



HEALTH EFFECTS
MONITORING PROGRAM

YELLOWKNIFE, NDILQ AND DETTAH



Progress Report²⁰²⁰

FOLLOW-UP TO PROGRESS REPORT 2019
February 2021



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Monitoring Program Advisory Committee

UNIVERSITY OF OTTAWA

Funding for the Health Effects Monitoring Program is provided by
Crown-Indigenous Relations and Northern Affairs Canada.



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et Affaires du Nord Canada

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Introduction



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This is the second progress report for the Yellowknife Health Effects Monitoring Program (YKHEMP). If interested, you can find our first report on our [website](#).

Why the Long-term Study?

The Health Effects Monitoring Program was established in 2017 to see whether residents of Yellowknife, Ndilq and Dettah are exposed to higher levels of arsenic compared to other Canadians. The first step was to establish baseline levels for arsenic and other metals of concern, which was completed by 2018. Establishing this baseline was very important in making sure accurate monitoring of exposure to arsenic is done in the years to come. The study will be repeated every five years to follow the trends and investigate the long-term relationships between arsenic in the urine and toenails, and health effects.

Who is Leading the Study?

The study is led by Dr. Laurie Chan, a Professor and Canada Research Chair in Toxicology and Environmental Health at the University of Ottawa, and managed by a Health Effects Monitoring Program Advisory Committee (HEMPAC) which meets monthly. You will find a complete list of our stakeholders under the Acknowledgements section on page 21.

What Information was Collected?

YKHEMP tested a total of 2037 residents of Yellowknife, Ndilq and Dettah including members of the Yellowknives Dene First Nation and North Slave Métis Alliance in 2017-2018, to establish a baseline. Samples of urine, toenails and saliva were taken from people between the ages of 3 to 79. Participants also provided consent to have their medical records reviewed by the research team for the past 5 years. In addition to having their medical records reviewed, the Yellowknives Dene also completed a medical questionnaire and a brief medical exam that included measurements of height, weight, and blood pressure. This additional component was added after recommendations from the Yellowknives Dene leadership. The current results give us a snapshot of people's exposure to arsenic and other metals as well as their health at the time of testing.

Monitoring Continues

We will retest children in 2022-23, and children and adults in 2027-28. The on-going monitoring of the local populations during and after Giant mine remediation activities are complete, will ensure that the cleanup does not negatively affect the health of the communities. A summary list of main YKHEMP activities is presented in Table 1.

If you have any questions regarding the results and information presented in this report please contact our project manager, Renata Rosol. You will find her contact information at the end of this document. Details of the design of the study, methodology and more technical results are presented in three peer-reviewed journal publications recently published online. The online links to the three publications are included in Table 1 and in Appendix 1: List of Publications.

Table 1: Overview of YKHEMP Activities 2017-2027

YEAR	ACTIVITY	DETAILS
2017	<ul style="list-style-type: none"> Community consultations Baseline sample collection begins 	Community consultation presentations available at www.ykhemp.ca/presentations.php
2018	Baseline sample collection concludes	University of Ottawa conducts analysis of urine, toenail and saliva samples
2019	<ul style="list-style-type: none"> Results Letters sent to 2037 participants Community presentations to share preliminary population-level results 	Community results presentations available at www.ykhemp.ca/results-presentations.php
2019	Progress Report 2019	Available at www.ykhemp.ca/reports.php
2021	<ul style="list-style-type: none"> Progress Report 2020 Results Pamphlet Radio, Facebook, Web Ads 	In lieu of in-person community meetings, as a result of COVID-19 restrictions, YKHEMP will share program updates through a results pamphlet, progress report, radio and online platforms.
2022-23	Retest children	Continue to monitor children in Yellowknife, Ndiłq and Dettah to ensure clean-up activities at Giant mine are not harming people.
2027-28	Retest children and adults	Continue to monitor children and adults in Yellowknife, Ndiłq and Dettah to ensure clean-up activities at Giant mine are not harming people.

APPENDIX 1: LIST OF PUBLICATIONS

2020	Publication 1: Description of study	Available online at bmjopen.bmj.com/content/10/9/e038507.full
2020	Publication 2: Fish and arsenic	Available online at www.tandfonline.com/doi/full/10.1080/10807039.2020.1799187
2020	Publication 3: Arsenic and human health risk	Available online at www.sciencedirect.com/science/article/pii/S1438463920305691

Things You Should Know About Arsenic

A few facts about arsenic to help you better understand the test results.

