



**Incidence of cancer among residents of high temperature
geothermal areas in Iceland: A census based study 1981 to 2010**

Aðalbjörg Kristbjörnsdóttir

Thesis for the degree of Master of public health sciences

University of Iceland

School of Health Sciences

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Abstract

Objective To assess whether residence in a high temperature geothermal area, where inhabitants are exposed to geothermal emissions and water containing hydrogen sulphide and radon, is associated with the risk of cancer.

Design Observational cohort study where the population of a high temperature geothermal area (35 707 person years) was compared with the population of a cold, non-geothermal area (571 509 person years). The follow up from 1981 to 2010 was based on record linkage by personal identifier with nation-wide death and cancer registries. Through the registries it was possible to ascertain emigration and vital status and to identify the cancer cases, 95% of which had histological verification. The hazard ratio (HR) and 95% confidence intervals (CI) were estimated in Cox-model, adjusted for age, gender, education and housing.

Setting Iceland with 229 000 inhabitants.

Participants Persons 5 to 65 years of age from the 1981 National Census, total 74 806 individuals.

Results Adjusted HR in the high-temperature geothermal area for all cancers was 1.22 (95% CI 1.05 to 1.42) as compared with the cold area. The HR for pancreatic cancer was 2.85 (95% CI 1.39 to 5.86), bone cancer 5.80 (95% CI 1.11 to 30.32), breast cancer 1.59 (95% CI 1.10 to 2.31), lymphoid and hematopoietic cancer 1.64 (95% CI 1.00 to 2.66), and non-Hodgkin's lymphoma 3.25 (95% CI 1.73 to 6.07). The HR for basal cell carcinoma of the skin was 1.61 (95% CI 1.10 to 2.35). The HRs were increased for cancers of the nasal cavities, larynx, prostate, thyroid gland and for soft tissue sarcoma; however the 95% CI included unity.

Conclusion More precise information on exposure is needed to draw firm conclusions from the findings. The significant excess risk of breast, and basal cell carcinoma of the skin, and the suggested excess risk of other radiation-sensitive cancers, indicates that radon exposure may contribute to the risk of cancer among the population in the high-temperature geothermal area. There are indications of an exposure-response relationship, as the risk was higher in comparison with the cold than with the warm reference area. Social status has been taken into account and data on reproductive factors and smoking habits show that these do not seem to explain the increased risk of cancers.

Ágrip

Markmið: Að athuga hvort útsetning fyrir efnum í hverfagufum og vatni, svo sem brennisteinsvetni og radon vegna búsetu á háhitasvæði, tengist áhættu á krabbameinum.

Aðferðir: Þetta er lýðgrunduð hóprannsókn þar sem íbúar háhitasvæða (35 707 mannár) voru bornir saman við íbúa lághitasvæða (571 509 mannár) og blandaðra svæða (1 294 570 mannár).

Íbúar á Íslandi 1. Janúar 1981 voru 229 327 og einstaklingar á aldrinum 5 til 65 ára úr manntali 1981, alls 74 806 einstaklingar voru í rannsókninni. Þeim var fylgt eftir frá 1981 til 2010 og var tenging á persónuupplýsingum byggð á kennitölum. Með því fengust upplýsingar um afdrif einstaklinga og hvort þeir hafi greinst með krabbamein á tímabilinu.

Áhættuhlutfall (hazard ration, HR) og 95% öryggisbil (confidence interval, CI) var reiknað út í COX-líkan, leiðrétt var fyrir aldri, kyni, menntun og húsnæði.

Niðurstöður: Leiðrétt HR á háhitasvæðum fyrir öll krabbamein var 1.22 (95% CI 1.05 til 1.42) samanborið við köld svæði á Íslandi. HR fyrir krabbamein í brisi var 2.85 (95% CI 1.39 til 5.86), bein krabbamein 5.80 (95% CI 1.11 til 30.32), brjóstakrabbameini 1.59 (95% CI 1.10 til 2.31), eitil og blóðmyndandi krabbamein 1.64 (95% CI 1.00 til 2.66), og non-Hodgkin's eitilæxli 3.25 (95% CI 1.73 til 6.07). HR fyrir grunnfrumukrabbameini í húð var 1.61 (95% CI 1.10 til 2.35). HR var hækkað fyrir krabbameini í nef holrúmi og barkakýli, mjúkvefja sarkmeini, krabbameinum í blöðruhálskirtli, og skjaldkirtli, en 95% CI fyrir þessi krabbamein innihélt einn.

Ályktun: Nákvæmari upplýsingar um útsetningu þarf til þess að draga ákveðnar ályktanir frá niðurstöðunum. Tölfræðilega marktæk aukin áhætta á brjóstakrabbameini og grunnfrumukrabbameini í húð, og vísbending um aukna áhættu annarra geisla næmra krabbameina, bendir til að radon útsetning gæti stuðlað að krabbameins hættu meðal fólks sem búsett er á háhitasvæðum.

Tekið hefur verið tillit til þjóðfélagsstöðu og tölur um frjósemiþætti og reykingar sýna að þessir þættir virðast ekki skýra aukninguna á krabbameinshættunni.

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This project is dedicated to all the people who have been diagnosed with cancer.

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Abbreviations

WHO	World Health Organization
US	United States
U.S. EPA	U.S. Environmental Protection Agency
ICR	Icelandic Cancer Registry
ICD	International Classification of Diseases
IARC	International Agency for Research on Cancer
HR	Hazard ratios
CI	Confidence intervals
ppb	parts per billion
ppm	parts per million
BCC	Basal cell carcinoma
SIR	Standardized incidence ratio
OECD	Organisation for Economic Co-operation and Development
NHL	Non-Hodgkin's Lymphoma
Bq/l	Becquerel per litre

Background

A proportion of total burden of disease worldwide has in a recent report from WHO¹ been attributed to indoor and outdoor air pollution, chemicals exposure, and different environmental hazards. According to even more recent WHO report² substantial proportions of the most common diseases are estimated to be due to environmental factors. According to health authorities in US³ it is important to study, monitor and regulate air pollution in the outdoor environment and numerous studies have noted that indoor air can be many times more contaminated than outdoor air. This is in accordance with a WHO report⁴ which underlines that deficiency of indoor air quality should be recognized as important risk factors for human health in low-, middle-, and high-income countries.

The importance of indoor air quality has increased lately because today, people spend the majority of their time indoors and studies from the United States and Europe show that the populations of the industrialized countries spend more than 90 percent of their time indoor.⁵

Environmental causes of cancer have been linked to encompassing environmental contaminants or pollutants, occupationally-related exposures and radiation.² Notable examples of environmental causes of cancer are asbestos, benzene, indoor and outdoor air pollution and contaminants such as arsenic. Ionizing radiation increases the risk for several cancer types.⁶⁻⁸ Diagnostic X-rays were estimated to contribute between 0.5 - 3% to the overall cancer burden in high-income countries.⁹ Risk related to radon is high in miners, and residential radon has been estimated to cause 2% of cancer deaths in Europe.¹⁰

Global burden of cancer has become the second leading cause of death worldwide. Almost 12.7 million new cancer cases and 7.6 million cancer deaths occurred in 2008 worldwide and leading causes of cancer deaths were lung, breast, colorectal, stomach, and liver cancers. More than two thirds of all cancer deaths occur in low- and middle-income countries.¹¹

Air pollution in volcanic and geothermal area

Air pollution and its impact on human health have been considered a serious problem in active volcanic areas. Millions of people globally are potentially exposed to volcanic gases, the effects of these exposures may differ from those of exposure to anthropogenic air pollution.^{12 13}

Research in volcanic air pollution hazards has mainly concerned the acute toxic effects of gas or ash in people exposed near to active vents. Volcanic eruptions in Iceland have emitted ash and gases which have been carried downwind to mainland Europe and historically such events

have been associated with climate change and increased mortality in England and elsewhere.¹⁴ Recent volcanic activities in Iceland have also disturbed commercial air traffic for weeks in the years 2010 and 2011.^{15 16}

People living in the close vicinity of the volcano are usually those who suffer most in case of eruption. Fortunately the eruptions do not usually last for weeks or months, although it happens, however this people may experience long term exposure to different toxic ground gas emissions.

The ground gas emissions in geothermal areas is a hazard which is characterised by the migration of gases from deep magma bodies or hydrothermal systems towards the surface and through the soil, where they are emitted into the air. In geothermal regions the hazards are attributed to toxic gases including carbon dioxide (CO₂), hydrogen sulphide (H₂S), radon (Rn), sulphur dioxide (SO₂), sulphuric acid (H₂SO₄), hydrogen chloride (HCl), and hydrogen fluoride (HF) are considered to pose chronic health hazards.¹⁷⁻¹⁹ Several other low-dose exposures have been of concern among them is arsenic (As), lead (Pb), and mercury (Hg).²⁰⁻²²

Hydrogen sulphide (H₂S) and sulphur dioxide (SO₂) is a typical gas emission from geothermal fields and epidemiological studies on possible chronic health effects were encouraged by a WHO's task group several years ago.²³ In still another WHO report published some years later, it is claimed that it is not possible to evaluate the carcinogenic potential of hydrogen sulphide on the basis of the human studies at hand.²⁴ According to the International Agency for Research on Cancer (IARC), SO₂ has not been classified as carcinogenic for humans, while sulphuric acid (H₂SO₄) is considered carcinogenic to humans.⁸

Radon is a natural radioactive gas produced by the decay of uranium and thorium, which are present in all rocks and soils in small quantities. Long-term exposure to Radon (Rn) by inhalation has been linked to lung cancer, in humans.²⁵

Some of the trace elements in geothermal field, such as Cd, Cr, Pb, Hg and As, and compounds that contain them are known to be carcinogenic to human.^{8 20 26}

Risk of cancer in volcanic and geothermal areas

Cancer risks attributable to exposure of geothermal area have mainly focused on the experience of populations exposed to volcano area, and radon or radon daughters.

In overview by Keller et al. it is stated that several studies have shown that building materials are associated with radon and exposure to ionizing radiation.²⁷ There are some building materials that may have high concentrations of radium. Examples of these are alum shale

concrete and building materials made of volcanic tuff, by-product phosphogypsum, and some industrial waste materials.²⁷

Amaral et al. conducted a study, in Azores, Portugal, by comparing two populations, one from an area with active manifestation of volcanism (Furnas) and the another from an area without volcanic activity since 3 million years ago (Santa Maria).²¹ Overall cancer incidence rates were higher in the volcanically active area when observing all cancers and both sexes combined.²¹

In a study from Sicily it was shown that residents of Catania province, which is a volcanic region, appear to have a higher incidence of papillary thyroid cancer than elsewhere in Sicily.²⁸ It is concluded from the study that the volcanic environment of Mt Etna may contribute to the increased risk of thyroid cancer and the authors generalize from their results and suggest that residents of other volcanic areas could be at increased risk for thyroid cancer and, possibly, of other cancers. However specific, known risk factor for thyroid cancer in this volcanic environment was not identified.²⁸

In a study from New Zealand of the city of Rotorua, the authors found a significant risk of nasal cancer (ICD-9 160) (SIR = 3.17, p=001) among the whole population and increased risk of lung cancer (SIR=1.48, p=0.02) among female Maoris, based on hospital registry.²² The references were made to the general population and to the female Maoris population of New Zealand. The authors of this study concluded that there were inadequate data on exposure to permit conclusions on possible causal relationships between hydrogen sulphide and cancer incidence, however they considered that the increase in lung cancer were not explained by difference in smoking habits.²²

The city of Rotorua had a population about 40.000 and lies near the centre of the North Island of New Zealand. The city used geothermal energy for industrial and domestic heating. In the geothermal active areas in the city the hydrogen sulphide were estimated to more than 500 parts per billion (ppb) away from the most active geothermal fields and to more than 5 parts per million (ppm) near fumaroles.^{19 29}

In a study from Alberta, Canada, on residents living downwind from natural gas refineries, emitting hydrogen sulphite, no increase in cancer incidence was noted.³⁰

