximal estimates of breastfeeding risk. No consideration was given to the carcinogenic role of aflatoxin in powdered milk or formula, the possible impact of pesticides in cow's milk on later cancer development, or the role of bottle feeding in increased incidence and thus disability and death from other diseases such as diabetes and Crohn's disease. Even with these maximal risk estimates, survival rates were higher for adults who had been breastfed in infancy[7]. In the Central Asian Republics, where the differences in death rates of breast and bottle-fed infants are probably greater than in England, the survival advantage for breastfeeding would be even more notable.

BENEFITS OF BREASTFEEDING

While questions remain regarding the long-term impact of environmental contaminants on health, there is clear and documented evidence of the health, contraceptive, and cost benefits from breastfeeding. These benefits are briefly discussed below.

Health Benefits

In the Central Asian Republics, infant mortality is between 40 and 60 per thousand, according to the U.S. Agency for International Development Health Profiles. Diarrhea and upper respiratory diseases are major contributors to infant mortality in these countries. Breastfeeding protects infants from contracting diarrhea and acute respiratory infections while water and breast milk substitutes can expose infants to bacteria and environmental contaminants. Water has been identified as a factor in the propagation of viral hepatitis, typhoid, and diphtheria.

The antibodies present in breastmilk serve as a child's first immunization. In view of recent declines in immunization rates in the Central Asian Republics, the immunities passed to the child through breast milk are very important. In addition to protecting infants against disease, breast milk meets all of an infant's nutritional requirements for growth and development for about the first six months of life.

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[6] Note, however, that these substances are generally not demonstrated <u>human</u> carcinogens.

[7] Furthermore, there is substantial disagreement about the methods used for estimating carcinogenicity and potential cancer deaths from environmental chemicals. Gold et al. (1992) have pointed out that natural food ingredients are as likely as pesticides and other synthetic chemicals to be carcinogenic in tests with rodents. Yet the natural chemicals are present in foods at concentrations thousands to tens of thousands times as high as all pesticides combined. Thus pesticide cancer risk may be greatly exaggerated by rodent tests.

Contraceptive Benefits

Breastfeeding modulates maternal fertility and improves birth spacing, particularly where contraception is not available or not practiced. In the Central Asian Republics, fertility is high, and contraceptive use is low. In 1990, total fertility rates, when adjusted for under reporting, were estimated to be as follows: Kyrgyzstan, 3.9 children per woman; Kazakhstan, 2.9; Turkmenistan, 4.4; and Tajikistan, 5.2 (US Bureau of the Census).

Family size and population growth are high in the Central Asian Republics, resulting in high dependency ratios. Population growth in the 1980s ranged from more than 3% in Kazakhstan, Turkmenistan and Tajikistan to 2.0% in Kyrgyzstan. These rates were considerably higher than the 0.7% growth rate of the former USSR. If birth spacing were to decrease, the economic and health burden of feeding infants with breast milk substitutes would become even greater. Population growth would require increased agricultural productivity, but some individuals are concerned that local agriculture would not be able to meet these demands due to shrinking water resources and deteriorating land quality.

Cost Savings

Breast milk, with its ideal composition and sterile packaging, is inexpensive. Breast milk does not require special resources (like refrigeration) or cash for purchase. It can be produced from all indigenous diets suitable for adults, without technological know-how or industrial development.

If breast milk substitutes are available, their price may be prohibitive. Hard currency is in short supply in the former Soviet Union, limiting purchases of breast milk substitutes from other countries. Purchase of breast milk substitutes diverts needed resources away from other family members, thus, increasing their poverty and undernutrition. For many families, low family income precludes formula use.

IMPLICATIONS OF BREAST MILK CONTAMINATION FOR PUBLIC POLICY

Some observers assume that if toxic substances can be demonstrated in breast milk, breastfeeding should be prevented or discouraged. This position is not supported by the information reported in this literature review. The conclusion of various studies of breast milk contaminants is that the known risks of adverse health effects are small while the benefits of breastfeeding are great.