Arsenic exists in different chemical forms organized into two groups:

ORGANIC (less harmful) and **INORGANIC** (toxic).

Arsenic is a naturally occurring chemical element found throughout our environment and its living systems. Arsenic levels are naturally higher in some areas of the Northwest Territories compared to other regions of Canada. Arsenic can enter groundwater through erosion and weathering of soils, minerals and ores. Arsenic compounds are used in the manufacture of a variety of products and may enter our environment directly from industrial processes and indirectly from atmospheric deposition. The transport of arsenic in soil, water and air is how foods can get contaminated with arsenic.

People get exposed to some levels of arsenic from the foods we eat and the water we drink. People can also be exposed to arsenic from inhaling dust and ingesting soil. Arsenic can be found at very low levels in many foods, including meat and poultry, milk and dairy products, bakery goods and cereals, vegetables, and fruits and fruit juices. The low levels of arsenic in foods generally reflect normal accumulation from the environment.

Both organic and inorganic forms of arsenic can be found in food, although their levels will depend on the type of food.

Organic Arsenic

Most organic arsenic substances are not known to be harmful to us. Available toxicological information suggests that most organic arsenic substances, such as arsenobetaine and arsenocholine have very limited toxicity. The organic arsenic compound arsenobetaine, for example is most commonly found in fish and shellfish, and has been found to be non-toxic to humans.

However, there is growing evidence that suggests, that metabolized forms of arsenic called monomethylarsonic acid (MMA) and dimethylarsinic acid (DMA) may be toxic. MMA and DMA are products of arsenic metabolism, which means that arsenic that enters the body is transformed into these forms. That is why both of these species are included in calculating a person's toxic (inorganic) arsenic levels.

Inorganic Arsenic

Inorganic arsenic is highly toxic, with more potential to harm peoples' health. Inorganic arsenic can occur naturally in soils and rocks, or it can also be released through mining activities (e.g., arsenic trioxide as a by-product of gold extraction from bedrock). Inorganic arsenic is not usually found at high levels in food, although rice and some types of seaweed can contain higher amounts of inorganic arsenic.

When calculating a person's inorganic arsenic level in urine, YKHEMP also includes the organic arsenic compounds of MMA and DMA to make sure we are getting the full picture of a person's "toxic" arsenic exposure.

Exposure to inorganic arsenic is often a combination of many factors, for example local geology, the foods you eat, the water you drink, the air you breathe, your occupation, life-style choices (for example smoking), and local industrial activities.

Most of the organic and inorganic forms of arsenic that enter the body leave in urine within 3-5 days. However, some arsenic can remain in parts of the body such as your toenails for months; that is why in addition to collecting urine, we also collect toenail samples. Your toenails can show us your exposure to arsenic from anywhere from 2 to 12 months.

Total Arsenic

Total arsenic is the combination of both inorganic arsenic and organic arsenic. Total arsenic provides a quick snapshot of arsenic exposure in a population.

Total arsenic in urine tells us how much arsenic you were exposed to in the past 3 to 5 days because of the foods you ate, and what you may have been exposed to in the environment. For example, eating a big fish meal a couple of days before giving a urine sample will show a higher level of total arsenic in the urine, although most of it will be in the organic (less toxic) form.

For more information on arsenic visit the following sites:

- Arsenic Compounds: www.hss.gov.nt.ca/en/services/contaminantsenvironnementaux/arsenic-compounds
- Arsenic: www.canada.ca/en/health-canada/services/food-nutrition/food-safety/chemical-contaminants/environmental-contaminants/arsenic.html

How does Arsenic Enter the Body?

The main way for arsenic to enter your body is through ingestion (eating and drinking), then inhalation (breathing), then very rarely through the skin.

- **Ingestion:** Arsenic enters easily into the body through food, water, or soil. This is the main way people get exposed to arsenic.
- **Breathing:** Dust may contain arsenic and when breathed in many of the particles settle onto the lining of the lungs. This is less common than ingestion, but it can be a problem in some job situations, for example contaminated dust from mining activities, or airborne dust from contaminated soils from historical site activities (e.g., Giant mine and Con mine are some examples).
- **Dermal:** For arsenic, this is very uncommon. Studies have found that arsenic rarely gets absorbed through the skin. Skin exposure may be of concern if there is direct exposure to a very high level of arsenic (e.g., in occupational settings).

