Maternal Child Health, Climate Change, Food Chain Contaminants in Rural Alaska

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Alaska Native MCH Environmental Health

- Background
- Major challenges
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Background

- Alaska Native population is 130,000, 19% of Alaska’s population the highest Native American population percentage of any State.
- Approximately 65% rural, 35% urban, 58% in villages of 200 or less.
- Most of the rural communities have no road connection with major population centers.
ALASKA NATIVE HEALTH STATUS
Alaska Population Estimates, 2002

NOTE: American Indian/Alaska Native alone or in combination with one or more of the other five races.

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Major Challenges

• Climate change
• Subsistence food safety
Climate Change

• The climate is changing more rapidly in the northern western hemisphere than anywhere else, more of the warming is in winter than summer.

• Some regions are cooling.
IMPACTS OF A WARMING ARCTIC

Arctic climate is now warming rapidly and much larger changes are projected.

(ANNUAL, °C)

The colors indicate the change in temperature from 1954 to 2003. The map indicates annual average temperature change, which ranges from a 2-3°C warming in Alaska and Siberia to a cooling of up to 1°C in southern Greenland.

(WINTER: Dec-Feb in °C)

This map indicates the temperature change during the winter months, ranging from a warming of up to 4°C in Siberia and Northwest Canada to a cooling of 1°C over southern Greenland.
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Climate Change and Contaminants in the Arctic

- Atmospheric and Ocean Processes
- ACIA Climate Model Projections
- Impact of Climate on Contaminants
- Conclusions
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Climate Change and Contaminants in the Arctic

Atmospheric Processes

Polar Vortex (PV)
A cyclonic wind pattern around the North Pole strongest in the troposphere above 15,000 ft., and strongest in winter. The PV profoundly influences temperature, barometric pressure, Arctic ice and surface water circulation as well as Arctic and Northern hemisphere weather.
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Climate Change and Contaminants in the Arctic

Atmospheric Processes

Arctic Oscillation (AO) Index

A measurement of difference in sea level pressure (SLP) between the Arctic high pressure field, and the northern hemisphere mid-latitude (37-45°N) low pressure field.
Effects of the Positive Phase of the Arctic Oscillation

Effects of the Negative Phase of the Arctic Oscillation

(Figures courtesy of J. Wallace, University of Washington)

Website: http://nsidc.org/arcticmet/patterns/arctic_oscillation.html
Climate Change and Contaminants in the Arctic

A positive AO increases wind currents into the Arctic, and raises the mean Arctic temperature, decreases sea ice, increases precipitation. A negative AO increases sea ice decreases mean temperature, increases cold air movement into northern latitudes.
• Strong positive AO causes increased cyclonic movement of surface water and ice in the Arctic Ocean.
• Strong positive AO diverts Russian Arctic river inflow (1000 Km³/yr.) into the Canada Basin, and the Canadian Archipelago.
• Strong negative AO causes Russian River water to be diverted to eastern Greenland.
Southern Oscillation Index

Cyclic changes in equatorial Pacific Ocean surface temperatures, as expressed by the gradient between Darwin, Australia and Tahiti, cold surface water in the western Pacific, and warm surface waters in the eastern Pacific result in El Niño events. Warm surface water in the western Pacific, and cold surface water in the eastern Pacific, result in La Niña events.
Climate Change and Contaminants in the Arctic

Climate and Contaminant Transport (Atmospheric)

• Strong ENSO events increase atmospheric transport of lower latitudes contaminants to Eastern Arctic Canada.
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Climate Change and Contaminants in the Arctic

ACIA Climate Model Projections

- Increase mean temperature of 1.6–5.8°C by 2100.
- Increase precipitation, mostly as rain.
- Decreased sea ice, decreased snow cover and albedo.
- Increase in sea level ≈ 20cm.
- Possible increase river output in some, not all, Arctic rivers.
- Decrease in permafrost in some regions.
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Climate Change and Contaminants in the Arctic

ACIA Climate Model Limitations

• No ability to model ocean processes.
• No ability to model AO, SO, PV.
• No ability to model clouds.
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Health Impacts from Climate Change in the Arctic

- Damage to permafrost dependent infrastructure
- Zoonotic Disease
- Contaminant Transport
Major Challenges