The Icelandic setting and the Nordic countries

The Nordic countries comprise Denmark, Norway, Finland, Sweden and Iceland. The Nordic countries are known for equality and equal access to health care for all citizens. Life expectancy in the five Nordic countries is among the highest in the world and has risen during the last decades.³¹ In Iceland the population is homogenous and Caucasian, numbering 229 327 in 1981 to 318 630 in 2010, the period that the study spanned³²

Icelandic women and men had in the year 2005 the highest life expectancy (women 79.2; men 83.1), in the Nordic countries and Icelandic men could expect to live longer than any other men included in OECD statistic in 2005.³¹

Geologically, Iceland is a young island located in the North Atlantic Ocean, 65 00 N, 18 00 W³³ on the boundary between the North American and Eurasian tectonic plates. These two plates are moving apart at a rate of about 2 cm per year and Iceland is an anomalous part of the ridge where deep mantle material wells up and creates a hot spot of unusually great volcanic productivity and several geothermal fields.^{34 35}

Iceland is one of the most tectonically active places on earth, resulting in a large number of volcanoes and hot springs. Earthquakes are frequent and more than 200 volcanoes are located within the active volcanic zone stretching through the country from the southwest to the northeast. In this volcanic zone have been located at least 20 high-temperature areas who are directly linked to the active volcanic systems, and about 250 separate low-temperature areas which were found mostly in the areas flanking the active volcanic zone and over 600 hot springs (temperature over 20°C).³⁴⁻³⁶

The high-temperature areas have underground temperatures over 150°C at 1000 m depth and the age of bedrock is less than 0.8 million year old.³⁶

Hydrogen sulphide present in the steam tends to be oxidised at the surface by atmospheric oxygen, either into elemental sulphur, which is deposited around the vents, or into sulphuric acid, which leads to acid waters altering the soil and bedrock.³⁴⁻³⁶

Low-temperature systems are all located on the west and east side of the volcanic zone passing through Iceland. The low-temperature areas contain hot or boiling springs with underground temperatures below 150°C at 1000 m depth and the age of bedrock is more than 0.8 million year old.

The largest of these systems are located in southwest Iceland on the flanks of the western volcanic zone, but smaller systems can be found throughout the country.³⁴⁻³⁶

Radon has been measured in the geothermal water in Iceland and its content has been studied in relation to earthquakes.^{37 38}

The use of geothermal energy in Iceland

Geothermal water and steam have been used for decades in Iceland for domestic heating, bathing and showering, in different industries and to generate electricity in power plants.^{35 36}

The domestic use started in 1908, when Stefan B. Jonsson who lived in Suður-Reykjum in Mosfellshreppi began using hot water for space heating in his farm and soon after other people began to independently create their own systems to heat their homes. Over the next several decades, geothermal domestic heating became widespread and today, well over 90% of homes in Iceland are heated by geothermal energy, the highest percentage in the world.³⁹

Cancer incidence in Iceland

The cancer incidence in Iceland is similar as in the Nordic countries. The average annual number of new cancer cases in the period 2005 – 2009 were 724 males and 663 females. Around one in three Icelanders can expect to be diagnosed with cancer during his or her lifetime and over 50% of cancers are diagnosed after the age of 65 years. Cancer causes were 28% of all deaths in Iceland and five year relative survival for all cancer has more than doubled since the year 1955.^{40 41}

All Nordic countries keep population-based registries of incident cancer and the Icelandic Cancer Registry (ICR) is a nationwide registry covering all cancer diagnosed in Iceland since 1955.^{31 40} The registry has virtually complete coverage and over 95% of the diagnoses are histologically confirmed. Presently the ICR uses ICD-03 for coding topography and morphology. Each neoplasm is also by comparison code according to ICD-7, ICD-9 and ICD-10, which for the present study the incident cancer cases were classified into all cancers and 26 primary diagnostic categories. Some categories have been further divided according to sub-site or morphological type.⁴⁰

Brest cancer

Breast cancer accounts for nearly one third of all incident cancer among women in the Nordic countries. During most of the period 1960 to 2005 the incidence was highest in Denmark and lowest in Finland.³¹

Breast cancer is the most common cancer among Icelandic women, with an age-standardized (world standard) incidence rate of 93.3 per 100 000 person years in the period 2005 to 2009, a level similar to that in other Nordic countries.^{31 40}

Risk factors for breast cancer in women are low parity or null parity, high age at first birth, low age at menarche and high age at menopause.⁴² Other established risk factors for breast cancer included ionising radiation, lack of physical activity, high body mass index and alcohol consumption.³¹ Among factors protecting from breast cancer are young age at first birth and given birth to many children.⁴²

Pancreatic Cancer

The incidence of pancreatic cancer in the Nordic countries is 50% higher in men than in women. In both genders in the Nordic countries, the incidence of pancreas cancer increased until the mid 1970s, and after that it decreased in men and was on the same level in women.³¹

In Iceland, cancer of the pancreas is slightly more common among men than women. Age-standardized incidence rate for Icelandic men were 5.7 per 100 000 person years⁴⁰ and for Icelandic women 5.1, in the period 2005 to 2009, which were the lowest in the Nordic countries.^{31 40}

Cigarette smoking is an established risk factor for pancreatic cancer. The findings from several large US cohort studies suggest that obesity may also be associated with an increased risk of pancreatic cancer.^{43 44}

Bone cancer

Bone cancer is rare type of cancer, and the incidence has been decreasing in men and women in the Nordic countries. It is now approximately 1 per 100 000 person years in men and one-third less in women. In the period 2005 to 2009 for Icelandic men age-standardized incidence rate were 1.9 which is among the highest in the Nordic countries and the rate for Icelandic women was 0.7.^{31 41}

Previous studies have indicated that the main environmental factors for bone cancer are ionising radiation and chemotherapy.⁸

Non-Hodgkin's Lymphoma

For several decades the incidence of NHL has increased more rapidly than almost any other cancer in the Nordic countries, but after 1990s the increased has stopped. Incidence in men is higher than in women in all Nordic countries, and Finland has the highest incidence.³¹

In Iceland, cancer of the NHL is higher among men than women. Age-standardized incidence rate for Icelandic men were 11.0 per 100 000 person years and for Icelandic women 6.2, in the period 2005 to 2009.^{40 41}

Known risk factors for non-Hodgkin's lymphoma are immunosuppressant, autoimmunity, and certain infectious agents. However these explain only a small fraction of the cases. Other possible risk factors include particular food products, medications, pesticides, and hair dyes. Recent evaluations of epidemiologic patterns of NHL according to histological subtype have documented clear differences among the different NHL subtypes, which strongly suggest they may also have different risk factor profiles.^{41 45}

Skin melanoma

Incidence of skin melanoma in the Nordic countries was increasing until the early 1990s, both in men and women. After that, there was a levelling-off in Norway and Finland, but a rapid increase in Iceland and Denmark.^{31 41}

The age-standardized incidence rate in Icelandic men is currently 10.2 per 100 000 person years (in 2005 to 2009) and in women 15.3, which is among the highest in the Nordic countries.^{31 40 41}

Non-melanoma skin cancer, excluding basal cell carcinoma

Incidence of non-melanoma skin cancer in the Nordic countries (Denmark not included) has been increasing through the years. The rate was higher in males than in females, especially in Norway and Sweden.

The age-standardized incidence rate in Icelandic men is currently 13.4 per 100 000 person years (in 2005 to 2009) and in women 10.3, which is among the highest in the Nordic countries.^{31 40}

Basal cell carcinomas

BCC is the most common type of skin cancer and in Iceland the number of new BCC were 3 468 (1 520 men and 1 948 women) in the census cohort in the period 1981 to 2010, which is 84.7% of all non-melanoma skin cancer (82.1% men and 86.8% women).

Risk of skin cancers

Exposure to ultraviolet radiation, sunburns and tanning is the major known risk factor for skin cancer, especially is intermittent exposure to ultraviolet radiation considered important in the aetiology of malignant melanoma.^{46 47}

It has been estimated that in the Nordic countries up to 95% of the skin melanoma could be avoided if exposure to ultraviolet radiation were eliminated.⁴⁸

Several chemical compounds have been identified as associated with an increased risk of skin cancer. These included arsenic and arsenic compounds, and components of oil, tar, and combustion products such as PAHs.^{31 41} Other risk factor associated with BCC is exposure to ionizing radiation and radon and radon daughters.⁴⁹⁻⁵¹

Aim of the study

The aim was to study whether residence in a high temperature geothermal area, where inhabitants are exposed to geothermal emissions and water containing hydrogen sulphide and radon, is associated with the risk of cancer.

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Article

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Incidence of cancer among residents of high temperature geothermal areas in Iceland: A census based study 1981 to 2010

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Abstract

Objective To assess whether residence in a high temperature geothermal area, where inhabitants are exposed to geothermal emissions and water containing hydrogen sulphide and radon, is associated with the risk of cancer.

Design Observational cohort study where the population of a high temperature geothermal area (35 707 person years) was compared with the population of a cold, non-geothermal area (571 509 person years). The follow up from 1981 to 2010 was based on record linkage by personal identifier with nation-wide death and cancer registries. Through the registries it was possible to ascertain emigration and vital status and to identify the cancer cases, 95% of which had histological verification. The hazard ratio (HR) and 95% confidence intervals (CI) were estimated in Cox-model, adjusted for age, gender, education and housing.

Setting Iceland with 229 000 inhabitants.

Participants Persons 5 to 65 years of age from the 1981 National Census, total 74 806 individuals.

Results Adjusted HR in the high-temperature geothermal area for all cancers was 1.22 (95% CI 1.05 to 1.42) as compared with the cold area. The HR for pancreatic cancer was 2.85 (95% CI 1.39 to 5.86), bone cancer 5.80 (95% CI 1.11 to 30.32), breast cancer 1.59 (95% CI 1.10 to 2.31), lymphoid and hematopoietic cancer 1.64 (95% CI 1.00 to 2.66), and non-Hodgkin's lymphoma 3.25 (95% CI 1.73 to 6.07). The HR for basal cell carcinoma of the skin was 1.61 (95% CI 1.10 to 2.35). The HRs were increased for cancers of the nasal cavities, larynx, prostate, thyroid gland and for soft tissue sarcoma; however the 95% CI included unity.

Conclusion More precise information on exposure is needed to draw firm conclusions from the findings. The significant excess risk of breast, and basal cell carcinoma of the skin, and the suggested excess risk of other radiation-sensitive cancers, indicates that radon exposure may contribute to the risk of cancer among the population in the high-temperature geothermal area. There are indications of an exposure-response relationship, as the risk was higher in comparison with the cold than with the warm reference area. Social status has been taken into account and data on reproductive factors and smoking habits show that these do not seem to explain the increased risk of cancers.

Keywords: Breast cancer, basal cell carcinoma of skin, pancreatic cancer, non-Hodkins lymphoma, radon

Introduction

Through the centuries, volcanic eruptions in Iceland have now and then emitted ash and gases, which have been carried downwind to mainland Europe; and historically such events have been associated with climate change and increased mortality in England and elsewhere.¹ Recent volcanic activities in Iceland have disturbed commercial air traffic for weeks in the years 2010 and 2011.^{2 3} People living in the close vicinity of the volcano are usually those who suffer most in cases of eruption.⁴ Fortunately the eruptions do not usually last for months, although it does happen. However people living on volcanic ground may experience long-term exposure to various toxic ground gas emissions, carbon dioxide (CO₂), hydrogen sulphide (H₂S), radon (Rn), sulphur dioxide (SO₂), sulphuric acid (H₂SO₄), hydrogen chloride (HCl), and hydrogen fluoride (HF), and these are considered to pose chronic health hazards.⁵⁻⁷ Several other low-dose exposures have been mentioned, among them arsenic (As), lead (Pb), and mercury (Hg).⁸ The risk of cancer among these populations has so far been the subject of only limited study and the results have been inconsistent.⁸⁻¹⁰ In the study from Rotorua, New Zealand, Bates et al. suggested an association of nasal and lung cancer with residence in a geothermal field, and particularly exposure to H₂S,⁹ although exposure to Rn was not high, according to later estimates.⁷ The study from the Azores, Portugal, found an association of female breast cancer with residence on an actively degassing geothermal field, and in that study, Amaral et al. suggested that trace elements and high Rn exposure might play a role.⁸ In a study from Sicily, residents of the volcanic region of Catania province seem to have higher incidence of thyroid cancer than other populations and it is mentioned that the concentration of Rn is elevated in the environment in the area.¹⁰ However, the authors were not able to conclude on the association of Rn exposure with the risk of thyroid cancer.¹⁰

Geothermal water and steam have been used for decades in Iceland for domestic heating, bathing and showering, and in various industries.^{11 12} In the year 2000, when seismological studies were conducted, the concentration of Rn measured 1.3 Bq/l to 9 Bq/l¹³ in geothermal hot water from drilled wells. Radon gas and its progeny are the major contributors to radiation exposure of the general population and are classified as carcinogenic by the International Agency for Research of Cancer (IARC), based on an increase in lung cancer among exposed human populations.¹⁴

The aim was to study whether residence in a high temperature geothermal area, where inhabitants are exposed to geothermal emissions and water containing hydrogen sulphide and radon, is associated with the risk of cancer.