YKHEMP reports both total and inorganic arsenic results for the population as they are the most relevant.

People Tested in 2017-2018

YKHEMP researchers asked people involved in the study about their lifestyle, diet, and health. They also asked for urine, toenails, and saliva samples.

Urine tells us about arsenic exposure in the previous 3 to 5 days.

Toenail clippings tell us about arsenic exposure in the past 2 to 12 months.

Saliva will tell us how our genes may influence the way our body processes (or metabolizes) arsenic. The study is looking at several specific DNA markers related to arsenic. The saliva testing results will be available in 2021.

Review of medical files for the past 5 years, along with the Yellowknives Dene medical questionnaire, will be used to investigate possible associations between arsenic and specific health outcomes. Information from this review will be available in 2021.

There is no way to measure long-term, past exposures to arsenic; for example, over a lifetime of living in Yellowknife, because there is no existing technology that can help us to do that. While toenail clippings can show arsenic that has been in the body anywhere from 2 to 12 months, arsenic does not build up in the body over the long term like other chemicals, such as PCBs (polychlorinated biphenyls) or mercury.

A total of 2,037 individuals were tested in 2017-2018. This data will form the baseline to which future results will be compared.

YKHEMP can only measure current levels of arsenic in the body, up to about one year.

Table 2: Individuals Tested in 2017-2018

POPULATION	CHILDREN (3-19 YEARS)	ADULTS (20-79 YEARS & ELDERS)	TOTAL
Yellowknives Dene	87	138	225
North Slave Métis Alliance	11	35	46
YK Random selection	217	673	890
YK Volunteer	191	685	876
TOTAL	506	1531	2037

Arsenic Test Results from Urine Samples

TOTAL ARSENIC: Comparing YKHEMP results with those of other Canadians.

In general, the total arsenic levels of YKHEMP participants were lower compared with the rest of Canada.

How do we know?

Statistics Canada measures arsenic levels by doing a Canadian Health Measures Survey (CHMS) every few years. Urine from thousands of Canadians is sampled and analyzed, and those results are representative of the Canadian population. We compared those results to the results of YKHEMP study.

From the CHMS data, Statistics Canada calculated a **reference level**. The reference level is the level below which results from 95 percent of the Canadian population fall. For **total arsenic in urine**, that level is **27 µg/L** (micrograms per litre).

How much is that? Think of it as 27 drops of water in a 10,000 gallon swimming pool.

Reference levels used in YKHEMP study do not reflect toxic effects but are instead used to compare populations.

If your result is above the reference level, it means that at the time of testing your concentration was higher than 95% of other Canadians, and as a precaution we want to continue to follow-up with you.

The chart below shows average total arsenic levels for each test group compared to the Canadian average.

Table 3: Average Total Arsenic Urine Results – Reference Level is 27 µg/L

POPULATION		AVERAGE TOTAL ARSENIC CONCENTRATION (µg/L)	NUMBER TESTED
Yellowknives Dene	Children	6.7	75
	Adults	5.4	119
North Slave Métis Alliance	Children	4.1	13
	Adults	5.9	33
Yellowknife Random	Children	7.5	211
	Adults	8.1	659
Yellowknife Volunteers	Children	8.2	198
	Adults	8.1	658
Canadian Average	Children	8.2	4709
	Adults	10.7	7094

Everyone's results in the study were well below levels known to be associated with certain health effects (that is, levels at which we begin to see diseases such as skin problems).

INORGANIC

ARSENIC: Children participants from Yellowknife and the Yellowknives Dene have slightly higher average urinary inorganic arsenic compared to other Canadian children and adults from our study.

We are following up with those individuals with arsenic results above the reference level.

There is presently no evidence that peoples' health is at risk at the arsenic levels we are seeing in the Yellowknife area. However, this is a long-term study and we will continue to look at health effects in future testing.

All test groups in YKHEMP had average total arsenic levels below the Canadian average, especially the Yellowknives Dene and North Slave Métis Alliance (NSMA) members. The Yellowknives Dene feel this is likely due to their vast knowledge of the land, and knowing which areas to avoid when hunting and harvesting. The NSMA feel that their own traditional knowledge may be the reason for lower arsenic levels reported for this group. The smaller sample size for NSMA participants, compared to the other population groups, may also be a reason for the lower arsenic levels.

