Temporal variation of brominated flame retardant levels in human breast milk over one year of lactation

Mohamed Abdallah[1] and Stuart Harrad[2]

[1]Department of Analytical Chemistry, Faculty of Pharmacy, Assiut University, Egypt

[2]School of Geography, Earth and Environmental Sciences, University of Birmingham, UK

Introduction

- Several studies have reported levels of various BFRs in both biotic and abiotic matrices from different parts of the world in the past few years.

- The only available information on BFRs in UK human samples is for tri- to hexa-BDEs (median = 6.3 and 4.18 ng/g lw in human milk and serum samples collected in 2003) . In addition, BDE-209 was detected in 11 out of 153 serum samples at concentrations from 15-240 pg/g lw).

- Very few studies have discussed variation of BFR levels in human milk over lactation and the possible implications of such variations on the body burdens of both the mother and the baby.

Levels of BFRs in UK human milk

- Recently, our research group have reported on the levels of various BFRs in human milk samples (n=34) from Birmingham, UK.

Average concentrations (ng/g lw) of BFRs in human milk

	UK*	Norway	France	Spain	Sweden	USA	Canada	Australia	China
TBBP-A	0.06	0.07	0.47						0.93
∑tri-hexa BDEs	5.95	2.34	2.51	2.14	3.57	34.0	42.8	7.6	2.53
BDE-209	0.31	0.61	1.62	2.9		0.92	0.43	0.31	3.0
∑HBCDs	5.95	1.7	2.2	47	0.45	0.5	3.8		2.4

1- Abdallah, M.A.; Harrad, S. Environ Int. 37:443-448; 2011.

2- Abdallah, M.A.; Harrad, S. Organohalogen Compounds. 73:100-104; 2011

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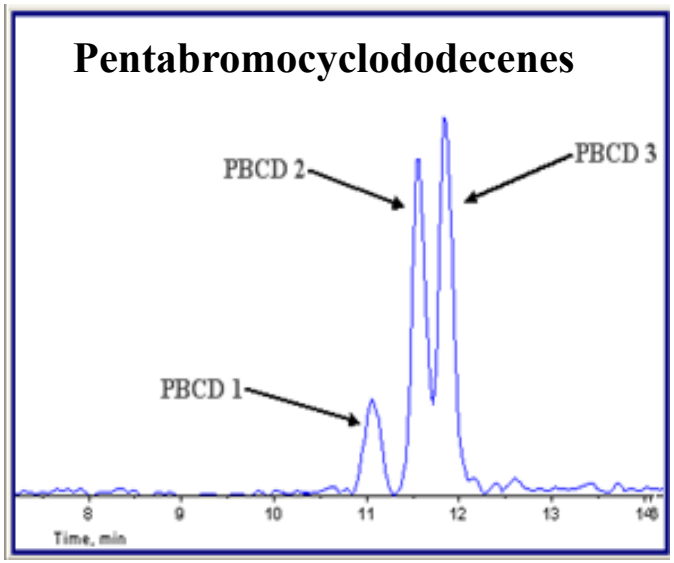
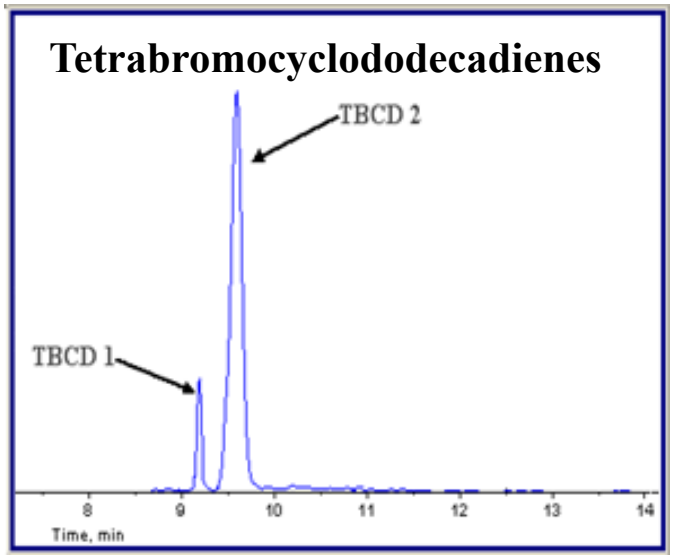
HBCD degradation products





Concentration (ng/g lw) of HBCD degradation products in human milk (n=34).