Methods

Geologically, Iceland is a young island located in the North Atlantic Ocean on the boundary between the North American and Eurasian tectonic plates. These two plates are moving apart at a rate of about 2 cm per year and Iceland is an anomalous part of the ridge where deep mantle material wells up and creates a hot spot of unusually great volcanic productivity and several geothermal fields.^{11 12} Iceland has a homogenous Caucasian population that grew from 229 000 in 1981 to 318 000 in 2010, the period that the study spanned.¹⁵

This is a population-based observational study. The source of data for the cohort was the 1981 National Census in Iceland, kept at Statistics Iceland. In the census, each individual is filed under a personal identification number that is allocated to individuals at birth. The census included information on gender, age, residency, education, and the type of residence. The cohort for this study was confined to people aged 5 to 65 years at the time of the census. The personal identification numbers were used in record linkage with the National Registry to obtain information, where applicable, on the date of emigration and with the National Cause-of-Death Registry to obtain information on vital status and, where applicable, the date of death. Both these registries are kept at Statistics Iceland. In this way, it was possible to ascertain the vital and emigration status for the entire cohort. Thus it was possible to define person years at risk for each individual. Those who emigrated could not be followed up in the cancer registry after the date of emigration, even in cases where they subsequently returned.

The Icelandic Cancer Registry, established in 1955, is a nation-wide registry of all cases of cancer. The registry has virtually complete coverage and over 95% of the diagnoses are histologically confirmed.¹⁶ The topography codes used during the study period were according to ICD-7, ICD-9, and ICD-10; however they were standardized by the registry to ICD-10, and the morphology was registered according to ICD-03. Basal cell carcinoma (BCC) has been registered since 1981 in a special file at the cancer registry. It is not counted with the overall cancers and these cases are analysed separately. The computer file of individuals in the census was linked to the Icelandic Cancer Registry by their personal identification numbers. Thus, we were able to establish whether these individuals had cancer, and if so, to identify the cancer site, morphology, and date of diagnosis.

The four-digit community code in the census was used to identify the populations living in two communities located in high-temperature geothermal areas. The first of these communities is a small town in southern Iceland (Hveragerdi), where geothermal hot water has been used since 1950 for heating greenhouses and for domestical heating, laundry, bathing, showering, and washing dishes. Geothermal hot water in Iceland is not used as drinking water, as it is unpalatable and foul smelling because of the gas and mineral content, and there is an abundance of other water sources available. The area surrounding Hveragerdi forms part of the Hengill central volcano and there are many hot springs, fumaroles and erupting geysers in the town. The second community is smaller and consists of a small town and agricultural district (Skutustadahreppur, Myvatn), located in the north-eastern part of Iceland, where geothermal hot water has been used since 1967 in industry and for domestic heating, laundry, bathing, showering, and washing dishes. This community is on the edge of the Krafla volcano. Fumes from geothermal activities are frequently seen in these communities and the rotten egg odour of hydrogen sulphide is often perceived. Both these communities are inland regions, unlike most communities in Iceland that are located in coastal regions. The geothermal field in these communities belongs to the high-temperature geothermal areas where the underground temperature at 1000 m depth is above 150°C, and the bedrock is less than 0.8 million years old, according to descriptions of the volcanic and geothermal zones in Iceland.^{11 12}

The two comparison populations, classified according to the community codes in the census, included residents of communities other than these high-temperature geothermal areas. The first of these comparison populations included residents living well outside of the volcanic zone, in what we call the cold reference area, where the bedrock is more than 3.3 million years old and the underground temperature at 1000 m depth is below 150°C.^{11 12} The population of the cold reference area is considered the main comparison population in the study. The second comparison population included those living within the volcanic zone, where the bedrock dates from different periods,^{11 12} referred to here as the warm reference area. The people in the warm reference area may or may not be living in the vicinity of geothermal fields, as these are spread out over the whole country. However, the community codes did not allow for differentiation between those exposed to high-temperature geothermal fields and those who are not, so this population is considered to have a mixed exposure. The rest of population living in the capital Reykjavik and in the south-west peninsula of Reykjanes

were excluded from the study. The reason were that according to the cancer registry, the capital and south-west area has had higher cancer incidence than other parts of the country for decades.¹⁶ The geology and the location of the areas are shown in figures 1 and 2.

The follow up started at the day of the census, 31 January 1981, and concluded at the date of emigration, or of death, or the date of diagnosis of cancer, or 31 December 2010 (the end of the follow up period), whichever occurred first. The dependent variables for this study were the incidence of first cancer occurring 31 January 1981 to 31 December 2010. The Cox proportional hazard model was used to estimate hazard ratio (HR) and 95% confidence intervals (95% CI) for all cancers and selected cancer sites in time-dependent analyses.¹⁷ Gender was introduced as a dichotomous variable, and age as a continuous variable in years. Educational level (basic, medium and academic education), was introduced as a categorical variable according to the previous classification in a census study¹⁸ with an additional two categories: one, unclassified for people under 20 years of age, who had not yet attained their full education level, and one missing educational information for individuals who did not indicate their education in the census. Type of residence, single-family house or other type of residence, was introduced as a dichotomous variable. According to Statistics Iceland, we divided the whole population into those living in the capital region, other urban regions and rural regions.¹⁵ The exposed population living in the high-temperature geothermal areas was compared with the other two populations (warm reference area and cold reference area) in separate analyses. We did several calculations in the model: crude comparison without any adjustments, comparison with adjustment for age and gender only, and with adjustment for age, gender, educational level, and lodging. These three models, as well as the calculations done by introducing age stratified in 10-year age groups, had nearly identical results. Only the results with all the adjustments are presented here. In cases where there were few instances of the cancer site, the confidence intervals were computed by a bootstrap resampling method. Separate analyses were done after dividing the material into groups of individuals who were 20 years of age or older at the time of the census and those who were under 20 years of age, in order to investigate possible bias from childhood cancer. The statistical analyses were performed using the PASW (SPSS) software version 18, STATA, and Microsoft Excel 2007. The National Bioethics Committee (VSNb2010060005/03.1) and the Data Protection Commission (2010060524BPJ/--) approved the study.

Result

The number of individuals aged 5 to 65 years included in the census was 184 114, and the number of persons in the same age range in the National Registry was 185 610 at the time of the census, thus 99.2% were included in the census.

The number of individuals in the study was 74 806 and altogether there were 1 901 786 person-years in the study. The average follow-up was 24.9 years. A total of 7 689 (4 039 men and 3 650 women) cases of first cancer were identified through the cancer registry, and there were 1 028 cases of first BCC (463 men and 565 women). During the follow up 10 570 individuals (5 599 men and 4 971 women) had emigrated and 6 458 (4 040 men and 2 418 women) had died. At the end of the study on 31 December 2010 there were 50 089 (25 449 men and 24 640 women) individuals alive without cancer.

Table 1 shows the characteristics of the cohort according to the 1981 census. The proportion of men was 52% and of women, 48%. The high-temperature geothermal areas were exclusively rural regions, the cold reference area was a mixture of other urban and rural regions, and the warm reference area was 40% other urban and 60% rural regions. As these variables have extreme and different distribution among the areas, it was not possible to enter them into the Cox-model; however, the cold area resembles the high-temperature geothermal areas with regard to these variables.

Table 2 shows the number of all cancers, and selected cancer sites in the high-temperature geothermal areas, and the HR and 95% CI. During the follow up, 184 cases of cancers were diagnosed among men and women in the high-temperature geothermal areas and the HRs for all sites were 1.16 (95% CI 1.00 to 1.34) and 1.22 (95% CI 1.05 to 1.42) compared with the warm reference area and the cold reference area respectively. The HRs for pancreatic cancer were 2.57 (95% CI 1.30 to 5.07), and 2.85 (95% CI 1.39 to 5.86) compared with the warm reference area and the cold reference area respectively. The HRs for bone cancer were 3.56 (95% CI 0.83 to 15.27), and 5.80 (95% CI 1.11 to 30.32) compared with the warm reference area and the cold reference area respectively, based on two cases; however, the CIs according to the bootstrap method were wide and included unity. The HRs for breast cancer were 1.43 (95% CI 1.00 to 2.05), and 1.59 (95% CI 1.10 to 2.31) compared with the warm reference area and the cold reference area respectively. The HRs for all cancers of lymphoid and haematopoietic tissue combined were 1.53 (95% CI 0.95 to 2.46), and 1.64 (95% CI 1.00 to

2.66) compared with the warm reference area and the cold reference area respectively. The HRs for non-Hodgkin's lymphoma (NHL) were 3.21 (95% CI 1.77 to 5.82), and 3.25 (95% CI 1.73 to 6.07) compared with the warm reference area and the cold reference area respectively. The HRs for several other cancer sites were increased, but these were based on few cases and with wide confidence intervals. The HRs for the 30 cases of BCC in the high-temperature geothermal areas were 1.37 (95% CI 0.95 to 1.97), and 1.61 (95% CI 1.10 to 2.35) compared with the warm reference area and the cold reference area respectively, shown in the lowest row of Table 2.

Among men, 90 cases of cancer were in the high-temperature geothermal areas. Table 3 shows the number of all cancers and selected cancer sites, and the HR and 95% CI. The HRs for pancreatic cancer were 2.52 (95% CI 1.01 to 6.28), and 3.66 (95% CI 1.37 to 9.82) compared with the warm reference area and the cold reference area respectively. The HRs for NHL were 3.12 (95% CI 1.43 to 6.78), and 2.58 (95% CI 1.16 to 5.78) compared with the warm reference area and the cold reference area respectively. The HRs for the 15 cases of BCC were 1.52 (95% CI 0.90 to 2.55), and 1.78 (95% CI 1.04 to 3.05) compared with the warm reference area and the cold reference area respectively.

Among women, 94 cases of cancer were in the high-temperature geothermal areas and Table 4 shows the number of all cancers and selected cancer sites, and the HR and 95% CI. The HRs for all sites were 1.27 (95% CI 1.03 to 1.56), and 1.30 (95% CI 1.05 to 1.61) compared with the warm reference area and the cold reference area respectively. The HRs for bone cancers were 7.95 and 7.20 compared with the warm reference area and the cold reference area respectively, based on two cases; however the CIs according to the bootstrap method were wide and included unity. The HRs for breast cancer were 1.46 (95% CI 1.02 to 2.09), and 1.62 (95% CI 1.12 to 2.36) compared with the warm reference area and the cold reference area respectively. The HRs for NHL were 3.31 (95% CI 1.32 to 8.34), and 5.20 (95% CI 1.87 to 14.45) compared with the warm reference area and the cold reference area respectively.

When confined to individuals 20 years of age and older and excluding those with missing information on education in the 1981 census, there were altogether 167 cancer cases in the high-temperature geothermal areas, 17 fewer cancers than in the total exposed cohort. In this older part of the cohort, the comparison of the high-temperature areas with the cold reference area yielded similar HRs as in the total exposed cohort. The HRs were somewhat lower and the 95% confidence intervals were a little wider, but the intervals were still not including unity for all cancers, pancreatic cancer, breast cancer and NHL. The HR for BCC was 1.52 (95% CI 1.01 to 2.73) based on 26 cases.