If breastfeeding is allowed to decline, serious undesirable consequences can occur. In the Central Asian Republics, these consequences will include increased infant mortality, increased demands on the curative health care system, increased demand for hard currency to buy breast milk substitutes and, most likely, increased birth rates as a result of shorter birth intervals.

The findings of this review have the following policy implications for education, research, and environmental rehabilitation.

Education

The idea that breast milk is "toxic" should be disputed. Knowledge of the immediate advantages of breastfeeding, both nutritionally and immunologically, should be widely disseminated so that informed evaluation can be made of any suspected or verified risks. It is important for the public to understand that if breastfeeding is allowed to decline, serious undesirable consequences will result.

The public should be aware that whole cow's milk is not an appropriate nutritional substitute for breast milk. Furthermore, if milk is from local cows or is diluted with local water, it will be contaminated (often at higher levels) with the same toxicants found in maternal milk in the area. Additional contamination of breast milk substitutes can come through enteric bacteria and other pathological organisms in the water.

The public should also be informed of ways to reduce their exposure to environmental contaminants, including the proper use of pesticides and dietary changes. DDT and PCBs can be ingested through consumption of contaminated fish and animal fat. Studies indicate that vegetarian women have lower levels of fat-soluble pollutants than do omnivorous women. Limiting weight loss during lactation could help to reduce mobilization of fat-soluble toxicants such as DDT, DDE and PCBs. In areas where maternal lead exposure is a problem, bone and lead mobilization might be reduced by ensuring adequate intake of vitamin D and calcium during pregnancy and lactation.

Research

Efforts must be made to collect more scientific data on the actual level of contamination in breast milk, other milks and foods, and water. Due to the paucity of factual information, early work should focus on identifying the most serious environmental toxicants. Work in other countries has shown the need to carefully and fully document the scope of the problem, educate the public about the most serious issues, and work on the most hazardous problems first.

Research is urgently needed to specify levels of contaminants in breast milk in highly polluted areas and to investigate any consequences for children. Population-based studies of breastfeeding practices in the Central Asian Republics were not found in the literature. Such information, gathered from a representative population sample, is important for determining infant exposure during breastfeeding.

To appropriately assess the public health effect of breast milk contaminants, the following information is needed:

- maternal demographic characteristics (age, parity, precise geographic areas of residence)
- maternal history of exposure (risk status), including occupational and household exposure and dietary contributors
- breastfeeding practices (incidence, frequency, and duration of exclusive and partial breastfeeding)
- infant exposure through other sources such as breast milk substitutes and water
- levels of breast milk contamination, and
- maternal and infant health outcomes and functional outcomes.

Any reports on breast milk analysis should indicate the range of concentration in positive samples using a specific variance indicator such as standard deviation. Reports should state the analytic methods that were used and give the lower limit of detection under standard conditions of analysis. Studies of breast milk are likely to discourage public support for breastfeeding unless they are carefully designed and responsibly reported. The benefits of breastfeeding should be considered along with data about contamination.

In addition to breast milk analysis, routine blood tests and the analysis of tissue samples obtained during surgeries could provide useful information. If collected with attention to good sampling principles, data from tissue and blood analysis could be more representative of the population than breast milk analysis. Consideration should be given to the development of procedures for routine tissue and blood sample collection and examinations. Monitoring direct infant exposures to environmental contaminants is another research activity that should be considered.

Environmental Rehabilitation

The possible subtle effects of environmental contamination on health and development can be reduced if policies are enacted to rehabilitate the environment. Rigorous studies of breast milk contamination could serve to raise awareness among professionals about more widespread environmental problems. Studies have demonstrated that 6 to 12 months of breastfeeding is generally responsible for a limited amount of exposure compared to 60 to 70 years of direct exposure to environmental contaminants. Existing concern about infant exposure to toxins provides an opportunity to educate the public about other environmental health problems and to mobilize support for corrective actions.

Information collected in studies in other countries and approaches field-tested elsewhere could help to inform public policy and minimize delays in undertaking programs to rehabilitate the environment.

The previously unpublished data presented in this paper indicate that banned substances are still in use in the Central Asian Republics. An early step in rehabilitation efforts should be to reduce use of previously banned chemicals and enforce regulations on pesticide use.

