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Save breast-milk from pollution

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ABSTRACT: Human milk is the most natural and superior food for infants, providing a range of benefits for growth, immunity and development a significant decreasing risk for several acute and chronic diseases. However, breast milk is not pure. Pollutants have been intentionally or inadvertently produced and introduced into the environment. Due to long half-lives and fat solubility, chemicals tend to bio accumulate in long-lived species at the top of the food-chain, including in human milk. Through breastfeeding, a mother may transfer potentially toxic chemicals to the suckling infant, exercising systemic and harmful effects on the health of children. Although scientific evidence indicates that the advantages of breast-feeding outweigh any risks from contaminants, it is important to identify communities with major sources of human exposure, limit the presence of pollutants in the food supply and modify their critical short-and long-term action in children. Furthermore, by controlling the use of these toxic products safe breastfeeding could be ensured and encouraged. This review summarizes what is known about the relationship between environmental pollutants and contamination of human milk.

KEYWORDS: breast-milk; pollutants; newborns; environmental exposure.

1 INTRODUCTION

Breastfeeding has been recognized and promoted by public health officials as the most beneficial source of nourishment, growth, and development during infancy [1] providing a significant decreasing risk for several acute and chronic diseases (e.g., atopy, autoimmunity, infections, obesity, cardiovascular disease, and neoplasia) [1,2]. Because of its well-known health effects, early encouragement of breastfeeding has been promoted. Exclusive breastfeeding for six months is the recommended feeding mode for the vast majority of infants, followed by continued breastfeeding with appropriate complementary foods for up to 2 years or beyond [1].

However, in women in industrially established, as well as developing nations, human breast-milk is not pure. Based on available evidence, several studies have been conducted, with improved analytic methods, to evaluate pollution residues in human milk [3]. Moreover, breast milk reflects quantities of chemical residues well, and relatively large volumes can be non-invasively collected.

However, literature data are still controversial. Although adverse effects have been documented as being associated solely with consumption of human milk containing background levels of environmental chemicals, none have been clinically or epidemiologically demonstrated. In addition, breast milk contains protective factors that counteract potential effects related to prenatal exposure to toxic compounds [4].

Moreover, during lactation, a mother can modify her diet to further reduce an infant's exposure to such chemicals, and ensure adequate intake of protective elements for newborn growth. Studies have reported that switching to formula milk is not recommended: formula may have higher chemical levels [5]. There is no evidence that formula feeding can attenuate any effects that may occur from foetal exposure [6]. A paper by Cinar et al. gives the false impression that milk is unsafe and that if the infant is not breastfed, chemical exposure will not occur [7]. Authors further reported that nursing is a potential source of exposure to toxic chemicals [e.g., polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT) and its metabolites, dioxins, polychlorinated dibenzofurans (PCDFs), polybrominated biphenyls (PBBs), polybrominated diphenylethers (PBDEs), and heavy metals], which are known to accumulate in the food chain [8].

Since 1976 the World Health Organization, through its GEMS/Food Programme, has collected and evaluated information on levels of persistent organic pollutants in foods, including human milk [9]. Such information provides guidance on the need for measures to reduce levels of these substances in human milk, which is an ideal matrix to generally monitor levels of persistent organic pollutants in the environment. A woman previously exposed to toxics, during lactation eliminates pollution up to 10% of the amount stored in her body [10], and an exclusively breast-fed infant, for a period greater than 6 months, accumulates 3 to 5% of these chemicals in serum, as well as in fat tissue [11]. Although newborns have higher recuperative capacities than adults, infants are growing and tissue is differentiating, thus deleterious effects can occur at lower exposure to pollutants [12]. Additionally, breast-milk levels of these chemical compounds may be higher than blood levels as breast tissue does not eliminate solvents as quickly as blood does [13].

Due to the extreme variability of the aforementioned data, to date, a final conclusion has not been reached. This review summarizes what is known about the relationship between environmental pollutants and contamination of human milk.

2 FACTORS INFLUENCING CHEMICAL RESIDUES IN BREAST MILK

Environmental chemicals can be absorbed by several routes: ingestion, dermal contact and infected blood. During nursing, all these pathways are involved in pollutant diffusion. Lipid-soluble pollutants tend to degrade slowly and are preferentially stored in the mother's adipose tissue, including brain, liver, kidney, and mammary glands. Here, the high-fat content, through a biological pathway also known as biomagnification, favours long half-lives and bio-accumulation of chemicals in breast milk [14]. These phenomena increase potentially significant impacts on a child's health. A large number of studies have reported that pesticide residues are implicated in causing immunological, neurological, endocrine and carcinogenic effects [15]. Probably, marked children's exposure to pesticides may also be related to less developed detoxification pathways [16], a longer life expectancy that favours diseases with long latency periods [17], and a higher body surface to adults [18].

A survey found that infant's intake of some pesticides from breast milk greatly exceeds adult acceptable daily intake levels [19].

Levels of chemical residues in breast milk may be influenced by individual (e.g., maternal age, number of pregnancies), demographic (place of residence), and lifestyle features (smoking, diet, occupation, household chemical use), as well as lactation related factors (e.g., previous lactation, duration of breastfeeding, volume and fat content milk) [20,21]. During the first week post-partum, a higher permeability of the epithelium of breast milk alveolar cells has been noted. Thus, maternal pathways and transferred chemical molecules probably display higher activity levels during this period.

