ᖁᓂᐃᓕᓵᕕᖏᑦ?Qanuilirpitaa?
ᓄᓇᕗᒻ2017
NUNAVIK 2017

# IODINE AND THYROID STATUS

## *QANUILIRPITAA? 2017*

Nunavik Inuit Health Survey



ᓄᓇᕗᒻᒥᐅᑦ ᐃᓚᖃᕐᓂᖅᓱᒃᑯᑦ ᑲᑎᒪᔨᖅ
RÉGIE RÉGIONALE DE LA SANTÉ ET DES SERVICES SOCIAUX DU NUNAVIK
NUNAVIK REGIONAL BOARD OF HEALTH AND SOCIAL SERVICES

ᖃᓄᐃᓕᓕᐹᑦ? Qanuilirpitaa?
ᓄᓇᕗᒻ 2017
NUNAVIK 2017

# IODINE AND THYROID STATUS

## *QANUILIRPITAA?* 2017

Nunavik Inuit Health Survey

ᓄᓇᕗᒥᒃ ᐃᓕᓴᕐᓂᐊᓕᖅᑐᑦ ᑲᑎᒪᔨᖅ
RÉGIE RÉGIONALE DE LA SANTÉ ET DES SERVICES SOCIAUX DU NUNAVIK
NUNAVIK REGIONAL BOARD OF HEALTH AND SOCIAL SERVICES

*Institut national de santé publique* Québec

**Nunavik Regional Board of Health and Social Services**
P.O Box 900
Kuujjuaq, (Quebec)  J0M 1C0
Phone number: 819-964-2222
Toll-free: 1 844-964-2244

Email: information_rrsss17@ssss.gouv.qc.ca
Website: nrbhss.ca/en/health-surveys

Legal deposit – December 2026
Bibliothèque et Archives nationales du Québec
ISBN: 978-2-925576-06-8 (PDF)
© Nunavik Regional Board of Health and Social Services – 2026

## AUTHORS

**Germaine Chapman**
Département de médecine sociale et préventive,
Université Laval

**Amira Aker, PhD, MPH**
School of Public Health, Boston University

**Pierre Ayotte, PhD**
Direction de la santé environnementale et de la toxicologie,
Institut national de santé publique du Québec
Département de médecine sociale et préventive,
Université Laval

**Mélanie Lemire, PhD**
Département de médecine sociale et préventive,
Université Laval
Axe santé des populations et pratiques optimales
en santé – Centre de recherche du CHU de Québec –
Université Laval

## EXECUTIVE DIRECTOR

**Danielle St-Laurent, Director**
Bureau d'information et d'études en santé des populations
Institut national de santé publique du Québec

## SCIENTIFIC DIRECTORS

**Pierre Ayotte, PhD, Professor**
Département de médecine sociale et preventive
Faculté de médecine, Université Laval
Axe santé des populations et pratiques optimales
en santé – Centre de recherche du CHU de Québec –
Université Laval
Institut national de santé publique du Québec

**Françoise Bouchard, MD, MPH, FRCPC**
Director of Public Health
Nunavik Regional Board of Health and Social Services

## STATISTICAL ANALYSIS

**Germaine Chapman**
Département de médecine sociale et préventive,
Université Laval

## WITH THE COLLABORATION OF

**Marie-Noelle Caron, Jonathan Leclerc, Philippe Dufresne and Marie-Josée Gauthier** from the Nunavik Regional Board of Health and Social Services

## COMMUNICATION

Nunavik Regional Board of Health and Social Services

## LINGUISITIC REVISION

Nunavik Regional Board of Health and Social Services

## VISUAL CREATION

**Alphatek**


## SUGGESTED CITATION


Chapman, C., Aker, A., Ayotte, P., Lemire, M. (2026). Iodine and Thyroid Status. Nunavik Inuit Health Survey 2017 *Qanuilirpitaa?* How are we now? Quebec: Nunavik Regional Board of Health and Social Services (NRBHSS) & Institut national de santé publique du Québec (INSPQ).

## *QANUILIRPITAA?* 2017 HEALTH SURVEY

# ACKNOWLEDGEMENTS

On behalf of the Steering Committee, I would like to express my gratitude to all Nunavimmiut who participated in the *Qanuilirpitaa?* 2017 Health Survey.

This important health survey was made possible thanks to the long-lasting partnership between the Nunavik Regional Board of Health and Social Services, the *Institut national de santé publique du Québec* and researchers from the Centre de recherche du CHU de Québec – Université Laval, McGill University and Trent University.

The valuable contribution of Inuit research advisors, leaders from each community, as well as representatives from the Avataq Cultural Institute, the Ungava Tulattavik Health Centre, the Inuulitsivik Health Centre, the Kativik Regional Government, Kativik Ilisarniliriniq, Makivik Corporation, the northern villages and the Qarjuit Youth Council is gratefully acknowledged. The Steering Committee and the Data Management Committee of *Qanuilirpitaa?* 2017 guided and enriched this work throughout the different phases, from planning to data interpretation and contextualization.

We want to highlight the invaluable contribution of Pierre Ayotte and Françoise Bouchard, the scientific directors, and Danielle St-Laurent, the project's executive director. We are also indebted to Geneviève Hamel, Suzanne Bruneau, Suzanne Côté and Nathalie Ouellet who coordinated the planning and realization of the survey.

We are sincerely thankful to the Inuit interviewers who carried out exceptional work in often challenging circumstances.

We are also grateful to all of the professionals, technicians, students, ground team and clerical staff, as well as the crew of the Canadian Coast Guard Ship *Amundsen*.

Finally, this survey could not have been undertaken without the financial support of the Nunavik Regional Board of Health and Social Services, the Kativik Regional Government, Makivik Corporation, Kativik Ilisarniliriniq, the *ministère de la Santé et des Services sociaux du Québec*, ArcticNet, the Amundsen Science Ship Fund and the Northern Contaminants Program.

Numerous people have contributed at different stages of the survey process; many of them are listed below, and there are many more.

Minnie Grey

Chairperson, *Qanuilirpitaa?* Steering Committee
Executive Director, NRBHSS

*In memory of Audrey Flemming and Linda Shipaluk.*

**PRINCIPAL INVESTIGATORS AND INUIT ADVISORS***

**Adult component**
Pierre Ayotte
Chris Furgal
Mélanie Lemire
Benoît Lévesque
Michel Lucas
Mary Pilurtuut

**Youth component**
Richard Bélanger
Gina Muckle
Louisa Yeates

**Community component**
Nancy Etok
Christopher Fletcher
Kitty Gordon
Betsy Palliser
Mylène Riva

**Oral health**
Aimée Dawson
Chantal Galarneau

**Men's Health**
Gilles Tremblay

**STEERING COMMITTEE AND DATA MANAGEMENT COMMITTEE (DMC) PARTICIPANTS**

Minnie Grey (Steering Committee chair)
Marie Rochette (DMC co-chair)
Robert Watt (DMC co-chair)
Alicia Aragutak
Ellen Avard
Jean-Etienne Bégin
Françoise Bouchard
Suzanne Bruneau
Marie-Noëlle Caron
Maria Cengarle
Yasmine Charara
Suzanne Côté
Serge Déry
Aleashia Echalook
Mona Eepa Belleau
Maggie Emudluk
Barrie Ford
Susie Gagnon
Marie-Josée Gauthier
Yoan Girard
Lucy Grey
Geneviève Hamel
Olivia Ikey
Suzy Kauki
Elena Koneak Labranche
Christine Leblanc
Stéphanie Léveillé
Eliana Manrique
Murray McDonald
Jennifer Munick
Tunu Napartuk
Jobie Tukkiapik
Larry Watt
Shirley White-Dupuis

**INTERVIEWERS/NURSES**

Linda Amidlak
Thomas Annanak
Lydia Audlaluk
Jeannie Calvin
Caroline Couture
Louis-Frédéric Daigle
Véronique Dion Roy
Geneviève Dorval
Véronique Doutreloux
Philippe Dufresne
Victoria E. Forest
Audrey Flemming
Jeannie Flemming
Elisabeth Gagné
Virginie Gargano
Suzie Gordon
Sarah Imak
Léa Laflamme
Pierre Lejeune
Alexandre Léveillé
Paul Marcoux
Josée Michaud
Laura McKeeman
Claude Morency
Julie Nastapoka
Julie Picard
Michel Poulin
Linda Shipaluk
Évelyne Thibault
Mina Tukai
Amelia Tukkiapik Whiteley

**COMMUNICATION AND TRANSLATION**

Minnie Amidlak
Annie Baron
Nicolas Baltazar
Brigitte Chalifoux
Caroline D'Astous
Nina Gilbert
Alasie Hickey
Nathalie Labonté
Irène Langis
Josée Lévesque
Robert Mackey
Émilie Pelletier
Eva Pilurtuut
Ida Saunders
Jenny Simpraseuth
Rhéal Séguin

**DENTISTS/RESPIRATORY THERAPISTS**

Élaine Audet
Lucie Bélanger
Hélène Fournier-Noël
Marie-Rose Gagnon Beaumont
Isabelle Gauthier
Gabrielle Gingras
Ariane H. Morin
Cassiopée Paradis-Gagnon

**GROUND-STAFF**

Stéphane Anctil
Julien Arsenault
Marie Bernard
Justine Blanco Lalande
Christian Brunet
Virginie Chadenet
Catherine Godin
Josianne Grenier
Dominique Hamel
Robert Ladouceur
Trina Manac'h
Laurence Millette
Guillaume Proulx
Sylvie Ricard
Camille Tremblay-Fournier
As well as all local research assistants and local logistics staff

**ADMINISTRATIVE SUPPORT AND INFORMATIC TECHNOLOGIES**

Vincent Gilbert
Denis Granghon
Eva Gunn
Ginette Laflamme
Liv Larsen
Richard Leboeuf
Sylvie Muller

**DATA PROCESSING, QUALITY CONTROL AND LAB WORK**

Véronique Boiteau
Marc-André Dubé
Marianne Dubé
Denis Hamel
Judith Labrecque
Jacinthe Larochelle
Caroline Moisan
Nathalie Ouellet
Louis Rochette
Mélanie St-Onge
Mélanie Tessier
Hamado Zoungrana

**COMMUNITY COMPONENT/ MOBILIZATION**

David Arsenault
Marie Baron
Imane Cheriet
Marie-Hélène Dion-Gagnon
Sarah Fraser
Melody Lynch
Marie-Claude Lyonnais
Cindy Ruel

**AND MANY MORE!**

** Each name is listed only once even though it may have been mentioned in more than one category.*

# TABLE OF CONTENTS


LIST OF TABLES VI

LIST OF FIGURES VII

LIST OF ABBREVIATIONS VIII

1 BACKGROUND OF THE *QANUILIRPITAA?* 2017 HEALTH SURVEY 1

Target population 1

Survey frame 1

Data collection 2

Participation 2

2 INTRODUCTION 3

Objectives 4

3 METHODOLOGICAL ASPECTS 5

Survey Design 5

Data Collection and Laboratory Analyses 5

Assessment of Thyroid Status 5

Assessment of Thyroid Autoimmunity 6

Assessment of Iodine Status 6

Statistical Analysis 6

Comparisons to Other Available Surveys or Studies 7

## 4 RESULTS 8

Thyroid Disorders 8

› Euthyroid 8

› Hyperthyroidism 9

› Hypothyroidism 10

› Thyroid Autoimmunity 10

Thyroid Biomarkers 11

› Thyroid-Stimulating Hormone (TSH) 11

› Free Thyroxine (fT4) 14

› Free and Total Triiodothyronine (fT3 and tT3) 16

› Urinary Iodine 17

Comparisons Summary 19

## 5 DISCUSSION 20

Thyroid Status 20

Thyroid Biomarkers 20

Iodine Status 21

Limitations 21

Conclusions 22

**REFERENCES** **23**

**APPENDIX** **26**

Comparisons with Greenland 26

› Euthyroid 27

› Hyperthyroidism 28

› Hypothyroidism 29

› Thyroid Autoimmunity 30

› TSH 31

› fT4 31

› fT3 32

› Urinary Iodine 33

Comparisons Summary 34

# LIST OF TABLES

**Table 1** P. 6 Reference ranges for assessing thyroid status in Inuit youth and adults in Nunavik

**Table 2** P. 8 Prevalence of euthyroid among the total population in 2017 (including those prescribed a thyroid medication)

**Table 3** P. 9 Prevalence of euthyroid among the untreated population in 2017

**Table 4** P. 9 Prevalence of suspected and treated hyperthyroidism among the total population in 2017

**Table 5** P. 10 Prevalence of suspected untreated hyperthyroidism among the untreated population in 2017 (i.e., excluding the 0.2% of participants with prescribed methimazole)

**Table 6** P. 11 Prevalence of thyroid autoimmunity biomarkers in Q2017

**Table 7** P. 12 Arithmetic and geometric means with percentiles and median for TSH (µIU/mL) in 2017

**Table 8** P. 14 Arithmetic and geometric means with percentiles and median for fT4 (pmol/L) in 2017

**Table 9** P. 16 Arithmetic and geometric means with percentiles and median for fT3 (pmol/L) in 2017

**Table 10** P. 17 Geometric means with percentiles and median for urinary iodine concentration (µg/L) in 2017

**Table 11** P. 19 Summary of comparisons between Nunavik in 2017 and 2004, and with the Canadian population aged 16-49 and 50+ years (CHMS 2014-2015), including the limitations of each study.

**Table S1** P. 26 Arithmetic and geometric means with percentiles and median for tT3 (nmol/L) in 2017

**Table S2** P. 34 Summary of comparisons between Nunavik in 2017 and 2004, the Canadian population aged 16-49 and 50+ years (CHMS 2014-2015), and Greenlandic Inuit aged 50-59 years, including the limitation of each study.

# LIST OF FIGURES

**Figure 1** P. 13 Comparisons of arithmetic mean TSH in Q2004 and Q2017 with the reference range

**Figure 2** P. 13 Comparisons of geometric mean TSH in Nunavik and CHMS Cycle 4 in groups aged 16-49 and 50+ with the Nunavik reference range

**Figure 3** P. 15 Comparisons of arithmetic mean fT4 in Q2004 and Q2017 with the reference range

**Figure 4** P. 15 Comparisons of geometric mean fT4 in Nunavik and CHMS Cycle 4 in groups aged 16-49 and 50+ with the Nunavik reference range

**Figure 5** P. 17 Comparisons of arithmetic mean tT3 in Q2004 and Q2017 with the reference range

**Figure 6** P. 18 Crude prevalences of inadequate iodine statuses based on urinary iodine concentration and WHO-established criteria in Nunavik and CHMS Cycle 2

**Figure 7** P. 19 Comparisons of median urinary iodine concentration in Nunavik regions and CHMS Cycle 4 in groups aged 16-49 and 50+ with the adequate nutrition range

**Figure S1** P. 27 Comparisons of the prevalence of individuals in the euthyroid range in Nunavik regions in 2017 and Inuit in Greenland in adults over 50 years old

**Figure S2** P. 28 Comparisons of prevalence of hyperthyroidism in Nunavik regions in 2017 and Greenlandic regions in adults over 50 years old

**Figure S3** P. 29 Comparisons of prevalence of hypothyroidism in Nunavik regions in 2017 and Greenlandic regions in adults over 50 years old

**Figure S4** P. 30 Comparisons of prevalence of thyroid autoimmunity in Nunavik regions in 2017 and Greenlandic regions in adults over 50 years old

**Figure S5** P. 31 Comparisons of geometric mean TSH in Nunavik and CHMS Cycle 4 in groups aged 16-49 and 50+ with the Nunavik reference range

**Figure S6** P. 31 Comparisons of median fT4 in Nunavik and Greenlandic regions in adults over the age of 50 with the Nunavik reference range

**Figure S7** P. 32 Comparisons of median fT3 in Nunavik and Greenlandic regions in adults over the age of 50 with the Nunavik reference range

**Figure S8** P. 33 Comparisons of median urinary iodine concentrations in Nunavik and Greenlandic regions with the adequate nutrition range

# LIST OF ABBREVIATIONS

| | |
|---|---|
| **T3** | Triiodothyronine |
| **T4** | Thyroxine or tetraiodothyronine |
| **fT3** | Free triiodothyronine |
| **fT4** | Free thyroxine |
| **tT3** | Total triiodothyronine |
| **tT4** | Total thyroxine |
| **TSH** | Thyroid-stimulating hormone |
| **WHO** | World Health Organization |
| **Q2004** | Nunavik Inuit Health Survey *Qanuippitaa?* 2004 |
| **Q2017** | Nunavik Inuit Health Survey *Qanuilirpitaa?* 2017 |
| **CHMS** | Canadian Health Measures Survey |
| **CCGS** | Canadian Coast Guard Ship |
| **TPOAb** | Thyroid peroxidase anti-body or anti-thyroid peroxidase |
| **TgAb** | Thyroglobulin anti-body or anti-thyroglobulin |

# 1 BACKGROUND OF THE *QANUILIRPITAA?* 2017 HEALTH SURVEY

The Qanuilirpitaa? 2017 Health Survey is a major population health survey conducted in Nunavik which involved the collection, analysis and dissemination of information on the health status of Nunavimmiut. The last health survey conducted prior to it in Nunavik dated from 2004. Since then, no other surveys providing updated information on the health of this population had been carried out. Thus, in February 2014, the Board of Directors of the Nunavik Regional Board of Health and Social Services (NRBHSS) unanimously adopted a resolution to conduct a new health survey in all 14 Nunavik communities, in support of the Strategic Regional Plan. The general objective of the 2017 health survey was to provide an up-to-date portrait of the health status of Nunavimmiut. It was also aimed at assessing trends and following up on the health and health determinants of adult participants since 2004, as well as evaluating the health status of Nunavik youth. This health survey has strived to move beyond traditional survey approaches so as to nurture the research capabilities and skills of Inuit and support the development and empowerment of communities. Qanuilirpitaa? 2017 included four different components: 1) an adult component to document the mental and physical health status of adults in 2017 and to follow up on the adult cohort of 2004; 2) a youth component to establish a new cohort of Nunavimmiut aged 16 to 30 years and to document their mental and physical health status; 3) a community component to establish the health profiles and assets of communities in a participatory research approach; and 4) a community-mobilization project aimed at mobilizing communities and fostering their development. This health survey relied on a high degree of partnership within Nunavik (Nunavik Regional Board of Health and Social Services (NRBHSS), Makivvik Corporation, Kativik Regional Government (KRG), Kativik Ilisarniliriniq (KI), Avataq Cultural Institute, Qarjuit Youth Council, Inuulitsivik Health Centre, Ungava Tulattavik Health Centre), as well as between Nunavik, the *Institut national de santé publique du Québec* and academic researchers from three Canadian universities: Université Laval, McGill University and Trent University. This approach followed the OCAP principles of Ownership, Control, Access and Possession (4).[1] It also emphasized the following values and principles: empowerment and self-determination, respect, value, relevance and usefulness, trust, transparency, engagement, scientific rigour and a realistic approach.

