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Skull pathology in East Greenland and Svalbard polar bears (*Ursus maritimus*) during 1892 to 2002 in relation to organochlorine pollution

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Abstract

East Greenland and Svalbard polar bears (*Ursus maritimus*) are heavily polluted with long-range transported organochlorines such as PCBs (polychlorinated biphenyls). To investigate the negative health impacts, a time-trend study of skull pathology was conducted on 269 East Greenland and 241 Svalbard polar bears. The skulls were sampled during 1892–2002 and 1964–1992, respectively. Seven different pathological changes were found: adonti, displacement of teeth, caries, osseous proliferations, exostosis, tooth wear and periodontitis. Only tooth wear and periodontitis was in a prevalence that allowed statistical treatment. The most severe cases of tooth wear and periodontitis were accompanied by a substantial loss of alveolar bone structure. The prevalence of tooth wear and periodontitis increased significantly with age ($p<0.001$) with incisor wear being more severe than in canines, premolars and molars ($p<0.001$). No sex difference was found for tooth wear ($p=0.22$) while a significant difference between sexes was found for periodontitis ($p=0.01$) with males having higher prevalence than females (odds ratio of 2.5 for males: females). In East Greenland, the prevalence of tooth wear was significantly higher in polar bears collected in the pre pollution period (<1960) than in bears sampled during polluted periods (1960–1980 and 1981–2002) ($p<0.001$). Regarding periodontitis, the prevalence was not significantly different between pre-pollution and pollution periods ($p=0.309$). Polar bears from Svalbard had significantly higher prevalence of tooth wear ($p<0.001$) and periodontitis ($p=0.02$) than polar bears from East Greenland. The tooth wear and periodontitis odds ratios for Svalbard:East Greenland were 135 and 2.6, respectively. Hence, we found a clear age/sex link and geographical difference but no evidence for an association between skull pathology and exposure to organochlorines in East Greenland and Svalbard polar bears.

Keywords: East Greenland; Organochlorines; Periodontitis; Polar bear; Svalbard; Tooth wear; *Ursus maritimus*

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1. Introduction

Polar bears (*Ursus maritimus*) from East Greenland, Svalbard and the Kara Sea are highly polluted with organochlorines (Lie et al., 2003; Dietz et al., 2004; Verreault et al., 2005). Recently, it has been suggested that high levels of organochlorines may induce endocrine disruption (Braathen et al., 2004; Haave et al., 2003; Oskam et al., 2003, 2004; Skaare et al., 2001) and immunosuppression (Bernhoft et al., 2000; Lie et al., 2004, 2005) in Svalbard polar bears. Furthermore, organochlorines are believed to reduce bone mineral density (BMD) and size of sexual organs and to be a co-factor in the development of renal lesions, liver and lymph organ changes in East Greenland polar bears (Sonne et al., 2004, 2005a, 2006a,b; Kirkegaard et al., 2005).

Laboratory studies have shown that organochlorines induce periodontitis in mink (*Mustela vison*) (Render et al., 2000a,b, 2001) and in humans PCB seems to interfere with normal teeth outbreak (Gladen et al., 1990; Rogan, 1979; Miller, 1985). In various studies of wildlife marine mammals, relationships between exposure to organochlorines and exostosis, periodontitis, osteoporosis and widening of canine alveoli have been documented (Zakharov and Yablokov, 1990; Bergman et al., 1992; Mortensen et al., 1992; De Guise et al., 1995; Schandorff, 1997a,b). In the present study, we examine pathology in polar bear skulls collected during 1892–2002 in East Greenland and during 1964–1992 in Svalbard. The prevalence of tooth wear and periodontitis is evaluated in relation to age, sex and sampling sites. Based on time trend organochlorine analyses by Dietz et al. (2004) and AMAP (2004) – and the fact that organochlorines may suppress the immune system of polar bears – the impact from pollution on prevalence of tooth wear and periodontitis is analyzed over time.

2. Materials and methods

2.1. Sampling, preparation and age estimation

Skulls from East Greenland (69°00′N to 74°00′N) were collected by scientific expeditions and hunters during 1892–2002 (n=269). They are now in the possession of Zoological Museum (Copenhagen, Denmark). Skulls from Svalbard held at the Museum of Natural History (University of Oslo, Norway) were collected during 1964–1992 (n=241). Skulls from 1964–1973 were collected by hunters, while skulls from 1974–1992 were collected from bears killed in self defence, for protection of properties or others reasons. Age determination was carried out by counting the cementum Growth Layer Groups (GLGs) of the lower I_3 tooth after decalcification, thin sectioning (14 μm) and staining (toluidine blue) using the method described by Dietz et al. (1991) and Hensel and Sorensen (1980).

2.2. Periodontitis and tooth wear

The skulls were examined for pathology. During the examination, 7 different pathological changes were found (tooth wear, periodontitis including alveolar bone loss, adonti, displacement of tooth, caries, osseous proliferations and exostosis). The prevalence of tooth breakage was close to zero and therefore included as wear (it was not possible to separate wear and breakage). However, only tooth wear and periodontitis prevalence allowed for quantitatively data analyses. The skulls were categorized into four groups according to the degree of tooth wear and periodontitis (Table 1).

2.3. Statistical analyses

All statistical analyses were performed with the free software R version 2.1.0 and the significance level was set to p=0.05. The number of skulls included in the different statistical analyses varied due to missing information in some cases on sex, age and collection year.

Wilcoxon rank sum test with continuity correction was used to test for a difference in the prevalence of tooth wear and periodontitis between left and right and among canines, molars, premolars and incisors. In the further statistical analyses, all data were transformed into only two categories (absence and presence) because the frequencies in the categories higher than 0 were too low for further sub-division to allow for statistical

Table 1
Description of categories of tooth wear and periodontitis used for analyses of 510 skulls of polar bears from East Greenland and Svalbard collected during 1892–2002 and 1964–1992, respectively

Pathology	Category			
	0	1	2	3
Tooth wear	No wear	Crown flattened 1–2 mm	Crown flattened 2–5 mm; pulp cavity exposed	Tooth worn more than 2/3
Periodontitis	No periodontitis	Widening of tooth alveoli	Widening of tooth alveoli; Partially loss (="holes") of alveolar bone tissue	Widening of tooth alveoli; Total loss of alveolar bone tissue