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Breastmilk as an indicator of levels of chemical residues in the environment

The entry into force of the UN Persistent Organic Pollutants Convention (POPs Convention)[1] in May 2004 means that increasing attention will be paid to monitoring of breastmilk as an indicator of levels of chemical residues in the human body. And in June 2004, the Ministers and Representatives of Member States in the European Region of WHO responsible for health and the environment stated that "Monitoring of chemical contamination of food for children and the total diet, as well as data on breastmilk" is one of the specific actions to reduce environmental health risks.[2]

Biological monitoring, or human bio-monitoring, measures the levels of various chemicals in the body. Scientists analyse samples of body fluids or body fat to assess the exposure of an individual or a population to a chemical. Many of the chemicals in our environment are fat-soluble contaminants that accumulate in the fatty tissue of animals as they are classified as being higher up the food chain. Breastmilk has a higher fat content than other body fluids and represents the top of the food chain. For this reason, residues of certain chemicals and heavy metals can be detected in breastmilk in higher concentrations.

Environmental campaigners have used evidence of levels of chemical residues in breastmilk as an effective campaign tool. Chemicals such as DDT, PCBs and pesticides have been banned following campaigns to show how these substances accumulate in the human body. The actual bans were made on the grounds that they accumulate in human tissue, as demonstrated by testing for residues in breastmilk. Bio-monitoring therefore can be used as an effective tool for policy change.

However, the results of bio-monitoring of breastmilk have been frequently misunderstood or misinterpreted by the media, health professionals and environmentalists. Campaigners and the press often use breastmilk as a symbol of environmental pollution, to cause shock among public and policy-makers who perceive breastfeeding as a symbol of purity. They look at the tree rather than the forest, which can lead to undermining breastfeeding rather than addressing the root causes of residues in breastmilk.

It is thus important to set bio-monitoring of breastmilk in context.

First, it is often argued that breastmilk is easier to collect and transport than blood and that breastmilk testing is a less invasive procedure. But chemical residues are detectable in blood, hair, nails, ear wax, infant cord blood and meconium. Why is there so little research into testing other body fluids and tissues? Using these may avoid the sole focus on breastmilk and the victimisation of the practice of breastfeeding, which creates a negative influence on breastfeeding mothers and undermines their confidence in their ability to breastfeed. Moreover, breastmilk testing is limited to a specific group (lactating mothers) and the results should not and cannot be generalised to the whole population.

Second, the use of bio-monitoring of breastmilk is acceptable if the levels of chemical residues are compared to all the intrinsic and extrinsic risks of artificial feeding, including water. This is because parents have the right to be informed about levels of residues in all the food and fluids they themselves eat and offer to their infants and young children. If this is done, it will often be found that the higher levels of chemical residues found in breastmilk pose a much smaller public health problem than the lower levels found in all the other foods, mainly because of all of the other advantages of breastmilk.

Third, the levels of chemical residues in breastmilk are decreasing in those countries that have taken measures to reduce environmental contamination.

Fourth, bio-monitoring of breastmilk shows the symptoms of environmental contamination, not its effects on health. Exposure to chemical residues in utero affects the unborn child at a critical stage of development of the brain and nervous and immune systems and has probably more impact than exposure to the same residues secreted in breastmilk.[3] There is little evidence that exposure through breastmilk is associated with damage; there is in fact some evidence that breastfeeding may counteract some of the negative effects of exposure to environmental contaminants in utero. For example, long-term breastfeeding may counterbalance the delay in mental and psychomotor development found in infants highly exposed to organochlorine compounds in utero.[4] In another study, children breastfed for at least 16 weeks did not show the delays in development of the central nervous system shown by children breastfed for 6 to 16 weeks or formula-fed, despite a similar prenatal exposure to PCBs.[5]

Finally, it should be emphasised that the problem is how dangerous our environment has become and not how dangerous breastmilk has become. The risk is that the media and the general public may view levels of residues in breastmilk in a separate context from the environmental issue, potentially producing a negative image of breastmilk and breastfeeding. It is critical to identify the sources of pollution and tackle this problem at its source: the industries that are contaminating our environment; however, breastfeeding must not become a victim of this campaign.