## TARGET POPULATION

The survey target population was all permanent Nunavik residents aged 16 years and over. Persons living full time in public institutions were not included in the survey. The most up-to-date beneficiaries register of all Inuit living in Nunavik, provided by Makivvik Corporation in spring 2017, was used to construct the main survey frame. According to this register, the population of Nunavik was 12 488 inhabitants spread out in 14 communities. The register allowed respondents to be selected on the basis of age, sex and coast of residence (Hudson coast and Ungava coast).

## SURVEY FRAME

The survey used a stratified proportional model to select respondents. Stratification was conducted based on communities and age groups, given that one of the main objectives of the survey was to provide estimates for two subpopulations aged, respectively, 16 to 30 years and 31 years and over. In order to obtain precise estimates, the targeted sample size was 1 000 respondents in each age group. Assuming a 50% response rate, nearly 4 000 people were required to obtain the necessary sample size. From this pool, the number of individuals recruited from each community was proportionate to population size and took into account the number of days that the survey team would remain in each community—a situation that imposed constraints on the number

1 OCAP® is a registered trademark of the First Nations Information Governance Centre (FNIGC).

of participants that could be seen. Within each stratum, participants were randomly selected from the beneficiaries register. However, the individuals from the 2004 cohort, all 31 years old and over (representing approximately 700 individuals), were automatically included in the initial sample.

## DATA COLLECTION

Data were collected from August 19, 2017, to October 5, 2017, in the 14 villages. The villages were reached by the *Amundsen*, a Canadian Coast Guard Icebreaker, and participants were invited on board the ship for data-collection purposes. Two recruitment teams travelled from one community to another before the ship's arrival. An Inuk assistant in each community helped: identify, contact and transport (if necessary) each participant; inform participants about the sampling and study procedures; obtain informed consent from participants (video) and fill in the identification sheet and sociodemographic questionnaire. Data-collection procedures for the survey included questionnaires, as well as clinical measurements. The survey duration was about four hours for each wave of participants, including their transportation to and from the ship. Unfortunately, this time frame was sometimes insufficient to complete the data-collection process. This survey received ethical approval by the *Comité d'éthique de la recherche du Centre Hospitalier Universitaire de Québec* – Université Laval. Aboard the ship, the survey questionnaires were administered by interviewers, many of whom were Inuit. Face-to-face interviews were conducted using a computer-assisted interviewing tool. If there were problems with the laptop connections, paper-form questionnaires were filled out. The questionnaires were administered in Inuktitut, English or French, according to the preference of the participants. Interviewers received training in administering the questionnaires prior to the start of the survey. The questionnaires were divided into five blocks: psychosocial interview (blocks 1 and 3), physical-health and food-security interview (block 2), food-frequency questionnaire (block 4), and sociodemographic interview (block 5). The survey also included a clinical component, with tests to document aspects of physical health, sampling of biological specimens (blood, oropharyngeal swabs, urine, stool and vaginal swabs), spirometry and an oral clinical exam. These sessions were supervised by a team comprised of nurses, respiratory therapists, dentists, dental hygienists and assistants, and laboratory technicians. The measurement of thyroid and iodine status was an addition to Q2017 approved by the Nunavik Health Surveys Committee in 2023.

## PARTICIPATION

There was a total of 1 326 participants, including 574 Nunavimmiut aged 16 to 30 years and 752 Nunavimmiut aged 31 years and over, for total response rates of 30.7% and 41.5%, respectively. The participants' distribution between the two coasts (Ungava and Hudson) was similar. The distribution of men and women was unequal, with twice as many women (873) as men (453) participating in the survey. If the results obtained from this sample are to be extrapolated to the target population, survey weights must be used. Overall, as compared to the 2004 survey, the response rate (i.e., the ratio between number of participants and total number of individuals on the sampling list) was lower than expected, especially among young people. This includes the refusal rate and especially a low contact rate. Several reasons might explain the low response rate, including the short time period available to contact individuals prior to the ship's arrival in the community and non-contact due to people being outside of the community or on the land. Nevertheless, among the individuals that were contacted (n = 1 661), the participation rate was satisfactory with an internal participation rate of 79.7%. More details on the collection, processing and analysis of the data are given in the Methodological Report (5).

# 2 INTRODUCTION

The thyroid is a gland at the base of the neck which synthesizes hormones, and these are key in regulating metabolism and body temperature (1). Thyroid disorders encompass the disorders related to the thyroid and its hormones and are defined by imbalances of these hormones. They can impact various bodily systems including the cardiovascular, nervous and skeletal systems. Thyroid disorders are the second most common endocrine disorders, affecting 200 million people globally (2, 6). Generally, the prevalence of thyroid disorders increases with age and is higher in women (2). In 2009, approximately 16% of Canadian women and 4% of Canadian men above the age of 45 reported being diagnosed with a thyroid disorder (7).

Under normal conditions, the body maintains multiple checks and balances on thyroid-hormone levels depending on the metabolic rate (energy use). The thyroid gland secretes two types of hormones: the more active form, triiodothyronine (T3) and, to a greater extent, the less active form, thyroxine (or tetraiodothyronine) (T4). Most T4 and T3 are transported in the bloodstream to the cells while bound to a protein. However, for T3 or T4 to enter cells and impact metabolism, they must be free and unbound to this protein. Less than 1% of T3 and T4 are unbound and are known as free T3 (fT3) and free T4 (fT4). Total T3 (tT3) and total T4 (tT4) refer to both the unbound and bound hormones. These bound hormones act as a stable and available reservoir of thyroid hormones in the bloodstream to be utilized when metabolic activity increases. T4 can be converted into T3 by removing a single iodine atom in a process known as deiodination by selenium containing enzymes. T3 and T4 availability in the bloodstream is further regulated by the secretion of thyroid-stimulating hormone (TSH) by the pituitary gland at the base of the brain. When the concentration of thyroid hormones is too low, TSH secretion increases in order to increase the production and secretion of T3 and T4. In contrast, when the concentration of thyroid hormones is too high, TSH secretion is lowered in order to decrease the production and secretion of T3 and T4.

Hyperthyroidism is a condition in which the thyroid gland overproduces thyroid hormones. It is associated with an increased risk of multiple health consequences including atrial fibrillation (irregular heartbeat), osteoporosis, and heart failure (8). Clinical hyperthyroidism is defined by an abnormally low level of TSH and abnormally high levels of fT4 or fT3, whereas subclinical hyperthyroidism is defined only by abnormally low levels of TSH. Hypothyroidism is a thyroid disorder in which the thyroid gland underproduces hormones. It has been associated with health effects that include hyperlipidemia (high cholesterol) and atherosclerosis (8). Clinical hypothyroidism is defined by an abnormally high level of TSH and abnormally low levels of fT4 or fT3, whereas subclinical hypothyroidism is only based on high levels of TSH. In iodine-sufficient populations, thyroid autoimmune diseases (diseases caused by immune-system malfunction) are the most common causes of thyroid disorders (9, 10). Grave's disease and Hashimoto's thyroiditis, both autoimmune diseases with strong genetic components and more common among women, are the main causes of hyperthyroidism and hypothyroidism, respectively (11). Globally, however, iodine deficiency remains the most important cause of hypothyroidism (9).

Iodine is an essential micronutrient required for the production of thyroid hormones and is a key building block of these hormones. The number of iodine atoms used in the hormone's structure is reflected in the names of each hormone: triiodothyronine (three iodine atoms) and tetraiodothyronine (four iodine atoms). Iodine is sourced via diet (12). Marine foods are the largest natural dietary sources of iodine as most of the earth's iodine is in the sea (13). Seaweed, in particular, is an excellent source of iodine (12, 13). Other rich sources include both marine and anadromous fish (sea-run), such as Arctic char, as well as mollusks (14, 15). Marine mammals, such as whales and seals, particularly in their blubber, have greater concentrations of iodine compared to terrestrial mammals (16). Inuit country foods include many of these species, indicating an iodine-rich diet. Other non-marine related iodine sources include dairy products, bread, eggs and, depending on the geography, drinking water (14, 17). Soil is generally low in iodine, leading to lower levels in plant-based foods (13, 18). As such, many countries have implemented a public-health intervention to include iodine in table salt (known as iodized salt) at the recommendations of the World Health Organization (WHO) to prevent iodine-deficiency disorders (3, 19).

Notably, while most processed foods contain salt, many are prepared with non-iodized salt (17, 20). In the Nunavik-specific context, seasonings such as Aromat® and table salt are regularly paired with country foods, both of which contain iodine additives (21, 22). However, the shift in dietary patterns, characterized by a decrease in the consumption of country foods and an increase in less nutrient-dense and processed market food, could potentially lead to reduced iodine intakes (23).

As previously mentioned, iodine deficiency remains the primary cause of hypothyroidism in iodine-deficient areas. When iodine levels are low, the pituitary gland increases TSH levels, signalling the thyroid to increase the amount of iodine it absorbs (24). In the presence of chronic severe iodine deficiency, the thyroid is no longer able to adapt and produce sufficient levels of thyroid hormones, leading to hypothyroidism (25). Alternatively, iodine deficiency can also lead to hyperthyroidism. In the presence of chronic mild to moderate iodine deficiency, the thyroid, having been overstimulated by TSH from its adaptation to absorb more iodine, develops nodules (19). These nodules can begin to autonomously produce thyroid hormones independently of TSH, leading to hyperthyroidism (26). Furthermore, smoking may increase this risk due to a cigarette compound called thiocyanate especially in regions of iodine deficiency (27).

The WHO considers iodine deficiency to be "the single most important preventable cause of brain damage" (3). This is because adequate iodine levels are particularly important during pregnancy as thyroid hormones are essential to fetal neurodevelopment. Adequate iodine is especially important during the first trimester prior to the fetus's thyroid's ability to function (28). Iodine deficiency during pregnancy can thus lead to developmental and cognitive delays in children (29).

Although rare, excessive dietary intake of iodine is also problematic, and can lead to both types of thyroid disorders, often referred to as iodine-induced hypothyroidism or hyperthyroidism. When iodine levels are excessively high, the thyroid, as a protective measure, adapts by lowering the production of thyroid hormones (30). This is known as the acute Wolff-Chaikoff effect (30). This effect is only temporary in most people as their bodies are able to adapt to or 'escape' this effect (30). However, in some more vulnerable individuals, such as those with thyroid autoimmunity, their bodies fail to escape the effect and is unable to reinstate a normal production of hormones, which leads to hypothyroidism (30). Moreover, in some cases of high iodine intake, the acute Wolff-Chaikoff effect itself fails, leading to an overproduction of thyroid hormones and hyperthyroidism (30). This phenomenon is known as the Jod-Basedow effect (30). This tends to occur more frequently following iodine supplementation in cases of iodine deficiency (30, 31).

Thyroid-hormone levels were measured in the last *Qanuippitaa?* Inuit Health Survey in 2004 (Q2004) but urinary iodine levels used to assess iodine status were not measured. The prevalence of hyperthyroidism and hypothyroidism were not reported but according to data reported by Dallaire et al. (2009), most participants in Q2004 had TSH levels within the normal range, very few participants (<1%) had abnormally high TSH levels indicating hypothyroidism and approximately 4% of participants had abnormally low TSH levels indicating hyperthyroidism (32). Unfortunately, few studies have reported thyroid hormones in Canada, and no information is available on the prevalence of thyroid disorders among this population. As previously stated, thyroid hormones are essential for thermoregulation and are influenced by genetics and environmental factors (33). Chronic cold exposure, such as experienced by hunters in the Arctic, is suggested to affect thyroid-hormone concentrations (34). As very few studies have researched thyroid health in Canada and specifically in the Canadian Arctic, comparisons with another Inuit population in Greenland can provide insight on disease patterns and biomarker concentrations.

## OBJECTIVES

This report aims to document the status of thyroid health and iodine levels among Nunavimmiut aged 16 and over.

More specifically, this report's objectives are to:

1. Document the prevalence of hyperthyroidism, hypothyroidism and thyroid autoimmunity among Nunavimmiut youth and adults in 2017 using the *Qanuilirpitaa?* 2017 Inuit Health Survey (Q2017) data;

2. Document the iodine status of Nunavimmiut youth and adults in 2017 using Q2017 data;

3. Compare thyroid and iodine status in Q2017 with those observed in Q2004 and the Canadian Health Measures Survey (CHMS), where possible. Comparisons with Greenlandic Inuit are also provided in the Appendix.

# 3 METHODOLOGICAL ASPECTS

## SURVEY DESIGN

In total, 1 326 individuals participated in the Q2017 survey aboard the Canadian Coast Guard Ship (CCGS) *Amundsen* between August and October 2017. Blood and spot urine samples were collected, and socio-demographic questionnaires were administered for most participants as detailed in the methodological report (35).

## DATA COLLECTION AND LABORATORY ANALYSES

Thyroid hormones were analysed in serum at the *Institut universitaire de cardiologie et de pneumologie du Québec*. TSH, total T3 and T4 as well as two thyroid antibodies used as markers of thyroid autoimmunity, anti-thyroid peroxidase (TPOAb) and anti-thyroglobulin (TgAb), were analysed by Abbott Architect chemiluminescent microparticle immunoassay. FT3 and fT4 were analyzed by luminescent oxygen channeling immunoassay using a Siemens Dimension Vista 1500.

Urinary iodine was analysed at the *Centre de toxicologie du Québec* (*Institut national de santé publique du Québec*, Québec, Canada) in a laboratory specialized in trace-element analysis by inductively coupled mass spectrometry (ICP-MS).

## ASSESSMENT OF THYROID STATUS

Thyroid statuses were defined based on reference values used in Nunavik for TSH, fT4 and fT3 (Table 1). Status was also defined by thyroid-medication prescription (i.e., levothyroxine sodium used to treat hypothyroidism (also known as Synthroid) or methimazole used to treat hyperthyroidism) based on the information extracted from participants' medical files during Q2017 (30). Pregnant women (n=33) were excluded from thyroid-disorder and thyroid-biomarker analyses as thyroid hormones and their reference values change during and throughout pregnancy (35). It is important to note that clinical diagnoses of thyroid disorders by physicians are based on both thyroid-biomarker assays and the presentation of symptoms (36, 37). For research purposes, as no information was collected on symptoms, the thyroid-status definitions are solely based on thyroid biomarker assays. Thyroid disorders are thus only suspected.

The euthyroid (i.e., normal) range was between 0.40 and 4.40 µIU/mL for TSH, between 9.8 and 18.8 pmol/L for fT4 and between 3.8 and 6.0 pmol/L for fT3. Clinical hyperthyroidism was defined as either TSH < 0.40 µIU/mL and fT4 > 18.8 pmol/L or fT3 > 6.0 pmol/L, or a methimazole prescription. Subclinical hyperthyroidism was defined as TSH < 0.40 µIU/mL with normal fT4 and fT3 levels. Clinical hypothyroidism was defined as either TSH > 4.40 µIU/mL and fT4 < 9.8 pmol/L or fT3 < 3.8 pmol/L, or a levothyroxine sodium prescription. Subclinical hypothyroidism was defined as TSH > 4.40 µIU/mL with normal levels of fT4 and fT3.