INORGANIC ARSENIC: Comparing YKHEMP results with those of other Canadians

In addition to total arsenic, it is important to test for inorganic arsenic because it is toxic. Too much exposure to inorganic arsenic over a long period of time may affect your health if you are exposed to it regularly over an extended period of time.

YKHEMP used a reference level to compare inorganic arsenic levels in participants from Yellowknife, Ndilq and Dettah with other Canadians. The **reference level** is the level below which results from 95 percent of the Canadian population fall. For **inorganic arsenic** the reference level is **21 µg/L** (micrograms per litre) in urine for children and adults.

How much is that? Think of it as 21 drops of water in a 10,000 gallon swimming pool.

In the table below you will find 3 types of information:

1. Average levels of inorganic arsenic for each population group;
2. Number of participants who provided a urine sample for testing; and
3. Number of participants with inorganic arsenic levels above the reference level.

Table 4: Inorganic Arsenic Urine Results – Reference Level is 21 µg/L

POPULATION		AVERAGE INORGANIC ARSENIC (µg/L)	NUMBER TESTED	NUMBER ABOVE THE REFERENCE LEVEL
Yellowknives Dene	Children	6.4	75	2
	Adults	4.5	119	0
North Slave Métis Alliance	Children	4.7	13	0
	Adults	4.2	33	0
Yellowknife Random	Children	6.6	211	15
	Adults	5.3	659	23
Yellowknife Volunteers	Children	7.2	198	21
	Adults	5.7	658	26
Canadian Average	Children	5.4	4709	–
	Adults	5.4	7094	–

In total, there were 49 out of 1469 ADULT participants, and 38 out of 497 CHILDREN participants with inorganic arsenic levels higher than the reference level of 21 µg/L.

Arsenic Test Results from Toenail Samples

YKHEMP collected toenail samples because they show arsenic exposure over the past 2-12 months. Urine tells us exposure of only the previous 3-5 days.

Steps Taken in Analyzing the Toenail Samples

First, we analyzed toenails for total arsenic to get a sense of how much arsenic people were being exposed to. This analysis took place at the University of Ottawa. Participants who provided a toenail sample received their personal result in May 2019 along with their urine result.

Then, we wanted to check if some part of the total arsenic in the toenail was caused by contamination on the surface of the nail by dust and/or soil. Contamination on the nail surface could happen from walking barefoot in arsenic contaminated soil for example. We asked individuals with higher total arsenic levels in their toenail samples, to meet with our nurse practitioner to provide another toenail sample for analysis using laser technology. The laser technology analysis was done at a specialty lab in British Columbia. This specialized work looked at how much of the arsenic in the nail was coming from inside the body, and how much of it was due to outside contamination from dust or soil on the surface of the toenail.

This additional testing was able to give the research team a good idea of the relative amount of arsenic on the toenail caused by outside contamination versus the arsenic in our body as a result of food, water and air (**see results on next page**).

Toenail results suggest that some children may be exposed to higher levels of arsenic.

This could be because:

1. Children have smaller bodies compared to adults and as a result have higher intakes of arsenic per body weight.

2. Children spend more time outdoors not washing their hands, and putting dirt or dirty hands into their mouths.

TOTAL ARSENIC: Comparing YKHEMP Toenail results with other Populations

The CHMS study did not measure arsenic in toenails; therefore, we cannot compare our results to the general Canadian population. Without a reference level like for metals in urine, YKHEMP team set levels for total arsenic in toenails based on the data collected from Yellowknife. We asked people to be retested if they were in the top 5% of arsenic levels among the adults we tested, and the top 20% of children. We chose the top 20% of children rather than the top 5% (as in adults) as we were being more cautious, allowing for more children to be retested.

- A total of 1,872 toenail samples were collected
- 158 people had arsenic levels above the set reference level in toenails (72 adults and 86 children)

Generally, the results of toenail arsenic levels in most of our study participants are similar to what is observed in other populations that have no known sources of arsenic exposure, such as Quebec, New Zealand and the United Kingdom.