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[1] The POPs Convention is a UN treaty adopted on 22 May 2001 at the Conference of Plenipotentiaries in Stockholm by 151 signatories and entered into force on 17 May 2004 after 96 countries had ratified it.

[2] WHO/EURO. Declaration of the Fourth Ministerial Conference on Environment and Health. Budapest, Hungary, 23-25 June 2004.

[3] Pronczuk J, Moy G, Vallenas C. Breast milk: an optimal food. Environ Health Perspect 2004;112:A722-3.

[4] Ribas-Fito N, Cardo E, Sala M, Eulalia dM, Mazon C, Verdu A, *et al*. Breastfeeding, exposure to organochlorine compounds, and neurodevelopment in infants. Pediatrics 2003;111:e580-5.

[5] Vreugdenhil HJ, Van Zanten GA, Brocaar MP, Mulder PG, Weisglas-Kuperus N. Prenatal exposure to polychlorinated biphenyls and breastfeeding: opposing effects on auditory P300 latencies in 9-year-old Dutch children. Dev Med Child Neurol 2004;46:398-405.

Breastfeeding why...

Chemical residues

Jacobson JL, Jacobson SW. Prenatal exposure to polychlorinated biphenyls and attention at school age. J Pediatr 2003;143:780-8

To examine the relation of prenatal polychlorinated biphenyl (PCB) exposure to child performance on neuropsychological tests of attention and information processing, 148 children exposed in utero (their mothers had eaten contaminated Lake Michigan fish), as measured by umbilical cord serum and maternal serum and breastmilk concentrations, were assessed on 15 neuropsychological tests at 11 years of age. After controlling for a broad range of potential confounding variables, prenatal exposure to PCBs was associated with greater impulsivity, poorer concentration, and poorer verbal, pictorial, and auditory working memory. There was no evidence of visual-spatial deficit or increased hyperactivity. Adverse effects were seen primarily in children who had not been breastfed. It is not clear whether the protection offered by breastfeeding is caused by nutrients in breastmilk or better quality of intellectual stimulation often provided by breastfeeding mothers.

Vreugdenhil HJ, Van Zanten GA, Brocaar MP, Mulder PG, Weisglas-Kuperus N. Prenatal exposure to polychlorinated biphenyls and breastfeeding: opposing effects on auditory P300 latencies in 9-year-old Dutch children. Dev Med Child Neurol 2004;46:398-405

The effects of perinatal exposure to PCBs on hearing were evaluated in a cohort of healthy term babies from Rotterdam. The 26 lowest and 26 highest prenatally PCB-exposed children from the breastfed and the formula-fed groups (n=104) were invited for hearing assessment when they were 9 years old. After adjusting for confounding variables, children with high prenatal exposure were found to have more hearing impairment than children with low prenatal exposure. Lactational exposure to PCBs through breastmilk was not related to hearing impairment, which was lower in children breastfed for at least 16 weeks than in children breastfed for 6 to 16 weeks and formula-fed children. The results of this exploratory study suggest that prenatal exposure to environmental levels of PCBs and related compounds delays mechanisms in the central nervous system that evaluate and process stimuli, whereas breastfeeding accelerates these mechanisms.

Riva E, Grandi F, Massetto N, Radaelli G, Giovannini M, Zetterstrom R, Agostoni C. Polychlorinated biphenyls in colostral milk and visual function at 12 months of life. Acta Paediatr 2004;93:1103-7

This study investigated whether PCBs impair early development of vision and whether such impairment can be modulated by essential long-chain polyunsaturated fatty acids (LC-PUFAs) found in breastmilk. Healthy term infants born in Milan, Italy, and its surroundings, and who were exclusively breastfed for at least 4 months, were prospectively examined up to the age of 12 months. Samples from colostrum, the first 2 days after delivery, and of mature breastmilk at 1 and 3 months were collected. The samples were analyzed for PCBs and DDT. The plasma levels of LC-PUFAs were analysed within the first 3 postnatal days. Visual function was evaluated at 12 months of age. On analysis, lower visual function was significantly related to higher colostral levels of DDT and PCBs. Plasma levels of LC-PUFAs were inversely associated with visual function. The authors of the study conclude that there is a weak relation between impaired visual function at 12 months and the levels of PCBs and DDT in colostral milk. The effect of this impairment was no longer evident after controlling for the plasma level of LC-PUFAs found in the infant a few days after birth.