In summary, the actions suggested by this review are as follows:

- **Support breastfeeding.** Educate health professionals and the general public about the nutritional, immunological, contraceptive and economic benefits of breastfeeding.

- **Define the scope of the problem.** Include total lifetime exposure risks when examining infant exposure risks. Begin research studies of the biological loads of the most hazardous substances in an area. Examine alternative (breastmilk substitute) and additional (e.g., air, water, and weaning food) sources of exposure for infants. Monitor breastfeeding practices and sources of exposure.

- **Reduce contaminants.** Identify local sources of contaminants and take action to prevent continued build-up. Enforce existing regulations for chemical use, including bans on certain substances. Use data from other countries as well as local data to develop rehabilitation plans based on a formal set of priorities.

- **Reduce risk of exposure.** Observe maximum safety measures in the work place, at hazardous waste disposal sites, and at home. Improve water and sewage treatment facilities

Environmental problems are numerous and sometimes severe. Perseverance will be needed in an effort that requires costly input as well as long-term commitment.

TABLE 1A

ENVIRONMENTAL CONTAMINANTS IN AREAS OF THE FORMER USSR:[1,2]
Contaminated medium not specified
(possibly in soil, food, water, and/or air)

Generic: salts, bacteria, fertilizers, pesticides, and defoliants
Elements/minerals: aluminum, antimony, arsenic, asbestos, chloride, chromium, cobalt, fluorite, fluorides, lead, manganese, mercury, molybdenum, nitrite, phosphate, selenium, silver, tellurium, titanium, tungsten, uranium, vanadium, zinc
Organic materials: aldrin, alkenyl substituted benzenes, benzene hexachloride, butifos, DDT, fazolone, fenitrothion, gardon, hexamethylene diamine, lindane, malathion, methyl styrene, mono and di-nitrobenzoates, Mg-ammophos, nitrobenzene, nitrotoluenes, omate, opoka dust, pentachloronitrobenzene, phenols, phthalate esters, polychlorophenols, prometrine, propoxur, styrene, treflane, viroden

TABLE 1B

ENVIRONMENTAL CONTAMINANTS IN AREAS OF THE FORMER USSR:
Air polluting substances

Elements/minerals: Arsenic, beryllium, bismuth, cobalt, cadmium, chromium, copper, fluorine, mercury, nickel, lead, selenium, thorium, uranium, vanadium, ozone, sulfur dioxide, nitrogen dioxide, other nitrogen oxides, carbon monoxide, ash[3], asbestos, hydrogen sulfide, hydrochloric acid, hydrofluoric acid, carbon disulfide
Organic materials: acetaldehyde, ambush, azocene, benzopyrene, CFCs, chlorinated hydrocarbons, dichlorpinacolin, 1,2 dichloroethane, dimethylformamide, dioxins, formaldehyde, freon, mercaptan, polycyclic aromatic hydrocarbons, phenols, PCBs, permethrine, sevin, trichodermin

TABLE 1C

ENVIRONMENTAL CONTAMINANTS IN AREAS OF THE FORMER USSR: Water polluting substances

Elements/minerals: Arsenic, calcium, cadmium, chlorine, cesium134, copper, mercury, iodine131, magnesium, ammonia nitrogen, lead, strontium90, sulfite, zinc, nitrates, nitrites, potassium
Leached with acid rain: Arsenic, beryllium, cadmium, cobalt, copper, nickel, lead, zinc
Salt: (sodium chloride specifically, as well as other mineral salts) is a major problem of rivers and other water bodies. The Aral Sea is said to contain 27 g (one ounce!) of salt per liter. Human milk contains about 0.37 g/l and cow's milk about 1.1 g/l
Organic materials: bacteria, benzopyrene, chlorinated phenols, hexachlorane, hydrocarbons, fatty acids, lignin, mono and difurfurylidene acetone, PCBs, pesticides, phenols, phthalimide, polychloronaphthalenes, polycyclic aromatic hydrocarbons, prothiophos, trifluralin (a dinitroaniline herbicide)