	Average	Range	Frequency
ΣPBCDs	0.04	<0.03-0.20	26%
ΣTBCDs	0.15	<0.03-0.36	73%

1- Abdallah, M.A; Harrad, S. Environ Int. 37:443-448; 2011.

2- Abdallah, M.A; Ibarra, C.; Neels, H.; Harrad, S.; Covaci, A.. J Chromatogr A. 1190:333-341; 2008

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AIMs

- Study the temporal variations of Tetrabromobisphenol-A (TBBP-A), hexabromocyclododecane (HBCD) and its degradation products Tetrabromocyclododecadiene (TBCD), Σtri-hexa brominated diphenyl ethers (BDEs; main components of the penta-BDE commercial formulation) and BDE-209 in human milk samples collected from 10 first-time (Primiparae) mothers on a monthly basis over the 1st year of lactation (n = 120 samples).

- Test the hypothesis that concentrations of persistent lipophilic chemicals decline over the course of lactation which also implies that assessments of early childhood exposures should incorporate decreasing breast milk levels over lactation.

Experimental

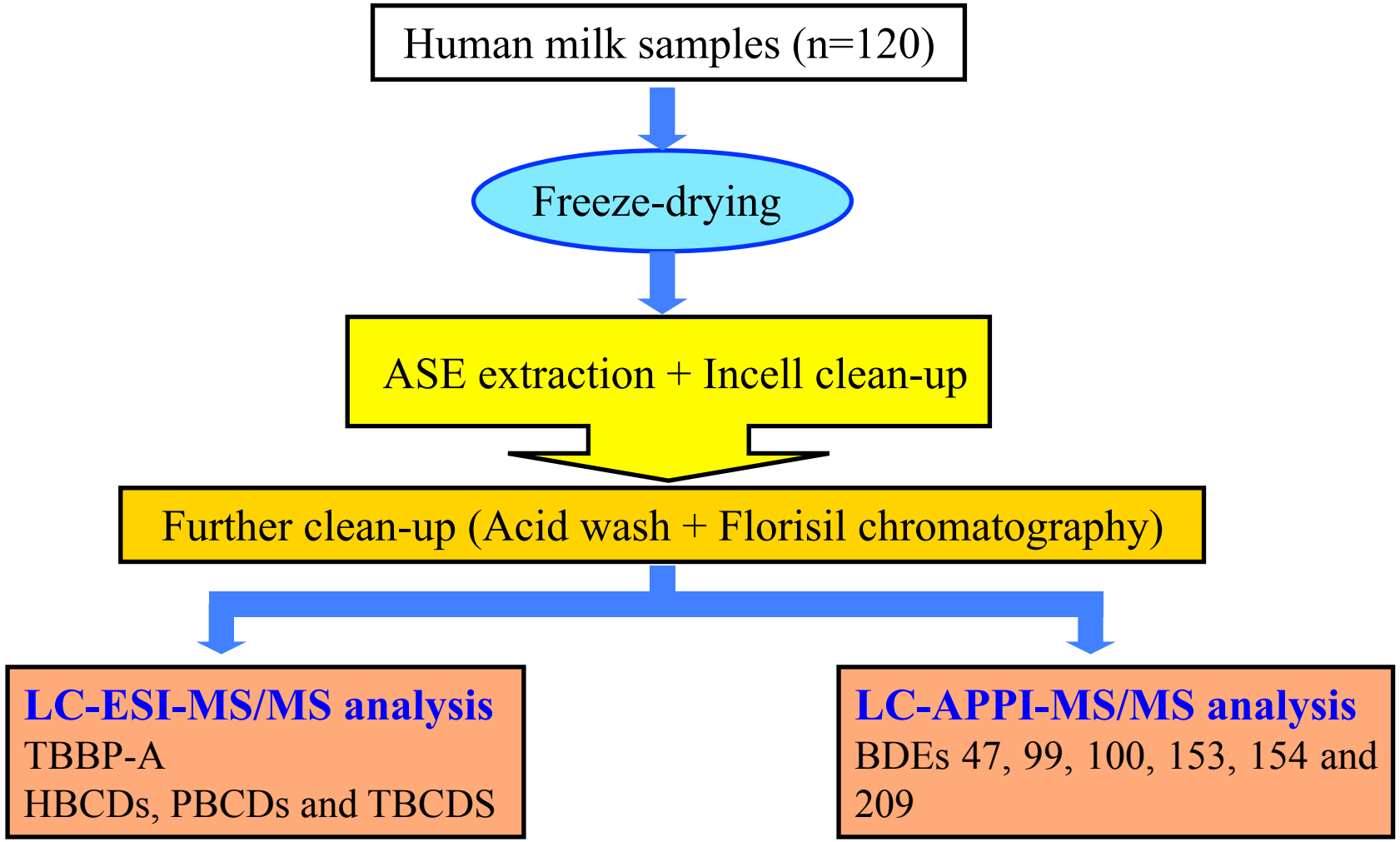
- One milk sample (~50 ml) was collected every month from 10 first-time mothers by the nursing staff at the BWH milk bank over the first year of lactation (n=120 samples).