To assess suspected untreated cases, participants with thyroid prescriptions were excluded (levothyroxine sodium n=21, methimazole n<5), and analyses were repeated using the same biomarker definitions. These suspected untreated cases will provide insight on the prevalence of disease among those who have not been prescribed thyroid medication for a diagnosed disorder.

**Table 1** Reference ranges for assessing thyroid status in Inuit youth and adults in Nunavik*

| Reference range | TSH (μIU/mL) | fT4 (pmol/L) | fT3 (pmol/L) |
|---|---|---|---|
| **Euthyroid** | 0.40 – 4.40 | 9.8 – 18.8 | 3.8 – 6.0 |
| **Hyperthyroidism** | | | |
| Clinical | < 0.40 | > 18.8 | > 6.0 |
| Subclinical | < 0.40 | 9.8 – 18.8 | 3.8 – 6.0 |
| **Hypothyroidism** | | | |
| Clinical | > 4.40 | < 9.8 | < 3.8 |
| Subclinical | > 4.40 | 9.8 – 18.8 | 3.8 – 6.0 |

* Based on values used by clinicians in Nunavik.

## ASSESSMENT OF THYROID AUTOIMMUNITY

The determination of thyroid autoimmunity status was based on the laboratory reference values for TPOAb and TgAb. A person was considered to have high levels of TPOAb if the levels were above 5.61 IU/mL and to have high levels of TgAb if the levels were above 4.11 IU/mL. Thyroid autoimmunity biomarkers were assessed individually and through the presence of high concentrations of either biomarker.

## ASSESSMENT OF IODINE STATUS

The median urinary-iodine concentration (μg/L) determined from the collected spot samples was used to evaluate the population's iodine status based on reference criteria established by the WHO. According to these criteria, adequate iodine nutrition is reflected by a median urinary-iodine concentration between 100 and 199 μg/L in adults and between 150 and 249 μg/L in pregnant women (3). The WHO also established two criteria for assessing iodine deficiency in a population. Using measured spot urine samples, a population is considered to be iodine-deficient if the median urinary-iodine concentration is below 100 μg/L and if more than 20% of the sample falls below 50 μg/L (3). The WHO has further categorized iodine status into severe iodine deficiency (< 20 μg/L), moderate iodine deficiency (20-49 μg/L), mild iodine deficiency (50-99 μg/L), more-than-adequate intake (200-299 μg/L) and excessive intake (>300 μg/L) (3). In pregnant women, the criteria for iodine deficiency are solely based on the pregnant population's median urinary-iodine concentration falling below 150 μg/L. It is important to note that these two criteria are purposefully designed to determine populational iodine status and not individual status. Thus, although an individual may have a spot urinary-iodine concentration below this threshold on the day of the survey, because urinary iodine varies greatly from day to day and only one sample was taken per individual, this does not necessarily mean this person is iodine-deficient (38). In the present report, crude prevalences were determined based on the WHO criteria, however, since only spot urine samples were available, it is important to mention they could overestimate the true prevalence of iodine deficiency (30). Furthermore, diurnal differences in urinary-iodine concentrations could impact results depending on the time of day at which the spot sample was collected (39). Studies have demonstrated that morning spot samples could underestimate urinary iodine excretion (39).

## STATISTICAL ANALYSIS

The sample sizes used in this report vary from 1 258 to 1 307 depending on the availability of data. Descriptive analyses were conducted. Survey weights were attributed to each participant to better represent the target population. These weights were determined based on the probability of being selected for the sample and were adjusted based on the non-response rate and on the stratification by age group, sex and community. Descriptive statistics are also presented by sex, age group, administrative region (Hudson and Ungava) and ecological region (Hudson Strait, Hudson Bay and Ungava Bay). Geometric means as well as 5th and 95th percentiles were calculated for each thyroid biomarker and urinary-iodine concentrations as they were not normally distributed. Arithmetic means were calculated for thyroid biomarkers to compare to results from Q2004. The median urinary-iodine concentration and percentage of participants falling below 50 μg/L were calculated in order to compare to the two WHO criteria for iodine deficiency. Comparisons

between geometric means were made using differences of least squares means. Prevalences of thyroid disorders in each category were compared using Rao-Scott chi-square tests. Pairwise comparisons between groups with more than two categories were made using differences of least squares means.

Estimates are not presented when there were fewer than five participants. All analyses were performed in SAS 9.4 (Cary, NC, USA) with a significance level of 5% (alpha = 0.05).

## COMPARISONS TO OTHER AVAILABLE SURVEYS OR STUDIES

Comparisons of Q2017 data with Q2004 data were limited. Prevalences of thyroid disorders were not reported in 2004 and can thus not be compared. Further, the only biomarkers measured in 2004 were TSH, fT4 and tT3 and only their arithmetic means were presented. Comparisons of calculated confidence intervals from the standard deviations from Q2004 and Q2017 data were used to assess if significant differences were found between the two surveys.

Comparisons with the general Canadian population were done using data from CHMS Cycle 2 (2009-2011) and Cycle 4 (2014-2015) (40, 41). Cycle 2 data were used to compare crude prevalences of inadequate iodine statuses as these data were not available for more recent surveys. However, no confidence intervals of these prevalences were presented. Furthermore, the crude prevalence of adequate iodine status was not reported.

Thyroid biomarkers (TSH and fT4, but not fT3 nor tT3) and population urinary-iodine concentrations were measured more recently in Cycle 4. Comparisons of confidence intervals between CHMS Cycle 4 data and Q2017 were used to assess if significant differences were found between the two surveys. There were some limitations with the confidence intervals due to the lower number of significant digits in the results provided for CHMS Cycle 4.

Three studies documented thyroid-hormone disorders and iodine status in Greenlandic Inuit over the age of 50 years (42-44). Comparisons with Greenlandic studies were thus performed solely with Nunavimmiut over the age of 50 years. For the comparisons of thyroid disorder, the prevalences included clinical, subclinical and treated suspected cases (43). The reference ranges differed slightly from those used in Nunavik where the range for Greenlandic Inuit was 0.3-4.5 mU/L for TSH, 9.8-20.4 pmol/L for fT4 and 3.6-6.9 pmol/L for fT3. Unfortunately, none of the Greenlandic studies presented confidence intervals in their results. As such, statistical comparisons with this population are limited. Further, the year of data collection is unclear, however it seems these data have been used in publications since at least 2005.

Although the data from these studies are dated, this report is primarily focusses on comparing trends and patterns with other populations rather than absolute values. The limitations of each study are presented in Table 11 and Table S2.

# 4 RESULTS

## THYROID DISORDERS

### Euthyroid

The majority (87.9%) of the total population was defined as euthyroid (Table 2). The prevalence of men in the euthyroid range was significantly higher than that of women (92.3% versus 83.3%). In both men and women, there were no significant differences between age groups.

Regional differences were only significant in women with a significantly higher prevalence of the population in the euthyroid range in the Ungava administrative region compared to the Hudson administrative region (90.1% versus 77.6%). Furthermore, there were significantly more women in the euthyroid range in Hudson Strait and Ungava Bay compared to Hudson Bay (86.6% and 91.1% versus 74.5%).

**Table 2** Prevalence of euthyroid among the total population in 2017 (including those prescribed a thyroid medication)

| | All | Women | Men |
|---|---|---|---|
| **Group** | **% (95% CI)** | **% (95% CI)** | **% (95% CI)** |
| **All** | 87.9 (85.9, 89.9) | **83.3** (80.6, 85.9) | **92.3** (89.5, 95.1) |
| **Age group** | | | |
| 16-29 | 89.0 (85.9, 92.1) | **84.5** (80.5, 88.4) | **93.1** (88.8, 97.4) |
| 30-49 | 86.7 (82.9, 90.6) | 83.9 (79.0, 88.8) | 89.5 (83.9, 95.2) |
| 50+ | 87.5 (84.0, 91.0) | **80.5** (74.8, 86.2) | **94.9** (91.2, 98.5) |
| **Administrative region** | | | |
| Hudson | 85.1 (82.0, 88.1) | **77.6** (73.3, 81.9) | **92.0** (87.9, 96.1) |
| Ungava | 91.4 (88.8, 93.9) | 90.1 (87.1, 93.0) | 92.7 (88.7, 96.7) |
| **Ecological region** | | | |
| Hudson Bay | 83.1[b] (79.4, 86.8) | **74.5**[b] (69.2, 79.9) | **90.6** (85.7, 95.5) |
| Hudson Strait | 90.5[a] (86.9, 94.2) | 86.6[a] (81.7, 91.5) | 94.8 (88.9, 100.0) |
| Ungava Bay | 91.9[a] (89.2, 94.6) | 91.1[a] (88.1, 94.2) | 92.7 (88.5, 96.9) |

Estimates in **bold** differ significantly between men and women.
Estimates in coloured cells and with different superscripts differ significantly between groups.
95% CI: 95% confidence interval.

Only 1.4% (n=21) of participants had a levothyroxine sodium prescription, and 0.2% (n<5) had a methimazole prescription. Similarly, when excluding these participants, the majority of the untreated population was in the euthyroid range with a prevalence of 89.2% (Table 3). Also like the total population, there were significant differences between men and women, and regional differences were only significant among women.

**Table 3** Prevalence of euthyroid among the untreated population in 2017

| Group | All<br>% (95% CI) | Women<br>% (95% CI) | Men<br>% (95% CI) |
|---|---|---|---|
| **All** | 89.2 (87.3, 91.2) | **85.1** (82.5, 87.7) | **93.1** (90.4, 95.9) |
| **Age group** | | | |
| 16-29 | 89.0 (85.9, 92.1) | **84.5** (80.5, 88.4) | **93.1** (88.8, 97.4) |
| 30-49 | 88.5 (84.8, 92.3) | 86.2 (81.4, 90.9) | 90.8 (85.4, 96.2) |
| 50+ | 90.7 (87.6, 93.8) | **84.6** (79.1, 90.1) | **96.7** (93.6, 99.8) |
| **Administrative region** | | | |
| Hudson | 86.2 (83.1, 89.2) | **79.7** (75.5, 84.0) | **92.0** (87.9, 96.1) |
| Ungava | 93.1 (90.7, 95.5) | 91.5 (88.7, 94.3) | 94.6 (90.9, 98.4) |
| **Ecological region** | | | |
| Hudson Bay | 84.2[b] (80.6, 87.9) | **76.8**[b] (71.6, 82.0) | **90.6** (85.7, 95.5) |
| Hudson Strait | 92.1[a] (88.5, 95.6) | 88.5[a] (83.9, 93.1) | 95.9 (90.2, 100.0) |
| Ungava Bay | 93.4[a] (90.9, 95.9) | 92.2[a] (89.3, 95.1) | 94.5 (90.6, 98.5) |

Estimates in **bold** differ significantly between men and women.
Estimates in coloured cells and with different superscripts differ significantly between groups.
95% CI: 95% confidence interval.

## Hyperthyroidism

The total prevalences of suspected untreated and treated clinical hyperthyroidism were low (2.2%) while the prevalence for subclinical hyperthyroidism was slightly higher (8.6%). The prevalence of subclinical hyperthyroidism was significantly higher in women than in men (11.8% versus 5.5%) (Table 4). For both sexes and both types of disorder (subclinical and clinical), there were no significant differences between age groups. Differences by region were only observed for the prevalence of subclinical hyperthyroidism among women. The prevalence of subclinical hyperthyroidism was significantly higher in women in the Hudson administrative region compared to women in the Ungava administrative region (16.7% versus 6.0%). Women in Hudson Bay had a significantly higher prevalence of subclinical hyperthyroidism compared to the women in both Hudson Strait and Ungava Bay (19.6% versus 7.5% and 5.9%).

**Table 4** Prevalence of suspected and treated hyperthyroidism among the total population in 2017

| | Clinical | | | Subclinical | | |
|---|---|---|---|---|---|---|
| | All | Women | Men | All | Women | Men |
| **Group** | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) |
| **All** | 2.2 (1.3, 3.1) | 3.2 (1.9, 4.6) | NP | 8.6 (6.9, 10.3) | **11.8** (9.5, 14.2) | **5.5** (3.1, 7.8) |
| **Age group** | | | | | | |
| 16-29 | 2.5 (1.0, 4.1) | 3.6 (1.3, 5.9) | NP | 8.4 (5.8, 11.1) | 12.0 (8.6, 15.3) | 5.3 (1.5, 9.2) |
| 30-49 | 2.4 (0.6, 4.2) | 3.2 (1.0, 5.4) | NP | 9.7 (6.3, 13.0) | 11.1 (6.8, 15.5) | 8.2 (3.5, 13.0) |
| 50+ | 1.4 (0.3, 2.5) | 2.8 (0.6, 4.9) | NP | 7.2 (4.4, 10.0) | **12.6** (7.6, 17.6) | **NP** |
| **Administrative region** | | | | | | |
| Hudson | 2.4 (1.0, 3.8) | 3.4 (1.5, 5.3) | NP | 11.4 (8.8, 14.0) | **16.7** (12.9, 20.4) | **6.6** (3.0, 10.1) |
| Ungava | 2.0 (0.7, 3.3) | 3.0 (1.3, 4.8) | NP | 5.0 (3.0, 7.0) | 6.0 (3.6, 8.4) | 4.0 (0.8, 7.3) |
| **Ecological region** | | | | | | |
| Hudson Bay | 2.6 (0.8, 4.4) | 3.4 (1.2, 5.7) | NP | 13.1[b] (10.1, 16.2) | **19.6**[b] (14.8, 24.3) | **7.5** (3.2, 11.7) |
| Hudson Strait | 2.3 (0.6, 4.0) | 4.5 (1.2, 7.7) | NP | 5.8[a] (2.5, 9.2) | 7.5[a] (3.8, 11.2) | NP |
| Ungava Bay | 1.6 (0.2, 3.0) | 2.1 (0.7, 3.5) | NP | 4.8[a] (2.8, 6.9) | 5.9[a] (3.3, 8.5) | 3.8 (0.8, 6.9) |

Estimates in **bold** differ significantly between men and women.
Estimates in coloured cells and with different superscripts differ significantly between groups.
NP: Data not presented (n < 5).
95% CI: 95% confidence interval.

As shown in Table 5, the prevalence of untreated clinical hyperthyroidism (2.0%) is similar to the total population when including individuals reported to be treated with thyroid medication (methimazole) in their medical file (2.2%) (Table 4). As the definition for subclinical hyperthyroidism did not change for the untreated population, the prevalences remain the same as those in the total population. This suggests that most suspected cases of hyperthyroidism were untreated at the time of the survey in 2017.

**Table 5** Prevalence of suspected untreated hyperthyroidism among the untreated population in 2017 (i.e., excluding the 0.2% of participants prescribed methimazole)

| | Clinical | | | Subclinical | | |
|---|---|---|---|---|---|---|
| | All | Women | Men | All | Women | Men |
| **Group** | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) |
| **All** | 2.0 (1.1, 2.9) | 2.8 (1.6, 4.1) | NP | 8.5 (6.8, 10.2) | **11.8** (9.4, 14.1) | **5.4** (3.1, 7.8) |
| **Age group** | | | | | | |
| 16-29 | 2.5 (1.0, 4.1) | 3.6 (1.3, 5.9) | NP | 8.4 (5.8, 11.1) | 12.0 (8.6, 15.3) | 5.3 (1.5, 9.2) |
| 30-49 | 2.1 (0.3, 3.9) | 2.7 (0.7, 4.7) | NP | 9.7 (6.4, 13.0) | 11.2 (6.8, 15.5) | 8.2 (3.5, 13.0) |
| 50+ | NP | NP | NP | 7.0 (4.2, 9.7) | **12.2** (7.3, 17.2) | **NP** |
| **Administrative region** | | | | | | |
| Hudson | 2.2 (0.8, 3.6) | 3.0 (1.1, 4.8) | NP | 11.3 (8.8, 13.9) | **16.5** (12.8, 20.2) | **6.6** (3.0, 10.1) |
| Ungava | 1.8 (0.5, 3.0) | 2.7 (1.0, 4.3) | NP | 5.0 (3.0, 7.0) | 6.0 (3.6, 8.4) | 4.0 (0.8, 7.3) |
| **Ecological region** | | | | | | |
| Hudson Bay | 2.3 (0.6, 4.1) | 2.8 (0.8, 4.9) | NP | 13.0[b] (10.0, 16.2) | **19.4**[b] (14.7, 24.1) | **7.5** (3.2, 11.7) |
| Hudson Strait | 2.0 (0.5, 3.5) | 3.8 (0.9, 6.7) | NP | 5.9[a] (2.5, 9.2) | 7.6[a] (3.9, 11.2) | NP |
| Ungava Bay | 1.6 (0.2, 3.0) | 2.1 (0.7, 3.5) | NP | 4.8[a] (2.8, 6.9) | 5.9[a] (3.3, 8.5) | 3.8 (0.8, 6.9) |

Estimates in **bold** differ significantly between men and women.
Estimates in coloured cells and with different superscripts differ significantly between groups.
NP: Data not presented (n < 5).
95% CI: 95% confidence interval.