TABLE 1D

ENVIRONMENTAL CONTAMINANTS IN AREAS OF THE FORMER USSR: Food contaminants cited in the literature

aflatoxin, benzopyrene, dimethoate, fenitrothion, formothion, fosmet, malathion, phenthoate, phosalone, patulin, nitrite, nitrates

Notes for Tables 1A-D:

1. Several pesticides and other substances such as DDT, aldrin, dieldrin, butifos, chlordane, hexachlorobenzene, PCBs, mirex, toxaphene, endrin, and heptachlor are either no longer manufactured, are restricted in use, or are outlawed in the U.S. and elsewhere. The USSR reportedly banned aldrin, dieldrin, endrin, chlordane, heptachlor, DDT, thimet, azinphos-methyl, dialiphos, dicrotophos, isofenphos, Ultracide, Nemacur, isodrin, carbamates, Temik, dioxicarb, dithiocarbamates, ziram, maneb, bipyridiliums, parathion, demeton, methyl demeton, Ekatin, Thiocron, dinoseb, and paraquat, and restricted the use of DDD. Whether all of these restrictions are observed or enforced is disputed.

2. This list has been culled from a variety of published sources (see bibliography). Some of these sources provided only abstracts or lacked documentation for their claims of contamination. Major sources consulted for this list are Golovleva, 1992; Kutz et al., 1991; Goldberg, 1989; Feshbach and Friendly, 1992; "The Quest for Clean Water" (unknown author); Levy, 1991; Technical University of Budapest, 1992; Bobak and Leon, 1992, and Keller, 1990.

3. Substances such as ash, asbestos, nitrogen dioxide, and ozone may have an adverse effect on lung function when inhaled but no adverse effect through breastfeeding.

TABLE 2

SOME SUBSTANCES THAT HAVE BEEN IDENTIFIED IN HUMAN MILK (WORLD-WIDE)

aldrin	dieldrin	lindane (gamma HCCH)	pentachlorobenzene
arsenic	DDT,DDE,DDD	mercury	perchloroethylene
benzene	Freon 113	methylene and its chloride	PBB,PCB,PCT
benzaldehyde	halothane	methyl mercury	polychlorinated terphenyls
bromide	heptachlor and its epoxide	Mirex	polonium 210
cadmium	hexachlorobenzene	naphthalene	toluene
carbon disulfide	hexachlorocyclo-hexanes	nicotine	selenium
cesium 137	iodine 129	nitrate	TCDD (a dioxin)
chlordane	kepone (chlordecone)	t-nonachlor	zinc compounds
chloride	Kerb (herbicide)	oxychlordane	
chlorofloromethanes	lead210	parathion	
chloroethylenes	limonene	paroxon	
chloroform			
cyclic alkanes			

From Wilson et al., 1980; Kanja et al. (Nairobi), 1992; Kutz et al., 1991; Rogan et al., 1991; Jensen, 1983; Schrieber, 1992, and others.

TABLE 3

PESTICIDES IN WHOLE HUMAN MILK[4] [(mg/l) x 100]
(Range of values and number positive)

REPUBLIC	**Turkmenistan**		**Tajikistan**
Region	Ashgabat	Uly-tan	Dushanbe
Period	May-July '89	May-July '89	July-Sept '89
	N = 16	N = 8	N = 43
PESTICIDE TESTED:			
Hexachlorocyclohexane (HCCH):			
gamma HCCH	0.02[1] (1/16)[2]	--	0.007-9.2 (23/43)
alpha HCCH	0.28-6.3 (16/16)	--	0.016-0.35 (19/23)
DDT and Metabolites:			
pp DDT	0.06-0.5 (13/16)	0.07 (7/8)	1.0-1.1 (29/43)
op DDT	--	--	--
pp DDT	--	--	0.14-0.28 (8/43)
op DDD	--	--	--
pp DDE	0.28-6.3 (16/16)	0.043;2.3 (8/8)	0.21-12 (43/43)
op DDE	0.08 (1/16)	--	--
Others:			
metaphos	--	--	0.48 (1/43)
carbophos	--	--	--
TCM-3[3]	--	--	--
thiodane	--	--	0.16-0.64 (7/43)
Bi-58	--	--	--

Data from the Almaty Scientific Research Institute on Regional Nutrition Problems/WHO Collaborating Centre for Nutrition.

