Contaminants in Arctic human populations

Khaled Abass, PhD, Docent, ERT

Arctic Health, Faculty of Medicine University of Oulu, Finland
Outline

- Exposure and risks
- Contaminants in Arctic human populations
- Chemicals of emerging Arctic concern
- Contaminants and infectious diseases
Contaminants - Exposure and risks

Contaminants in biological matrices provides the aggregate exposure from different routes.
# Health outcomes reported in published Arctic cohort studies associated with exposure to contaminants

<table>
<thead>
<tr>
<th>Health endpoint</th>
<th>Findings</th>
<th>Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cardiovascular system effects</strong></td>
<td>Hg in cord blood associated with decreased heart rate variability in children at ages 7 and 14 years old</td>
<td>Faroe Islands</td>
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<td></td>
<td>Hg in child blood correlated with reduction of heart rate variability</td>
<td>Nunavik</td>
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<td></td>
<td>Hg was associated with elevated blood pressure among adults</td>
<td>Faroe Islands and Nunavik</td>
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<tr>
<td><strong>Endocrine system effects</strong></td>
<td>Prenatal exposure to high levels of PCBs associated with lower serum testosterone in boys</td>
<td>Faroe Islands</td>
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<td>Exposure to PCBs interferes with thyroid hormone homeostasis in adults</td>
<td>Hudson River (USA)</td>
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<td></td>
<td>The serum POPs have hormone disruptive potentials to ER, AR, and AhR</td>
<td>Greenland</td>
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<td><strong>Immune system effects</strong></td>
<td>Serum PCB conc. at 7 years of age positively associated with total immunoglobin E. conc.</td>
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<td>Parental exposure to OCs increases the susceptibility to infectious diseases</td>
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<td>Nervous system</td>
<td>Postnatal PCB exposure affects information processing at later stages.</td>
<td>Arctic Québec</td>
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<td>Parental MeHg exposure, up to the age of 22, decreased motor function,</td>
<td>Faroe Islands</td>
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<td>effects</td>
<td>verbal ability, memory, and defects in general mental ability</td>
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<td>Parental exposure to Hg linked to, up to the age of 11, several neuro-</td>
<td>Nunavik</td>
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<td>developmental outcomes in children i.e. lower estimated IQ, poorer</td>
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<td></td>
<td>memory functions, increased risk of attention problems &amp; ADHD behavior.</td>
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<td>Reproductive</td>
<td>PCB153 strongly correlated with the level of SHB globulin.</td>
<td>Norway</td>
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<tr>
<td>effects</td>
<td>High PCB levels associated with low semen quality in men</td>
<td>Faroe Islands</td>
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<td>High levels of PFCs in blood were adversely associated with longer</td>
<td>Greenland</td>
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<tr>
<td></td>
<td>menstrual cycles</td>
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<td></td>
<td>Prenatal exposure to OCs was associated with reduced gestation duration</td>
<td>Arctic Quebec</td>
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<td></td>
<td>Serum PFC levels were associated significantly with breast cancer risk</td>
<td>Greenland</td>
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<tr>
<td>Skeletal system</td>
<td>PCB105 and PCB118 inversely associated with the bone stiffness index</td>
<td>Eastern James Bay (Canada)</td>
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<tr>
<td>effects</td>
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Contaminant-mediated biological effects reported in Arctic wildlife and fish

- Hormone levels
- Immune function
- Oxidative stress
- Blood biochemistry
- Bone density
- Reproduction
- Vitamin status
- Enzyme activity
- DNA damage
- Tissue pathology
- Neurological and behavioral effects

Legacy chemicals and mercury continue to pose a significant concern for Arctic biota.
Outline

• Exposure and risks
• Contaminants in Arctic human populations
• Chemicals of emerging Arctic concern
• Contaminants and infectious diseases
Temporal trends of contaminants in Arctic human populations

Khaled Abass¹,² • Anastasia Emelyanova³ • Arja Rautio¹,³

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Abstract
The first Arctic Monitoring and Assessment Programme (AMAP) report was published in 1998 and followed by three assessment reports of human health (AMAP 2003, 2009 and 2015). The focus area of the AMAP reports was to monitor levels of environmental contaminants in the Arctic and to assess the health effects connected with detected levels in Arctic countries. This review gives an overview of temporal trends of contaminants and their health effects in humans of the Arctic based on data published by AMAP as well as research scientific literature. Simultaneously over six contaminants in humans of the Arctic countries.
Trends of blood POPs concentrations from same children. Data presented as geometric means. POPs and OCs are in µg/kg plasma lipid.
Data represented as geometric means (µg/kg plasma lipid) for specific locations and periods of time.