## Hypothyroidism

The total prevalences of suspected untreated and treated clinical hypothyroidism (1.4%) and subclinical hypothyroidism (<1%) were low (data not shown since n<5 in each category). After excluding the 1.4% of participants who had a levothyroxine sodium prescription, the prevalences of suspected untreated clinical (<1%) and subclinical (<1%) hypothyroidism were even lower. These prevalence differences suggest that most with hypothyroidism were treated for their condition at the time of the survey.

## Thyroid Autoimmunity

The prevalence of thyroid autoimmunity based on elevated TPOAb or elevated TgAb levels was 4.9% among Nunavimmiut (Table 6). The prevalence of individuals with high TgAb was significantly higher than the prevalence of individuals with high TPOAb (3.7% versus 1.1%). For each of the autoimmunity biomarkers, there were no significant differences between sexes or age groups. No regional difference was found for TgAb; there were significant differences between regions for TPOAb, such that the prevalence of high TPOAb was higher in the Ungava administrative region and Ungava Bay compared to other regions. The majority of participants with high levels of thyroid autoimmunity biomarkers were in the euthyroid range.

**Table 6** Prevalence of thyroid autoimmunity biomarkers in Q2017

| Group | TPOAb or TgAb % (95% CI) | TPOAb % (95% CI) | TgAb % (95% CI) |
|---|---|---|---|
| **All** | 4.9 (3.6, 6.2) | **1.1** (0.5, 1.7) | **3.7** (2.5, 4.9) |
| **Sex** | | | |
| Women | 4.8 (3.4, 6.2) | **1.4** (0.7, 2.1) | **3.4** (2.2, 4.6) |
| Men | 4.9 (2.7, 7.2) | **NP** | **4.1** (2.0, 6.2) |
| **Age group** | | | |
| 16-29 | 4.3 (2.5, 6.1) | 1.0 (0.0, 2.1) | 3.3 (1.7, 4.8) |
| 30-49 | 4.9 (2.4, 7.5) | 1.1 (0.3, 1.9) | 3.8 (1.4, 6.2) |
| 50+ | 5.8 (3.4, 8.2) | 1.4 (0.2, 2.5) | 4.5 (2.3, 6.7) |
| **Administrative region** | | | |
| Hudson | 4.2 (2.4, 5.9) | NP | 3.7 (2.0, 5.4) |
| Ungava | 5.8 (3.8, 7.8) | 2.0 (0.7, 3.3) | 3.8 (2.1, 5.5) |
| **Ecological region** | | | |
| Hudson Bay | 3.6 (1.6, 5.7) | **NP**[a] | **3.4** (1.4, 5.4) |
| Hudson Strait | 5.0 (2.6, 7.3) | **NP**[ab] | **3.9** (1.8, 6.0) |
| Ungava Bay | 6.4 (3.9, 8.8) | 2.3[b] (0.8, 3.9) | 4.0 (2.0, 6.1) |

Estimates in **bold** differ significantly between autoimmunity biomarkers.
Estimates in coloured cells and with different superscripts differ significantly between groups.
NP: Data not presented (n < 5).
95% CI: 95% confidence interval.

# THYROID BIOMARKERS

## Thyroid-Stimulating Hormone (TSH)

Overall, the geometric mean TSH level was 0.82 µIU/mL (Table 7). TSH levels were significantly higher in men compared to women (0.92 µIU/mL versus 0.73 µIU/mL). There were also significant differences between age groups and regions. TSH levels were significantly lower in the 16-29 and 30-49-year age groups compared to the 50+ age group (0.79 µIU/mL and 0.75 µIU/mL versus 1.01 µIU/mL). Furthermore, TSH levels were significantly higher in individuals living in the Ungava administrative region compared to those living in the Hudson administrative region (0.92 µIU/mL vs 0.75 µIU/mL). Also, there were significant differences between ecological regions, with those in Ungava Bay having the highest levels, followed by those in the Hudson Strait and those in Hudson Bay having the lowest (0.95 µIU/mL versus 0.83 µIU/mL versus 0.73 µIU/mL).

**Table 7** Arithmetic and geometric means with percentiles and median for TSH (µIU/mL) in 2017

| Group | 5th percentile | Arithmetic mean (95% CI) | Geometric mean (95% CI) | Median (95% CI) | 95th percentile |
|---|---|---|---|---|---|
| **All** | 0.28 | 1.05 (1.00, 1.09) | 0.82 (0.78, 0.87) | 0.89 (0.85, 0.93) | 2.36 |
| **Sex** | | | | | |
| Women | 0.23 | 0.94 (0.89, 0.99) | 0.73 (0.57, 0.94) | 0.76 (0.72, 0.81) | 2.07 |
| Men | 0.37 | 1.15 (1.07, 1.22) | 0.92 (0.73, 1.15) | 0.98 (0.92, 1.03) | 2.57 |
| **Age group** | | | | | |
| 16-29 | 0.27 | 0.97 (0.92, 1.02) | 0.79[a] (0.71, 0.89) | 0.85 (0.80, 0.90) | 2.02 |
| 30-49 | 0.25 | 0.96 (0.90, 1.02) | 0.75[a] (0.60, 0.94) | 0.86 (0.79, 0.93) | 2.05 |
| 50+ | 0.33 | 1.31 (1.18, 1.44) | 1.01[b] (0.70, 1.45) | 1.02 (0.93, 1.12) | 3.37 |
| **Administrative region** | | | | | |
| Hudson | 0.25 | 0.98 (0.92, 1.04) | 0.75 (0.62, 0.92) | 0.81 (0.76, 0.87) | 2.47 |
| Ungava | 0.37 | 1.13 (1.07, 1.19) | 0.92 (0.74, 1.15) | 0.97 (0.92, 1.01) | 2.32 |
| **Ecological region** | | | | | |
| Hudson Bay | 0.25 | 0.94 (0.87, 1.01) | 0.73[b] (0.56, 0.95) | 0.79 (0.73, 0.86) | 2.09 |
| Hudson Strait | 0.34 | 1.06 (0.97, 1.15) | 0.83[a] (0.75, 0.92) | 0.85 (0.77, 0.92) | 2.65 |
| Ungava Bay | 0.37 | 1.17 (1.10, 1.24) | 0.95[c] (0.72, 1.24) | 1.02 (0.95, 1.09) | 2.33 |

Estimates exclude those prescribed thyroid medications (n=22).
Estimates in coloured cells and with different superscripts differ significantly between groups.
95% CI: 95% confidence interval.

When comparing arithmetic means of TSH in Q2004 and Q2017, TSH levels were significantly lower in 2017 than they were in 2004 (1.05 (1.00;1.09) µIU/mL vs 1.18 (1.12; 1.24) µIU/mL) but remained within the reference range (Figure 1) (32).

When comparing geometric means of TSH among individuals between the ages of 16 and 49 years, TSH levels were significantly lower in Nunavik compared to CHMS Cycle 4 (0.8 (0.7; 0.9) µIU/mL versus 1.4 (1.2; 1.5) µIU/mL) (Figure 2). Among individuals older than 50 years, there was no significant difference in TSH levels between Nunavik and the general Canadian population (1.0 (0.70;1.5) µIU/mL versus 1.5 (1.4; 1.6) µIU/mL).

**Figure 1** Comparisons of arithmetic mean TSH in Q2004 and Q2017 with the reference range

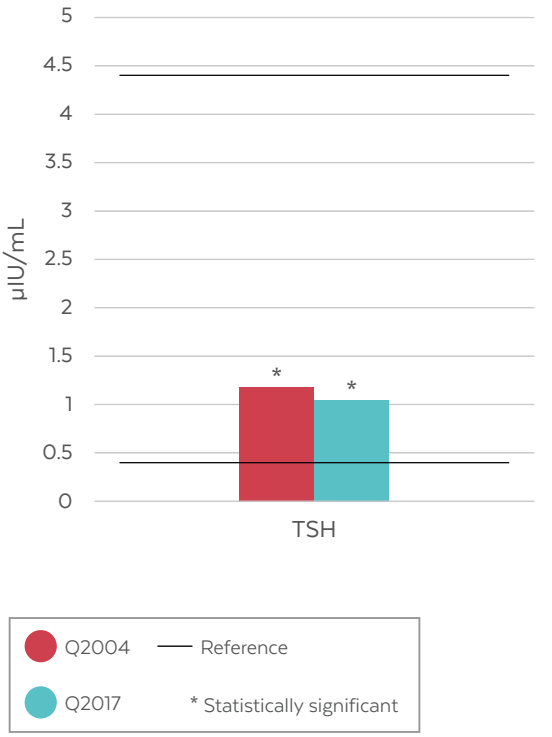
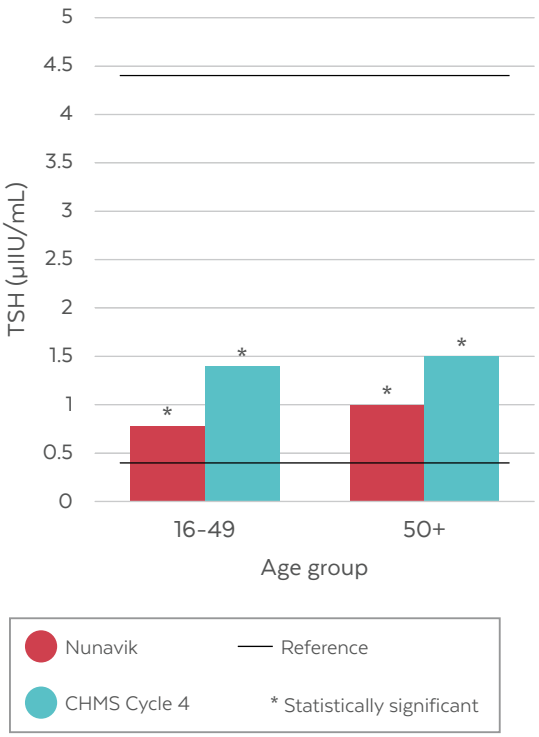



**Figure 2** Comparisons of geometric mean TSH in Nunavik and CHMS Cycle 4 in groups aged 16-49 and 50+ with the Nunavik reference range



## Free Thyroxine (fT4)

The geometric mean fT4 levels among Nunavimmiut was 14.07 pmol/L (Table 8). There were no significant differences between men and women. There were however significant differences between age groups and regions. Individuals in the 16-19 age group had significantly higher fT4 levels than the other two age groups (14.39 pmol/L versus 13.86 pmol/L and 13.81 pmol/L). Levels of fT4 were also significantly higher in individuals living in the Hudson administrative region compared to individuals living in the Ungava administrative region (14.24 pmol/L versus 13.86 pmol/L). Furthermore, individuals living in Hudson Bay had significantly higher fT4 levels compared to those living in Ungava Bay (14.31 pmol/L versus 13.85 pmol/L).

**Table 8** Arithmetic and geometric means with percentiles and median for fT4 (pmol/L) in 2017

| Group | 5th percentile | Arithmetic mean (95% CI) | Geometric mean (95% CI) | Median (95% CI) | 95th percentile |
|---|---|---|---|---|---|
| **All** | 11.29 | 14.24 (14.08, 14.40) | 14.07 (13.93, 14.21) | 13.92 (13.78, 14.06) | 18.05 |
| **Sex** | | | | | |
| Women | 11.26 | 14.11 (13.92, 14.29) | 13.93 (13.60, 14.26) | 13.79 (13.62, 13.95) | 17.94 |
| Men | 11.29 | 14.37 (14.12, 14.61) | 14.20 (13.87, 14.54) | 14.04 (13.82, 14.26) | 18.16 |
| **Age group** | | | | | |
| 16-29 | 11.65 | 14.56 (14.29, 14.83 | 14.39[a] (13.75, 15.05) | 14.20 (13.98, 14.42) | 18.23 |
| 30-49 | 11.15 | 14.03 (13.76, 14.30) | 13.86[b] (13.38, 14.35) | 13.66 (13.40, 13.93) | 18.05 |
| 50+ | 10.96 | 13.96 (13.71, 14.22) | 13.81[b] (13.25, 14.39) | 13.78 (13.54, 14.03) | 17.35 |
| **Administrative region** | | | | | |
| Hudson | 11.34 | 14.41 (14.20, 14.62) | 14.24 (13.88, 14.61) | 14.16 (13.97, 14.36) | 18.31 |
| Ungava | 11.24 | 14.03 (13.80, 14.26) | 13.86 (13.41, 14.32) | 13.66 (13.50, 13.81) | 17.53 |
| **Ecological region** | | | | | |
| Hudson Bay | 11.40 | 14.46 (14.22, 14.69) | 14.31[a] (13.82, 14.81) | 14.28 (14.02, 14.53) | 18.40 |
| Hudson Strait | 11.14 | 14.15 (13.83, 14.46) | 13.96[ab] (13.63, 14.30) | 13.73 (13.51, 13.95) | 17.55 |
| Ungava Bay | 11.23 | 14.04 (13.77, 14.31) | 13.85[b] (13.37, 14.35) | 13.64 (13.46, 13.83) | 17.70 |

Estimates exclude those prescribed thyroid medications (n=22).
Estimates in coloured cells and with different superscripts differ significantly between groups.
95% CI: 95% confidence interval.

Arithmetic mean levels of fT4 were significantly lower in 2017 compared to 2004 (14.2 (14.1; 14.4) pmol/L versus 15.5 (15.3; 15.7) pmol/L) but remained in the reference range (Figure 3) (32).

When comparing geometric mean fT4 among those aged 16 to 49 years, fT4 levels were significantly lower in Nunavik compared to CHMS Cycle 4 (14.2 (13.9; 14.4) pmol/L versus 15 (15; 16) pmol/L) (Figure 4). Among those older than 50 years, there were no significant differences in fT4 levels between Nunavik and the general Canadian population (13.8 (13.3; 14.4) pmol/L versus 15 (14; 15) pmol/L) although the absence of decimals in numbers reported in CHMS limits our ability to make comparisons.

**Figure 3** Comparisons of arithmetic mean fT4 in Q2004 and Q2017 with the reference range

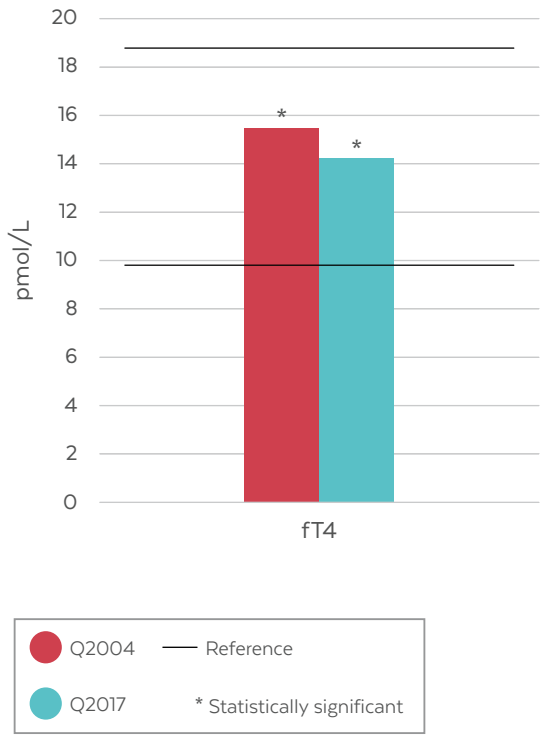
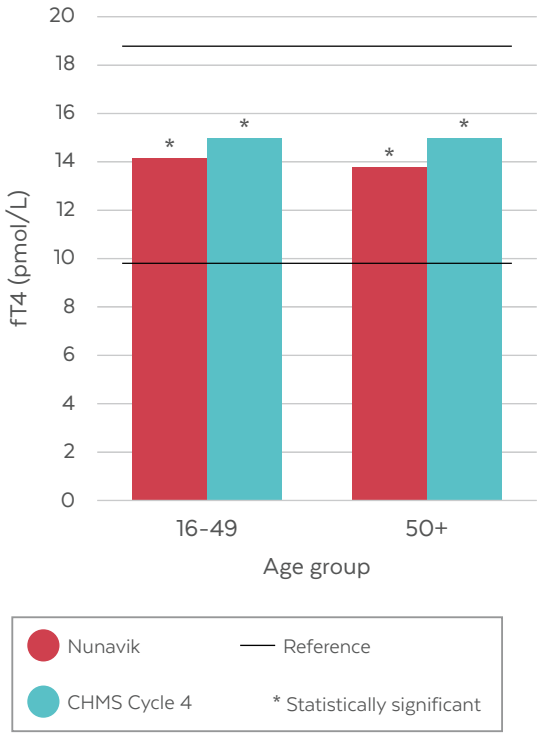



**Figure 4** Comparisons of geometric mean fT4 in Nunavik and CHMS Cycle 4 in groups aged 16-49 and 50+ with the Nunavik reference range



## Free and Total Triiodothyronine (fT3 and tT3)

The geometric mean of fT3 for all Nunavimmiut was 5.02 pmol/L (Table 9). There were significant differences between sexes, age groups and regions. The levels of fT3 were significantly higher in men than in women (5.20 pmol/L versus 5.01 pmol/L). These levels were significantly higher in the 16-29 age group compared to the other two (5.21 pmol/L versus 4.89 pmol/L and 4.85 pmol/L). Furthermore, individuals living in the Hudson administrative region had higher fT3 levels than individuals living in the Ungava region (5.07 pmol/L versus 4.94 pmol/L). Individuals living in Hudson Bay also had higher levels of fT3 compared to the other regions (5.17 pmol/L versus 4.97 pmol/L and 4.87 pmol/L).

