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Environmental organic pollutants in human milk before and after weight loss

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HIGHLIGHTS

- Levels of PCB 153 in milk increased in women who lost weight during lactation.
- Infant intake remained stable because of decreased breastfeeding and energy demand.
- A weight loss restricted to 0.5 kg/week may be recommended for lactating women.

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ABSTRACT

Many persistent organic pollutants (POPs) are banned because they accumulate in organisms and are toxic. Lipophilic POPs are stored in maternal adipose tissue and concentrations in human milk (HM) may increase during weight loss. Our aim was to examine associations between weight loss and concentrations of chlorinated POPs in HM in lactating women participating in a weight loss study. We analysed POPs (PCB 28, PCB 153, HCB, DDE) in HM at 12 and 24 weeks postpartum from 32 women who participated in a randomized, 2 × 2 factorial trial of diet and exercise for postpartum weight loss. Participants donated milk before and after the intervention period. We examined associations between weight loss and change in POP concentrations and estimated the intake of POPs by their breastfed infants. Most (n = 27) women lost weight during intervention, 0.45 ± 0.30 kg/week (mean ± SD). Among these women, the concentration of PCB 153 in HM was significantly (p = 0.04) higher at follow-up than at baseline. Weight loss was significantly positively associated with changes in concentrations of all studied POPs (2.0–2.4% increase per percent weight loss). Estimated mean intakes of POPs (ng/day) remained stable because infant milk consumption decreased during the study period. As infants gained weight, estimated mean intakes per kg body weight decreased 17–22%. Changes in concentrations of POPs in HM correlated positively with maternal weight loss, but it is unlikely that the balance between the benefits and risks of breastfeeding will change if the weight loss is restricted to 0.5 kg per week.

1. Introduction

Persistent organic pollutants (POPs) in the environment originate from various human activities (e.g. prior use in dielectrical fluids and as flame retardants, insecticides and fungicides). Although some chlorinated POPs were banned more than 20 years ago, they still persist in the environment and can also be found in adipose tissue and human milk (HM). As a result of fat mobilization, the secretion of HM is a major way chlorinated POPs are eliminated

Abbreviations: BMI body, mass index; bw, body weight; DDE, dichlorodiphenyl-dichloroethylene; DDT, dichlorodiphenyl-trichloroethane; HCB, hexachlorobenzene; HCH, hexachlorocyclohexane; HM, human milk; LEVA, Lifestyle for Effective Weight Loss during Lactation; LOD, limit of detection; LOQ, limit of quantification; PCB, polychlorinated biphenyl; PCDD, polychlorinated dibenzo-*p*-dioxin; PCDF, polychlorinated dibenzofuran; POP, persistent organic pollutant; SCF, European Scientific Committee on Food.

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from the mother's body. Therefore, the consumption of HM is an important route of exposure for breastfed infants (Jensen, 1991; Shen et al., 2007). The concentrations of chlorinated POPs in HM vary between countries, and a general decrease in their concentrations has been observed in most countries, including Sweden (Noren and Meironyte, 2000; Lignell et al., 2009; Loganathan and Lam, 2012).

Early exposure to chlorinated POPs has been linked to several health outcomes. Very high exposure to polychlorinated biphenyl (PCB) and PCDD/Fs (polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans) early in life is, for example, associated with reduced birth weight, delayed cognitive development, effects on thyroid function and higher frequencies of certain infectious diseases (Aoki, 2001; Guo et al., 2004; Baccarelli et al., 2008). Similar but more subtle effects have been suggested in populations with background exposure (Longnecker et al., 2003; Schantz et al., 2003; Lundqvist et al., 2006; Langer, 2008). Breastfed infants are exposed to high concentrations of chlorinated POPs from HM. It has been shown in several studies that nursing affects serum concentrations of, for example, PCB, PCDD/Fs and dichlorodiphenyl-dichloroethylene (DDE) in children from infancy up to adolescence (Karmaus et al., 2001; Nawrot et al., 2002; Lackmann et al., 2004; Link et al., 2005; Ribas-Fito et al., 2005; Lignell et al., 2011). In epidemiological studies, however, it is difficult to separate effects that result from exposure *in utero* from those that result from exposure via breastfeeding.

Despite the high exposure to chlorinated POPs from HM and the risks associated with high exposure early in life, breastfeeding is strongly encouraged. Inasmuch as the breastfeeding period is short, the European Scientific Committee on Food (SCF) and the World Health Organization have concluded that possible risks from high exposure to PCDD/Fs from HM are outweighed by the beneficial effects of breastfeeding (WHO, 2000; SCF, 2001). Overweight and obese women are encouraged to lose weight postpartum and lactation may assist them to lose weight. A postpartum weight loss of up to 2 kg/month is consistent with maintaining an adequate milk volume according to the Institute of Medicine in the United States (National Academy of Sciences, 1991). The Swedish National Food Agency likewise advises women not to lose more than 0.5 kg per week during lactation (Swedish National Food Agency, 2008).