Some participants, particularly children, had higher arsenic levels in toenail, similar to levels reported in other studies conducted with children living in areas adjacent to former copper mine sites in Arizona and gold mine sites in Victoria, Australia. For more information on this, check out our publication online at www.sciencedirect.com/science/article/pii/S1438463920305691

We are in the process of gathering additional information on possible soil and dust exposures of children participants with elevated arsenic. The results will be ready in 2021-22.

Results from Retesting of Toenails using Laser Technology

Only 35 out of 158 people with higher arsenic in toenails contacted YKHEMP to submit a follow up toenail sample to be tested using laser technology.

For the laser analysis, a level of 0.5 µg/g was used as a reference level. The literature on arsenic concentrations in all nails in populations across the globe suggests that a typical range for arsenic in nails of people living in non-contaminated areas is between 0.02 and to 0.5 µg/g.

About half of the people retested (18 out of 35) had results higher than 0.5 µg/g however, they were mostly due to outside contamination (i.e., dirt rubbing into the nail). **In the end, only 3 out of the 35 people had an arsenic level in the toenail higher than the 0.5µg/g reference level that was not from dirt on the surface of the toenail. The study team is following up with these individuals.**




Higher Test Results for Other Chemicals

Much of the focus of the YKHEMP study is on arsenic, but we also looked at other metals including cadmium, lead, antimony, manganese and vanadium. The Giant Mine Remediation Project Team completed a human health and ecological risk assessment study that identified these chemicals as being of potential concern. If you are interested in learning more about that study, a summary of the risk assessment report is available on our website at www.ykheмп.ca/documents/giant_hhera_plain_language_summary_2018

YKHEMP found that some people had higher levels of lead and cadmium in their urine. The study team is following up with these individuals.




Number of People with Higher Lead and Cadmium Levels for all Populations

HIGHER LEVELS OF LEAD IN URINE

	YKDFN	NSMA	RANDOM	VOLUNTEER
	6 out of 74 8.1%	0 out of 11 0%	14 out of 212 6.6%	11 out of 183 6.0%
	5 out of 120 4.1%	0 out of 35 0%	41 out of 658 6.2%	40 out of 673 5.9%
TOTAL 	11 out of 194 5.6%	0 out of 46 0%	55 out of 870 6.3%	51 out of 856 5.9%

YKHEMP is keeping all test results in a password protected database at the University of Ottawa. They provide a future baseline to which future results will be compared.

HIGHER LEVELS OF CADMIUM IN URINE

	YKDFN	NSMA	RANDOM	VOLUNTEER
	0 out of 74 0%	0 out of 11 0%	4 out of 212 1.9%	0 out of 183 0%
	0 out of 120 0%	4 out of 35 1.1%	19 out of 658 2.9%	14 out of 673 2.0%
TOTAL 	0 out of 194 0%	4 out of 46 8.7%	23 out of 870 2.6%	14 out of 856 1.6%

Results for Cadmium and Lead

YKHEMP results showed that:

- Overall, YKHEMP participants had lower urinary cadmium levels compared to other Canadians.
- Higher cadmium levels were mostly found among adults, most of whom smoked.
- Some adults and children had elevated levels of lead in urine, compared to other Canadians.
- We asked people with higher lead levels in their urine to have a blood test as a follow-up. Urine is not a reliable test and is only used for screening purposes. The most reliable test for lead in the body is blood.
 - Most people who had the more reliable blood test were below the lead guidelines in blood of 5.0 µg/dL for children and pregnant women, and 10 µg/dL for adults. For example, the highest blood level recorded in the study for a retested non-pregnant adult participant was 8.5 µg/dL and for a child was 3.3 µg/dL.

If you want to learn more about Lead and Cadmium, please refer to the following websites:

- State of Science Report on Lead (2013) at www.canada.ca/content/dam/hc-sc/migration/hc-sc/ewh-semt/alt_formats/pdf/pubs/contaminants/dhhssrl-rpecscepsh/dhhssrl-rpecscepsh-eng.pdf
- YKHEMP Lead FAQ: www.ykhemp.ca/documents/metal-faqs/Lead-FAQs.pdf
- Environmental Contaminants - Lead: www.hss.gov.nt.ca/en/services/contaminants-environnementaux/lead
- YKHEMP Cadmium FAQ: www.ykhemp.ca/documents/metal-faqs/Cadmium-FAQs.pdf

Results for Antimony, Manganese and Vanadium

YKHEMP did not find high levels of antimony, manganese and vanadium among the participants tested. Since there are currently no established reference levels for these metals, we will keep the results in our data bank to allow for future comparisons.