Subsistence Food Safety
- Rural Alaska Natives are the most subsistence dependent population in the US.
- Accumulation of organic contaminants in the food web biomagnifies; the developing fetus and pregnant women are most sensitive.
- Transport of contaminants by ocean, river, and atmospheric mechanisms may be increased by a warming climate.
Alaska Subsistence Food Harvest
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Major Challenges

Subsistence Food Safety

• Highly persistent, fat soluble, easily transportable.
• Industrial origin – PCBs, PBFRs.
• Agricultural pesticides – DDT, Toxaphene, Mirex, HCCH.
• Industrial by-products – Dioxans, Furans, HCB.
Major Challenges

Subsistence Food Safety

Heavy Metals

- Hg, Pb, As, Cd
- All are naturally occurring, easily transported.
- Hg, As, Cd exist in forms that vary greatly in toxic potential.
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Traditional Diet
Alaska Native MCH Environmental Health

Major Challenges

Subsistence Food Safety
Toxicological Effects
• Growth, neurologic development
• Endocrine disruption
• Immunologic effects
• Adult chronic disease
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Major Challenges

Subsistence Food Safety

Transport

• Air currents are hemispheric.
• Ocean currents are global.
• All local sources are eventually distributed globally.
• Warming Arctic climate may be increasing transport from lower latitudes to Arctic.
Arctic Influence on Ocean Circulation

The Arctic plays a fundamental role in circulation of water in the oceans of the world. When warm, salty North Atlantic water reaches the cold Arctic around Greenland and Iceland and in the Labrador Sea, it becomes denser as it cools, and therefore sinks to deeper layers of the ocean. This process of forming deep water is slow, but takes place over a huge area. Every winter, several million cubic kilometers of water sink to deeper layers, which move water slowly south along the bottom of the Atlantic Ocean.

*The polar front influences global ocean currents*
North Pacific Ocean Currents

- Yellow = West Wind Drift (or North Pacific Current)
- Pink = California Current
- Orange = Alaska Current
- Red = Alaskan Stream
- Pink = Kamchatka Current
- Green = Oyashio Current
- Light Blue = Kuroshio Current
- Blue = West Kamchatka Current
- Black = Alaska Coastal Current
Fig. 1. A general conceptual model of seasonal distribution and movements of Pacific salmon in the open ocean. Salmon are distributed in both the Bering Sea and North Pacific Ocean in the summer and primarily in the North Pacific Ocean in the winter. Immature salmon generally move to the south and east in winter (black arrows) and to the north and west in summer (grey arrows). Base map showing oceanographic features and approximate current speed (km/d) is from Quinn (2005).
Yukon River Chinook Salmon Muscle Contaminant Levels (ppb, wet weight)

Toxaphene

DDE

HCB

United States Fish & Wildlife Service, 2001, A. Matz, personal communication
Yukon River Chinook Salmon Muscle Contaminant Levels (ppm, ww)

United States Fish & Wildlife Service, 2001, A. Matz, personal communication
Alaska Native Traditional Food Safety Monitoring Program
Blood Levels of Persistent Organic Compounds
in Circumpolar Pregnant Women

Mean Values ppb lipid

- Beta-HCH
- p,p'-DDE
- p,p'-DDT
- Oxychlorodane
- Trans-nonachlor
- PCB

1 Alaska Native Traditional Food Safety Monitoring Program
2 Arctic Monitoring and Assessment Program, The Human Health Assessment - 2009
Alaska Native Maternal Blood O3-FA Levels

Arctic Coast

Yukon-Kuskokwim Delta

C20:5w3  C22:5w3  C22:6w3

percentage

0 0.5 1 1.5 2 2.5 3 3.5 4 4.5

Alaska Native Traditional Food Safety Monitoring Program – 1999-2003
ALASKA NATIVE HEALTH STATUS
Low Birthweight, CY 1999-2001