Minh NH, Someya M, Minh TB, Kunisue T, Iwata H, Watanabe M, Tanabe S, Viet PH, Tuyen BC. Persistent organochlorine residues in human breast milk from Hanoi and Hochiminh City, Vietnam: contamination, accumulation kinetics and risk assessment for infants. Environ Pollut 2004;129:431-41

Despite the ban on persistent organochlorines (OCs) in most of the developed nations, their usage continued until recently in many Asian developing countries including Vietnam, for agricultural purposes and vector-borne disease eradication programmes. In this study, human breastmilk samples from Hanoi (n=42) and Hochiminh (n=44) showed high levels of OCs. In particular, DDT residue levels were among the highest values reported for Asian developing countries as well as developed nations. This result suggests recent usage of DDTs in both north and south Vietnam and continuous intake in the population. The daily intake of infants exposed to DDTs via breastmilk is close to or above the threshold for adverse effects which may raise concern for children's health.

Obesity

Kramer MS, Guo T, Platt RW, Vanilovich I, Sevkovskaya Z, Dzikovich I, Michaelsen KF, Dewey K; Promotion of Breastfeeding Intervention Trials Study Group. Feeding effects on growth during infancy. J Pediatr 2004;145:600-5

To examine the effects of formula, other milks, other liquids, cereals, and other solid foods on growth during infancy, this study compared the growth during the intervals 1 to 3, 3 to 6, 6 to 9, and 9 to 12 months in a cohort of children tested within a large (n=17,046) randomized trial (see BB33, Kramer *et al.* JAMA 2001;286:322-6). Mixed breastfeeding and formula or other milk feeding were associated with significantly higher, compared to breastmilk only, length for age at 1 to 3 months. In the 3- to 6-month interval, mixed breastfeeding and formula/other milk feeding led to significantly higher weight and length for age, whereas cereal intake was associated with large and highly significant reductions in both measures. Mixed breastfeeding and formula/other milk feeding continued to have positive albeit smaller associations with weight and length for age in the 6- to 9-month and 9- to 12-month intervals. These results confirm the growth-accelerating effects of formula and other milks (versus

breastmilk) on weight and length gain throughout infancy, with a dose-response gradient and largest associations observed at 3 to 6 months.

Baker JL, Michaelsen KF, Rasmussen KM, Sorensen TI. Maternal prepregnant body mass index, duration of breastfeeding, and timing of complementary food introduction are associated with infant weight gain. *Am J Clin Nut.* 2004;80: 1579-88

This study examined how maternal prepregnant body mass index (BMI) and infant feeding pattern are associated with infant weight gain among 3,768 mother-infant pairs from the Danish National Birth Cohort. After adjustment for potential confounders, increasing maternal prepregnant BMI, decreasing durations of breastfeeding, and early complementary food introduction were associated with increased infant weight gain. Earlier complementary food introduction (less than 16 weeks) was associated with greater infant weight gain; however, the timing of complementary food introduction did not increase infant weight gain at longer durations of breastfeeding (20 weeks or more).

Arenz S, Ruckerl R, Koletzko B, Von Kries R. Breastfeeding and childhood obesity: a systematic review. Int J Obes Relat Metab Disord 2004;28:1247-56

This systematic review of nine studies with more than 69,000 participants shows that breastfeeding reduces significantly the risk of obesity in childhood, defined as body mass index percentiles. The protective effect is small but consistent: a reduction by 15% to 30% of the risk after adjustment by study type, age groups, definition of breastfeeding or obesity, and number of confounding factors. A dose-dependent effect of breastfeeding duration was reported in four studies.