Follow up Steps for People with Metal Levels Above the Reference Level

Some people in the study had higher levels of arsenic, cadmium and/or lead at the time of testing. We asked these people to follow up with our nurse practitioner. We asked additional questions about their diet and lifestyle, and for another sample to confirm their exposure. This is to help the team figure out where their exposure may be coming from, and to recommend ways to reduce their exposure.

In majority of the follow-up samples, the results came back below the reference level, and no further follow-up was necessary. For those who continue to have higher levels they will be followed-up every 6 months until their levels are consistently below the reference level. This is to ensure that people with higher levels receive continuous advice and support.

What Do the Higher Metal Levels Mean to Your Health?

Being above the reference level does not necessarily mean that you will experience any health problems. Reference levels used in the YKHEMP study are to compare populations and are not based on toxic effects. If your level is above the reference levels, it only means your concentration was higher than 95% of other Canadians at the time of testing, and as a precaution we want to follow-up with you.

The team will continue to follow-up with these individuals until their metal levels are consistently low.

At present, we found no evidence that peoples' health is at risk at the metal levels we are seeing in the Yellowknife area.

Assessing Health Risks of Arsenic Exposure

Arsenic is toxic (especially inorganic arsenic) but its harmful effects depend on how much arsenic you are exposed to, the way arsenic enters your body (mouth, nose or skin), and for how long you are exposed (days, months, or years). Health risks also vary individually and can depend on many other factors (e.g. exposure to other chemicals, age, sex, diet, occupation, genetics, family history, lifestyle (such as smoking), and your general state of health).

One Useful Tool For Interpreting Biomonitoring Data Collected In Urine Samples Is The Biomonitoring Equivalent (BE).

YKHEMP looked at exposure to arsenic among the people in Yellowknife, Ndilo and Dettah and the potential health risks. First, we compared the levels of arsenic in our study to those of the Canadian population (refer to pages 9-10). Then, to further understand the potential health risks of arsenic exposure, we used a guidance value called Biomonitoring Equivalent (BE). The BE is commonly used by health regulatory agencies such as Health Canada, to assess the risk of arsenic exposure in the population. The BE is a calculated arsenic level in urine that is equivalent to the oral intake level of arsenic that is known to have a minimal risk for skin lesions and cancer. **Any person with urine concentrations below this level is considered to be at very low risk for those health effects. Any person above the BE value is at higher risk if they are exposed to that level daily and over a long period of time.**

For more information on Biomonitoring Equivalents check out www.canada.ca/en/services/health/publications/science-research-data/biomonitoring-equivalents-screening-tool-population-level-data.html

Risk Factors Linked to Higher Levels of Inorganic Arsenic

Using YKHEMP data, the research team looked to see which risk factors are associated with higher levels of arsenic in a person's body. Studies from around the world tell us that diet, occupation, certain lifestyle factors such as smoking, drinking water or swimming in lake waters with higher arsenic levels, and living close to mine sites, may lead to higher levels of arsenic in your body.

The data collected through the lifestyle questionnaires showed that in both adults and children, higher inorganic arsenic levels were linked to diets high in store-bought fish, shellfish (e.g. shrimp, crab, lobster, clams, mussels, oysters) and rice, when eaten at least once a week or more.

For more information check out our publication online at www.sciencedirect.com/science/article/pii/S1438463920305691

In addition to seafood and rice, we found that smoking and eating local mushrooms and berries contributed to higher amounts of arsenic in the urine among some adults.

Among children, we found that higher levels may be due to drinking untreated lake water. The study team also suspects, although has not yet proven, that children's higher levels may also be due to the fact that younger children collect more soil and/or dirt on their hands by playing on the floor/ground which they then put in their mouths. This information will be kept in mind when planning begins for retesting children in 2022.

For more information on Human Health and arsenic check out the Government of Northwest Territories website at www.hss.gov.nt.ca/sites/hss/files/resources/faqs-human-health.pdf

At present, we saw no evidence that peoples' health is at risk at the arsenic levels measured in the Yellowknife area, including those above the reference level. However, this is a long-term study and we will continue to look at health effects in future testing.