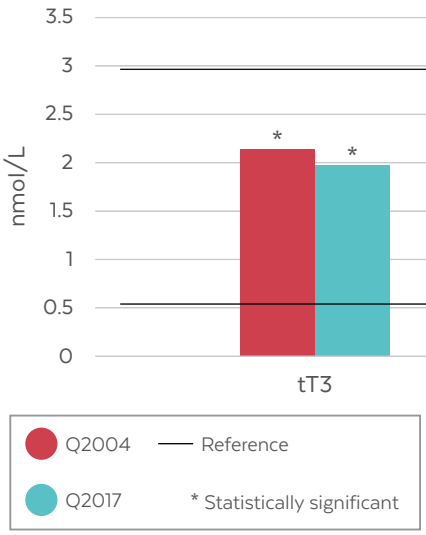
**Table 9** Arithmetic and geometric means with percentiles and median for fT3 (pmol/L) in 2017

| Group | 5th percentile | Arithmetic mean (95% CI) | Geometric mean (95% CI) | Median (95% CI) | 95th percentile |
|---|---|---|---|---|---|
| **All** | 3.88 | 5.11 (5.04, 5.18) | 5.02 (4.96, 5.07) | 4.95 (4.90, 5.00) | 6.60 |
| **Sex** | | | | | |
| Women | 3.79 | 5.01 (4.91, 5.11) | 4.90 (4.68, 5.14) | 4.84 (4.79, 4.90) | 6.60 |
| Men | 4.03 | 5.20 (5.11, 5.30) | 5.12 (4.91, 5.35) | 5.06 (4.97, 5.14) | 6.59 |
| **Age group** | | | | | |
| 16-29 | 4.10 | 5.29 (5.20, 5.38) | 5.21[a] (4.83, 5.63) | 5.12 (5.04, 5.20) | 7.00 |
| 30-49 | 3.84 | 4.96 (4.86, 5.06) | 4.89[b] (4.63, 5.16) | 4.85 (4.76, 4.93) | 6.22 |
| 50+ | 3.77 | 4.99 (4.79, 5.20) | 4.85[b] (4.52, 5.21) | 4.73 (4.64, 4.81) | 6.23 |
| **Administrative region** | | | | | |
| Hudson | 4.02 | 5.16 (5.06, 5.27) | 5.07 (4.94, 5.20) | 5.01 (4.95, 5.08) | 6.27 |
| Ungava | 3.75 | 5.04 (4.95, 5.13) | 4.94 (4.79, 5.10) | 4.85 (4.77, 4.93) | 7.01 |
| **Ecological region** | | | | | |
| Hudson Bay | 4.05 | 5.25 (5.13, 5.37) | 5.17[b] (4.87, 5.47) | 5.10 (5.01, 5.19) | 6.31 |
| Hudson Strait | 3.77 | 5.08 (4.94, 5.22) | 4.97[a] (4.84, 5.11) | 4.79 (4.70, 4.88) | 7.00 |
| Ungava Bay | 3.76 | 4.95 (4.85, 5.05) | 4.87[a] (4.57, 5.18) | 4.82 (4.74, 4.90) | 6.51 |

Estimates exclude those prescribed thyroid medications (n=22).
Estimates in coloured cells and with different superscripts differ significantly between groups.
95% CI: 95% confidence interval.

In 2004, only tT3 was measured (see annex for detailed Q2017 tT3 results). Arithmetic mean tT3 was significantly lower in 2017 compared to 2004 (1.97 (1.95; 2.00) nmol/L versus 2.14 (2.12; 2.17) nmol/L) (Figure 5) but remained in the reference range (32).

**Figure 5** Comparisons of arithmetic mean tT3 in Q2004 and Q2017 with the reference range




## Urinary Iodine

The median urinary iodine was 79.8 µg/L in the total population and 91.9 µg/L among pregnant women (Table 10). The geometric mean urinary-iodine concentration was significantly higher in women than it was in men (83.3 µg/L versus 74.7 µg/L). It was significantly lower in the 30 to 49 age group compared to the other two groups (70.4 µg/L versus 85.2 µg/L and 80.9 µg/L). Furthermore, urinary-iodine concentrations were found to be higher in the Ungava administrative region than in the Hudson region (88.9 µg/L versus 71.7 µg/L). Additionally, they were significantly higher in Ungava Bay compared to the other two ecological regions (93.5 µg/L versus 78.2 µg/L and 69.1 µg/L).

**Table 10** Geometric means with percentiles and median for urinary-iodine concentration (µg/L) in 2017

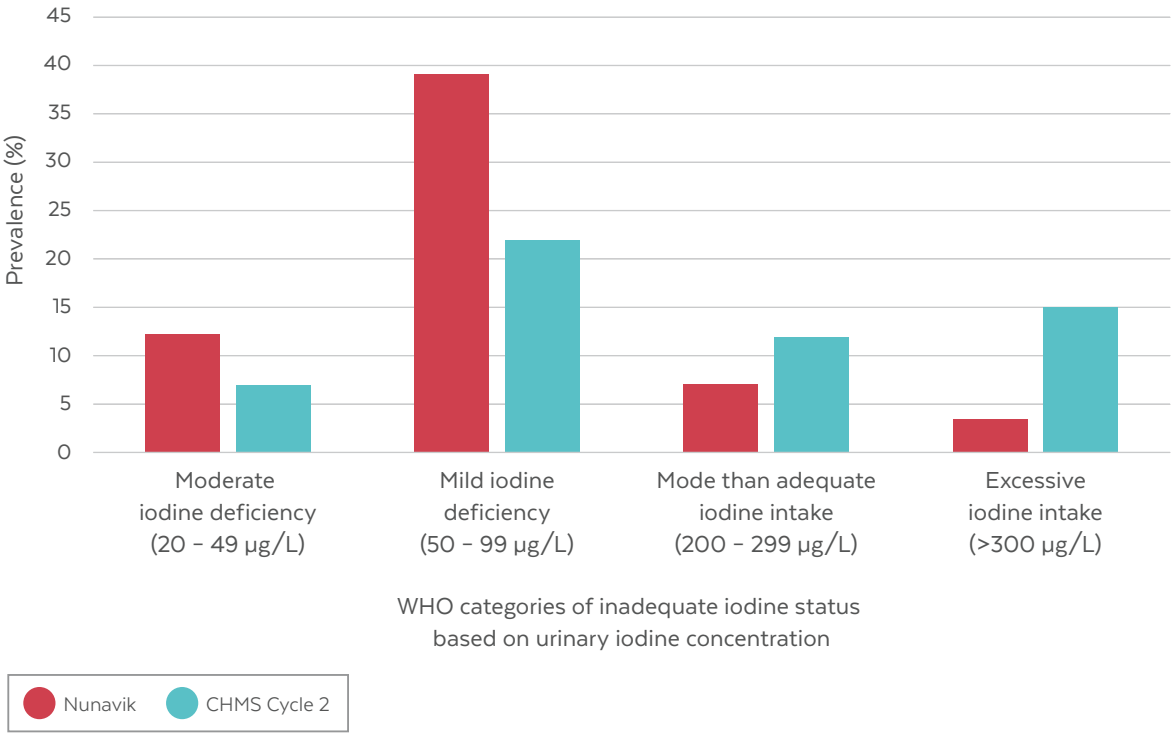
| Group | 5th percentile | Median urinary iodine (µg/L) (95% CI) | Geometric mean (µg/L) (95% CI) | 95th percentile | Percentage below 50 µg/L (95% CI) |
|---|---|---|---|---|---|
| **All** | 12.7 | 79.8 (73.4, 86.2) | 78.7 (74.8, 82.9) | 249.7 | 20.3 (17.7, 22.9) |
| **Sex** | | | | | |
| Women | 12.7 | 89.8 (82.7, 96.8) | 83.3 (73.7, 94.1) | 266.1 | 20.5 (17.5, 23.6) |
| Men | 12.7 | 72.1 (64.7, 79.5) | 74.7 (65.4, 85.3) | 245.7 | 20.0 (16.1, 24.0) |
| **Age group** | | | | | |
| 16-29 | 12.7 | 91.4 (81.1, 101.6) | 85.2[a] (71.9, 101.1) | 263.9 | 18.0 (14.2, 21.9) |
| 30-49 | 12.7 | 68.4 (61.5, 75.3) | 70.4[b] (55.0, 90.0) | 212.8 | 22.9 (18.2, 27.6) |
| 50+ | 12.7 | 88.3 (80.6, 96.1) | 80.9[a] (72.8, 89.8) | 262.8 | 20.3 (15.7, 24.9) |
| **Administrative region** | | | | | |
| Hudson | 12.7 | 70.5 (65.1, 75.9) | 71.7 (58.5, 87.8) | 237.1 | 22.6 (18.7, 26.4) |
| Ungava | 12.7 | 97.0 (87.5, 106.4) | 88.9 (70.4, 112.3) | 267.7 | 17.3 (14.3, 20.4) |
| **Ecological region** | | | | | |
| Hudson Bay | 12.7 | 67.5 (61.0, 74.0) | 69.1[a] (51.9, 91.9) | 217.7 | 23.1 (18.8, 27.5) |
| Hudson Strait | 12.7 | 78.7 (66.7, 90.6) | 78.2[a] (70.2, 87.0) | 257.2 | 21.7 (16.3, 27.2) |
| Ungava Bay | 12.7 | 103.6 (94.4, 112.9) | 93.5[b] (68.0, 128.5) | 292.5 | 15.6 (12.3, 18.9) |
| **Pregnant women (n = 32)** | 12.7 | 91.9 (52.2, 131.6) | 87.7 (57.0, 134.9) | 344.0 | |

Estimates in coloured cells and with different superscripts differ significantly between groups.
95% CI: 95% confidence interval.

Overall, 20.3% of the Nunavik population in 2017 had a urinary-iodine concentration below 50 µg/L (Table 10). The crude prevalence of severe iodine deficiency (<20 µg/L) was 7.9% while those of moderate (20-49 µg/L) and mild (50-99 µg/L) iodine deficiency were respectively 12.4% and 39.2%. Since the mean urinary iodine was below 100 µg/L and about 20% had levels below 50 µg/L, this suggests that in 2017, according to the two WHO criteria, the Nunavik population as a whole would classify as mildly iodine-deficient. Most subgroups in Nunavik met both these criteria. Although those aged 16-29 and those living in the Ungava administrative region did have median urinary-iodine concentrations below 100 µg/L, less than 20% of those individuals had levels below 50 µg/L. This suggests these subgroups were not iodine-deficient according to the two WHO criteria, however close to 20% of these populations fell below 50 µg/L. Interestingly, individuals living in Ungava Bay had a median urinary-iodine concentration above 100 µg/L and only 15.6% of individuals had levels below 50 µg/L, highlighting that iodine deficiency was not as prevalent in this Nunavik sub-region.

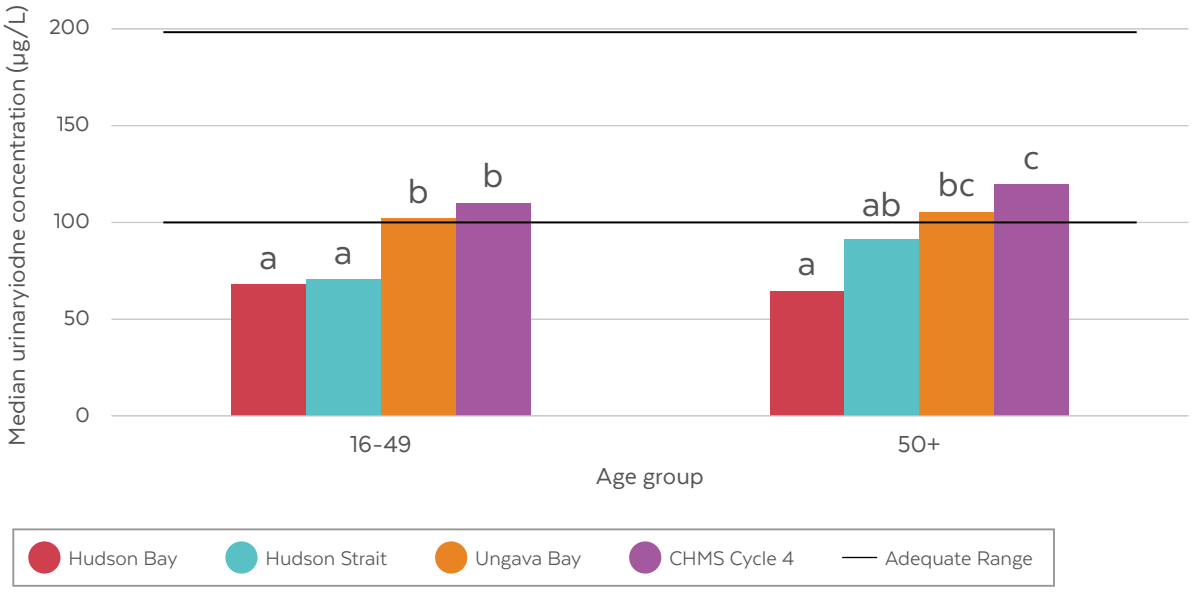
The crude prevalence of moderate (20-49 µg/L) and mild (50-99 µg/L) iodine deficiency was higher in Nunavik than in CHMS Cycle 2 (12.4% versus 7% and 39.2% versus 22%) (Figure 6) (40). Furthermore, the crude prevalence of more-than-adequate and excessive iodine intakes was lower in Nunavik compared to CHMS Cycle 2 (7.1% versus 12% and 3.6% versus 15%).

**Figure 6** **Crude prevalences of inadequate iodine statuses based on urinary-iodine concentration and WHO-established criteria in Nunavik and CHMS Cycle 2 (3, 40)**




Among those aged 16 to 49 years and those aged 50 years and above, the median urinary-iodine concentration in CHMS Cycle 4 (110 µg/L and 120 µg/L) was significantly greater than those in Hudson Strait (70.6 µg/L and 91.3 µg/L) and Hudson Bay (67.8 µg/L and 65 µg/L), while there were no significant differences between CHMS Cycle 4 and Ungava Bay (102.1 µg/L and 105.8 µg/L) (Figure 7).

**Figure 7** Comparisons of median urinary-iodine concentration in Nunavik regions and CHMS Cycle 4 in groups aged 16-49 and 50+ with the adequate nutrition range. Estimates with different superscripts differ significantly between groups




## COMPARISONS SUMMARY

**Table 11** Summary of comparisons between Nunavik in 2017 and 2004, and with the Canadian population aged 16-49 and 50+ years (CHMS 2014-2015), including the limitation of each study

| Measure | Q2004 | CHMS Cycle 4 (16-49) | CHMS Cycle 4 (50+) |
|---|---|---|---|
| **Euthyroid prevalence** | | | |
| **Hyperthyroid prevalence** | | | |
| **Hypothyroid prevalence** | | | |
| **TSH** | ^ | ^ | – |
| **fT4** | ^ | ^ | – |
| **fT3** | | | |
| **tT3** | ^ | | |
| **Urinary-iodine concentration** | | ^ Hudson Bay<br>^ Hudson Strait<br>– Ungava Bay | ^ Hudson Bay<br>^ Hudson Strait<br>– Ungava Bay |
| **Limitations** | > Only arithmetic means available<br>> No measure of iodine | > No measure of fT3<br>> No disorder prevalences | |

Blank cells represent measures that were not reported for that population.

^ : Higher compared to Q2017.

v : Lower compared to Q2017.

– : Similar to Q2017.

# 5 DISCUSSION

The data analysed in this report were collected in 2017. Although precautions should be taken during the interpretation, these data remain insightful for identifying thyroid disorder-prevalence patterns and iodine-nutrition recommendations.