In the analysis of those who were under 20 years of age at the census, there were 12 cancers, three among men and nine among women, in the high-temperature geothermal areas. The mean age in this group of cancer cases was 16 years (range 11 to 19 years) at the 1981 census, and the mean age at diagnosis of the cancer was 33.4 years (range 18 to 45 years). The HR for breast cancer was 2.99 (95% CI 1.03 to 8.66), based on four cases, when comparing this younger part of the exposed cohort with the cold reference area. For other cancer sites there were fewer cases. The HR for BCC was 2.70 (95% CI 0.94 to 7.73) based on four cases.

Discussion

This study based on 184 cancer cases in high-temperature geothermal areas showed an excess for all cancers as compared with the reference areas. There is evidence of an exposure-response relationship, as the HRs were higher in the comparison with the cold reference area than with the warm reference area. The most significant results are the excess of BCC in the total cohort based on 30 cases, and the excess of breast cancer and NHL among women and the excess of NHL and pancreatic cancer among men. Many of these cancer sites, which in the present study are found increased, were not included in previous studies of the populations of geothermal areas.⁸⁻¹⁰ However, breast cancer was found in excess among the female population of Furnas, Azores⁸ and in that study a high rate for cancer of the lip, oral cavity and pharynx was found, although it was based on few cases.

Pancreatic cancer

There was a high rate of pancreatic cancer in the total exposed cohort and among men and a non-significant elevated rate among women; male gender is one of the risk factors for pancreatic cancer. The most important external risk factor for this malignancy, smoking, is not known on an individual basis, but information on smoking in these populations is accessible from the annual surveys of the Public Health Institute of Iceland¹⁹ from the year 1989 to 2010. These data show that the number of smokers has been declining from 31.0% to 14.2% in the population over the period, and the number of smokers has been similar in the capital area and in the rest of the country for decades, so smoking habits are not likely to be a confounder. Supporting this view is the fact that the lung cancer rate was not increased in the exposed cohort. There is no obvious connection of the geothermal field pollution and pancreatic cancer, as the carcinogenic effect of Rn has in most of the studies been related to lung cancer. However, in a collaborative analysis of 11 studies of Rn-exposed underground miners, Darby et al. found that mortality for pancreatic cancer was significantly related to cumulative exposure.²⁰ In the conclusion of that study, this relation was dismissed, despite the fact that pancreatic cancer is with high mortality and therefore suitable for a mortality study, as compared to cancers with better prognosis.

Breast cancer

As indicated previously, the elevated incidence of breast cancer is in line with the finding in the much smaller study on the population in Furnas,⁸ and the authors concluded that the increased risk of breast cancer may be partially explained by the gas emission, trace elements and Rn exposure. Besides the Portuguese study⁸ there is scanty literature on the association of exposure to Rn and cancer among women: there were no female workers in the mining populations²¹ and the case-control studies on residential exposure to radon did not deal with breast cancer.

Data on reproductive factors, the most important possible confounder in breast cancer studies of this design,²² were available from Statistics Iceland.¹⁵ Between 1991 and 1995, the fertility rate for the high-temperature geothermal areas was 2.21, for the warm reference area 2.23, and for the cold reference area 2.26. The figures for mean age at first birth were 22.56 for the high-temperature geothermal areas, 23.11 for the warm reference area, and 23.29 for the cold reference area. This information suggests that reproductive factors are not positive confounders for breast cancer in this study

Bone cancer

The best known etiological factors for bone cancer are ionizing radiation, radionuclides and x-ray therapy, and alkylating agents. In the present study, only first cancers were included and thus therapeutic ionizing radiation and chemotherapy with alkylating agents is unlikely to be involved. The histology of bone cancers was one giant cell sarcoma and one hemangiosarcoma. This rare malignancy was not found in excess among the mining populations.²⁰

NHL

NHL is heterogeneous in etiology and is classified into many histological types and by sites of origin. Many infectious agents, immune deficiencies, autoimmunity and high doses of ionizing radiation have been associated with NHL. Furthermore, other possible risk factors are farming, pesticides, organochlorines, besides host factors such as personal and family history of cancer and certain medical conditions.²³ A detailed knowledge of these risk factors among the population of the high-temperature geothermal areas or the reference areas is not at

hand; however considerable agricultural activity and greenhouses were present in one of the areas. Previous study on pesticide users in Iceland did not find increased incidence of NHL.²⁴ NHL has not been associated with Rn exposure in miners.²⁰

BCC

Exposures to Rn and alpha radiation have previously been associated with BCC in a study of uranium miners.²⁵ In that study, surface contamination of the skin by Rn and its progeny was considered of importance, as the basal cell layer of the skin lies within the range of the alpha particles.²⁵ Ionizing radiation exposure and ultraviolet radiation from the sun are well known causes of BCC, and the interaction of these factors has been debated and partially rejected.²⁶ A recent ecological study in South West England showed an association of residential exposure to Rn and risk of squamous cell carcinoma,²⁷ and a previous study in the same setting also indicated an association of residential exposure to Rn and non-melanoma skin cancers. In that study, basal cell carcinoma was included among the non-melanoma skin cancers.²⁸ Arsenic in the water is unlikely to be a positive confounder for skin cancer in the present study, as geothermal hot water was not used as drinking water. Excessive exposure to ultraviolet radiation is also not likely to be a confounder for the BCC in this study, as there is no corresponding increase in the rates of malignant melanoma or other skin cancers.

Other cancers

Many of the rarer cancer sites had few cases; however high HRs were observed for cancers of the nasal cavities, larynx, prostate, and for soft tissue sarcoma. The standardized incidence ratio for cancer of the nasal cavities was increased among the population of Rotorua, New Zealand.⁹ The rates for prostate cancer and cancer of the thyroid gland were elevated, but the 95% CI for these cancer sites included unity.

Strength and limitations

To our knowledge, the follow up time in our cohort study is the longest of the populations in geothermal areas, thus far. The strength of the study is the use of comprehensive population registries and the universal use of personal identification numbers, which enabled accurate record linkage. For the cohort, it was thus possible to ascertain vital and emigration status through the National Registry and National Cause-of-Death Registry for all cohort members,

and complete identification of cancer cases was ensured through the Icelandic Cancer Registry. The nation-wide cancer registry is virtually complete, with more than 95% of the diagnoses histologically confirmed, and the registry was used for case finding for both the exposed population and the reference populations.¹⁶

BCC may be considered a special case, as these were all histologically verified and the incidence has increased dramatically through the years along with the incidence of malignant melanoma and other skin cancers in the Icelandic population. The increase may in part be attributed to more complete reporting to the cancer registry. In the study on skin cancer in South West England, the proportion of BCC to all non-melanoma skin cancers was 70%,²⁷ and the corresponding figure in the present study was 85% for the total cohort and 88% for the high-temperature geothermal areas.

Both the present study and previous studies on populations in geothermal areas have been limited by a lack of individual exposure information on the cohort members in terms of mode and magnitude of the ground gas emission and the exact content of the hot water.⁸⁻¹⁰

Census-based studies, including studies from Iceland, have in any case been widely used to evaluate occupational and socioeconomic determinates of cancers.^{18 29} That type of study is often handicapped because of limited control on possible confounders. However, in the present study, we were able to adjust for educational level, lodging, and residential areas. On the other hand, we were only able to control indirectly for possible confounding from fertility rates, the mean age at the first birth, and smoking habits.

The excess rates of the different cancer sites found in this study seem hard to explain by single carcinogenic exposure specifically to geothermal gas emission, and that is the novelty of the study. The significant excess of BCC and breast cancer, and the suggested excess of cancer sites such as bone, nasal cavity, larynx, thyroid gland, and of soft tissue sarcoma, all of these being radiation-sensitive cancers, indicate that Rn may contribute to the increased risk of cancer among the population in the high-temperature geothermal areas. According to IARC, Rn and its progeny are carcinogenic because of evidence of an increased risk for lung cancer¹⁴ and IARC has stated that internalized radionuclides that emit alpha particles are carcinogenic to humans. The role of Rn seems not to be supported by the high rates found for pancreatic cancer and NHL, as cancers of these sites have infrequently been related to

ionizing radiation. However, cytogenetic analysis in peripheral lymphocytes of persons exposed to increased levels of domestic Rn concentrations showed increased frequency of the translocation in stable cells compared with control individuals.³⁰ It was concluded in that study that the translocations were induced in the blood-forming tissue and then transmitted to the peripheral blood.³⁰ The respiratory tract has been considered the main target tissue of radon and its progeny; however, a part of the inhaled radon is absorbed into the blood and transported to all tissues of the body and deposited in higher concentrations in fatty tissues.¹⁴
^{30 31} Various tissues, including bone marrow, are thus exposed to alpha particles.¹⁴

In future studies of the geothermal areas, detailed information is needed on exposure on an individual level. These studies should also gather larger data and from different settings, and information on the length of residency in the geothermal areas should be obtained, as this can be used as a surrogate of the exposures among these populations. New studies are needed to confirm or refute the present findings.

Conclusion

More precise information on exposure is needed to draw firm conclusions from the findings. The significant excess risk of breast cancer and basal cell carcinoma of the skin and the suggested excess risk of other radiation sensitive cancers indicate that radon exposure may contribute to the risk of cancer among the population in the high-temperature geothermal area. There are indications of an exposure-response relationship, as the risk was higher in comparison with the cold than with the warm reference area. Social status has been taken into account and data on reproductive factors and smoking habits show that these do not seem to explain the increased risk of cancers.

Authors contributions:

All the authors actively participated in designing the study, planning of analysis, drafting the article, interpreting the conclusions and agreeing on the final version. Kristbjornsdottir and Rafnsson initiated the study and Rafnsson obtained the funding and is the guarantor.

Conflict of interest disclosures:

The authors have none competing interest. All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflict of Interest.

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What is already known in this topic

Radon gas and its progeny are the major contributors to radiation exposure of the general population and are classified as carcinogenic to humans.

People living in geothermal fields are exposed to ground gas emission and they use the geothermal hot water for bathing and showering; the radon concentration of the water is higher than in other places.

What this study adds

Residents of the high temperature geothermal areas had significantly higher incidence for cancers of breast, pancreas, non-Hodgkin's lymphoma and basal cell carcinoma of the skin than those living in the reference areas.

There are indications of exposure-response relationship as the risk is higher in cold reference area than in warm reference area.

Some of these cancer sites are sensitive for radiation indicating that radon may contribute to the increased cancer risk as the excess of cancers seem not to be explained by social or lifestyle factors

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Table

Table 1 |

Baseline characteristics in the high-temperature geothermal areas and different reference areas.....41

Table 2 |

Number of all cancers and selected cancer types in the high-temperature geothermal areas, hazard ratio (HR), 95% confidence intervals (CI) according to references to the populations in Warm area and Cold area, adjusted for age, gender, education, and type of housing. Statistically significant HRs are bolded.....42

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Number of all cancers and selected cancer types among men in the high-temperature geothermal areas, hazard ratio (HR), 95% confidence intervals (CI) according to references to the populations in Warm area and Cold area, adjusted for age, gender, education, and type of housing. Statistically significant HRs are bolded.....44

Table 4 |

Number of all cancers and selected cancer types among women in the high-temperature geothermal areas, hazard ratio (HR), 95% confidence intervals (CI) according to references to the populations in Warm area and Cold area, adjusted for age, gender, education, and type of housing. Statistically significant HRs are bolded.....45

Table 1 | Baseline characteristics in the high-temperature geothermal areas and different reference areas according to census 1981.