<table>
<thead>
<tr>
<th>Location</th>
<th>Percent of Total Births</th>
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<tbody>
<tr>
<td>US All Races</td>
<td>7.6</td>
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<tr>
<td>IHS Total</td>
<td>6.6</td>
</tr>
<tr>
<td>Bemidji</td>
<td>6.2</td>
</tr>
<tr>
<td>Alaska</td>
<td>5.6</td>
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<tr>
<td>California</td>
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<tr>
<td>Aberdeen</td>
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<td>Oklahoma</td>
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<tr>
<td>Billings</td>
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<tr>
<td>Nashville</td>
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<tr>
<td>Tucson</td>
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ALASKA NATIVE HEALTH STATUS
High Birthweight, CY 1999-2001

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<td>Alaska</td>
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Percent of Alaska Adults who Are Obese, 1991-2002
(Body Mass Index >=30; 3-Year Moving Averages)

Note: “Body mass index” is a measurement of body fat based on height and weight, BMI = weight (kilograms) / height (meters)^2

Source: ISER, Status of Alaska Native Report, 2004 pg. 3-39; (Behavioral Risk Factor Surveillance System)
ALASKA NATIVE HEALTH STATUS
Birth Rates with Diabetic Mother, CY 1999-2001

Rate per 1,000 Live Births
With Diabetes Status of the Mother Reported

Regional Differences in Indian Health 2002-2003 Edition, Part 2
### ZOONOTIC ARBOVIRUS Serology in Alaska Residents

<table>
<thead>
<tr>
<th>VIRUS</th>
<th>HUMAN SEROLOGY</th>
<th>Zarnke</th>
<th>Walters</th>
<th>Stanfield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jamestown Canyon</td>
<td>54%</td>
<td>17.60%</td>
<td>20.50%</td>
<td></td>
</tr>
<tr>
<td>Snowshoe hare</td>
<td>42%</td>
<td>6.80%</td>
<td>13.60%</td>
<td></td>
</tr>
<tr>
<td>Northway</td>
<td>14%</td>
<td>3.10%</td>
<td>3.90%</td>
<td></td>
</tr>
<tr>
<td>Klamath</td>
<td>5.00%</td>
<td></td>
<td></td>
<td>3.40%</td>
</tr>
</tbody>
</table>


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- Climate warming has resulted in northward spread of zoonotic diseases.
- West Nile Virus is steadily extending northward into cold regions.
Cancer Sites Which Have Lower Incidence Rates among Alaska Natives than among US Whites, 1999-2003
Men and Women Combined

- Brain/NS: 0.3
- Prostate: 0.4
- Urinary Bladder: 0.5
- Uterus: 0.5
- Ovary: 0.5
- Leukemia: 0.5
- Lymphoma: 0.6

Cancer in Alaska Natives 1969-2003
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- Naturally occurring Hg.
- Naturally occurring Asbestos.
- Anthropogenic POPs in Wildlife.
- Changing prevalence of Zoonotic Diseases.
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Zoonotic Diseases

• Climate warming has resulted in northward spread of zoonotic diseases.
• West Nile Virus is steadily extending northward into cold regions.
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Chronic Disease Research

• High intake of 0-3FA reduces risk of arrhythmia, but increases bleeding risk; increases insulin sensitivity and probably decreases risk for metabolic syndrome, and diabetes.
• Climate warming may have increased the risk of domoic acid production in northern shellfish.
• Selenium may decrease the risk of prostate cancer.
• Contaminant exposure may increase risk for Diabetes, and other chronic diseases such as hypertension, neurologic effects, osteoporosis, malignancy.
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Research Opportunities

Genetics
• 5-HTT – Depression; obesity; SIDS.

Contaminants
• Hg linked to hypertension in children and adults
• Persistent organochlorines are linked to cognitive impairment in the elderly
• T2 DM
• Protective effects of 03-FA
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Conclusions

• Alaska Natives have multiple health disparities, some with well-known risk factors, others as yet unexplained

• A unitary medical record system, geographic isolation, and a unified health care system make epidemiologic research possible in an otherwise small, dispersed population

• Dietary practices probably confer protective and, theoretically risk factors

• Genetic and zoonotic disease may play a significant role in risk for chronic disease
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Conclusions

- The traditional diet confers significant cultural and public health benefits.
- The traditional diet is the source of contaminant exposure for Yupik Alaska Natives and has theoretical risks even at low exposure levels.
- Arctic climate regime change has increased risk in traditional marine and terrestrial food species.