- Samples were kept in clean screw-capped containers and transferred from the Milk Bank to the laboratory in special ice boxes then stored at -20°C until the time of analysis.

- Lipid weight of the studied samples was determined gravimetrically on separate aliquots using a standard procedure (The European Standard EN 1528-2, 1996).

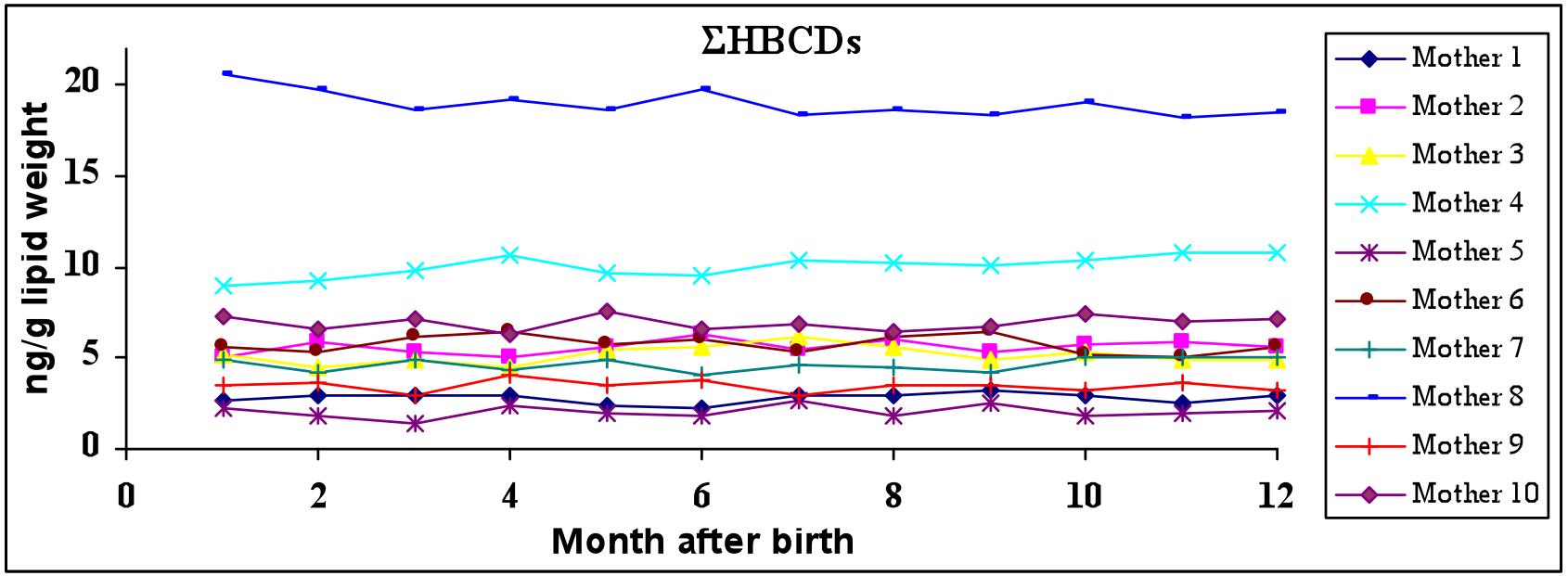
The study protocol was approved by Warwickshire Research Ethics Committee and the R&D Department in Birmingham Women's NHS foundation trust. Informed consent was obtained from all the participants before sample collection.