Unfortunately, the concentrations of chlorinated POPs in HM before and after weight loss have been studied only infrequently. In 1993, Vaz et al. showed that the concentrations of DDE and PCBs in the milk of one woman who had fasted and lost 10 kg increased considerably between 4 and 10 months postpartum (Vaz et al., 1993). Earlier, Fooken et al. showed no correlation between weight loss up to 9 months postpartum and changes in hexachlorocyclohexane (HCH), hexachlorobenzene (HCB), DDE, dichlorodiphenyl-trichloroethane (DDT) or PCBs in the HM of 5 women who lost between 0 and 8 kg (Fooken and Butte, 1987). There was also no correlation in the study of Ennaceur et al. regarding HCHs, DDE, DDT, HCB and dieldrin in 4 Tunisian women who lost 4–8 kg during the first 8–10 months of lactation (Ennaceur and Driss, 2013). The largest study to date ($n = 21$) was performed by Lovelady et al., in 1999. They studied concentrations of HCB, DDE and DDT in HM from 10 weight-stable and 11 women who lost 4.1 ± 0.4 kg between 2 and 5 months postpartum (Lovelady et al., 1999). Weight loss in these women with low exposure to POPs did not increase the concentration of the studied contaminants in HM.

Our aim was to determine if weight loss affected the concentration of chlorinated POPs in the milk of 32 overweight or obese Swedish women who were enrolled in a weight loss study between 12 and 24 weeks postpartum. We also studied possible associations between loss of weight, loss of fat mass and changes in chlorinated POPs in HM. Finally, we estimated the intake of these pollutants by infants at 12 and 24 weeks of age in the subset of mothers in this trial who lost weight.

2. Material and methods

2.1. Recruitment, intervention and sampling

The study Livsstil för Effektiv Viktminskning under Amning/Lifestyle for Effective Weight Loss during Lactation (LEVA), was a randomized, clinical trial in which change of weight and body composition following dietary and/or physical exercise behavior modification treatment was examined in lactating women (ClinicalTrials.gov NCT01343238) (Bertz et al., 2012). It was performed during 2007–2011 at the Department of Internal Medicine and Clinical Nutrition, the Sahlgrenska Academy, University of Gothenburg, Sweden. The study was approved by the Regional Ethics Board in Gothenburg, Sweden (registration number 483-06). All participants gave written informed consent.

In LEVA, 68 women with self-reported pre-pregnancy overweight or obesity (body mass index, BMI, of 25–35 kg/m^2) were recruited from 15 antenatal clinics when pregnant or up to 8 weeks postpartum. To be included in the study, women had to intend to breastfeed for at least 6 months and provide <20% of the baby's estimated energy intake from formula at inclusion. They also had to be non-smoking and free of serious illness. The infant had to be a singleton born at full-term with a birth weight >2500 g and free of serious illness.

Briefly, data were collected at 8–12 weeks and 20–24 weeks postpartum, including anthropometric measurements (mother and infant), body composition, dietary intake and physical activity. Questions regarding parity, education and marital status were collected at baseline. At week 10–14 postpartum the participants were randomized to 4 groups; control (C), diet (D), exercise (E) and diet + exercise (DE). The diet and physical activity treatments were delivered by a dietician or a physical therapist, respectively, and have been described in detail previously (Bertz et al., 2012, 2015). In short, the goal for the D group was to lose 0.5 kg/week during the 12-week intervention by reducing energy intake with approximately 500 kcal/day. The D group monitored their weight through self-weighing and they were advised to lose no more than 0.5 kg/week since this is recommended by the Swedish National Food Agency (Swedish National Food Agency, 2008). The E group was advised to take a 45 min brisk walk 4 times each week at 60–70% of their maximum heart rate, monitored with a heart rate monitor. The DE group received both treatments. Participants in all treatment groups reported their current weight (D and DE) and/or frequency of walks (E and DE) in a text message every 2 weeks during the intervention period. The control group was encouraged to live as usual during the study period.

Of the 68 women who participated in the study, the last 41 were offered the opportunity to donate about 15 mL of their milk at baseline and post intervention. They were informed that this was voluntary and not part of the intervention. At baseline and follow-up (week 8–12 and 20–24 postpartum respectively), 32 women donated HM samples. Of the 32 women, 8 were in group C, 7 were in group D, 8 were in group E and 9 were in group DE. The weight change among the participating women in these groups were C: $+0.3 \pm 2.5$ kg (mean ± SD), D: -6.2 ± 3.7 kg, E: -2.3 ± 2.9 kg and DE: -8.2 ± 2.7 kg, respectively. Irrespective of group, 5 women were weight stable or gained weight (0.0–4.4 kg), 27 women lost weight (−0.2 to −13.6 kg).

The milk (15 mL) was sampled by the mothers, preferably during breastfeeding, using either a manual breast milk pump or a collection cup. They were instructed to wash their hands and rinse