## THYROID STATUS

Most Nunavimmiut were in the euthyroid range in 2017 with more men than women being in this range, as expected. Of those who were not in this range, more had hyperthyroidism (10.7%) than hypothyroidism (1.6%). When excluding individuals with a thyroid-medication prescription at the time of the survey, these prevalences dropped to 10.4% and 0.3%. This prevalence pattern is in agreement with the observed mild iodine deficiency in the Nunavik population at the time of the survey.

Other population studies also demonstrated similar prevalence patterns in areas of mild iodine deficiency. For instance, in a Danish population aged 68 years with mild to moderate iodine deficiency, the prevalence of hyperthyroidism (9.7%) was higher than that of hypothyroidism (3.8%) (45). In Nunavik, regional differences in the prevalence of thyroid disorders were only significant among women, and the pattern seemed to follow urinary-iodine concentrations. Indeed, in Hudson Bay, the prevalence of subclinical hyperthyroidism among women was significantly higher compared to the other two ecological regions. This region also had the lowest urinary-iodine concentrations. As presented in the Appendix, while the Inuit population in Greenland was considered to be iodine-sufficient, the thyroid disorder-prevalence pattern observed was similar to that of Nunavik with the prevalence of hyperthyroidism exceeding that of hypothyroidism. If we compare with another population with iodine sufficiency, such as the United States general population, the prevalence pattern differs with the prevalence of hypothyroidism (4.6%) exceeding that of hyperthyroidism (1.3%) (46). Unfortunately, there are few studies among the general Canadian population which report prevalences of thyroid disorders. In one study using data from 2011 and 2012, 10.3% of Quebec province residents above the age of 35 responded positively to the question 'In the past month, that is from 1 month ago to yesterday, did you take: thyroid medication such as Synthroid or Levothyroxine?' (47). Since this medication is for hypothyroidism, this would suggest a much higher prevalence of treated hypothyroidism in the Quebec population compared to Nunavik's. This study did not look into hyperthyroidism.

Thyroid autoimmunity in Nunavik was observed in less than 5% of the population in 2017 and most individuals with high levels of thyroid-autoimmunity biomarkers had thyroid-hormone levels in the euthyroid range. This may suggest that thyroid autoimmunity is not driving thyroid disorders in Nunavik. This prevalence of autoimmunity resembled that of Inuit in West Greenland (4%) (44). In contrast, the U.S. National Health and Nutrition Examination Survey (NHANES 1988-1994) observed high levels of each thyroid-autoimmunity biomarker in over 10% of the study population (46). These similarities with Greenland and differences with the U.S. general population could exemplify the genetic component of thyroid autoimmunity (48).

## THYROID BIOMARKERS

Although there were some significant differences in thyroid-biomarker levels between age and regional groups in 2017, most Nunavimmiut had thyroid biomarkers within the euthyroid range. Overall thyroid-biomarker levels were significantly and systematically lower in 2017 compared to 2004. Notably, laboratory methods for thyroid biomarkers differed between the two studies (Elecsys® 1010/2010 and the Modular Analytics E170 in 2004 versus Abbott Achitect and Siemens Vista 1500 in 2017). This could be one reason behind the observed differences between Q2004 and Q2017.

Compared to the general Canadian population in CHMS Cycle 4, TSH and fT4 levels were significantly lower in Nunavik in those aged 16 to 49 years but not among those 50 years old and above. As detailed in the Appendix, while TSH levels were similar across Inuit populations in Nunavik

and Greenland, there were some differences in median fT4 and fT3 levels. Median levels of fT4 were lower in each Nunavik region than they were in either Greenlandic region but median fT3 levels in Nunavik resembled those in East Greenland although they were lower compared to West Greenland. Another Greenlandic study had suggested that the difference between East and West Greenland could be due to cold adaptation in individuals and hunters living in more remote Eastern communities (34). The majority (87%) of Nunavimmiut reported often or occasionally going out on the land, which may explain the similarity to East Greenland (49). Thyroid biomarkers are affected by numerous dietary and environmental factors. Multivariate analyses are needed to elucidate the associations between these factors and thyroid biomarkers in Nunavik, and these will help further understand these populational differences and similarities.

## IODINE STATUS

Overall, Nunavik's population in 2017 can be considered to be mildly iodine deficient based on the two criteria established by the WHO (median urinary-iodine concentration of 79.8 µg/L with 20.3% of the population having a urinary-iodine concentration below 50 µg/L). Pregnant Nunavimmiut in the survey were also considered to have insufficient iodine intake (median urinary-iodine concentration of 91.9 µg/L). Iodine deficiency during pregnancy can have sizeable health consequences for the mother and the fetus (28). According to these criteria and similarly to the general Canadian population in 2009-2011, only the Ungava Bay region was considered to have adequate iodine nutrition (CHMS: 134.5 µg/L with 7% between 20 and 49 µg/L, Ungava Bay: 103.6 µg/L with 15.6% below 50 µg/L). As such, these regional differences suggest that only Hudson Bay and Hudson Strait were considered to be deficient in iodine.

Interestingly, the patterns of urinary-iodine concentrations seem to follow those of seaweed and mollusk consumption, which was reported to be more frequent in the Ungava Bay and Hudson Strait regions in 2017 (22). When presenting these results to Inuit colleagues, they also mentioned that waters in the Hudson Bay are less saline than those in the Ungava Bay because of the substantial freshwater input from southern Canada's watershed. Studies have demonstrated that total dissolved iodine levels in estuaries are correlated to salinity; it is possible that marine species harvested in Ungava Bay are higher in iodine than those in Hudson Bay (50, 51). As there are other possible sources of iodine such as iodized salt in Nunavik, multivariate analyses taking into account possible confounders are needed to identify local main sources of iodine in Nunavik diets.

As shown in the Appendix, contrary to Nunavik in individuals older than 50 years, iodine status in Greenlandic Inuit was considered to be generally adequate (108 µg/L and 115 µg/L in East Greenland and 70 µg/L in West Greenland), and this was linked to Greenlandic Inuit participation in traditional activities and consumption of traditional foods (42). However, iodine levels were lower than expected, considering how Inuit diets are rich in marine foods. The authors of the Greenlandic study have thus suggested that Inuit require more iodine to prevent deficiency as the thyroid has adapted to high levels of iodine through the consumption of iodine-rich foods that constitute traditional diets (43). A different study in Greenland determined that Inuit who consumed seaweed more frequently had higher iodine excretion (52). The discrepancy between iodine sufficiency in Greenlandic Inuit and insufficiency in Nunavimmiut aged 50+ could potentially reflect the different time periods in which the studies were conducted, as the Greenlandic Inuit study was published 20 years ago. This study may no longer reflect contemporary dietary, socioeconomic and lifestyle habits tied to iodine status among elderly persons.

Compared to the general Canadian population, iodine concentrations were lower in Hudson Strait and Hudson Bay while similar in Ungava Bay. A notable difference between these two populations could potentially be the main sources of iodine. The main source of iodine for those in the general Canadian population is iodized salt, whereas the main sources of iodine in Nunavik also likely include many marine foods. It has been suggested that the bioavailability of iodine differs depending on the source (53). While the bioavailability of iodine from salt has been suggested to be 100%, that of seaweed has been found to range between 31% and 90% depending on the species (53, 54). Furthermore, if Noahsen's (2021) theory on Inuit having adapted to high iodine levels and thus requiring more to fulfill iodine nutritional needs is accurate, this could also potentially explain the discrepancy between Nunavik and the general Canadian population.

## LIMITATIONS

The greatest limitation of this report is the lack of repeated urine samples to account for within-person variation. The availability of only spot urine samples limited the report's ability to estimate accurate iodine-status prevalences. Median urinary-iodine concentrations from the collected spot samples could be compared to the two WHO-established criteria for some indication of iodine status. However, morning urine spot samples in Q2017 may have underestimated the median urinary-iodine concentrations. Additionally, although comparisons with Greenlandic Inuit were performed (see Appendix),

it is important to note that the reference ranges for thyroid disorders used in the Greenlandic study differed slightly, and the date of data collection is unknown. Furthermore, as mentioned at the beginning of the discussion, the data analysed for this report date back eight years and may no longer reflect accurate prevalences.

## CONCLUSIONS

Mild iodine deficiency was found in Nunavik in 2017, specifically in the Hudson Bay and Hudson Strait regions. Iodine deficiency was also observed among pregnant women involved in the survey. The urinary-iodine concentration in Nunavik was lower than that of the general Canadian population, with the exception of Ungava Bay. Future studies examining the factors associated with iodine levels will help further understand the dietary, sociodemographic, socioeconomic and lifestyle determinants of iodine nutrition in Nunavik.

The pattern of suspected thyroid disease resembled that of Greenlandic Inuit and of other populations with mild to moderate iodine deficiency with a greater prevalence of hyperthyroidism than hypothyroidism. Again, further investigations into the associated factors will increase the understanding of these disorders and their pattern in Nunavik.

# REFERENCES


**1. Moini J**, Pereira K, Samsam M. Chapter 2 – Structures and functions of the thyroid gland. 2020. In: Epidemiology of Thyroid Disorders [Internet]. Elsevier; [21-43]. Available from: https://doi.org/10.1016/B978-0-12-818500-1.00002-5.

**2. Moini J**, Pereira K, Samsam M. Chapter 1 – Global epidemiology of thyroid disorders. 2020. In: Epidemiology of Thyroid Disorders [Internet]. Elsevier; [3-19]. Available from: https://doi.org/10.1016/B978-0-12-818500-1.00001-3.

**3. World Health Organization**. Assessment of iodine deficiency disorders and monitoring their elimination: a guide for programme managers. World Health Organization [Internet]. 2007. Available from: https://iris.who.int/bitstream/handle/10665/43781/9789241595827_eng.pdf?sequence=1.

**4. First Nations Information Governance Centre**. OCAP: Ownership, Control, Access and Possession [Internet]. 2007. Available from: https://fnigc.ca/ocap-training/

**5. Hamel D**, Hamel G, Gagnon S. Methodological Report. Nunavik Inuit Health Survey 2017 Qanuilirpitaa? [Internet]. 2020. Available from: https://nrbhss.ca/sites/default/files/health_surveys/A11991_RESI_Rapport_methodologique_EP4.pdf.

**6. Heuck CC**, Kallner A, Kanagasabapathy A, Riesen W. Diagnosis and monitoring of diseases of the thyroid2000. Available from: https://iris.who.int/bitstream/handle/10665/66342/WHO_DIL_00.4_eng.pdf?sequence=1&isAllowed=y.

**7. Statistics Canada**. Healthy aging indicators 2010. Available from: https://doi.org/10.25318/1310046601-eng.

**8. Imam SK**, Ahmad SI. Thyroid disorders: basic science and clinical practice: Springer Cham; 2016. Available from: https://www.doi.org/10.1007/978-3-319-25871-3.

**9. Moini J**, Pereira K, Samsam M. Chapter 5 – Hypothyroidism. 2020. In: Epidemiology of Thyroid Disorders [Internet]. Elsevier; [89-120]. Available from: https://doi.org/10.1016/B978-0-12-818500-1.00005-0.

**10. Samsam M**. Chapter 6 – Hyperthyroidism. 2020. In: Epidemiology of Thyroid Disorders [Internet]. Elsevier; [121-45]. Available from: https://doi.org/10.1016/B978-0-12-818500-1.00006-2.

**11. Stathatos N**, Daniels GH. Autoimmune thyroid disease. Current opinion in rheumatology [Internet]. 2012; 24(1):[70-5 pp.]. Available from: http://dx.doi.org/10.1097/BOR.0b013e32834ddb27.

**12. Smyth PPA**. Iodine, Seaweed, and the Thyroid. Eur Thyroid J [Internet]. 2021; 10(2):[101-8 pp.]. Available from: https://www.doi.org/10.1159/000512971.

**13. Fuge R**, Johnson CC. Iodine and human health, the role of environmental geochemistry and diet, a review. Applied Geochemistry [Internet]. 2015; 63:[282-302 pp.]. Available from: https://doi.org/10.1016/j.apgeochem.2015.09.013.

**14. Sorrenti S**, Baldini E, Pironi D, Lauro A, D'Orazi V, Tartaglia F, et al. Iodine: Its Role in Thyroid Hormone Biosynthesis and Beyond. Nutrients [Internet]. 2021; 13(12). Available from: https://doi.org/10.3390/nu13124469.

**15. Sprague M**, Chau TC, Givens DI. Iodine Content of Wild and Farmed Seafood and Its Estimated Contribution to UK Dietary Iodine Intake. Nutrients [Internet]. 2021; 14(1). Available from: https://doi.org/10.3390/nu14010195.

**16. Andersen S**, Hvingel B, Laurberg P. Iodine content of traditional Greenlandic food items and tap water in East and West Greenland. International journal of circumpolar health [Internet]. 2002; 61(4):[332-40 pp.]. Available from: https://doi.org/10.3402/ijch.v61i4.17491.

**17. National Institutes of Health**. Iodine – Fact Sheet for Health Professionals 2024. Available from: https://ods.od.nih.gov/factsheets/Iodine-HealthProfessional/.

**18. Zimmermann MB**. Symposium on 'Geographical and geological influences on nutrition' Iodine deficiency in industrialised countries: Conference on 'Over – and undernutrition: challenges and approaches'. Proceedings of the Nutrition Society [Internet]. 2010; 69(1):[133-43 pp.]. Available from: https://www.doi.org/10.1017/S0029665109991819.

**19. Zimmermann MB**. Iodine Deficiency. Endocrine Reviews [Internet]. 2009; 30(4):[376-408 pp.]. Available from: https://doi.org/10.1210/er.2009-0011.

**20. People in the WHO European Region at greater risk of iodine deficiency due to changing diets** [press release]. 2024.

**21. Knorr**. Aromat Seasoning n.d. Available from: https://www.knorr.com/ie/p/aromat-seasoning.html/05000184221241.

**22. Allaire J**, Johnson-Down L, Little M, Ayotte P, Lemire M. Country and Market Food Consumption and Nutritional Status. Nunavik Inuit Health Survey 2017 Qanuilirpitaa? [Internet]. 2021. Available from: https://nrbhss.ca/sites/default/files/health_surveys/Country_Food_and_Market_Food_Consumption_and_Nutritional_Status_fullreport_en.pdf.

**23. Little M**, Hagar H, Zivot C, Dodd W, Skinner K, Kenny TA, et al. Drivers and health implications of the dietary transition among Inuit in the Canadian Arctic: a scoping review. Public Health Nutr [Internet]. 2021; 24(9):[2650-68 pp.]. Available from: https://www.doi.org/10.1017/s1368980020002402.

**24. Zimmermann MB**, Boelaert K. Iodine deficiency and thyroid disorders. The Lancet Diabetes & Endocrinology [Internet]. 2015; 3(4):[286-95 pp.]. Available from: https://doi.org/10.1016/S2213-8587(14)70225-6.

**25. Zimmermann MB**. Chapter 25 – Iodine and the iodine deficiency disorders. 2020. In: Present Knowledge in Nutrition (Eleventh Edition) [Internet]. Academic Press; [429-41]. Available from: https://doi.org/10.1016/B978-0-323-66162-1.00025-1.

**26. Cooper DS**. Hyperthyroidism. The Lancet [Internet]. 2003; 362(9382):[459-68 pp.]. Available from: https://doi.org/10.1016/S0140-6736(03)14073-1.

**27. Knudsen N**, Brix TH. Genetic and non-iodine-related factors in the aetiology of nodular goitre. Best Practice & Research Clinical Endocrinology & Metabolism [Internet]. 2014; 28(4):[495-506 pp.]. Available from: http://dx.doi.org/10.1016/j.beem.2014.02.005.

**28. Bath SC**. The effect of iodine deficiency during pregnancy on child development. Proceedings of the Nutrition Society [Internet]. 2019; 78(2):[150-60 pp.]. Available from: https://www.doi.org/10.1017/S0029665118002835.

**29. Zimmermann MB**. The Effects of Iodine Deficiency in Pregnancy and Infancy. Paediatric and Perinatal Epidemiology [Internet]. 2012; 26(s1):[108-17 pp.]. Available from: https://doi.org/10.1111/j.1365-3016.2012.01275.x.

**30. Sohn SY**, Inoue K, Rhee CM, Leung AM. Risks of Iodine Excess. Endocrine Reviews [Internet]. 2024; 45(6):[858-79 pp.]. Available from: https://doi.org/10.1210/endrev/bnae019.

**31. Farebrother J**, Zimmermann MB, Andersson M. Excess iodine intake: sources, assessment, and effects on thyroid function. Annals of the New York Academy of Sciences [Internet]. 2019; 1446(1):[44-65 pp.]. Available from: https://doi.org/10.1111/nyas.14041.

**32. Dallaire R**, Dewailly E, Ayotte P. Exposition aux contaminants organiques et effets potentiels sur les fonctions thyroïdiennes chez la femme enceinte, le nouveau-né et l'adulte. Québec: Université Laval; 2009.