Very low birth weight infants

Ronnestad A, Abrahamsen TG, Medbo S, Reigstad H, Lossius K, Kaaresen PI, Egeland T, Engelund IE, Irgens LM, Markestad T. Late-onset septicemia in a Norwegian national cohort of extremely premature infants receiving very early full human milk feeding. Pediatrics 2005;115:e269-76

A prospective study of all infants born in Norway in 1999 and 2000 with gestational age of less than 28 weeks or birth weight of less than 1000 g was performed to investigate the occurrence of and risk factors for late-onset septicemia (LOS). Of 464 eligible infants, 462 (99.6%) were enrolled and 405 (87.7%) survived until day 7. LOS was diagnosed for 80 (19.7%). Case fatality rates were 10% in general and 43% for septicemia due to Candida species. Necrotizing enterocolitis (NEC) or bowel perforation was diagnosed for 19 infants (4%). Enteral feeding with human milk was initiated within the third day for 98% of patients, and 92% were receiving full enteral feeding (FEF) with human milk within the third week. On analysis, the overall most influential risk factor for LOS was the number of days without establishment of FEF with human milk; if FEF was not established within the second week of life infants had 3.7 (2.0-6.9) times risk for LOS.

Breastfeeding how...

BFHI

Broadfoot M, Britten J, Tappin DM, MacKenzie JM. The Baby Friendly Hospital Initiative and breast feeding rates in Scotland. Arch Dis Child Fetal Neonatal Ed 2005;90:F114-6

Data routinely gathered on the Guthrie Inborn Errors Screening card at 7 days in 464,246 infants born between 1995 and 2002, and annual surveys of progress towards the BFHI in all 33 maternity units with over 50 births per year, were used to examine the effect of the BFHI on breastfeeding rates in Scotland. Babies born in a hospital with the UK BFHI standard award were 28% more likely to be exclusively breastfed at 7 days than those born in other maternity units, after adjustment for mother's age, deprivation, hospital size, and year of birth. Maternity hospitals that were certified BFHI in the period 1995 - 2002, saw their breastfeeding rates increase significantly faster than in other maternity hospitals (11.39% vs. 7.97%). All maternity units should be encouraged to undertake the significant strategic and practical changes required to achieve BFHI status.

Bottles, cups and dummies

Collins CT, Ryan P, Crowther CA, McPhee AJ, Paterson S, Hiller JE. Effect of bottles, cups, and dummies on breast feeding in preterm infants: a randomised controlled trial. BMJ 2004;24;329:193-8

This randomised controlled trial was carried out in two large tertiary hospitals and 54 peripheral hospitals in Australia to determine the effect of artificial teats (“dummy”) and cups on breastfeeding in preterm infants. A total of 319 preterm infants born at 23-33 weeks' gestation were randomly assigned to one of four groups: cup/no dummy (n = 89), cup/dummy (n = 72), bottle/no dummy (n = 73), bottle/dummy (n = 85). Cup or bottle feeding occurred when the mother was unable to be present to breastfeed. Infants randomised to the dummy groups received a dummy on entry into the trial. 303 infants and 278 mothers were included in the analysis. There were no significant differences for any of the study outcomes according to use of a dummy. Infants randomised to cup feeds were 73% (4-88%) more likely to be fully breastfed on discharge, but had a longer length of hospital stay. Cup feeding had no effect on breastfeeding following discharge.

Alves da Cunha AJL, Madeiro Leite A, Tavares Machado MM. Breastfeeding and pacifier use in Brazil. Indian J Pediatr 2005;72:13-16

A cohort of 500 exclusively breastfed healthy newborns with birthweight less than 3,000 g were enrolled in eight maternity hospitals in Fortaleza, Brazil, between November 1996 and April 1997 to study the relationship between pacifier use and the duration of exclusive breastfeeding in the first 6 months of age. One third of the mothers were adolescents, one fifth were working outside the home by the sixth month, and most attended prenatal care visits. Approximately 60% of the children were using pacifiers by the first month. The average number of days for exclusive breastfeeding for pacifier users by the sixth month was 87.0 compared to 125.3 among non-users. Children using pacifiers were 1.9 times

more likely to have stopped exclusive breastfeeding by the sixth month compared to non-users, after controlling for potential confounders. As a possible marker of early weaning, pacifier use can help health workers identify those mothers in need of extended counselling to reinforce breastfeeding practices.

