Impact of prenatal and postnatal exposure to food contaminants on the risk of Parkinson's disease

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Background

This study aims to determine whether prenatal and/or lifetime exposures to methylmercury (MeHg) and persistent organohalogen pollutants (POPs), especially polychlorinated biphenyls (PCBs), from traditional food increase the risk of developing Parkinson's disease (PD) in the Faroe Islands. PD has a prevalence in the Faroe Islands twice as high as expected. The high prevalence is unexplained, but may be linked to the increased exposure to MeHg and POPs, an exposure that has occurred for a long time due to the tradition of catching pilot whales that bioaccumulate these neurotoxicants. However, only mercury would have occurred at increased concentrations at the time current PD patients were born.

Method

Subjects
We identified a total of 100 prevalent idiopathic PD cases (July 2005) and 72 previously verified cases who were deceased during the previous ten years. Almost all cases were diagnosed at ages above 50 years and are therefore unlikely to be due to genetic factors only. Six controls for each patient were retrieved from the population registry, using the birth date and sex as matching parameters. Clinical examinations were carried out and included 79 idiopathic cases along with two matched controls for each of them.

Methodology
Prenatal exposure to MeHg was estimated at household level. Because the main source of MeHg is pilot whale meat, the estimated prenatal methylmercury exposure was determined based on the detailed whaling records and lists of whale meat distributions to households in each district. PD cases and controls were of the same age, but often born in different districts, where access to whale meat differed. We used a kinetic model and the assumption that each mother would eat 3 kg of whale meat per month, when available.

In order to assess postnatal exposure to both MeHg and POPs, questionnaires were applied to record lifetime information on residence, dietary habits and metal exposures. In addition, blood and hair samples were collected to assess current exposures to MeHg and relevant POPs, including PCBs. The latter are relevant only postnatally, because marine pollution became important only after about 1950.

Table 1 Number of PD cases and controls included in the prenatal and postnatal exposure assessment.

	Prenatal exposure – register-based analysis	Postnatal exposure – clinically examined
PD cases	172	79
Controls	1018	156

Data analysis
Estimated average MeHg exposure during the whole pregnancy, during the third trimester, and at the beginning of the third trimester were used for each subject. Mantel-Haenszel odds ratio for matched data stratified by age and sex was used, categorizing MeHg exposure as a binary exposure variable where 'not exposed' were defined as MeHg equal to zero or within the lowest tertile of the non-zero MeHg distribution. Further, odds ratios were compared without matching using $\chi 2$ to assess differences in odds between PD and MeHg exposure levels, categorized as a binary variable or as 3 categories based on the tertiles of the MeHg distribution. In addition, logistic regressions were used to assess the relationship between PD and MeHg exposure categories, adjusted for age and sex.

Logistic regressions, adjusted for sex and age, were used to assess the relationship between PD and postnatal exposures based on the questionnaire.

Results

Table 2 Association between PD and estimated prenatal MeHg exposure[a]

	Cases n=172	Controls n=1018	OR	95% CI	$\chi 2$
Average MeHg during the entire pregnancy					
Not exposed[b]	95	565	1.00		
Some exposure[c]	35	230	0.91	0.60 -1.38	
High exposure[d]	42	223	1.13	0.76 -1.67	p=0.69
Average MeHg during the third trimester					
Not exposed[b]	107	639	1.00		
Some exposure[c]	33	189	1.06	0.70 -1.62	
High exposure[d]	32	190	1.12	0.72 -1.73	p=0.98
MeHg at the start of the third trimester					
Not exposed[b]	116	699	1.00		
Some exposure[c]	28	160	1.06	0.68 -1.66	
High exposure[d]	28	159	1.07	0.68 -1.70	p=0.95

Abbreviations: CI, confidence interval; OR, odds ratio
[a]Analysis without matching
[b]MeHg levels equal zero (NE) and lowest tertile of the non-zero MgHg distribution
[c]MeHg levels in the second tertile of the non-zero MeHg distribution
[d]MeHg levels in the third tertile of the non-zero MeHg distribution

Table 3 Association between PD and lifetime exposure to traditional food

	Blubber consumption[b]	Whale meat consumption[b]
Adjusted OR[a]	4.64	5.72
95% CI	2.27 - 9.46	2.87 - 11.41

Abbreviations: CI, confidence interval; OR, odds ratio
[a] adjusted for sex and age
[b] the subjects were separated based on consumption "at least twice per month" and "no more than once per month" to obtain groups of approximately equal sizes

Table 4 Association between PD and current MeHg and POP exposure

	log ∑PCB[a]	log PCB-TEQ[b]	log *p,p*-DDE	log HCB	log β-HCH	log *o,p*-DDT	log B-Hg	log H-Hg
Adjusted OR[a]	1.56	1.39	1.12	1.19	7.51	0.78	1.18	0.73
95% CI	0.65-3.70	0.59-3.32	0.57-2.23	0.45-3.17	2.19-25.76	0.37-1.67	0.60-2.30	0.36-1.50

Abbreviations: CI, confidence interval; OR, odds ratio; HCB, hexachlorobenzene; β-HCH, beta-hexachlorocyclohexane; B-Hg, blood-mercury; H-Hg, hair-mercury
[a] adjusted for sex and age
[b]∑PCB is calculated as 2.0 x PCB (138+153+180)
[c]PCB-TEQ is calculated as ((PCB105 + PCB118 + 5*PCB156) *10

Conclusion

No significant association between PD and estimated prenatal MeHg exposure was found. The confidence intervals suggest that prenatal MeHg exposure is unlikely to explain the doubling of PD prevalence in the Faroes, even taking into account misclassified exposures. Questionnaire information showed that cases had a much higher consumption of whale blubber and whale meat in adulthood than controls, thus suggesting a positive association between lifetime POP and MeHg exposure and development of PD. Current blood concentration levels mainly reflect recent exposure levels and were fairly similar, but β-HCH was significantly higher in the cases.

Acknowledgement

This study was supported by Danish Parkinson Foundation, Faroese Parkinson Foundation and PHIME (European Commission). The work of the neurologists, Sára Bech and Lene Wermuth, in examining and the diagnosing the PD cases is highly appreciated.

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