**33. Braverman LE**, Cooper DS, Kopp PA. Werner & Ingbar's the thyroid a fundamental and clinical text. Eleventh edition ed. Philadelphia: Wolters Kluwer; 2021.

**34. Andersen S**, Kleinschmidt K, Hvingel B, Laurberg P. Thyroid hyperactivity with high thyroglobulin in serum despite sufficient iodine intake in chronic cold adaptation in an Arctic Inuit hunter population. European Journal of Endocrinology [Internet]. 2012; 166(3):[433-40 pp.]. Available from: https://doi.org/10.1530/EJE-11-0888.

**35. Springer D**, Jan J, Zdenka L, Tomas Z, and Potlukova E. Thyroid in pregnancy: From physiology to screening. Critical Reviews in Clinical Laboratory Sciences [Internet]. 2017; 54(2):[102-16 pp.]. Available from: https://doi.org/10.1080/10408363.2016.1269309.

**36. Kravets I**. Hyperthyroidism: diagnosis and treatment. American family physician [Internet]. 2016; 93(5):[363-70 pp.]. Available from: https://www.aafp.org/pubs/afp/issues/2016/0301/p363.pdf.

**37. Wilson SA**, Stem LA, Bruehlman RD. Hypothyroidism: diagnosis and treatment. American family physician [Internet]. 2021; 103(10):[605-13 pp.]. Available from: https://www.aafp.org/pubs/afp/issues/2021/0515/p605.pdf.

**38. Zimmermann MB**, Andersson M. Assessment of iodine nutrition in populations: past, present, and future. Nutrition reviews [Internet]. 2012; 70(10):[553-70 pp.]. Available from: https://doi.org/10.1111/j.1753-4887.2012.00528.x.

**39. Eriksson J**, Barregard L, Sallsten G, Berlinger B, Weinbruch S, Manousou S, et al. Urinary iodine excretion and optimal time point for sampling when estimating 24-h urinary iodine. Br J Nutr. 2023;130(8):1289-97.

**40. Statistics Canada**. Iodine status of Canadians, 2009 to 2011 2013. Available from: https://www150.statcan.gc.ca/n1/pub/82-625-x/2012001/article/11733-fra.htm.

**41. Statistics Canada**. Canadian Health Measures Survey (CHMS) 2014. Available from: https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&Id=148760.

**42. Andersen S**, Hvingel B, Kleinschmidt K, Jørgensen T, Laurberg P. Changes in iodine excretion in 50–69-y-old denizens of an Arctic society in transition and iodine excretion as a biomarker of the frequency of consumption of traditional Inuit foods21–3. The American Journal of Clinical Nutrition [Internet]. 2005; 81(3):[656-63 pp.]. Available from: https://doi.org/10.1093/ajcn/81.3.656.

**43. Noahsen P**, Rex KF, Bülow Pedersen I, Mulvad G, Florian-Sørensen HC, Pedersen ML, et al. Adaptation to a High Iodine Intake in Greenland Inuit Suggested by Thyroid Disease Pattern. Thyroid [Internet]. 2021; 31(12):[1850-7 pp.]. Available from: https://www.doi.org/10.1089/thy.2021.0342.

**44. Noahsen P**, Rex KF, Bülow Pedersen I, Mulvad G, Florian-Sørensen HC, Pedersen ML, et al. Thyroid autoimmunity in Greenlandic Inuit. Eur Thyroid J [Internet]. 2022; 11(3). Available from: https://www.doi.org/10.1530/etj-22-0071.

**45. Laurberg P**, Pedersen KM, Hreidarsson A, Sigfusson N, Iversen E, Knudsen PR. Iodine Intake and the Pattern of Thyroid Disorders: A Comparative Epidemiological Study of Thyroid Abnormalities in the Elderly in Iceland and in Jutland, Denmark. The Journal of Clinical Endocrinology & Metabolism. 1998;83(3):765-9.

**46. Hollowell JG**, Staehling NW, Flanders WD, Hannon WH, Gunter EW, Spencer CA, et al. Serum TSH, T4, and Thyroid Antibodies in the United States Population (1988 to 1994): National Health and Nutrition Examination Survey (NHANES III). The Journal of Clinical Endocrinology & Metabolism [Internet]. 2002; 87(2):[489-99 pp.]. Available from: https://doi.org/10.1210/jcem.87.2.8182.

**47. Stoll K**. Disparities in Thyroid Screening and Medication Use in Quebec, Canada. Health Equity [Internet]. 2019; 3(1):[328-35 pp.]. Available from: https://www.doi.org/10.1089/heq.2018.0051.

**48. Pearce EN**, Farwell AP, Braverman LE. Thyroiditis. The New England Journal of Medicine. 2003;348(26):2646-55.

**49. Furgal C**, Lemire M, Lévesque B, Martin R, Boyd A. Hunting, fishing, gathering, ammunition use and public health messaging. Nunavik Inuit Health Survey 2017 Qanuilirpitaa? [Internet]. 2023. Available from: https://nrbhss.ca/sites/default/files/health_surveys/Hunting-Fishing_EN_FULL%20REPORT.pdf.

**50. Jianrong L**. Dissolved iodine in the Changjiang River Estuary, China. Water Science and Technology [Internet]. 2023; 88(5):[1269-79 pp.]. Available from: http://dx.doi.org/10.2166/wst.2023.263.

**51. Wong GTF**, Zhang L-S. Seasonal variations in the speciation of dissolved iodine in the Chesapeake Bay. Estuarine, Coastal and Shelf Science. 2003;56(5):1093-106.

**52. Andersen S**, Noahsen P, Rex KF, Florian-Sørensen HC, Mulvad G. Iodine in Edible Seaweed, Its Absorption, Dietary Use, and Relation to Iodine Nutrition in Arctic People. Journal of Medicinal Food [Internet]. 2019; 22(4):[421-6 pp.]. Available from: https://doi.org/10.1089/jmf.2018.0187.

**53. Blikra MJ**, Henjum S, Aakre I. Iodine from brown algae in human nutrition, with an emphasis on bioaccessibility, bioavailability, chemistry, and effects of processing: A systematic review. Compr Rev Food Sci Food Saf [Internet]. 2022 Mar; 21(2):[1517-36 pp.]. Available from: https://www.doi.org/10.1111/1541-4337.12918.

**54. Lipiec E**, Warowicka O, Ruzik L, Zhou Y, Jarosz M, Połeć-Pawlak K. Investigation of iodine bioavailability from chicken eggs versus iodized kitchen salt with in vitro method. European Food Research and Technology [Internet]. 2012; 234(5):[913-9 pp.]. Available from: https://doi.org/10.1007/s00217-012-1693-z.

# APPENDIX

**Table S1** Arithmetic and geometric means with percentiles and median for tT3 (nmol/L) in 2017

| Group | 5th percentile | Arithmetic mean (95% CI) | Geometric mean (95% CI) | Median (95% CI) | 95th percentile |
|---|---|---|---|---|---|
| **All** | 1.38 | 1.97 (1.95, 2.00) | 1.93 (1.91, 1.95) | 1.94 (1.92, 1.96) | 2.67 |
| **Sex** | | | | | |
| Women | 1.36 | 1.96 (1.93, 1.98) | 1.91 (1.85, 1.96) | 1.91 (1.89, 1.94) | 2.67 |
| Men | 1.39 | 1.99 (1.95, 2.03) | 1.95 (1.90, 2.00) | 1.95 (1.91, 1.99) | 2.63 |
| **Age group** | | | | | |
| 16-29 | 1.44 | 2.07 (2.03, 2.11) | 2.03[a] (1.83, 2.24) | 2.05 (2.01, 2.09) | 2.77 |
| 30-49 | 1.36 | 1.92 (1.87, 1.96) | 1.87[b] (1.75, 2.00) | 1.89 (1.84, 1.93) | 2.56 |
| 50+ | 1.29 | 1.88 (1.83, 1.93) | 1.84[b] (1.66, 2.03) | 1.86 (1.82, 1.89) | 2.54 |
| **Administrative region** | | | | | |
| Hudson | 1.46 | 2.04 (2.01, 2.08) | 2.00 (1.86, 2.16) | 1.98 (1.95, 2.02) | 2.68 |
| Ungava | 1.31 | 1.88 (1.85, 1.92) | 1.84 (1.66, 2.03) | 1.87 (1.83, 1.90) | 2.58 |
| **Ecological region** | | | | | |
| Hudson Strait | 1.58 | 2.19 (2.13, 2.24) | 2.14[a] (1.76, 2.61) | 2.15 (2.10, 2.21) | 2.80 |
| Hudson Bay | 1.45 | 1.99 (1.95, 2.03) | 1.96[b] (1.89, 2.03) | 1.95 (1.91, 1.99) | 2.61 |
| Ungava Bay | 1.28 | 1.80 (1.76, 1.84) | 1.75[c] (1.44, 2.13) | 1.78 (1.74, 1.82) | 2.36 |

Estimates exclude those prescribed thyroid medications (n=22).
Estimates in coloured cells and with different superscripts differ significantly between groups.
95% CI: 95% confidence interval.

## COMPARISONS WITH GREENLAND

As previously stated, thyroid hormones are essential for thermoregulation and are influenced by genetics and environmental factors (33). Chronic cold exposure, such as experienced by hunters in the Arctic, is suggested to affect thyroid hormone concentrations (34). As very few studies have researched thyroid health in Canada and specifically in the Canadian Arctic, comparisons with another Inuit population in Greenland can provide insight on disease patterns and biomarker concentrations.

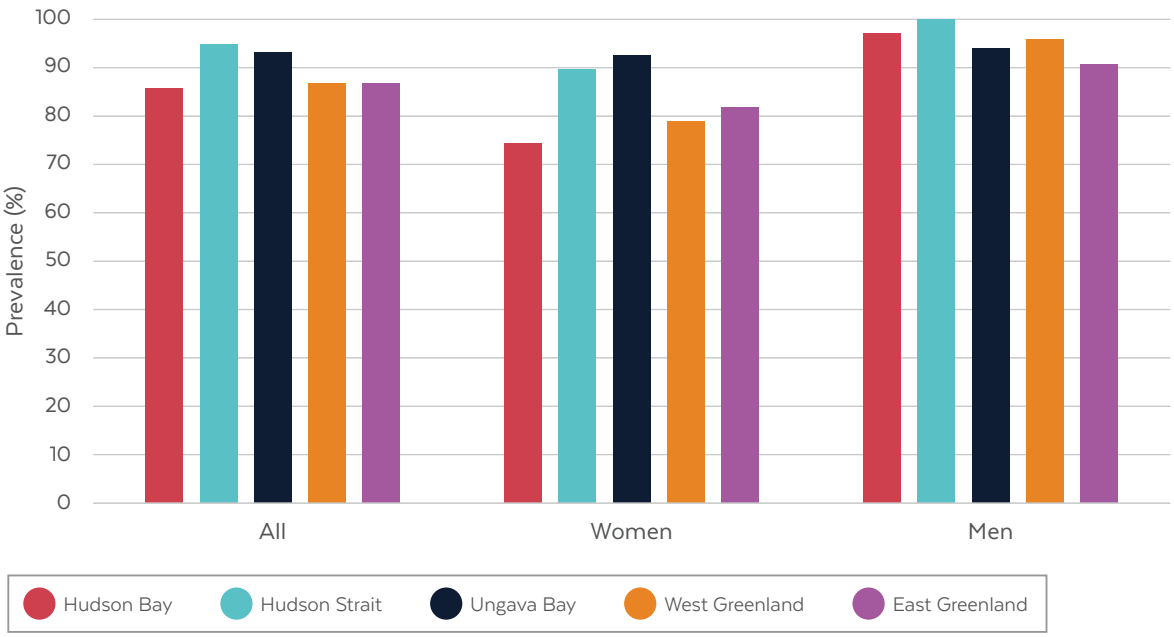
Three studies documented thyroid hormones disorders and iodine status in Greenlandic Inuit over the age of 50 years old (42-44). Comparisons with Greenlandic studies were thus performed solely with Nunavimmiut over the age of 50 years. For the comparisons of thyroid disorder, the prevalences included clinical, subclinical, and treated suspected cases (43). The reference ranges differed slightly from those used in Nunavik where the range for TSH for Greenlandic Inuit was 0.3-4.5 mU/L, for fT4 was 9.8-20.4 pmol/L, and for fT3 was 3.6-6.9 pmol/L. Unfortunately, none of the Greenlandic studies presented confidence intervals in their results. As such, statistical comparisons with this population are limited. Further, the year of data collection is unclear, however it seems this data has been used in publications since at least 2005.

Although the data from these studies is dated, these comparisons are primarily focused on comparing trends and patterns rather than absolute values.

## Euthyroid

Among individuals above the age of 50 years, the prevalence of men in the euthyroid range was similar in all Nunavik regions and in both regions in Greenland (Figure S1) (43). In each of these regions, the prevalence was lower in women than in men (Hudson Bay: 74.4% versus 97.2%; Hudson Strait: 89.7% versus 100%; Ungava Bay: 92.6% versus 93.8%; West: 78.8% versus 95.7%; East: 81.6% versus 90.6%).

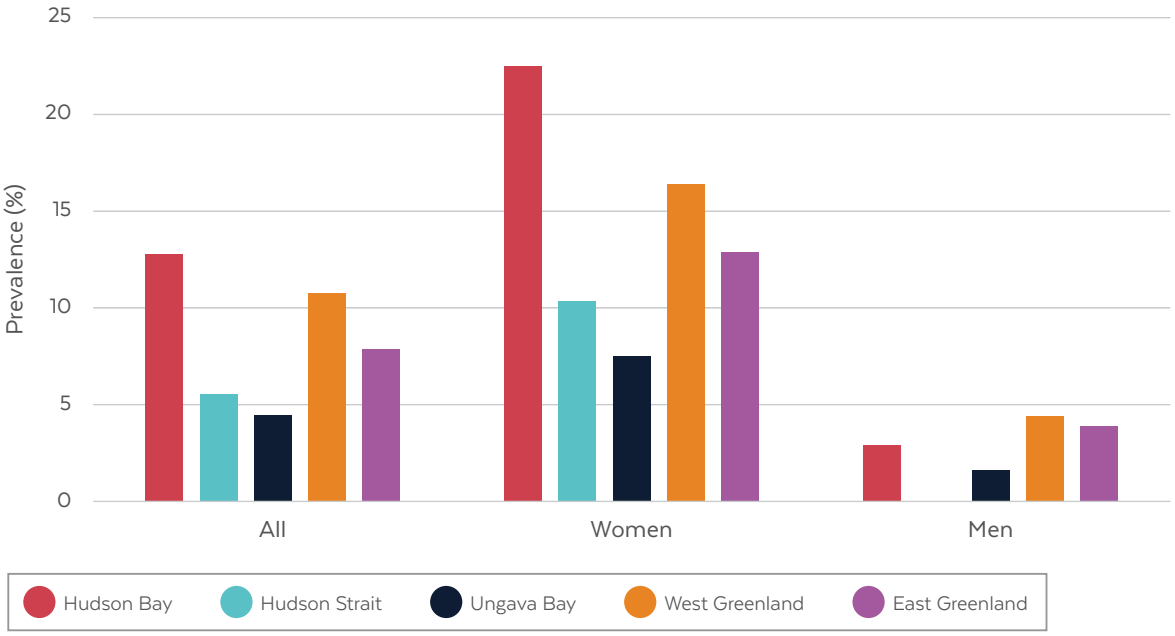
**Figure S1** Comparisons of the prevalence of individuals in the euthyroid range in Nunavik regions in 2017 and Greenlandic regions in adults over 50 years old (43)



## Hyperthyroidism

In adults over the age of 50 years, the prevalence of hyperthyroidism (clinical and subclinical) was higher among women across Nunavik regions and in both Greenlandic regions compared to men (Figure S2) (43).