Experimental



Temporal Variations of HBCDs

- α-HBCD was the major congener in all of the studied samples contributing 60-89% to ΣHBCDs (average 79%).
- ΣHBCDs showed no statistically significant ($p>0.05$) trend over the studied period.



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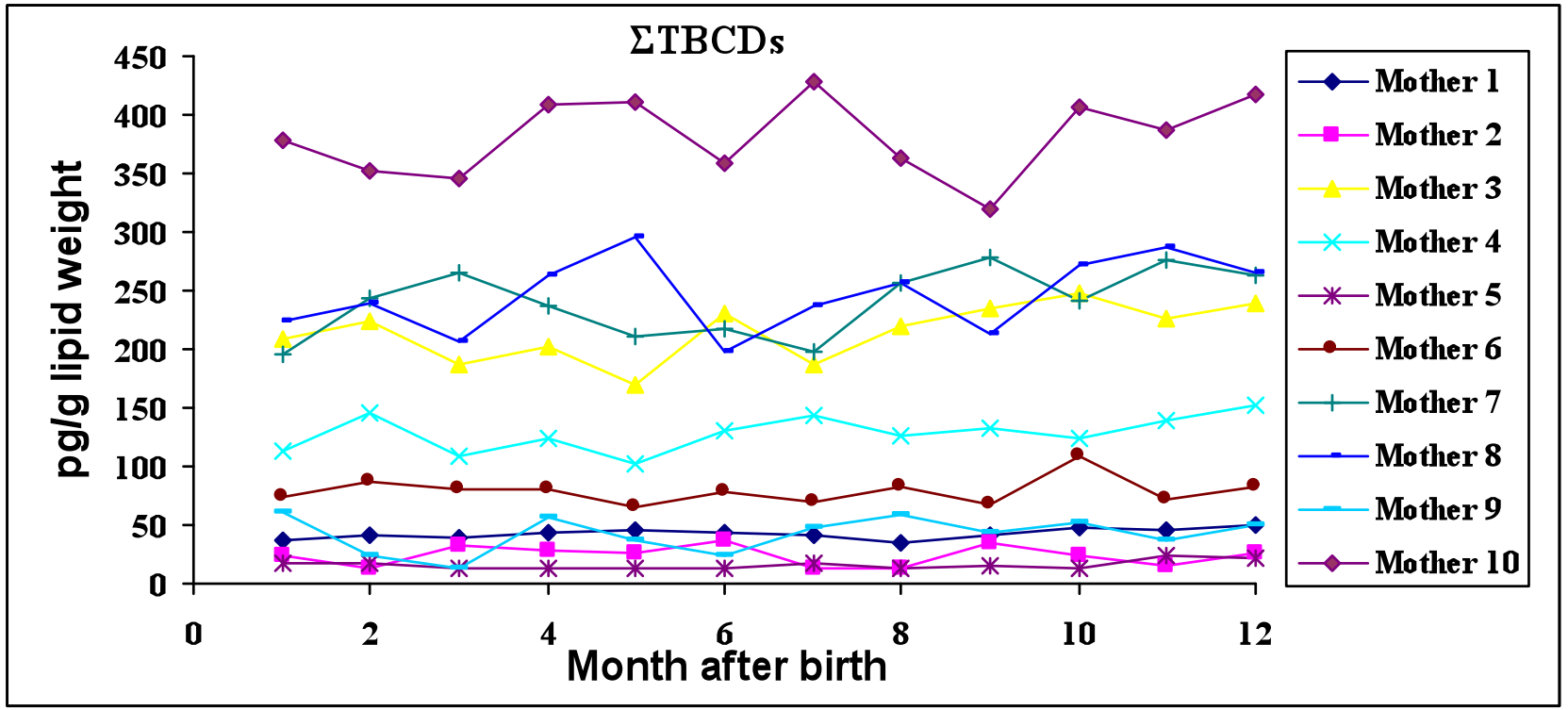
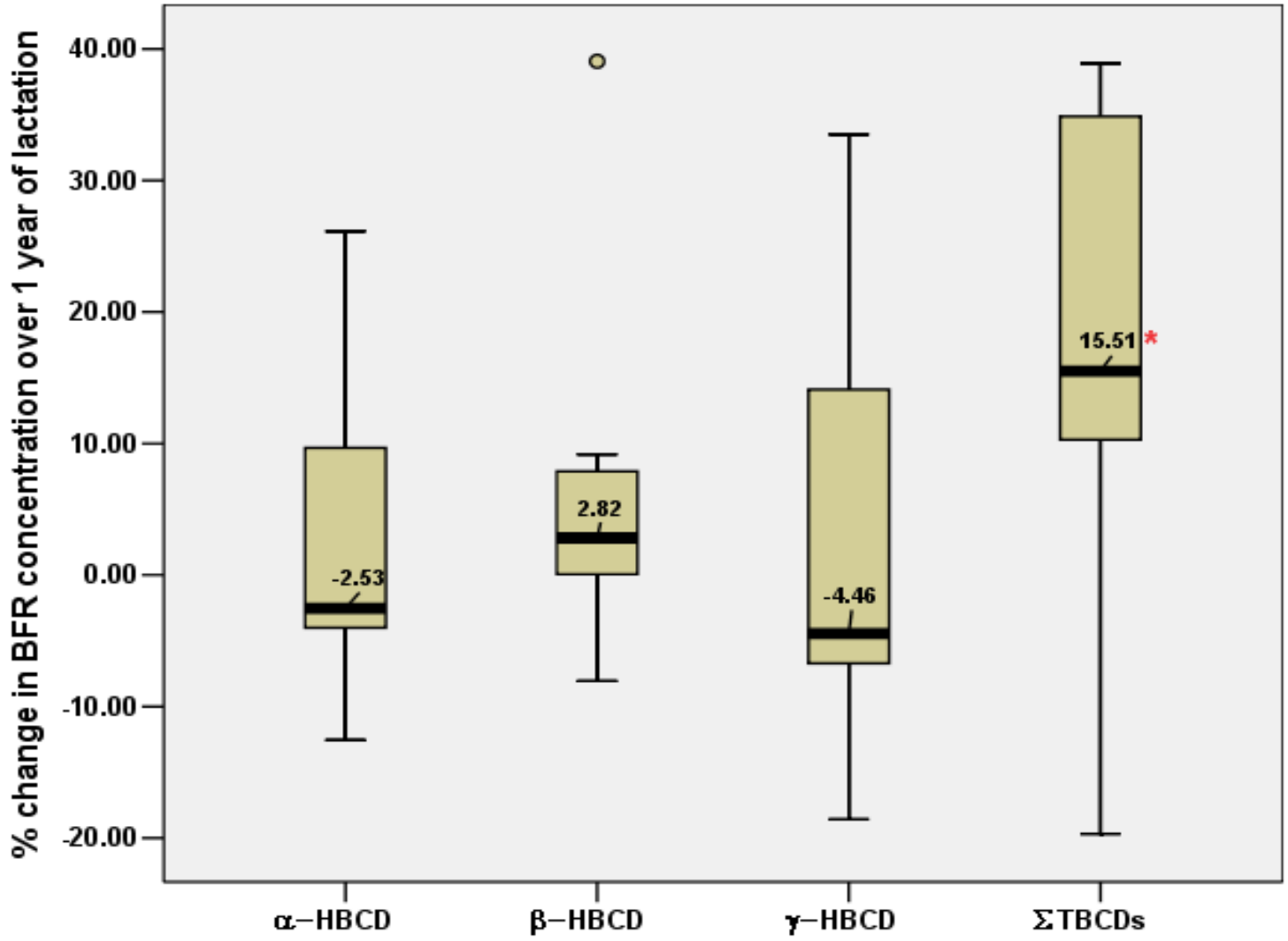
Temporal Variations of TBCDs