	Geothermal areas	Warm reference area	Cold reference area
	N (%)	N (%)	N (%)
Number of people	1 497 (100)	50 878 (100)	22 431 (100)
Gender			
Men	767 (51.2)	26 431 (51.9)	11 929 (53.2)
Woman	730 (48.8)	24 447 (48.1)	10 502 (46.8)
Age, year			
Mean \pm SD	29.69 \pm 17.22	28.12 \pm 16.28	28.06 \pm 16.20
Median, IQR (0.25 ; 0.75)	27 (15 ; 43)	25 (15 ; 40)	25 (15 ; 39)
Education			
Basic education	368 (24.6)	13 831 (27.2)	6 565 (29.3)
Medium education	428 (28.6)	13 414 (26.4)	5 665 (25.3)
Academic education	140 (9.4)	3 653 (7.2)	1 428 (6.4)
Unclassified	535 (35.7)	19 404 (38.1)	8 481 (37.7)
Missing	36 (1.7)	576 (1.1)	292 (1.3)
Housing			
Single family home	1 205 (80.5)	33 761 (66.4)	17 343 (77.3)
Other type of house	292 (19.5)	17 117 (33.6)	5 088 (22.7)
Region			
Capital region	0	0	0
Other urban regions	0	20 958 (41.2)	4 863 (21.7)
Rural regions	1 497 (100.0)	29 920 (58.8)	17 568 (78.3)

Abbreviations: SD standard deviation, IQR interquartile range

Table 2 | Number of all cancers and selected cancer types in the high-temperature geothermal areas, hazard ratio (HR), 95% confidence intervals (CI) according to references to the populations in Warm area and Cold area, adjusted for age, gender, education, and type of housing. Statistically significant HRs are bolded.

Cancers (ICD-10)	Geothermal areas	Reference with Warm area		Reference with Cold area	
	p-yr 35 707 No of Cancers	p-yr 1 294 570 HR	95%CI	p-yr 571 509 HR	95%CI
All sites (C00-C97 and D45-D47)	184	1.16	1.00 to 1.34	1.22	1.05 to 1.42
Lip, Oral cavity, and Pharynx (C00-C14)	2	0.64	0.16 to 2.60	0.81	0.20 to 3.38
Oesophagus (C15)	1	0.50	0.07 to 3.58	0.58	0.08 to 4.20
Stomach (C16)	7	1.13	0.53 to 2.41	0.99	0.46 to 2.14
Colon, Rectum, and Anus (C18-C21)	16	1.13	0.69 to 1.86	1.17	0.70 to 1.94
Bile and Liver (C22-C24)	2	0.95	0.23 to 3.88	1.02	0.24 to 4.29
Pancreas (C25)	9	2.57	1.30 to 5.07	2.85	1.39 to 5.86
Nasal cavity and middle ear (C30)	1	3.32	0.42 to 26.32	2.58	0.30 to 22.33
Larynx (C32)	2	2.21	0.53 to 9.30	3.04	0.66 to 13.98
Lung and bronchus (C33-C34)	20	1.24	0.80 to 1.95	1.11	0.70 to 1.75
Bone (C40-C41)	2	3.56	0.83 to 15.27*	5.80	1.11 to 30.32*
Melanoma (C43)	2	0.51	0.13 to 2.04	0.62	0.15 to 2.56
Other cancer of skin (C44)	4	0.84	0.31 to 2.27	1.01	0.37 to 2.79
Soft tissue sarcoma (C49)	2	1.86	0.45 to 7.78	1.97	0.45 to 8.66
Breast (C50)	31	1.43	1.00 to 2.05	1.59	1.10 to 2.31
Vulva (C51)	1	4.03	0.50 to 32.36	2.96	0.34 to 25.58
Cervix uteri (C53)	2	0.85	0.21 to 3.45	1.04	0.25 to 4.37
Uterus (C54-C55)	3	0.82	0.26 to 2.60	0.88	0.27 to 2.82
Ovary (C56-C57)	5	1.25	0.51 to 3.05	1.25	0.50 to 3.12
Prostate (C61)	29	1.16	0.80 to 1.68	1.37	0.93 to 2.00
Kidney (C64-C66)	5	0.67	0.28 to 1.62	0.83	0.34 to 2.04
Bladder (C67)	8	1.12	0.56 to 2.28	1.02	0.50 to 2.10
Brain and central nervous system (C70-C72, C75.1 and C75.3)	5	0.82	0.34 to 2.00	0.90	0.37 to 2.23
Thyroid gland (C73)	6	1.51	0.66 to 3.42	1.51	0.65 to 3.50
Cancer without specification of site (C80)	1	0.32	0.04 to 2.26	0.28	0.04 to 2.05
Lymphoid and haematopoietic tissue (C81-C96 and D45-D47)	18	1.53	0.95 to 2.46	1.64	1.00 to 2.66
Hodgkin's Lymphoma (C81)	1	1.03	0.14 to 7.56	1.50	0.19 to 11.61
Non-Hodgkin's Lymphoma (C82-C85)	12	3.21	1.77 to 5.82	3.25	1.73 to 6.07

Table 2 (continued)

Immunoproliferative diseases (C88)	1	1.31	0.18 to 9.76	2.00	0.24 to 16.40
Leukaemia (C91-C95 and D45-D47)	4	1.07	0.39 to 2.89	1.07	0.39 to 2.95
Chronic Lymphocytic Leukaemia (CLL)(C91.1)	1	0.76	0.10 to 5.54	0.70	0.09 to 5.24
Non-CLL (C91-C95 and D45-D47, except C91.1)	3	1.23	0.39 to 3.90	1.30	0.40 to 4.22
Not included in all cancers					
		p-yr 36 606	p-yr 1 320 220	p-yr 581 772	
Basal Cell Carcinoma of the skin	30	1.37	0.95 to 1.97	1.61	1.10 to 2.35

* 95% CI computed with bootstrap method were wide and included unity.

Table 3 | Number of all cancers and selected cancer types among men in the high - temperature geothermal areas, hazard ratio (HR), 95% confidence intervals (CI) according to references to the populations in Warm area and Cold area, adjusted for age, gender, education, and type of housing. Statistically significant HRs are bolded.

Cancers (ICD-10)	Geothermal areas	Reference with Warm area		Reference with Cold area	
	p-yr 18 181 No of Cancer	p-yr 667 069 HR	95%CI	p-yr 300 297 HR	95%CI
All sites (C00-C97 and D45-D47)	90	1.06	0.86 to 1.30	1.14	0.92 to 1.42
Lip, Oral cavity, and Pharynx (C00-C14)	2	0.99	0.24 to 4.03	1.14	0.27 to 4.82
Oesophagus (C15)	1	0.63	0.09 to 4.55	0.91	0.12 to 6.86
Stomach (C16)	4	1.02	0.38 to 2.77	0.78	0.29 to 2.14
Colon, Rectum, and Anus (C18-C21)	9	1.12	0.58 to 2.18	1.14	0.58 to 2.25
Bile and Liver (C22-C24)	1	0.68	0.09 to 4.93	1.37	0.17 to 10.83
Pancreas (C25)	5	2.52	1.01 to 6.28	3.66	1.37 to 9.82
Nasal cavity and middle ear (C30)	1	6.46	0.75 to 55.75	13.08	0.79 to 215.51
Larynx (C32)	2	2.78	0.65 to 11.81	4.30	0.89 to 20.84
Lung and bronchus (C33-C34)	9	1.00	0.52 to 1.94	0.95	0.48 to 1.86
Other cancer of skin (C44)	3	1.12	0.35 to 3.54	1.22	0.38 to 3.98
Soft tissue sarcoma (C49)	1	1.62	0.22 to 12.13	2.52	0.30 to 21.04
Prostate (C61)	29	1.16	0.80 to 1.68	1.37	0.93 to 2.00
Kidney (C64-C66)	2	0.43	0.11 to 1.74	0.54	0.13 to 2.22
Bladder (C67)	7	1.24	0.58 to 2.65	1.11	0.52 to 2.41
Brain and central nervous system (C70-C72, C75.1 and C75.3)	2	0.65	0.16 to 2.64	0.70	0.17 to 2.89
Thyroid gland (C73)	1	0.73	0.10 to 5.30	1.08	0.14 to 8.21
Lymphoid and haematopoietic tissue (C81-C96 and D45-D47)	11	1.59	0.87 to 2.91	1.62	0.87 to 3.02
Non-Hodgkin's Lymphoma (C82-C85)	7	3.12	1.43 to 6.78	2.58	1.16 to 5.78
Leukaemia (C91-C95 and D45-D47)	4	1.73	0.63 to 4.75	1.68	0.60 to 4.74
Chronic Lymphocytic	1	1.33	0.18 to 9.84	1.19	0.16 to 9.14
Non-CLL (C91-C95 and	3	1.95	0.61 to 6.25	2.00	0.60 to 6.66
Not included in all cancers					
	p-yr 18 463	p-yr 678 577		p-yr 305 053	
Basal Cell Carcinoma of the skin	15	1.52	0.90 to 2.55	1.78	1.04 to 3.05

Table 4 | Number of all cancers and selected cancer types among women in the high - temperature geothermal areas, hazard ratio (HR), 95% confidence intervals (CI) according to references to the populations in Warm area and Cold area, adjusted for age, gender, education, and type of housing. Statistically significant HRs are bolded.

Cancers (ICD-10)	Geothermal areas	Reference with Warm area		Reference with Cold area	
	p-yr 17 526	p-yr 627 500		p-yr 271 213	
	No of Cancer	HR	95%CI	HR	95%CI
All sites (C00-C97 and D45-D47)	94	1.27	1.03 to 1.56	1.30	1.05 to 1.61
Stomach (C16)	3	1.33	0.42 to 4.22	1.55	0.46 to 5.14
Colon, Rectum and Anus (C18-C21)	7	1.16	0.54 to 2.46	1.24	0.57 to 2.70
Bile and Liver (C22-C24)	1	1.54	0.21 to 11.56	0.82	0.11 to 6.17
Pancreas (C25)	4	2.68	0.96 to 7.45	2.26	0.78 to 6.52
Lung and bronchus (C33-C34)	11	1.56	0.85 to 2.86	1.26	0.68 to 2.33
Bone (C40-C41)	2	7.95	1.70 to 37.23*	7.20	1.30 to 39.96*
Melanoma (C43)	2	0.85	0.21 to 3.46	0.85	0.20 to 3.53
Other cancer of skin (C44)	1	0.48	0.07 to 3.43	0.66	0.09 to 4.91
Soft tissue sarcoma (C49)	1	2.21	0.29 to 16.90	1.62	0.20 to 12.90
Breast (C50)	31	1.46	1.02 to 2.09	1.62	1.12 to 2.36
Vulva (C51)	1	4.03	0.50 to 32.36	2.96	0.34 to 25.58
Cervix uteri (C53)	2	0.85	0.21 to 3.45	1.04	0.25 to 4.37
Uterus (C54-C55)	3	0.82	0.26 to 2.60	0.88	0.27 to 2.82
Ovary (C56-C57)	5	1.25	0.51 to 3.05	1.25	0.50 to 3.12
Kidney (C64-C66)	3	1.04	0.33 to 3.29	1.27	0.39 to 4.16
Bladder (C67)	1	0.67	0.09 to 4.85	0.65	0.09 to 4.85
Brain and central nervous system (C70-C72, C75.1 and C75.3)	3	1.01	0.32 to 3.20	1.11	0.34 to 3.62
Thyroid gland (C73)	5	1.92	0.78 to 4.74	1.65	0.65 to 4.18
Cancer without specification of site (C80)	1	0.55	0.08 to 4.01	0.56	0.08 to 4.11
Lymphoid and haematopoietic tissue (C81-C96 and D45-D47)	7	1.46	0.68 to 3.12	1.66	0.76 to 3.63
Hodgkin's Lymphoma (C81)	1	2.13	0.28 to 16.22	4.42	0.49 to 39.63
Non-Hodgkin's Lymphoma (C82-C85)	5	3.31	1.32 to 8.34	5.20	1.87 to 14.45
Immunoproliferative diseases (C88)	1	4.38	0.54 to 35.34	11.92	0.72 to 197.59
Not included in all cancers					
	p-yr 18 143	p-yr 641 643		p-yr 276 719	
Basal Cell Carcinoma of the skin	15	1.24	0.74 to 2.08	1.45	0.85 to 2.47

* 95% CI computed with bootstrap method were wide and included unity.