[1]To convert numbers to mg/liter, divide number by 100.
[2]The numbers in parentheses indicate the number of positive samples over the total number of samples analyzed.
[3]TCM-3 is trichlorinemetaphos-3.
[4]Whole human milk was tested, rather than the fat-fraction of human milk.
-- Double dashes indicate that no samples were positive.

TABLE 4

PESTICIDES IN WHOLE HUMAN MILK [(mg/l) x 100]

REPUBLIC	**Kazakhstan**					
Region	Atyray	Atyrau	Chimkent	Chimkent	Dzhambul	Kzylorda
Period	Aug '88	1990	Aug '88	1990	Aug '88	Aug '88
	N = 11	N = 21	N = 22	N = 44	N = 8	N = 14
PESTICIDE TESTED:						
HCCH:						
gamma HCCH	1[1] (2/11)[2]	0.014	0.6-13 (16/22)	0.18	--	--
alpha HCCH	3 (1/11)	0.02	0.03-8 (2/22)	0.03	--	0.01-0.03 (2/14)
DDT and metabolites:						
pp DDT	6-8 (3/11)		--		--	--
op DDT	--		1-10 (2/22)^		1.6-3 (2/8)^	5-10 (2/14)^
pp DDD	3-14 (4/11)		^		^	^
op DDD	--		4-68 (14/22)++		0.1-13 (7/8)++	1-30 (13/14)++
pp DDE	6-98 (9/11)		++		++	++
op DDE	--		--		--	--
DDT metabolites		1.9		1.2		
Others:						
metaphos	--	--	--	--	0.8 (1/8)	1-10 (2/14)
carbophos	4-22 (7/11)	0.47	--	5.3	3-20 (7/8)	--
TCM-3	--	--	--	--	0.3-0.5 (2/8)	1.3 (1/14)

Region	Atray	Atyrau	Chimkent	Chimkent	Dzhambul	Kzylorda
thiodane	--		--		--	--
Bi-58	0.8-15 (2/11)	0.1	--	--	0.08-3 (3/8)	0.02-23 (4/41)

Data from the Almaty Scientific Research Institute on Regional Nutrition Problems/WHO Collaborating Centre for Nutrition. For Tables 4 and 5, data for 1986 and 1990, the mean of the analyzed samples is given.

[1]To convert numbers to mg/liter, divide number by 100.
[2]For 1988 data, the range of concentrations in positive samples is given. The numbers in parentheses indicate the portion of positive samples.
-- Double dashes indicated that no samples were positive.
+ + Indicates that the measurement was of both isomers combined (o,p DDD & p,p DDE).
^ Indicates that the measurement was of both isomers combined (o,p DDT & p,p DDD).

TABLE 5

PESTICIDES IN WHOLE HUMAN MILK [mg/l) x 100]

REPUBLIC	**Kazakhstan**							
Region	Almaty	Almaty	Kustanai	Kustanai	Akmula	Akmola	Kokchetav	North Kazakhstan
Period	Aug '88	1990	Aug '88	1986	Aug '88	1990	1986	1986
	N = 14	N = 26	N = 7	N = ?	N = 11	N = 10	N = ?	N = ?
PESTICIDE TESTED:								
HCCH:								
gamma HCCH	0.2-2[1] (4/14)[2]	0.015	10 (1/7)	0.13 (100%)	0.04-1 (7/11)	0.083	0.26 (100%)	0.35 (80%)
alpha HCCH	0.06 (1/14)	0.0005			0.07 (1/11)	0.005		
DDT and metabolites:								
pp DDT	0.6 (1/14)		--		--			
op DDT	2-4 (3/14)^		--		--			
pp DDD	^		--		--			
op DDD	1.3-23 (6/14)++		4-130 (3/7)++		1.4-48 (7/11)++			
pp DDE	++		++		++			
op DDE	--		--		--			
DDT metabolites		0.5				1.6		

Region	Almaty	Almaty	Kustanai	Kustanai	Akmula	Akmola	Kokchetav	North Kazakhstan
Others:								
metaphos	0.1 (1/14)	0.09	--		3.7-10 (3/14)	0.13		
carbophos	--	1.4	8-310 (2/7)		--	--		
TCM-3	0.9 (1/14)	0.005	--		0.1 (1/14)	--		
thiodane	--		--		--			
Bi-58	--	--	--		--	--		

Notes: See Table 4.