Trends of POPs in maternal blood
Data are represented for the specific period of sampling
PBDE in Finnish breast milk represented PBDE47+PBDE99+PBDE100+PBDE153+PBDE209. TEQ: dioxin toxic equivalents
Trends of PFCs geometric means (µg/kg plasma lipid) in Yup'ik maternal blood; (µg/kg pooled blood serum) Swedish first-time mothers three weeks after delivery and (µg/L whole blood) in Nunavik maternal blood, and median (ng/ml serum) in men serum sample from Northern Norway.

PFOS perfluorooctane sulfonic acid; PFOA perfluooctanoic acid; PFDA Nonadecafluorodecanoic acid
Geometric means (μg/L whole blood) in Yup’ik, Nunavik, coastal Chukotka and Disko Bay maternal blood and *median (μg/L whole blood) in women and men from Västerbotten, Sweden.

Data represented for the specific period of sampling.
Different significances on trend data based on biota, location and contaminants.

Riget et al., Sci Total Environ. 2010; Abass et al. Unpublished
Modelled relative change of PCBs in the Arctic and European atmosphere. The model indicates what happens with PCBs when climate change is taken into account. PCB concentrations will show a relative increase in the Arctic Ocean and atmosphere, mostly due to the climate change impact on temperature.
Permafrost thaw has major implications for the global mercury cycle. The results of the recent study finds that more than 15 million gallons of mercury is frozen in permafrost in the Northern hemisphere—it is roughly 10 times the amount of global mercury emissions over the last 30 years.

(Schuster et al. 2018 Geophysical Research Letter)
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• Exposure and risks
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Chemicals of emerging Arctic concern

- Current-use pesticides
- Per- and polyfluoroalkyl substances
- Brominated flame retardants
- Chlorinated flame retardants
- Organophosphate-based flame retardants and plasticizers
- Siloxanes
- Pharmaceuticals and personal care products
- Polychlorinated naphthalenes
- Hexachlorobutadiene
- Pentachlorophenol (PCP) and pentachloroanisole
- Organotins
- Polycyclic aromatic hydrocarbons
- ‘New’ unintentionally generated PCBs
- Halogenated natural products
- Marine plastics and microplastics
CUP are only licensed for use if they do not persist in the environment and have low bioaccumulation and short range transport potential.
CYPs are important in the metabolism of wide range of endogenous substrates as well as a wide range of xenobiotics.
The inhibition of major human hepatic cytochrome P450 enzymes by 18 pesticides: Comparison of the N-in-one and single substrate approaches

Khaled Abass\textsuperscript{a,b,n,1}, Olavi Pelkonen\textsuperscript{a}
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Is there a link between pollutant exposure and emerging infectious disease?

A scoping literature review found evidence supporting the hypothesis that a population’s pollution status could help refine classification of emerging infectious disease hotspots

(Hodges and Tomcej Can Vet J v.57(5); 2016)

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Percentages of PubMed results from searches about climatic factors and infectious diseases by region. 8% of the research done in this field is from the Arctic. The study revealed a positive trend in the number of publications. Tick-borne diseases, tularemia, anthrax, and vibriosis were the most diseases likely to be impacted by climatic factors in the Arctic.
Holistic integration of human health risks

Abass et al. 2019. One Arctic - One Health. Finnish Food Authority Research Reports 3/19
Contaminants in human biological matrices showed declining trends in most of the monitored Arctic locations, with the exception of oxychlordane, HCB, PBDE153 and PFCs.

Strengthened collaborations between research scientists, indigenous communities and knowledge holders to facilitate a broader understanding of factors impacting human health in a rapidly changing Arctic.