The Risk of Cancer

Long-term exposure (over many years to decades) to high levels of inorganic arsenic is known to contribute to the risk of certain human cancers, and can affect the gastrointestinal tract, kidneys, liver, lungs, and skin. However, not everybody who is exposed to arsenic will develop cancer as that is dependent on many other factors including genetics, diet and lifestyle.

In general, the risk of cancer related to arsenic exposure for people in Yellowknife, Ndilo and Dettah was no different from the Canadian general population.

Since YKHEMP is designed as a long-term monitoring program, future data collection may show stronger relationships between arsenic levels and specific health outcomes.

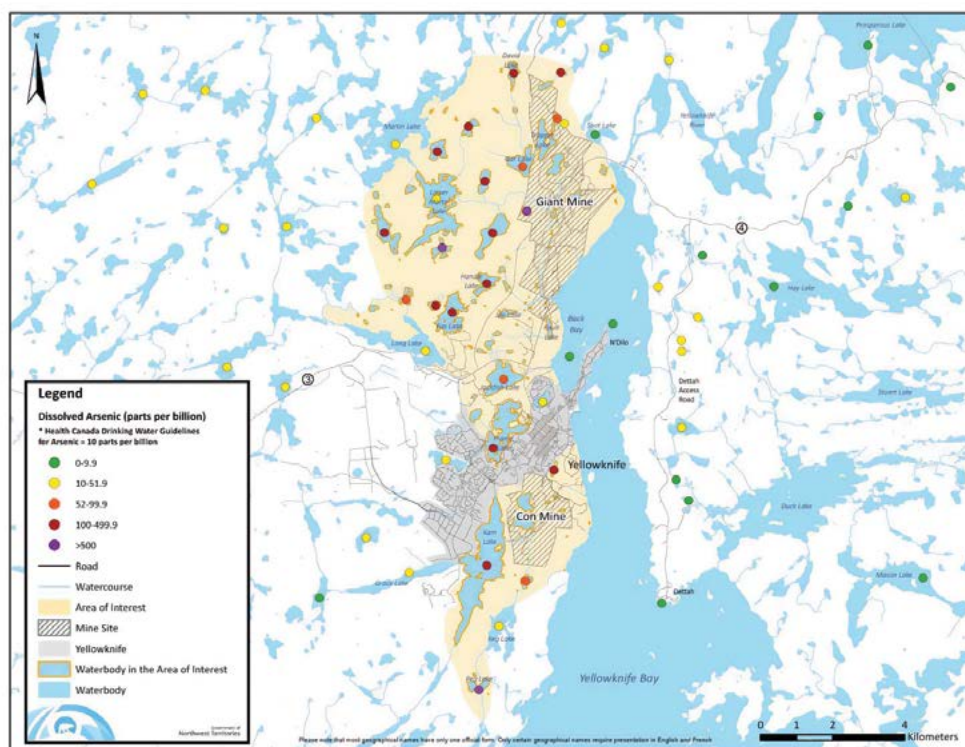
For more information about arsenic and health risks please refer to our publication online at www.sciencedirect.com/science/article/pii/S1438463920305691

Assessing Health Risks of Eating Locally Sourced Foods

Should Residents still eat Berries, use Plants, Trap and Hunt?

Yes. It is safe to eat wild berries and other plants around Dettah, and on the Ingraham Trail east of the Yellowknife River because arsenic levels in these areas have been determined to be low and are below levels of concern. Harvesting within Yellowknife and Ndilo is not recommended since these areas are close to the old mine sites and may have elevated levels of arsenic.

Click on the map to view an online PDF with more information.



For more information on plants and mushrooms, visit: www.hss.gov.nt.ca/sites/hss/files/resources/faqs-soil-plants-mushrooms-gardening.pdf

Eating foods harvested through hunting and trapping activities were not found to be related to elevated arsenic levels.

Traditional foods are healthy, safe to eat, and often people like them better than food from the grocery store.

What about eating Fish?

YKHEMP looked at information people gave us about how much fish they eat, what kind, and from what lakes. In addition to that, we tested 180 fish samples from nine lakes around Yellowknife. The three fish included whitefish, northern

pike and burbot which were the fish most commonly eaten by the people in our study.

We found that on average, the Yellowknives Dene First Nation members eat 3 times more fish than other Yellowknife area residents.

Fish is an important traditional food and continues to be a healthy food option. The fish tend to have organic (less toxic) form of arsenic which is not a concern for human health. It is safe to eat fish from Great Slave Lake and many other local lakes.