TABLE 6

PESTICIDES IN HUMAN MILK BY SEASON [mg/l) x 100]

REPUBLIC	Kazakhstan				
Region	North Kazakhstan				
Period	1986				
	N = 74				
	Mean[1]	Percentage of positive samples			
		Fall (N = 20)	Spring (N = 14)	Summer (N = 20)	Winter (N = 20)
PESTICIDE TESTED:					
HCCH:					
gamma HCCH	0.5	90% +	88% +	45% +	20% ÷
alpha HCCH	0.5	60% +	93% +	100% +	20% +
DDT and metabolites:					
"DDT"	1	60% +	14% +	15% +	10% +
"DDD"	2	100% +	35% +	80% +	90% +
"DDE"	0.5	80% ÷	7% +	15%	5% +
Others:					
	Mean[1]	Fall (N = 20)	Spring (N = 14)	Summer (N = 20)	Winter (N = 20)
metaphos	0.19	20% +	35% +	35% +	5% +
carbophos	0.08	0% +	7% +	80% +	0% +

Region	Kazakhstan				
TCM-3[2]	0.5	55%+	35%+	35%+	0%+
heptachlor	0.1	50%+	7%+	20%+	30%+
aldrin	0.2	15%+	7%+	0%+	0%+

[1]To convert mean to mg/liter, divide number by 100.
[2]Mean shown is an unweighted simple mean of values from the 4 seasons.

TABLE 7

PESTICIDES IN WHOLE HUMAN MILK, WATER, AND COW'S MILK [(mg/l) x100]

(Range of values and number positive)

REPUBLIC	Kazakhstan			
Region	Taldy-Kalgan		Almaty	
Period	Apr-Jun '92		Dec '87	
	Breast milk	Water	Breast milk	Cow's milk
	N = 24	N = 37	N = 26	N = 19
HCCH:				
gamma HCCH	--	0.04-0.0009 (22/37)	0.1-5 (5/26)	0.01-2 (11/19)
alpha HCCH	--	--	0.01-1 (16/26)	--
DDT and metabolites:				
pp DDT	0.0005 (1/24)	--	0.2-40 (10/26)	1 (1/19)
op DDT	0.003-14 (5/24)^	--	1-15 (10/26)^	0.5-2 (2/19)^
pp DDD	^	--	^	^
op DDD	0.25-8 (19/24)++	0.00002-0.006 (3/37)++	5-72 (25/36)++	0.5-2 (2/19)++
pp DDE	++	++	++	++
op DDE	0.009-3.4 (3/24)	0.0001-0.002 (8/37)	5 (1/26)	--
Others:				
metaphos	0.16-0.5 (3/24)	0.001-0.02 (9/37)	0.4-8 (8/26)	0.3-2 (9/19)
carbophos	0.01-3.3 (8/24)	0.0006-0.004 (12/37)	--	--
TCM-3	0.2 (1/24)	--	--	0.06 (1/19)
	N = 24	N = 37	N = 26	N = 19
thiodane	0.6 (1/24)	0.0003-0.02 (12/37)	--	--
Bi-58	--	--	--	--

Region	Taldy-Kalgan		Almaty	
Propanide	0.25 (1/24)	0.002-0.02 (10/37)	--	--
Heptachlorine	--	--	--	--
Saturn	14-50 (2/23)	--	--	--
Akreks	--	0.01-0.05 (9/37)	--	--
A30	0.2-24 (10/24)	0.002-0.6 (13/37)	--	--
Kaltin	0.005-0.8 (8/24)	0.0001-0.002 (6/37)	--	0.03 (1/19)

Notes: see Table 4.