In addition to aforementioned maternal characteristics, chemical peculiarity must be also considered [22]. The degree of ionization determines transfers into milk. Non-polar compounds are easily transported and, due to lipophilic properties, can be retained in milk fat. Furthermore, a molecular weight less than 800 Dalton favours passive transport mediated by plasma proteins or erythrocytes [22].

In addition to lipid solubility, the pH of plasma and milk both play a crucial role. Higher breast milk levels of weak alkaline pollutants rather than weak acids are reported [23]. Other factors modulating the quantity of chemical pollutants in human-milk include degree of "water solubility" and related elimination rate. Pollutants with a slower elimination rate have a long half-life, allowing for more time in the body. The ability of blood and/or milk to bind toxic components is also relevant. Milk components pass from capillaries to alveolar epithelial cell of the breast. During this process, chemical molecules are incorporated into breast milk [23]. These biological mechanisms highlight how lactation is the primary ways excretion human body. Thus, during lactation, maternal chemical values progressively decrease in a process known as ''depuration''. The medium half-life of pollutants in breast milk has been estimated to be approximately 6 months after environmental exposure [23]. Conversely, other research has indicated that breast-milk pollutant levels were not substantially reduced after 6 months of nursing. It might reflect differences in sources, pathways of human exposure, and mode of nursing (continuous vs. intermittent; exclusive vs. mixed) [24].

3 EFFECTS OF POLLUTANTS ON CHILD DEVELOPMENT

Although mechanism remains unclear, pollutant effects can be deleterious and/or irreversible in a growing subject, promoting the onset of several disorders. In humans, organochlorine compounds have been associated with changes in cellular and humoral immunity [25], and particularly with changes in T-cell–mediated immune cytokines related to allergies, such as interleukin-4 [26].

Moreover, the correlation between levels of pollutants such as chlorinated pesticides in the placenta and mothers' milk, and bleeding tendencies of their infants has been reported, suggesting an organochlorine-induced immunotoxicity in infants developmentally exposed to pollutant agents. Breast milk toxic molecule values were associated with prolonged prothrombin time, a significant decrease in lymphocytes and platelet count, decreased serum vitamin K levels added to depressed cytokine secretion, i.e., TNF-α and IL-10, inducing altered bleeding tendencies [27].

The immature brain of a child is vulnerable to environmental exposure. There is a suspected relationship between lactation exposure to toxic molecules and decrements in mental and psychomotor development diseases (e.g., autism, attention deficit and hyperactivity disorders, brain cancer) [28,29], resulting from oxidative stress, neuroinflammation, and mitochondrial dysfunction [30].

Chemicals found in the environment have several mechanisms through which they may interfere also with endocrine and reproductive systems [31].

Many toxic chemicals are disruptors of endocrine signalling with critical effects on reproduction, diabetes, cardiovascular disease, overweight, and [32] growth. Breast-milk pollutant levels have been negatively correlated with head circumference and weight for age at birth [33].

Intake of chemical substances can modify thyroid function by competitively inhibiting iodide uptake in infants [34]. Some authors have hypothesized that environmental toxins could alter the distribution and kinetics of iodide in a time-dependent mode [35].

Rogan et al. state that pollutants can modulate anogenital distance at birth, thyroid function, peripubertal growth and the onset of puberty in female children. Toxic substances interfere with hormonal processes through induction of enzymes that metabolizes endogenous estrogens and through antiandrogen-like activities [36]. It has been reported that environmental chemicals might also mimic estrogens and, by binding to their specific kinase pathways and G protein-coupled receptors, [37] alter puberty timing [38].

Accordingly, increased amounts of pollutants in breast milk appear to modify the function of serum transporters. Due to transfer to breast milk, these chemical molecules compete for binding to iron and manganese and inhibit calcium secretion. Both pathways seem to promote renal damage, such as tubular proteinuria. Moreover, it has been reported that pollutant concentration in breast milk was significantly correlated with urinary pollutant levels [39].

Finally, evidence also suggests that pollutants, through increased genotoxicity of other chemicals, are promoting a higher prevalence of testicular cancer, male reproductive disorders, and impaired development of the foetal testis [40].

Although further data are needed, there are sufficient epidemiological results to talk about causal relationships between environmental chemical contaminants, breast-feeding and adverse child health outcomes.

4 CONCLUSIONS

In the light of literature data, we wish to underline that chemical contamination of human breast-milk requires higher consideration. Contaminants are numerous and data have been collected on a limited number of them. Additionally, levels of toxic elements in breast milk can vary in different regions. An effective monitoring program would identify communities with major sources/pathways of human exposure.

Moreover, breast-milk, the main food source for many newborns, might play a further critical role in children's exposure to pollutants. Infants may exhibit peculiar susceptibilities to the toxic effects of chemical toxins as they are undergoing rapid tissue growth and development at the same time as they take human milk. Although exposure occurs early in life, it predisposes the younger population to a higher risk of diseases in later life. Further studies are needed to better understand the relationship between maternal exposure to harmful environmental chemicals, breast-feeding and short- and long-term effects in children. Moreover, by controlling the use of these toxic products safe breastfeeding could be ensured and encouraged without discouraging it. In fact, depriving nursing infants of human milk will not reduce *in utero* effects of these dangerous substances. Moreover, environmental pollutants also occur in formula milk. Given that breastfeeding reduces child mortality and has health benefits that extend into adulthood, every effort should be made to protect, promote and support breastfeeding.

However, it should also be borne in mind that environmental pollutants remain a public health concern and information on human exposure to toxic agents is essential to protect human health.

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