Figures

Figure 1 |

Geological map of Iceland, showing the distribution of natural geothermal activity and the age of bedrock. Modified with permission from National Energy Authority.....48

Figure 2 |

Map of Iceland, showing the study areas according to the community codes: 1) High-temperature geothermal area. 2) Cold reference area. 3) Warm reference area. 4) Capital and South West area. 5) Uninhabited area. Modified with permission from National Land Survey of Iceland.....49

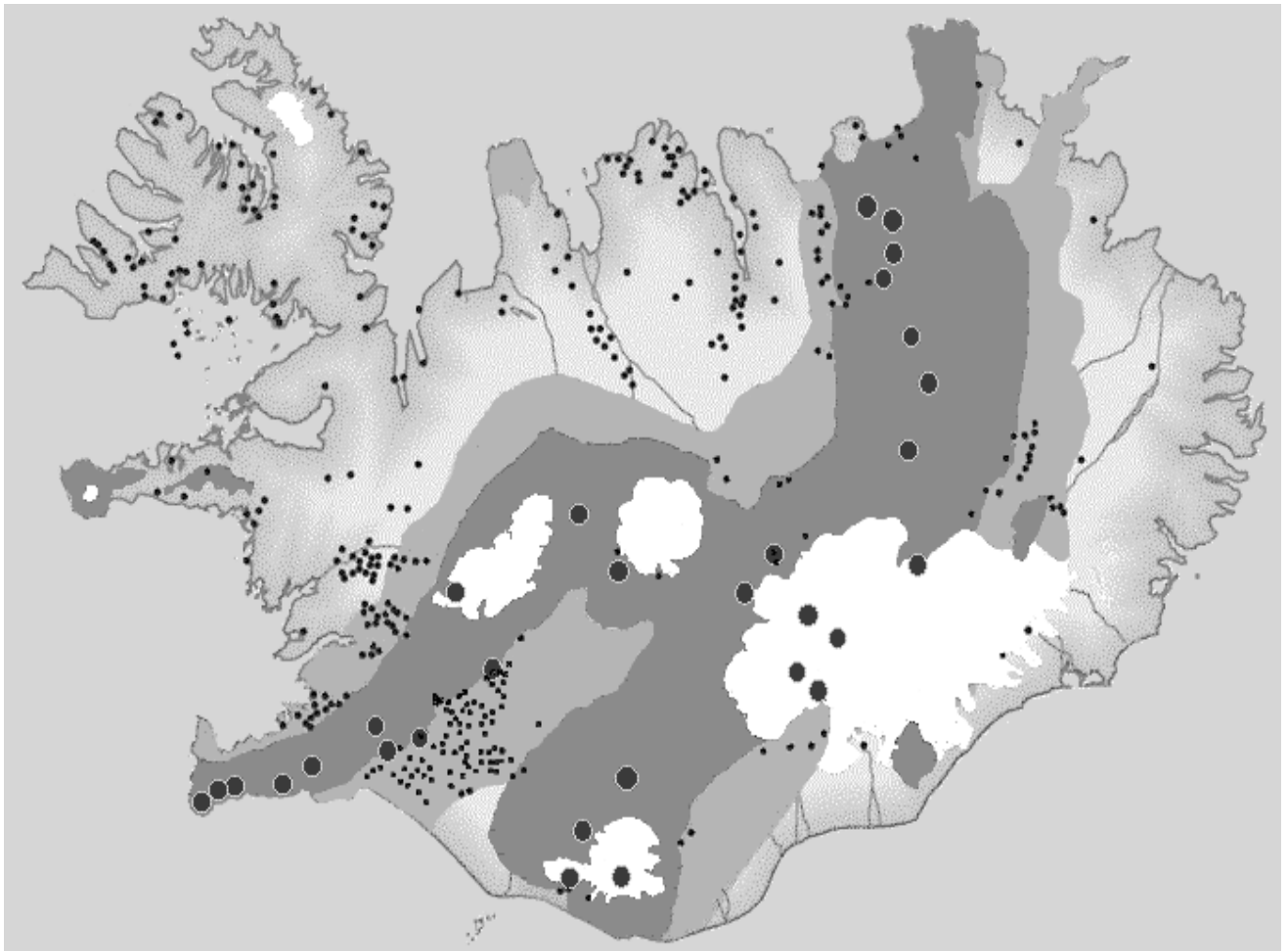


Figure 1 | Geological map of Iceland, showing the distribution of natural geothermal activity and the age of bedrock. Modified with permission from National Energy Authority.

Geothermal field

- Low temperature field
- High temperature field

Age of bedrock

- < 0.8 million years
- 0.8 to 3.3 million years
- 3.3 to 15 million years
- Glaciers

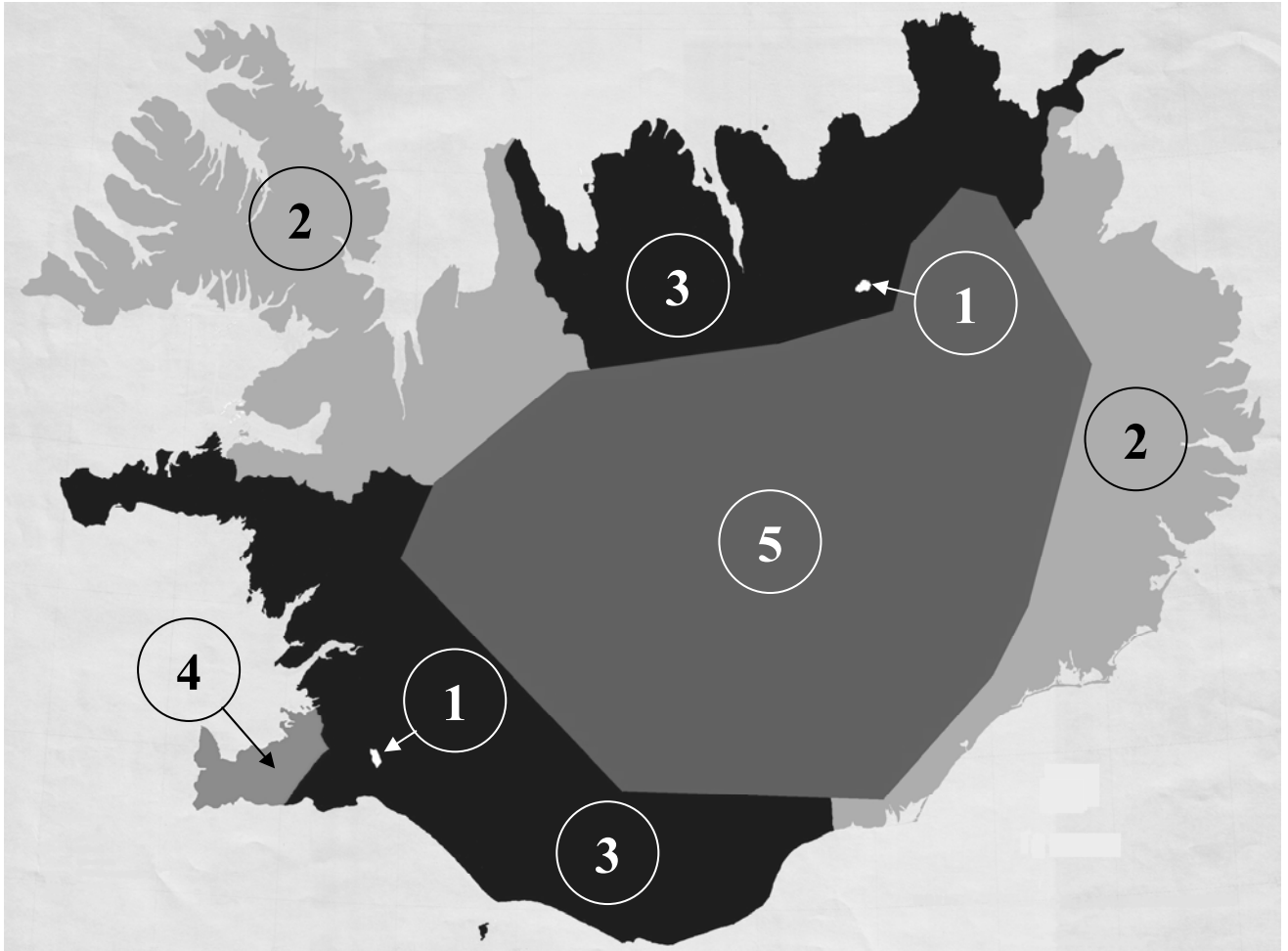


Figure 2 | Map of Iceland, showing the study areas according to the community codes: 1) High-temperature geothermal area. 2) Cold reference area. 3) Warm reference area. 4) Capital and South West area. 5) Uninhabited area. Modified with permission from National Land Survey of Iceland.

Appendix

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Baseline characteristics in the high-temperature geothermal areas and different reference areas according to census 1981.....	53
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Model 1: Number of all cancers and selected cancer types in the high-temperature geothermal areas, hazard ratio (HR), 95% Confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, not adjusted. Statistically significant HRs are bolded.....	58
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Model 2: Number of all cancers and selected cancer types in the high-temperature geothermal areas, hazard ratio (HR), 95% Confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, adjusted for age and gender. Statistically significant HRs are bolded.....	60
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Model 3: Number of all cancers and selected cancer types in the high-temperature geothermal areas, hazard ratio (HR), 95% confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, adjusted for age, gender, education, and type of housing. Statistically significant HRs are bolded. Statistically significant HRs are bolded.....62

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Model 1: Number of all cancers and selected cancer types among men in the high-temperature geothermal areas, hazard ratio (HR), 95% Confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, not adjusted. Statistically significant HRs are bolded.....64

Table 3 b |

Model 2: Number of all cancers and selected cancer types among men in the high-temperature geothermal areas, hazard ratio (HR), 95% Confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, adjusted for age and gender. Statistically significant HRs are bolded.....66

Table 3 c |

Model 3: Number of all cancers and selected cancer types among men in the high-temperature geothermal areas, hazard ratio (HR), 95% confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, adjusted for age, gender, education, and type of housing. Statistically significant HRs are bolded.....68

Table 4 a |

Model 1: Number of all cancers and selected cancer types among women in the high-temperature geothermal areas, hazard ratio (HR), 95% Confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, not adjusted. Statistically significant HRs are bolded.....70

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Model 2: Number of all cancers and selected cancer types among women in the high-temperature geothermal areas, hazard ratio (HR), 95% Confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, adjusted for age and gender. Statistically significant HRs are bolded.....72

Table 4 c |

Model 3: Number of all cancers and selected cancer types among women in the high-temperature geothermal areas, hazard ratio (HR), 95% confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, adjusted for age, gender, education, and type of housing. Statistically significant HRs are bolded.....74

Table 1 a | Baseline characteristics in the high-temperature geothermal areas and different reference areas according to census 1981.

	Geothermal areas	Cold area	Warm area	Capital and South West area	All area except geothermal area
	N (%)	N (%)	N (%)	N (%)	N (%)
Number of people	1 497 (100)	22 431 (100)	50 878 (100)	109 308 (100)	182 617 (100)
Gender					
Men	767 (51.2)	11 929 (53.2)	26 431 (51.9)	54 702 (50.0)	93 062 (51.0)
Woman	730 (48.8)	10 502 (46.8)	24 447 (48.1)	54 606 (50.0)	89 555 (49.0)
Age, year					
Mean ± SD	29.69 ± 17.22	28.06 ± 16.20	28.12 ± 16.28	29.81 ± 16.46	29.12 ± 16.40
Median, IQR (0.25 ; 0.75)	27 (15 ; 43)	25 (15 ; 39)	25 (15 ; 40)	27 (16 ; 43)	26 (16 ; 42)
Education					
Basic education	368 (24.6)	6 565 (29.3)	13 831 (27.2)	25 785 (23.6)	46 181 (25.3)
Medium education	428 (28.6)	5 665 (25.3)	13 414 (26.4)	30 222 (27.6)	49 301 (27.0)
Academic education	140 (9.4)	1 428 (6.4)	3 653 (7.2)	15 032 (13.8)	20 113 (11.0)
Unclassified	535 (35.7)	8 481 (37.7)	19 404 (38.1)	36 300 (33.2)	64 185 (35.1)
Missing	36 (1.7)	292 (1.3)	576 (1.1)	1 969 (1.8)	2 837 (1.6)
Housing					
Single family home	1 205 (80.5)	17 343 (77.3)	33 761 (66.4)	31 552 (28.9)	82 656 (45.3)
Other type of house	292 (19.5)	5 088 (22.7)	17 117 (33.6)	77 756 (71.1)	99 961 (54.7)
Region					
Capital region	0	0	0	65 961 (60.4)	65 961 (36.1)
Other urban regions	0	4 863 (21.7)	20 958 (41.2)	37 758 (34.5)	63 579 (34.8)
Rural regions	1 497 (100.0)	17 568 (78.3)	29 920 (58.8)	5 589 (5.1)	53 077 (29.1)

Abbreviations: SD standard deviation, IQR interquartile range

Table 1 b | Name and number of municipalities areas in Iceland 1981.