TABLE 8

PESTICIDES IN WHOLE HUMAN MILK AND COW'S MILK [(mg/l) x 100]
(Range of values and number positive)

REPUBLIC	**Kazakhstan**			
Region	Almaty		Almaty	
Period	Mar '88		July '88	
	Breast milk	Cow's milk	Breast milk	Cow's milk
	N = 13	N = 10	N = 7	N = 11
HCCH:				
gamma HCCH	1-5 (6/13)	0.6-0.7 (2/10)	0.3 (1/7)	0.2-3 (10/11)
alpha HCCH	--	--	0.3 (1/7)	0.2-11 (11/11)
DDT and metabolites:				
pp DDT	1 (1/13)	--	1-9 (3/7)	1-9 (2/11)
op DDT	2-6 (10/13)^	0.5-5 (9/10)^	1-5 (3/7)^	3-19 (3-11)^
pp DDD	^	^	^	^
op DDD	2-10 (12/13)++	1-3 (4/10)++	9-27 (4/7)++	11-12 (2/11)++
pp DDE	++	++	++	++
op DDE	--	--	--	2-31 (2/11)
Others:				
metaphos	--	--	--	--
carbophos	--	--	--	--
TCM-3	--	--	--	1 (1/11)
thiodane	--	--	--	--
Bi-58	--	--	--	--
Propanide	--	--	--	--
Heptachlorine	--	--	--	--
Saturn	--	--	--	--
Akreks	--	--	--	--
A30 (chlorobiphenyl)	--	--	--	--

Region	Almaty		Almaty	
	N = 13	N = 10	N = 7	N = 11
Kaltin	--	--	0.005-0.8 (8/24)	0.0001-0.002 (6/37)

Notes: see Table 4.

TABLE 9

PESTICIDES IN HUMAN MILK IN OTHER COUNTRIES [(mg/l) x 100]

Region	United States	Canada	Kenya (Nairobi)	Austria (Vienna)	Belgium	Denmark (Aarhus)	Japan	Japan
			1986	1973-4	"1968?"	1965	1971	1979
				N = 22	N = 20	N = 6	N = 644	N = 35
Data Source++	Calabrese, 1982 (from Rogan et al, 1980) ("typical levels")	Same	Kanja et al, 1992	Jensen, 1983	Same	Same	Same	Same
HCCH:								
alpha HCCH		0.3	<0.0002 (1/8)**					
sum of HCCH							7.2[1]	3.5[1]
DDT and metabolites:								
pp DDT				4	4.7 [2-7.5]	2.9		
pp DDE				12.2	7.2 [4-10.5]	5.0		

Region	United States	Canada	Kenya (Nairobi)	Austria (Vienna)	Belgium	Denmark (Aarhus)	Japan	Japan
sum of DDT metabolites	5-20	13	15.4 [2.6-32.7]** (8/8)	16.2 [7.7-35.8]		8.5 (6/6)		

[1]To convert tabulated numbers to mg/liter, divide number by 100.

++References cited here include data from other sources cited in the references.

**Numbers in ( ) parentheses are number of samples positive over total number of samples. Numbers in [ ] brackets show range of values in positive samples.

TABLE 10

PESTICIDES IN COW'S MILK AND MEAT [(mg/l) x 100]

REPUBLIC	Kazakhstan				
Region	North Kazakhstan				
Period	1986				
	Mean[1]	Mean	% positive	Mean	% positive
	Breast milk	Cow's milk		Cow meat	
	N = 74	N = 43		N = 33	
HCCH:					
gamma HCCH	0.5	2	80%	0.1	95%
alpha HCCH	0.5	5.7	96%	0.7	90%
DDT and metabolites:					
"DDT"	1	3.9	27%	2.2	32%
"DDD"	2	2	42%	0.1	85%
"DDE"	0.5				
Others:					
metaphos	0.19	0.5	50%	0.6	50%
carbophos	0.08				
TCM-3	0.5	0.8	50%	0.9	64%
heptachlor	0.1				
aldrin	0.2				

Data from the Almaty Scientific Re:earch Insittutet on Regional Nutrition Problems/WHO Collaborating Centre for Nutrition. Means shown for breast milk are the same as shown in Table 6, and are the unweighted simple mean of values from the 4 seasons.