- ΣTBCDs increased ($p<0.01$) by a median of 15% by the end of the year indicating a higher bioaccumulation potential than the parent compound.



% Change of HBCDs and its degradation products



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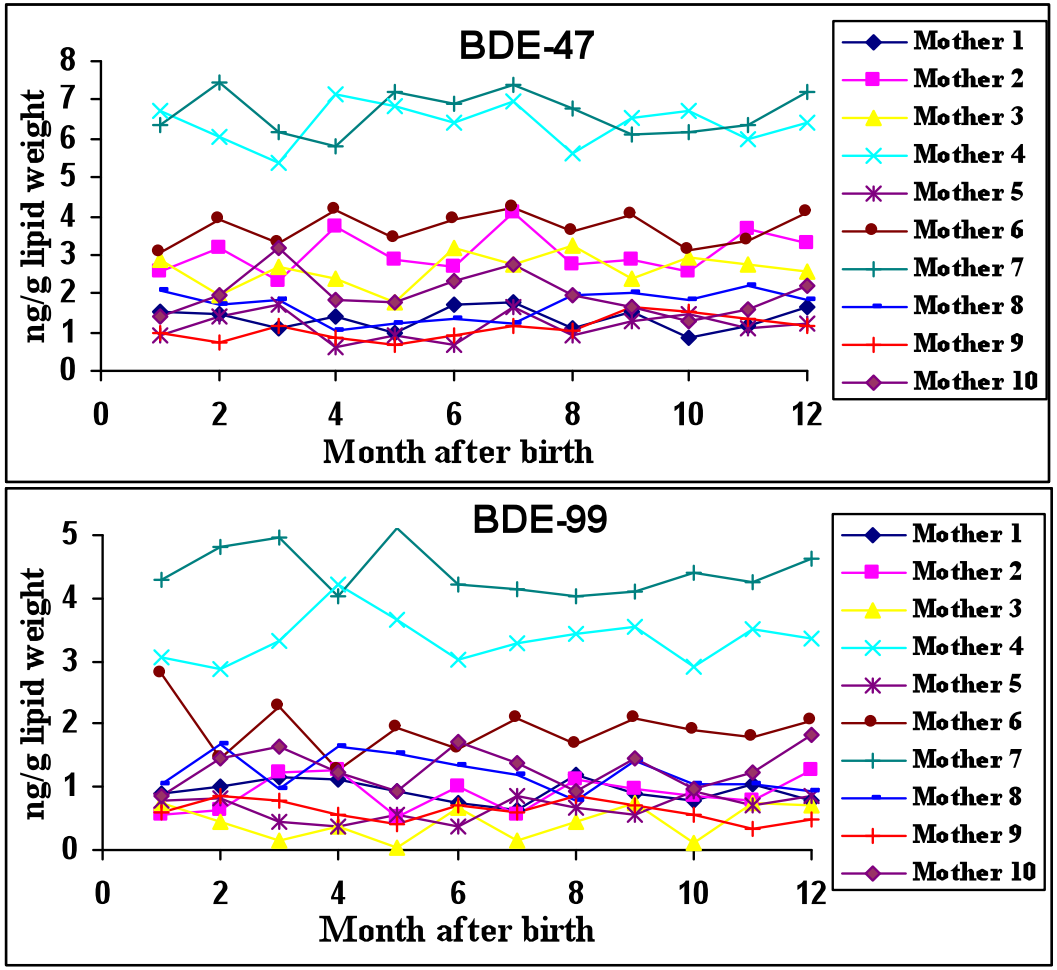
Temporal Variations of Σtri-hexa BDEs

- BDEs 28, 47, 99,100 and 153 were detected in >70% of samples.
- BDEs 47 and 99 were the major congeners constituting >70% of ΣPBDEs.
- Neither BDE-47 nor 99 and consequently ΣPBDEs showed a statistically significant decrease over the studied period.