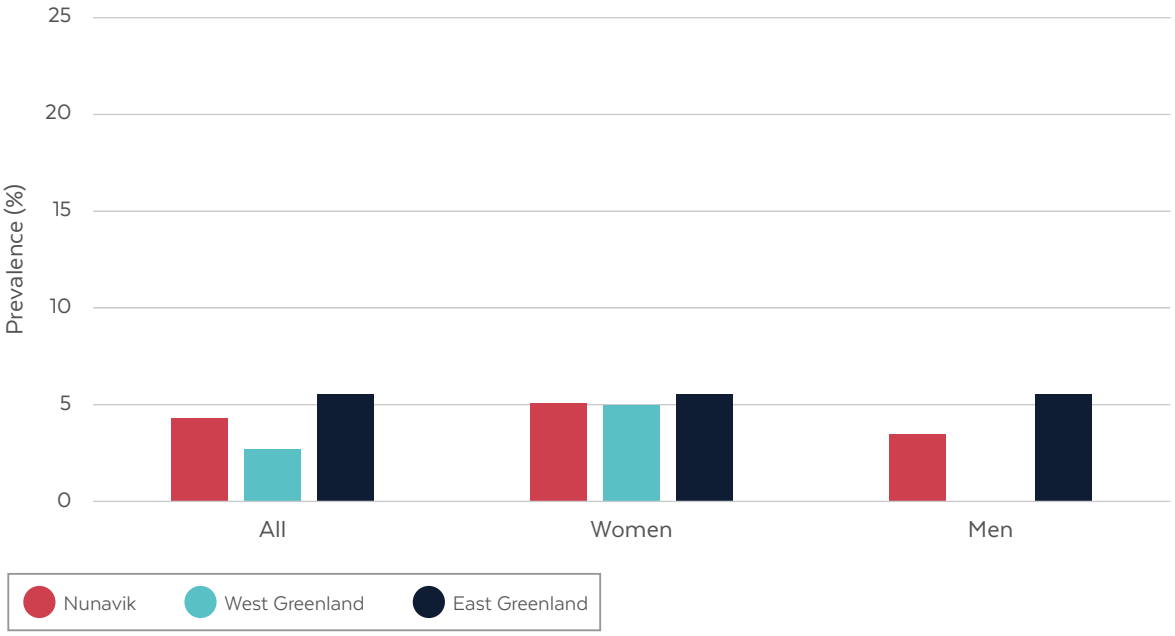
**Figure S2** Comparisons of prevalence of hyperthyroidism in Nunavik regions in 2017 and Greenlandic regions in adults over 50 years old (43)



## Hypothyroidism

Among those aged 50 years and above, the prevalence of hypothyroidism (both clinical and subclinical) was similarly low in Nunavik and both Greenlandic regions (Figure S3) (43). Comparisons of hypothyroidism among the three regions in Nunavik were not made due to there being fewer than 5 participants per region.

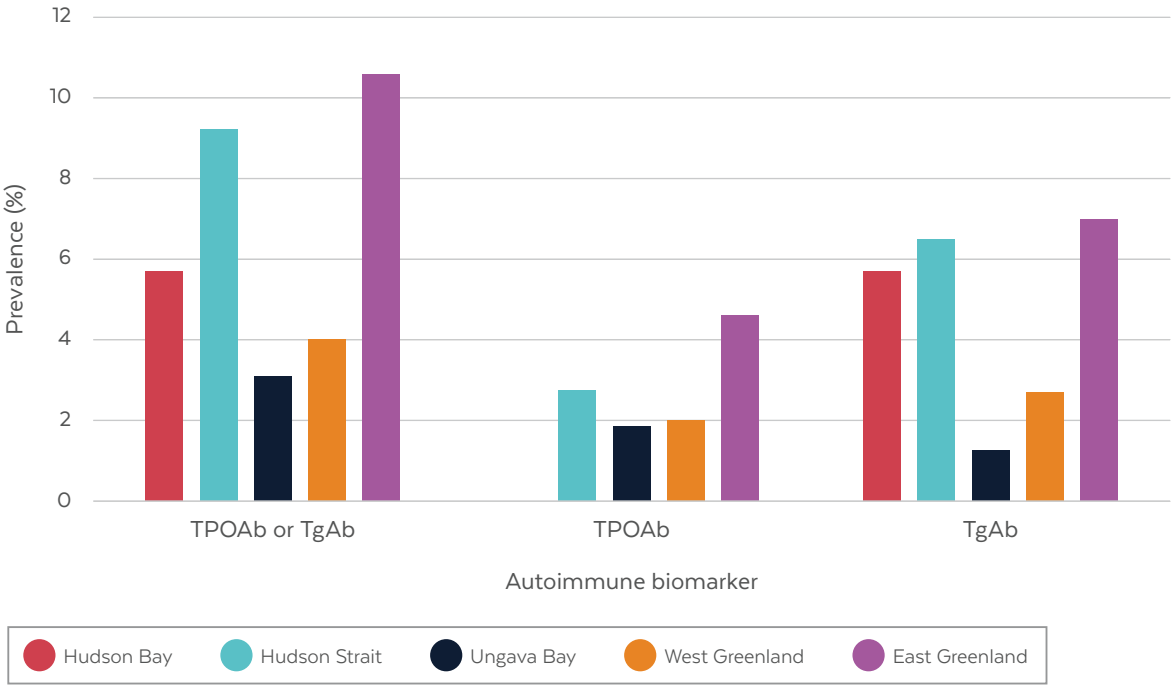
**Figure S3** Comparisons of prevalence of hypothyroidism in Nunavik regions in 2017 and Greenlandic regions in adults over 50 years old (43)



## Thyroid Autoimmunity

Among adults over 50 years old in Nunavik and Greenlandic regions, the prevalence of either thyroid autoimmunity biomarkers in Hudson Strait appeared similar to East Greenland (9.2% and 10.6%), while those in Hudson Bay and Ungava Bay resembled West Greenland (5.7%, 3.1%, and 4.0%) (Figure S4) (44). The prevalence of TPOAb was also similar across Nunavik regions and West Greenland while lower than East Greenland (0%, 2.8%, 1.8%, 2.0% versus 4.6%). The prevalence of TgAb was similar in Hudson Bay, Hudson Strait, and East Greenland (5.7%, 6.5%, and 7%), while that in Ungava Bay reassembled more West Greenland (1.3% and 2.7%).

**Figure S4** Comparisons of prevalence of thyroid autoimmunity in Nunavik regions in 2017 and Greenlandic regions in adults over 50 years old



## TSH

Among adults over 50 years old, median TSH levels appeared similar in all Nunavik and in both Greenlandic regions (1.02 µIU/L, 0.86 µIU/L, 1.23 µIU/L, 1.13 µIU/L, 1.10 µIU/L) (Figure S5) (43).

## fT4

Among adults over the age of 50 years, median levels of fT4 appeared lower in each Nunavik regions than they were in either Greenlandic region (14.2 pmol/L, 13.4 pmol/L, and 13.4 pmol/L versus 15.8 pmol/L and 15.7 pmol/L) (Figure S6) (43).

**Figure S5** Comparisons of median TSH in Nunavik and Greenlandic regions in adults over 50 years old with the Nunavik reference range (43)

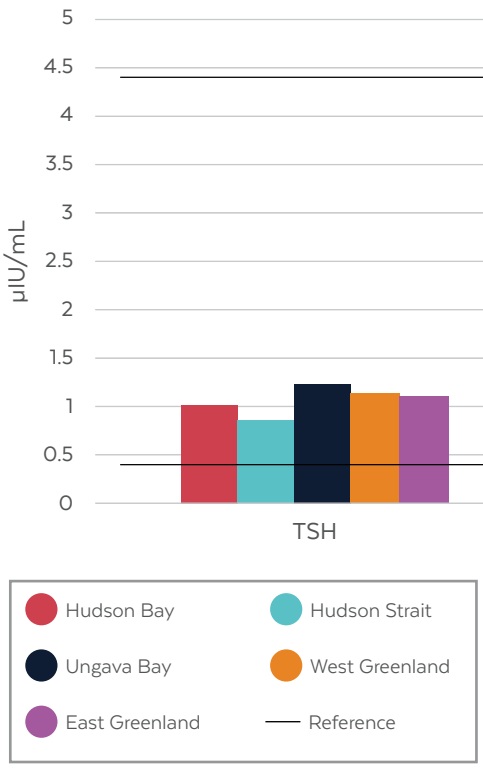
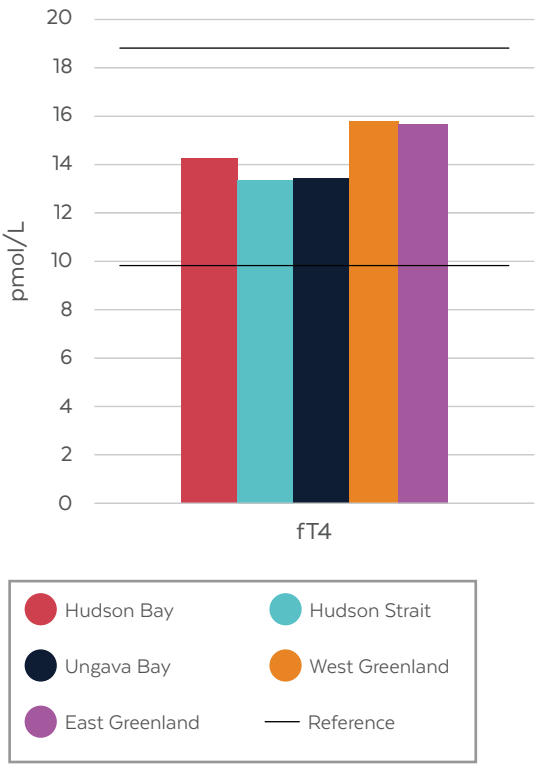


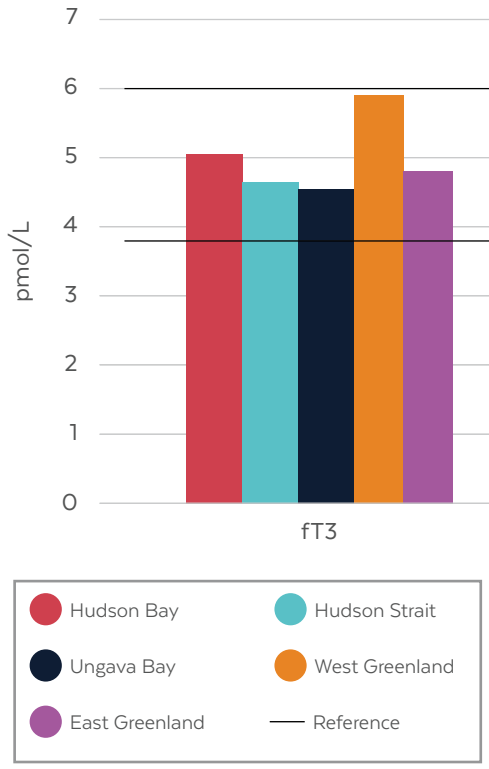

**Figure S6** Comparisons of median fT4 in Nunavik and Greenlandic regions in adults over the age of 50 with the Nunavik reference range



## fT3

Among those aged 50 years and above, geometric mean fT3 levels differed significantly between each Nunavik region (Hudson Bay: 5.1 pmol/L, Hudson Strait: 4.6 pmol/L, Ungava Bay: 4.5 pmol/L) but were not very different from East Greenland (4.8 pmol/L) (Figure S7). To the contrary, all regions were lower compared to those in West Greenland (5.9 pmol/L).

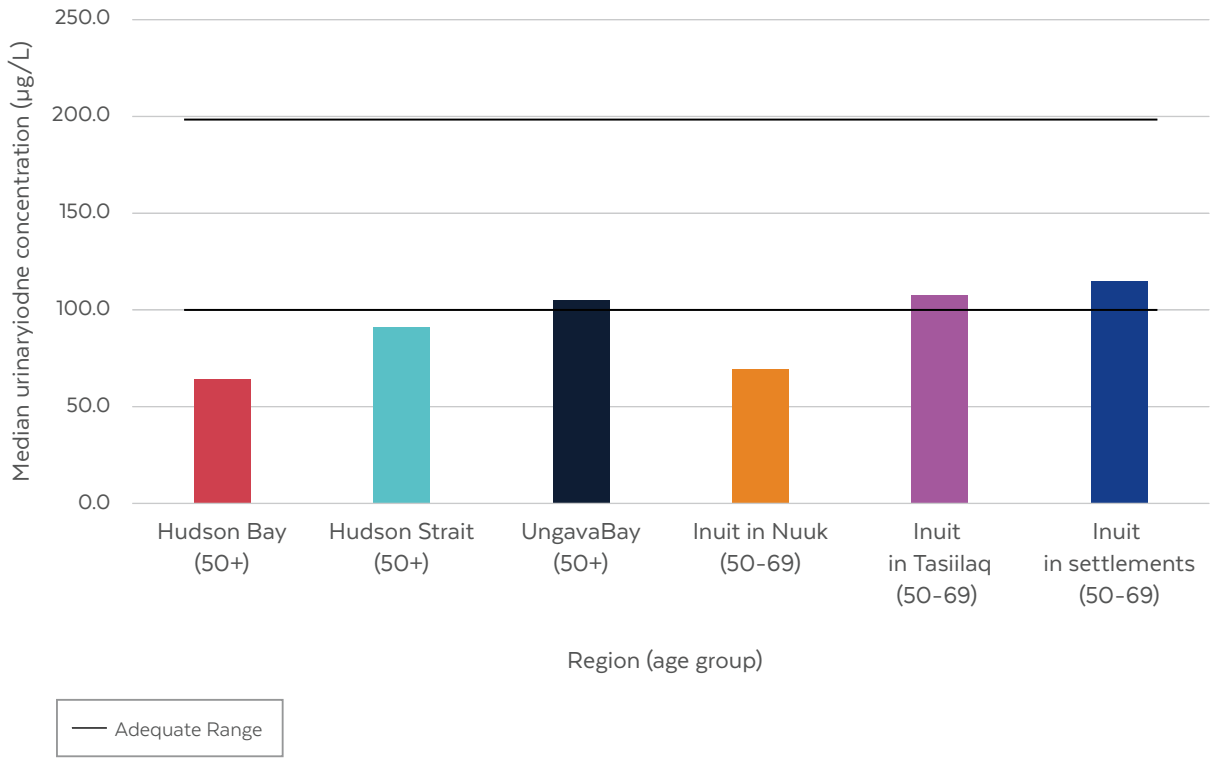
**Figure S7** Comparisons of median fT3 in Nunavik and Greenlandic regions in adults over the age of 50 with the Nunavik reference range



## Urinary Iodine

When comparing those aged 50 years old and above, the median urinary iodine concentration in Hudson Bay was similar to the median urinary iodine concentration in Nuuk, in West Greenland (a larger community) (65.0 µg/L versus 70 µg/L), while those in Ungava Bay resembled more closely levels reported in the two other more remote regions in East Greenland (Tasiilaq and Inuit settlements) (105.8 µg/L versus 108 µg/L and 115 µg/L) (Figure S8).

**Figure S8** Comparisons of median urinary iodine concentrations in Nunavik and Greenlandic regions with the adequate nutrition range (42)



# COMPARISONS SUMMARY

**Table S2** Summary of comparisons between Nunavik in 2017 and 2004, the Canadian population aged 16-49 and 50+ years (CHMS 2014-2015), and Greenlandic Inuit aged 50-59 years, including the limitation of each study

| Measure | Q2004 | CHMS Cycle 4 (16-49) | CHMS Cycle 4 (50+) | West Greenland (50-69) | East Greenland (50-69) |
|---|---|---|---|---|---|
| **Euthyroid prevalence** | | | | **Men**<br>— all regions<br>**Women**<br>— Hudson Bay<br>⌄ Hudson Strait<br>⌄ Ungava Bay | **Men**<br>— all regions<br>**Women**<br>— Hudson Bay<br>⌄ Hudson Strait<br>⌄ Ungava Bay |
| **Hyperthyroid prevalence** | | | | **Men**<br>— all regions<br>**Women**<br>⌄ Hudson Bay<br>⌃ Hudson Strait<br>⌃ Ungava Bay | **Men**<br>— all regions<br>**Women**<br>⌄ Hudson Bay<br>⌃ Hudson Strait<br>⌃ Ungava Bay |
| **Hypothyroid prevalence** | | | | **Men**<br>— all regions<br>**Women**<br>— all regions | **Men**<br>— all regions<br>**Women**<br>— all regions |
| **TSH** | ⌃ | ⌃ | — | — all regions | — all regions |
| **fT4** | ⌃ | ⌃ | — | ⌃ all regions | ⌃ all regions |
| **fT3** | | | | ⌃ all regions | — all regions |
| **tT3** | ⌃ | | | | |
| **Urinary iodine concentration** | | ⌃ Hudson Bay<br>⌃ Hudson Strait<br>— Ungava Bay | ⌃ Hudson Bay<br>⌃ Hudson Strait<br>— Ungava Bay | — Hudson Bay<br>⌄ Hudson Strait<br>⌄ Ungava Bay | ⌃ Hudson Bay<br>⌃ Hudson Strait<br>— Ungava Bay |
| **Limitations** | › Only arithmetic means available<br>› No measure of iodine | › No measure of fT3<br>› No disorder prevalences | | › Unknown date of data collection<br>› No confidence intervals reported | |

Blank cells represent measures that were not reported for that population.

⌃ : Higher compared to Q2017.

⌄ : Lower compared to Q2017.

— : Similar to Q2017.

ᑲᓇᕐᑎ ᐃᓄᐃᑦᑕᓂᖅᓱᒃᑯᑦ ᑲᑎᒪᔨᖅᑕᑦ
RÉGIE RÉGIONALE DE LA SANTÉ ET DES SERVICES SOCIAUX DU NUNAVIK
NUNAVIK REGIONAL BOARD OF HEALTH AND SOCIAL SERVICES