Peer counselling

Chapman DJ, Damio G, Young S, Perez-Escamilla R. Effectiveness of Breast-Feeding Peer Counseling in a Low-Income, Predominantly Latina Population. Obstet Gynecol Surv 2005;60:157-158

In the USA, low-income women breastfeed their infants much less often than the general population of women. The authors conducted a randomised, prospective trial at an urban US hospital serving a large number of low-income Latina women aged 18 years or older recruited from the prenatal clinic at 26 weeks gestation or earlier. All the participants were considering breastfeeding, and all delivered healthy singleton infants at term. Women randomised to the intervention group (n=95) had at least one prenatal home visit by a peer counsellor. A counsellor saw the women at least once a day while hospitalised after delivery and provided hands-on aid in proper breastfeeding techniques. All participants had at least three postpartum home visits, the first one within 24 hours of discharge. Control women (n=75) received routine education in breastfeeding and had access to an international board-certified lactation consultant. Nearly 90% of those in the intervention group reported perinatal contact with a peer counsellor; the number of visits averaged 2.7. Approximately half the women acknowledged postpartum home visits and telephone calls. Peer counselling was significantly associated with initiating breastfeeding. Compared with control women, those counselled had a 61% lower risk of not starting breastfeeding. Results at 1 and 3 months postpartum were less impressive but still evident. At 6 months postpartum, no effect of peer counselling on the incidence of breastfeeding was apparent.

Painful breastfeeding

Anderson JE, Held N, Wright K. Raynaud's phenomenon of the nipple: a treatable cause of painful breastfeeding. Pediatrics 2004;113:e360-4

Raynaud's phenomenon, associated with a vasospasm of arterioles, has been reported to affect the nipples of breastfeeding mothers and is recognized by many lactation experts as a treatable cause of painful breastfeeding. This study reports the cases of twelve women who breastfed fourteen infants, seen in a paediatric practice and a lactation consultation centre in San Francisco, California. All women suffered from extremely painful breastfeeding, with symptoms precipitated by cold temperatures and associated with blanching of the nipple followed by cyanosis and/or erythema. Poor positioning and poor attachment were excluded as contributing factors. Eight of the twelve mothers and their infants received multiple courses of antifungal therapy for Candida albicans infection without relief before the diagnosis of Reynaud's phenomenon was made. Treatment options include methods to prevent or decrease cold exposure, avoidance of vasoconstrictive drugs and nicotine that could precipitate symptoms, and pharmacological measures. There are reports in the lay press of the use of herbal medicines, aerobic exercise, and dietary supplements, but because most women with painful breastfeeding require immediate relief of the pain to continue breastfeeding successfully, it is important to offer a treatment plan that will alleviate the pain quickly. Nifedipine, a calcium channel blocker with very low and safe levels in breastmilk, was used by six mothers in this series, and all had prompt relief of pain; only one mother developed side effects.

Francis-Morrill J, Heinig MJ, Pappagianis D, Dewey KG. Diagnostic value of signs and symptoms of mammary candidosis among lactating women. J Hum Lact 2004;20:288-95

Mammary candidosis in lactating women is not well defined and is most often presumptively diagnosed by signs and symptoms. This study evaluates the sensitivity, specificity, positive predictive value, and likelihood ratios of signs and symptoms of mammary candidosis based on the presence of Candida species on the nipple/areola or in the milk. The nipple/areola skin and milk of 100 healthy breastfeeding mothers were cultured from each breast at two weeks postpartum, and mothers were interviewed regarding signs and symptoms associated with mammary candidosis between 2 and 9 weeks postpartum. The prevalence of a positive test result for Candida species of the nipple/areola or milk was 18% (36/200) of breasts. Positive predictive value for Candida colonization was highest when there were three or more signs or symptoms simultaneously (sore, burning, stabbing pain, painful, shiny or flaky nipple) or when flaky or shiny skin of the nipple/areola was reported together or in combination with breast pain.

Co-sleeping

Quillin SI, Glenn LL. Interaction between feeding method and co-sleeping on maternal-newborn sleep. J Obstet Gynecol Neonatal Nurs 2004;33:580-8

Thirty three first-time mothers and their newborns were studied to investigate whether there is an interaction between type of feeding and sleeping arrangements during the fourth postpartum week. Breastfed newborns had less total sleep per day than bottle-fed newborns, and breastfeeding mothers had more sleep periods in 24 hours than bottle-feeding mothers. Breastfeeding mothers slept more than bottle-feeding mothers when co-sleeping, but bottle-feeding mothers' sleep was unaffected by location of newborn. Average total sleep for 4-week-old newborns was about 14 hours daily.

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