Fish from some lakes closer to mining areas had more total arsenic compared to the lakes farther away from the mines. The Government of Northwest Territories Department of Health and Social Services recommends that you do not eat fish from lakes close to the old Giant and Con mines. These include Kam Lake, Frame Lake, Jackfish Lake, Rat Lake, Peg Lake, Meg Lake, Fox Lake, Handle Lake, Gar Lake, and David Lake.

Government of Northwest Territories Health and Social Services has a public health advisory on unsafe fishing locations at www.hss.gov.nt.ca/en/newsroom/arsenic-lake-water-around-yellowknife

YKHEMP found that it is safe to eat locally sourced fish, except for those from lakes near the Giant and Con mines.

Next Steps for YKHEMP

- Continue to follow up with people who have higher metal levels.
- Continue to do laboratory analysis.
- Prepare papers for publication.
- Continue to share baseline study updates as more results become available (i.e., genetics related to arsenic, medical history).
- Continue to monitor populations during Giant mine remediation.

We will test children again in 2022-23, and children and adults in 2027-28.

We want to monitor arsenic levels among the populations to ensure that clean-up activities at Giant mine will not harm peoples' health.

Ethical Considerations

The YKHEMP research continues to follow the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans and in particular Chapter 9, research involving the First Nations, Inuit and Métis Peoples of Canada (Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, Social Sciences and Humanities Research Council of Canada 2010). As well as the document entitled: Indigenous Peoples & Participatory Health Research: Planning & Management, Preparing Research Agreements published by the World Health Organization (2010).

The protocol of the YKHEMP was accepted by the Ethical Review Boards at the University of Ottawa, Aurora Research Institute, and Aurora College Research Ethics Committee. The YKHEMP also follows the First Nations principles of Ownership, Control, Access and Possession (OCAP®) of data (Schnarch, 2004). Individual participation in the project was voluntary and based on informed written consent following an oral and written explanation of each project component. Project direction followed agreed-upon guiding principles (see www.ykhemp.ca), which were jointly established by the Health Effects Monitoring Program Advisory Committee (HEMPAC) and consultation with Statistics Canada for the sampling methodology and random sample selection. Each of the participating communities, the Yellowknife general population, Yellowknives Dene First Nation and the North Slave Métis Alliance, were offered opportunities to contribute to the methodology and refinement of the data collection tools as well as results communications and any follow-up required through public consultation meetings.

Acknowledgements

We would like to thank those who have been involved in the Health Effects Monitoring Program and in preparing this document.

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Erika Nyyssonen, Government of Northwest Territories Environment and Natural Resources – Co-Proponent of GMRP

All aspects of YKHEMP are overseen by HEMPAC. The committee members meet once a month to discuss matters regarding program protocols, study design, data analysis, communications, and publications.

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All information collected is kept confidential throughout the study at the University of Ottawa.

APPENDIX 1:

List of Publications

Publication 1: Description of Study

Hing Man Chan, Xue Feng Hu, Janet S. Cheung,
Rajendra Prasad Parajuli, Renata Rosol,
Emmanuel Yumvihoze, Linna Williams &
Asish Mohapatra (2020) Cohort profile:
Health Effects Monitoring Programme in Ndilo,
Dettah and Yellowknife (YKHEMP), BMJ Open

[PDF](#)

Publication 2: Fish and Arsenic

Claudia Tanamal, Jules M. Blais,
Emmanuel Yumvihoze & Hing Man Chan (2020)
Health risk assessment of inorganic arsenic
exposure through fish consumption in
Yellowknife, Northwest Territories, Canada,
Human and Ecological Risk Assessment:
An International Journal

[PDF](#)

Publication 3: Arsenic and Human Health Risk

Janet Sze-Jing Cheung, Xue Feng Hu,
Rajendra Prasad Parajuli, Renata Rosol,
Allan Torng, Asish Mohapatra, Ellen Lye,
Hing Man Chan (2020) Health risk assessment of
arsenic exposure among the residents in Ndilo,
Dettah, and Yellowknife, Northwest Territories,
Canada, International Journal of Hygiene and
Environmental Health

[PDF](#)

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YELLOWKNIFE, NDILQ AND DETTAH
Progress Report 2020

FOLLOW-UP TO 1st PROGRESS REPORT 2019
February 2021