High-temperature geothermal area

8716 Hveragerðishreppur³
6607 Skútustaðahreppur³

Cold area

3712 Skógarstrandahreppur ³	4602 Rauðasandshreppur ³	4903 Hrófbergshreppur ³	5606 Bólstaðahlíðahreppur ³
3801 Hörðudalshreppur ³	4603 Patrekshreppur ³	4904 Hólmavíkurhreppur ³	5607 Engihlíðahreppur ³
3802 Miðdalshreppur ³	4604 Tálknafjarðahreppur ³	4905 Kirkjubólshreppur ³	5608 Vindhælishreppur ³
3803 Haukadalshreppur ³	4605 Ketildalshreppur ³	4906 Fellahreppur ³	5609 Höfðahreppur ³
3804 Laxárdalshreppur ³	4606 Suðurfjarðahreppur ³	4907 Óspakseyrarhreppur ³	5610 Skagahreppur ³
3805 Hvammshreppur ³	4701 Auðkúluhreppur ³	4908 Bæjarhreppur ³	7000 Seyðisfjörður ²
3806 Fellsstrandahreppur ³	4702 Þingeyjarhreppur ³	5501 Staðahreppur ³	7100 Neskaupstaður ²
3807 Klofningshreppur ³	4703 Mýrahreppur ³	5502 Fremri-Torfustaðahr. ³	7200 Eskifjörður ³
3808 Skarðshreppur ³	4704 Mosfellshreppur ³	5503 Ytri-Torfustaðahreppur ³	7501 Skeggjastaðahreppur ³
3809 Saurbæjarhreppur ³	4705 Flateyrarhreppur ³	5504 Hvammstangahreppur ³	7502 Vopnafjarðahreppur ³
4000 Ísafjörður ²	4706 Suðureyrarhreppur ³	5505 Kirkjuhvammshreppur ³	7503 Hlíðahreppur ³
4100 Bolungarvík ³	4803 Súðavíkurhreppur ³	5506 Þverárhreppur ³	7504 Jökuldalshreppur ³
4501 Geiradalshreppur ³	4804 Ögurhreppur ³	5507 Þorkelshólahreppur ³	7505 Fljótsdalshreppur ³
4502 Reykhólahreppur ³	4805 Reykjafjarðahreppur ³	5601 Áshreppur ³	7506 Fellahreppur ³
4503 Gufudalshreppur ³	4806 Nauteyrarhreppur ³	5602 Sveinsstaðahreppur ³	7604 Eiðahreppur ³
4504 Múlahreppur ³	4807 Snæfjallahreppur ³	5603 Torfalækjarhreppur ³	7605 Mjóafjarðahreppur ³
4505 Flateyrarhreppur ³	4901 Árneshreppur ³	5604 Blönduóshreppur ³	7606 Norðfjarðahreppur ³
4601 Barðastrandahreppur ³	4902 Kaldrananeshreppur ³	5605 Svínavatnshreppur ³	7607 Helgustaðahreppur ³

Table 1 b (continued)

7609	Reyðarfjarðarhreppur ³	7615	Búlandshreppur ³	7704	Mýrahreppur ³	7509	Borgarfjarðarhreppur ³
7610	Fáskrúðsfjarðarhreppur ³	7616	Geithellnahreppur ³	7705	Borgarhafnarhreppur ³	7511	Seyðisfjarðarhreppur ³
7611	Búðahreppur ³	7701	Bæjarhreppur ³	7706	Hofshreppur ³	7601	Skriðdalshreppur ³
7612	Stöðvarhreppur ³	7702	Nesjahreppur ³	7507	Tunguhreppur ³	7602	Vallahreppur ³
7613	Breiðdalshreppur ³	7703	Hafnarhreppur ³	7508	Hjaltastaðarhreppur ³	7603	Egilsstaðahreppur ³
7614	Beruneshreppur ³						

Warm area

2603	Kjalarnes ³	3605	Borgarhreppur ³	5100	Sauðárkrókur ²	6100	Húsavík ²
2604	Kjósarhreppur ³	3606	Borgarneshreppur ³	5701	Skefilsstaðahreppur ³	6200	Ólafsfjörður ²
3000	Akranes ²	3607	Álftaneshreppur ³	5702	Skarðshreppur ³	6300	Dalvík ³
3501	Strandarhreppur ³	3608	Hraunhreppur ³	5703	Staðarhreppur ³	6501	Grímseyjarhreppur ³
3502	Skilmannahreppur ³	3701	Kolbeinsstaðahreppur ³	5704	Seiluhreppur ³	6502	Svarfaðardalshreppur ³
3503	Innri-Akraneshreppur ³	3702	Eyjahreppur ³	5705	Lýtingsstaðahreppur ³	6504	Hríseyjarhreppur ³
3504	Leirár- og Melahreppur ³	3703	Miklaholtshreppur ³	5706	Akrahreppur ³	6505	Árskógshreppur ³
3505	Andakílshreppur ³	3704	Staðarsveit ³	5707	Rípurhreppur ³	6506	Arnarneshreppur ³
3506	Skorradalshreppur ³	3705	Breiðuvíkurhreppur ³	5708	Viðvíkurhreppur ³	6507	Skriðuhreppur ³
3507	Lundarreykjadalshreppur ³	3706	Neshreppur ³	5709	Hólahreppur ³	6508	Öxnadalshreppur ³
3508	Reykholtsdalshreppur ³	3707	Ólafsvíkurhreppur ³	5710	Hofshreppur ³	6509	Glæsibæjarhreppur ³
3509	Hálsahreppur ³	3708	Fróðárhreppur ³	5711	Hofsóshreppur ³	6510	Hrafnagilshreppur ³
3601	Hvítársíðuhreppur ³	3709	Eyrarsveit ³	5712	Fellshreppur ³	6511	Saurbæjarhreppur ³
3602	Þverárhlíðarhreppur ³	3710	Helgafellssveit ³	5713	Haganeshreppur ³	6512	Öngulsstaðahreppur ³
3603	Norðurárdalshreppur ³	3711	Stykkishólmshreppur ³	5714	Holtshreppur ³	6601	Svalbarðsstrandarhr. ³
3604	Stafholtstungnahreppur ³	5000	Siglufjörður ²	6000	Akureyri ²	6602	Grýtubakkahreppur ³

Table 1 b (continued)

6604	Hálshreppur ³	6707	Þórshafnarhreppur ³	8603	A-Landeyjahreppur ³	8706	Hraungerðishreppur ³
6605	Ljósavatnshreppur ³	6708	Sauðaneshreppur ³	8604	V-Landeyjahreppur ³	8707	Villingaholtshreppur ³
6606	Bárðdælahreppur ³	8000	Vestmannaeyjar ³	8605	Fljótshlíðarhreppur ³	8708	Skeiðahreppur ³
6608	Reykdælahreppur ³	8100	Selfoss ³	8606	Hvollhreppur ³	8709	Gnúpverjahreppur ³
6609	Aðaldælahreppur ³	8501	Hörgslandshreppur ³	8607	Rangárvallahreppur ³	8710	Hrunamannahreppur ³
6610	Reykjahreppur ³	8502	Kirkjubæjarhreppur ³	8608	Landmannahreppur ³	8711	Biskupstungnahreppur ³
6611	Tjörneshreppur ³	8503	Skaftártunguhreppur ³	8609	Holtahreppur ³	8712	Laugardalshreppur ³
6701	Kelduneshreppur ³	8504	Leiðvallarhreppur ³	8610	Ásahreppur ³	8713	Grímsneshreppur ³
6702	Öxarfjarðarhreppur ³	8505	Álftavershreppur ³	8611	Djúpárhreppur ³	8714	Þingvallahreppur ³
6703	Fjallahreppur ³	8506	Hvammshreppur ³	8701	Gaulverjabæjarhreppur ³	8715	Grafningshreppur ³
6704	Presthólahreppur ³	8507	Dyrhólahreppur ³	8702	Stokkseyrarhreppur ³	8717	Ölfushreppur ³
6705	Raufarhafnarhreppur ³	8601	A-Eyjafjallahreppur ³	8703	Eyrbakkahreppur ³	8718	Selsvoghreppur ³
6706	Svalbarðshreppur ³	8602	V-Eyjafjallahreppur ³	8704	Sandvíkurhreppur ³		

Capital and South West area

0000	Reykjavík ¹	1400	Hafnarfjörður ²	2300	Grindavík ³	2504	Gerðahreppur ³
1000	Kópavogur ²	1603	Bessastaðahreppur ²	2400	Njarðvík ³	2506	Vatnsleysustrandarhr. ³
1100	Seltjarnarnes ²	1604	Mosfellshreppur ²	2502	Hafnarhreppur ³		
1300	Garðabær ²	2200	Keflavík ²	2503	Miðneshreppur ³		

¹ Capital region, ² Other urban regions, ³ Rural regions.

Table 2 a | Model 1: Number of all cancers and selected cancer types in the high-temperature geothermal areas, hazard ratio (HR), 95% Confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, not adjusted. Statistically significant HRs are bolded.

Cancers (ICD-10)	Geothermal areas	Cold area		Warm area		Capital and South West area		All areas except geothermal areas	
	p-yr 35 707 No of Cancers	p-yr 571 509 HR	95%CI	p-yr 1 294 570 HR	95%CI	p-yr 2 632 027 HR	95%CI	p-yr 4 498 106 HR	95%CI
All sites (C00-C97 and D45-D47)	184	1.37	1.18 to 1.59	1.28	1.11 to 1.48	1.01	0.87 to 1.16	1.11	0.96 to 1.29
Lip, Oral cavity, and Pharynx (C00-C14)	2	0.90	0.22 to 3.73	0.75	0.19 to 3.05	0.86	0.21 to 3.46	0.83	0.21 to 3.34
Oesophagus (C15)	1	0.66	0.09 to 4.84	0.54	0.08 to 3.92	0.47	0.07 to 3.36	0.51	0.07 to 3.63
Stomach (C16)	7	1.12	0.52 to 2.41	1.26	0.59 to 2.68	1.14	0.54 to 2.41	1.17	0.56 to 2.46
Colon, Rectum, and Anus (C18-C21)	16	1.36	0.82 to 2.26	1.30	0.79 to 2.13	0.92	0.56 to 1.50	1.05	0.64 to 1.72
Bile and Liver (C22-C24)	2	1.12	0.27 to 4.71	1.04	0.26 to 4.25	0.91	0.23 to 3.68	0.97	0.24 to 3.90
Pancreas (C25)	9	3.26	1.59 to 6.66	2.77	1.41 to 5.45	1.90	0.98 to 3.67	2.22	1.15 to 4.28
Nasal cavity and middle ear (C30)	1	3.24	0.38 to 27.76	4.05	0.51 to 31.96	4.11	0.55 to 30.75	3.97	0.54 to 29.04
Larynx (C32)	2	3.27	0.72 to 14.93	2.34	0.56 to 9.76	1.94	0.48 to 7.92	2.16	0.54 to 8.75
Lung and bronchus (C33-C34)	20	1.24	0.79 to 1.96	1.32	0.85 to 2.07	0.91	0.59 to 1.42	1.04	0.67 to 1.62
Bone (C40-C41)	2	6.51	1.26 to 33.58	3.43	0.80 to 14.64	3.07	0.75 to 12.64	3.40	0.84 to 13.86
Melanoma (C43)	2	0.67	0.16 to 2.74	0.52	0.13 to 2.11	0.34	0.09 to 1.37	0.41	0.10 to 1.64
Other cancer of skin (C44)	4	1.12	0.41 to 3.09	0.94	0.35 to 2.53	0.73	0.27 to 1.95	0.82	0.31 to 2.19
Soft tissue sarcoma (C49)	2	2.20	0.50 to 9.60	2.02	0.49 to 8.39	2.64	0.64 to 10.80	2.37	0.59 to 9.60
Breast (C50)	31	1.81	1.25 to 2.62	1.55	1.08 to 2.23	1.09	0.77 to 1.56	1.27	0.89 to 1.80
Vulva (C51)	1	3.23	0.38 to 27.63	4.09	0.52 to 32.31	2.73	0.37 to 20.10	3.09	0.43 to 22.50
Cervix uteri (C53)	2	1.11	0.27 to 4.66	0.83	0.21 to 3.39	0.65	0.16 to 2.61	0.74	0.18 to 2.95