[1]To convert mean to my/liter, divide number by 100.
Blanks indicate no data were reported.

TABLE 11

PESTICIDES IN COW'S MILK BY SEASON [(mg/l) x 100]

REPUBLIC	Kazakhstan				
Period	1986				
	Mean[1]	Percentage of positive samples			
	N = 43	Fall (N = 15)	Spring (N = 8)	Summer (N = 10)	Winter (N = 10)
HCCH:					
gamma HCCH	2	66%	88%	100%	70%
sum of HCCH	7.7	93%	100%	100%	90%
DDT and metabolites:					
"DDT"	3.9	78%	0%	30%	0%
"DDD"	1.7	86%	12%	60%	10%
"DDE"	8	79%	0%	30%	10%
sum of DDT metabolites	5	86%	12%	80%	10%
Others:					
metaphos	0.52	88%	63%	40%	10%
carbophos	13.5	60%	88%	100%	0%
TCM-3[2]	0.8	62%	78%	60%	0%
chlorinephos	267	73%	0%	40%	10%
aldrin	0.2	28%	0%	0%	0%
2,4 dichlorinephenol	--	--	--	--	--

Data from the Almaty Scientific Research Institute on Regional Nutrition Problems/WHO Collaborating Centre for Nutrition. Unpublished annual report, 1986.
Note: First column of data are the same data as shown in the first column of data in Table 10.

[1]To convert mean to mg/liter, divide number by 100.

TABLE 12

ALFLATOXIN CONTAMINATION OF DAIRY PRODUCTS IN SOUTH EAST KAZAKHSTAN (1990)

FOOD ITEM	# Samples		Aflatoxin levels [(mg/l) x 100]			
	Total #	# (%) contam.	B1 range	B1	G1	M1
Whole cow's milk	41	--	--	--	--	--
Powdered milk	119	21 (18%)	0.01-0.08	0.075	0.13	0.02
Hard Cheese	63	5 (8%)	++	0.63	0.10	--
Butter	45	13 (29%)	0.01-0.08	^	--	--
INFANT FORUMLAS:						
Malysh	52	13 (25%)	0.01-0.08	1.25	0.18	--
Maylutka	7	2 (28%)	0.08	^	^	--
Vitalak	31	7 (23%)	0.02-0.08	^	^	--
Detolact	25	1 (4%)	^	0.54	0.58	--
"4Molocnaya smesi"	12	--	--	--	--	--
Total N	395					
Total positive		62 (15.6%)		55	7	3

Data from Almaty Scientific Research Institute on Regional Nutritional Problems/WHO Collaborating Centre for Nutrition. Unpublished annual report, 1990.

Note: table provided had several inconsistencies, making data hard to interpret.

– Substance not found in food named.
++ Data provided were not useable.
^ No data provided.

TABLE 13

CADMIUM IN BREAST MILK AND DRINKING WATER [(mg/l) x 100]
ARAL SEA REGION OF TURKMENISTAN
(Summer 1990)

	Whole Breast milk	**Drinking Water**
	N = 10	N = 10
Cadmium concentration	0.4	290-730

Data from Turkmenistan Institute for Maternal and Child Health Protection, and the Chemical Institute. Dr. Viktor Radzinsky, Director of Institute for MCH Protection. Researchers: D. Orazvalieva (Inst. for MCH Protection), Mr. Iskanderov (Chemical Institute).
Note: only one figure was provided for breast milk but a range was provided for water. I assume the breast milk value is a mean.

TABLE 14

CADMIUM IN HUMAN MILK IN OTHER COUNTRIES [(mg/l) x 100]

Region	Vienna, Austria	Munster, Germany	Uppsala, Sweden	Cinn. Ohio, USA
	1975	1976	1978-9	1968
	N = 20	N = 5	N = 41	N = 22
Cadmium	4.3 [2.8-9.5]	1.0 [0.3-3.5]	0.01 (median) [0.05-0.38]	1.9

Data Source: Jensen, 1983.

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