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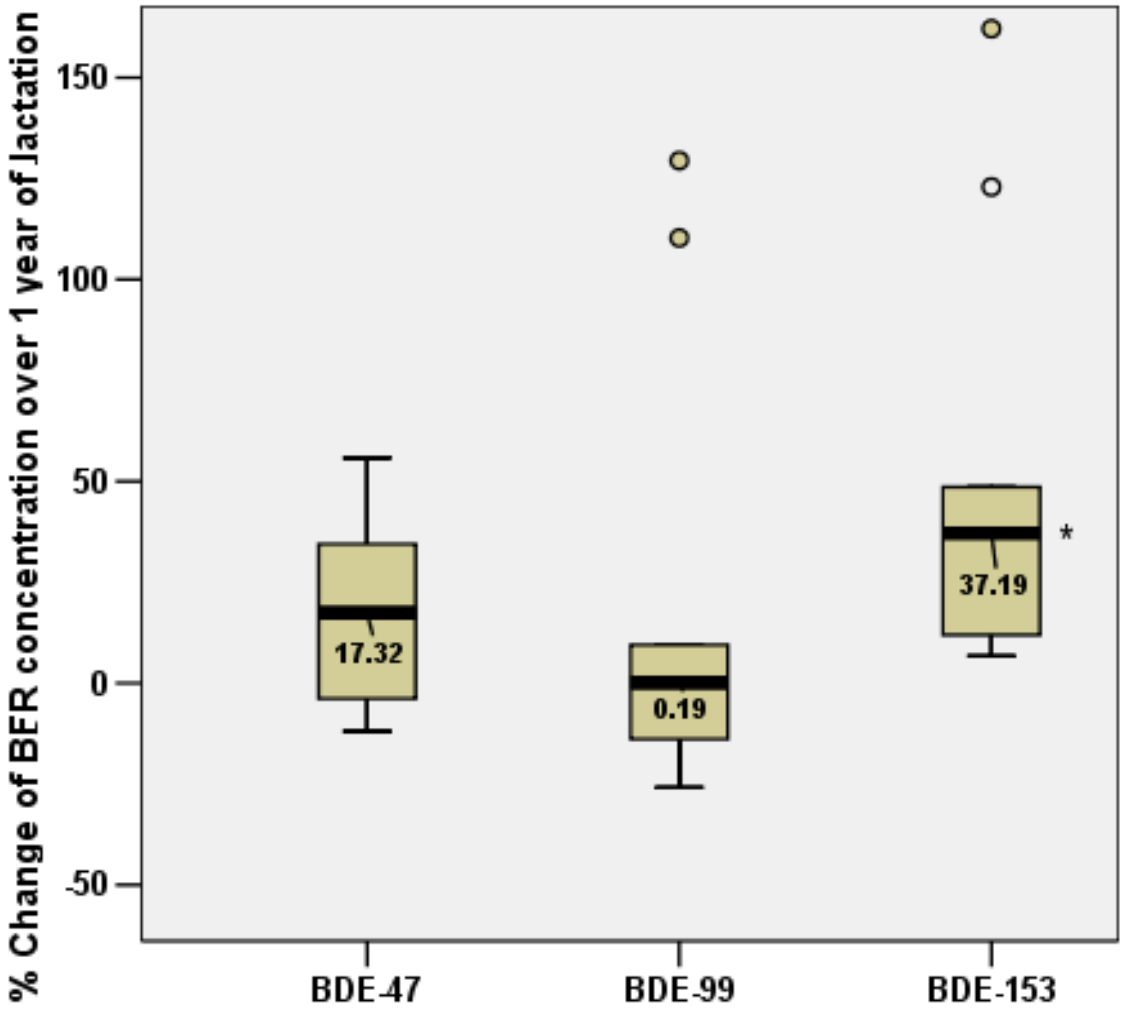
% Change of Σtri-hexa BDEs

- Interestingly, BDE-153 showed a statistically significant ($p<0.05$) increase over the studied period.
- This may reflect different levels of continuous exposure over the postpartum period among the different congeners. However, variability in metabolism and possible biodebromination of BDE-209 should also be considered.



Comparison with previous studies

Median % Change of BDE concentration over 1 year of lactation.

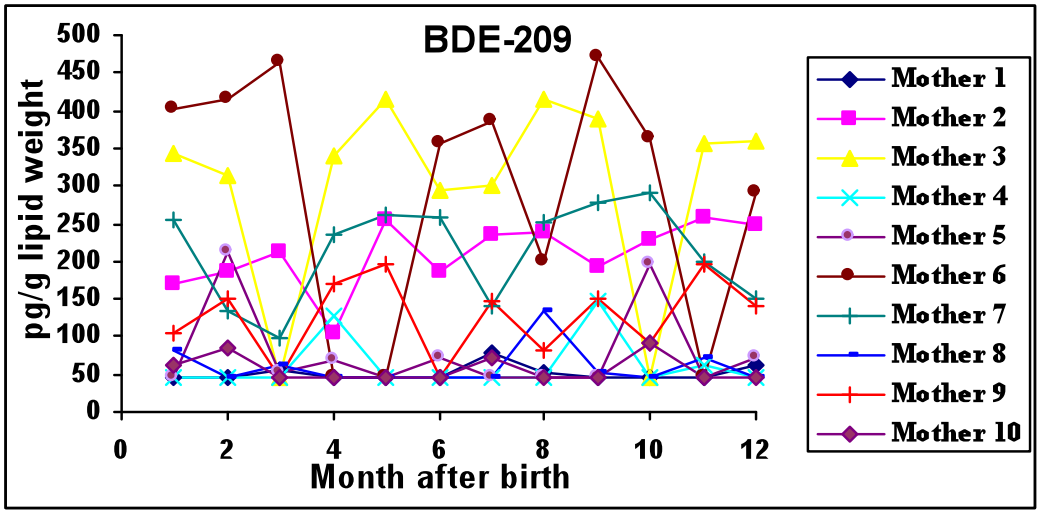
	This Study	Norway [1]	USA [2]
BDE-47	17.3	-33.3*	2
BDE-99	0.2	-27.8	18
BDE-153	37.2*	-20.9	18*
ΣPBDEs	15.8	-30.5*	14

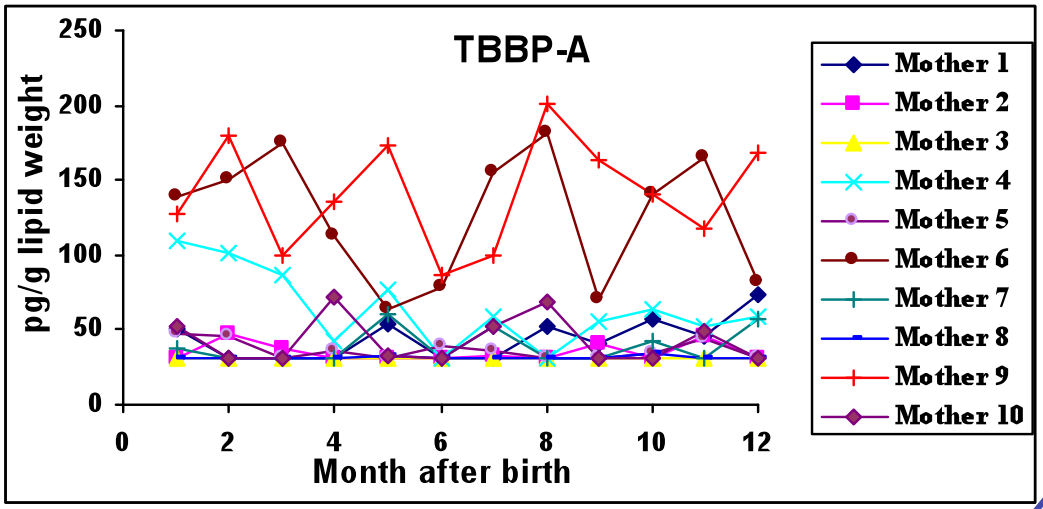
1- Thomsen, C.; Haug, L.S.; Stigum, H.; Froshaug, M.; Broadwell, S.L.; Becher, G. Environ Sci Technol. 44:9550-9556; 2010

2- Daniels, J.L.; Pan, I.J.; Jones, R.; Anderson, S.; Patterson, D.G., Jr.; Needham, L.L.; Sjodin, A. Environ Health Perspect. 118:155-160; 2010

TBBP-A and BDE-209

- Datasets were highly skewed and showed no evident trends over the studied period.
- Both compounds have short human $t_{0.5}$ and the measured levels may reflect very recent exosures.
- Both compounds are reported to preferentially partition to plasma rather than milk.





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Conclusions

- Concentrations of HBCDs and Penta-BDEs showed no statistically significant decrease in the studied human milk samples over 1 year of lactation.

- TBCDs increased ($p<0.01$) by a median of 15% by the end of the year indicating a higher bioaccumulation potential than parent HBCDs.

- Interestingly, Concentrations of BDE-153 increased significantly ($p<0.05$) over the studied period. This is in agreement with a large study from USA.

Conclusions

- TBBP-A and BDE-209 concentrations showed large variations and no general trend could be established for both compounds. This may be attributed to their short human half-lives and preferential partitioning to serum.

- Our results indicate that a general decreases in concentration of BFRs (on a lipid-adjusted basis) during lactation should no longer be assumed. Thus, the concept of “pumping and dumping” early milk to reduce infantile exposure to lipophilic contaminants can not be supported.

Acknowledgements

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