Table 2 a (continued)

Uterus (C54-C55)	3	1.06	0.33 to 3.41	0.96	0.30 to 3.00	0.70	0.22 to 2.17	0.79	0.25 to 2.46
Ovary (C56-C57)	5	1.40	0.56 to 3.48	1.32	0.54 to 3.23	1.02	0.42 to 2.47	1.14	0.47 to 2.74
Prostate (C61)	29	1.55	1.06 to 2.27	1.38	0.96 to 2.00	1.16	0.80 to 1.67	1.26	0.87 to 1.81
Kidney (C64-C66)	5	0.93	0.38 to 2.29	0.76	0.32 to 1.85	0.77	0.32 to 1.86	0.78	0.33 to 1.89
Bladder (C67)	8	1.18	0.58 to 2.42	1.26	0.62 to 2.55	0.97	0.48 to 1.95	1.07	0.53 to 2.14
Brain and central nervous system (C70-C72, C75.1 and C75.3)	5	0.96	0.39 to 2.37	0.87	0.37 to 2.10	0.74	0.31 to 1.79	0.80	0.33 to 1.92
Thyroid gland (C73)	6	1.62	0.70 to 3.76	1.64	0.73 to 3.73	1.45	0.65 to 3.26	1.52	0.68 to 3.41
Cancer without specification of site (C80)	1	0.31	0.04 to 2.25	0.34	0.05 to 2.41	0.32	0.05 to 2.29	0.33	0.05 to 2.31
Lymphoid and haematopoietic tissue (C81-C96 and D45-D47)	18	1.76	1.08 to 2.86	1.67	1.04 to 2.68	1.47	0.92 to 2.35	1.56	0.98 to 2.48
Hodgkin's Lymphoma (C81)	1	1.46	0.19 to 11.27	1.02	0.14 to 7.41	1.23	0.17 to 8.88	1.18	0.17 to 8.46
Non-Hodgkin's Lymphoma (C82-C85)	12	3.51	1.88 to 6.54	3.43	1.90 to 6.20	2.88	1.62 to 5.13	3.09	1.74 to 5.48
Immunoproliferative diseases (C88)	1	2.34	0.29 to 19.06	1.50	0.20 to 11.09	1.61	0.22 to 11.69	1.64	0.23 to 11.81
Leukaemia (C91-C95 and D45-D47)	4	1.12	0.41 to 3.10	1.18	0.44 to 3.20	0.97	0.36 to 2.61	1.05	0.39 to 2.80
Chronic Lymphocytic Leukaemia (CLL)(C91.1)	1	0.79	0.11 to 5.84	0.93	0.13 to 6.73	0.89	0.12 to 6.40	0.89	0.12 to 6.33
Non-CLL (C91-C95 and D45-D47, except C91.1)	3	1.31	0.41 to 4.26	1.31	0.41 to 4.13	1.00	0.32 to 3.13	1.11	0.36 to 3.46
Not included in all cancers									
Basal Cell Carcinoma of skin	30	1.81	1.24 to 2.64	1.53	1.06 to 2.21	0.91	0.63 to 1.30	1.11	0.78 to 1.59

Table 2 b | Model 2: Number of all cancers and selected cancer types in the high-temperature geothermal areas, hazard ratio (HR), 95% Confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, adjusted for age and gender. Statistically significant HRs are bolded.

Cancers (ICD-10)	Geothermal areas	Cold area		Warm area		Capital and South West area		All areas except geothermal areas	
	p-yr 35 707	p-yr 571 509		p-yr 1 294 570		p-yr 2 632 027		p-yr 4 498 106	
	No of Cancers	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI
All sites (C00-C97 and D45-D47)	184	1.21	1.04 to 1.41	1.15	0.99 to 1.33	1.00	0.87 to 1.16	1.06	0.92 to 1.23
Lip, Oral cavity, and Pharynx (C00-C14)	2	0.80	0.19 to 3.31	0.66	0.16 to 2.69	0.85	0.21 to 3.42	0.78	0.20 to 3.14
Oesophagus (C15)	1	0.56	0.08 to 4.16	0.46	0.06 to 3.32	0.44	0.06 to 3.14	0.46	0.06 to 3.28
Stomach (C16)	7	0.95	0.44 to 2.04	1.08	0.51 to 2.30	1.07	0.51 to 2.26	1.06	0.50 to 2.23
Colon, Rectum, and Anus (C18-C21)	16	1.17	0.71 to 1.96	1.13	0.69 to 1.87	0.90	0.55 to 1.48	0.98	0.60 to 1.61
Bile and Liver (C22-C24)	2	0.95	0.23 to 3.98	0.91	0.22 to 3.71	0.89	0.22 to 3.59	0.90	0.22 to 3.63
Pancreas (C25)	9	2.79	1.36 to 5.71	2.38	1.21 to 4.68	1.85	0.95 to 3.58	2.06	1.07 to 3.98
Nasal cavity and middle ear (C30)	1	2.68	0.31 to 22.94	3.48	0.44 to 27.49	4.01	0.54 to 30.09	3.71	0.51 to 27.18
Larynx (C32)	2	2.93	0.64 to 13.40	2.06	0.49 to 8.62	1.81	0.45 to 7.39	1.98	0.49 to 8.01
Lung and bronchus (C33-C34)	20	1.07	0.68 to 1.69	1.16	0.74 to 1.81	0.90	0.58 to 1.40	0.98	0.63 to 1.52
Bone (C40-C41)	2	5.90	1.14 to 30.49	3.45	0.81 to 14.72	3.07	0.75 to 12.64	3.40	0.84 to 13.86
Melanoma (C43)	2	0.64	0.16 to 2.63	0.51	0.13 to 2.05	0.35	0.09 to 1.39	0.41	0.10 to 1.63
Other cancer of skin (C44)	4	0.96	0.35 to 2.65	0.83	0.31 to 2.23	0.72	0.27 to 1.92	0.77	0.29 to 2.05
Soft tissue sarcoma (C49)	2	2.10	0.48 to 9.21	1.85	0.45 to 7.68	2.64	0.64 to 10.82	2.33	0.58 to 9.43
Breast (C50)	31	1.61	1.11 to 2.34	1.43	1.00 to 2.05	1.16	0.82 to 1.66	1.27	0.89 to 1.81
Vulva (C51)	1	2.60	0.30 to 22.30	3.71	0.47 to 29.35	2.91	0.40 to 21.41	3.10	0.43 to 22.55

Table 2 b (continued)

Cervix uteri (C53)	2	1.07	0.26 to 4.50	0.82	0.20 to 3.31	0.67	0.17 to 2.71	0.74	0.19 to 2.97
Uterus (C54-C55)	3	0.90	0.28 to 2.90	0.87	0.28 to 2.73	0.75	0.24 to 2.33	0.79	0.25 to 2.45
Ovary (C56-C57)	5	1.23	0.49 to 3.07	1.21	0.50 to 2.95	1.09	0.45 to 2.63	1.13	0.47 to 2.74
Prostate (C61)	29	1.35	0.92 to 1.97	1.17	0.81 to 1.69	1.02	0.71 to 1.48	1.09	0.76 to 1.58
Kidney (C64-C66)	5	0.82	0.33 to 2.03	0.68	0.28 to 1.65	0.75	0.31 to 1.82	0.74	0.31 to 1.78
Bladder (C67)	8	1.03	0.50 to 2.11	1.10	0.54 to 2.23	0.91	0.45 to 1.82	0.97	0.48 to 1.94
Brain and central nervous system (C70-C72, C75.1 and C75.3)	5	0.88	0.36 to 2.17	0.82	0.34 to 1.98	0.75	0.31 to 1.81	0.78	0.32 to 1.87
Thyroid gland (C73)	6	1.53	0.66 to 3.53	1.55	0.69 to 3.52	1.49	0.66 to 3.34	1.51	0.68 to 3.38
Cancer without specification of site (C80)	1	0.26	0.04 to 1.88	0.29	0.04 to 2.10	0.32	0.05 to 2.26	0.31	0.04 to 2.17
Lymphoid and haematopoietic tissue (C81-C96 and D45-D47)	18	1.59	0.98 to 2.59	1.52	0.95 to 2.44	1.45	0.91 to 2.31	1.48	0.93 to 2.36
Hodgkin's Lymphoma (C81)	1	1.48	0.19 to 11.48	1.02	0.14 to 7.45	1.22	0.17 to 8.80	1.18	0.17 to 8.44
Non-Hodgkin's Lymphoma (C82-C85)	12	3.20	1.71 to 5.98	3.11	1.72 to 5.63	2.85	1.60 to 5.08	2.95	1.67 to 5.23
Immunoproliferative diseases (C88)	1	2.18	0.27 to 17.74	1.32	0.18 to 9.74	1.61	0.22 to 11.64	1.55	0.22 to 11.17
Leukaemia (C91-C95 and D45-D47)	4	1.01	0.37 to 2.79	1.07	0.40 to 2.90	0.95	0.36 to 2.55	0.99	0.37 to 2.64
Chronic Lymphocytic Leukaemia (CLL)(C91.1)	1	0.66	0.09 to 4.90	0.80	0.11 to 5.81	0.86	0.12 to 6.15	0.82	0.11 to 5.85
Non-CLL (C91-C95 and D45-D47, except C91.1)	3	1.23	0.38 to 4.01	1.21	0.38 to 3.81	0.99	0.32 to 3.08	1.06	0.34 to 3.31
Not included in all cancers									
Basal Cell Carcinoma of skin	30	1.62	1.11 to 2.36	1.40	0.97 to 2.01	0.93	0.65 to 1.33	1.08	0.76 to 1.55

Table 2 c | Model 3: Number of all cancers and selected cancer types in the high-temperature geothermal areas, hazard ratio (HR), 95% confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, adjusted for age, gender, education, and type of housing. Statistically significant HRs are bolded. Statistically significant HRs are bolded.

	Geothermal areas	Cold area		Warm area		Capital and South West area		All areas except geothermal areas	
	p-yr 35 707	p-yr 571 509		p-yr 1 294 570		p-yr 2 632 027		p-yr 4 498 106	
Cancers (ICD-10)	No of Cancers	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI
All sites (C00-C97 and D45-D47)	184	1.22	1.05 to 1.42	1.16	1.00 to 1.34	1.02	0.88 to 1.18	1.10	0.95 to 1.27
Lip, Oral cavity, and Pharynx (C00-C14)	2	0.81	0.20 to 3.38	0.64	0.16 to 2.60	1.04	0.25 to 4.24	0.81	0.20 to 3.27
Oesophagus (C15)	1	0.58	0.08 to 4.20	0.50	0.07 to 3.58	0.51	0.07 to 3.69	0.50	0.07 to 3.58
Stomach (C16)	7	0.99	0.46 to 2.14	1.13	0.53 to 2.41	1.07	0.50 to 2.27	1.08	0.51 to 2.27
Colon, Rectum, and Anus (C18-C21)	16	1.17	0.70 to 1.94	1.13	0.69 to 1.86	0.90	0.55 to 1.48	1.04	0.63 to 1.70
Bile and Liver (C22-C24)	2	1.02	0.24 to 4.29	0.95	0.23 to 3.88	0.81	0.20 to 3.31	0.92	0.23 to 3.69
Pancreas (C25)	9	2.85	1.39 to 5.86	2.57	1.30 to 5.07	2.03	1.04 to 3.98	2.31	1.19 to 4.48
Nasal cavity and middle ear (C30)	1	2.58	0.30 to 22.33	3.32	0.42 to 26.32	5.72	0.70 to 46.91	3.58	0.48 to 26.57
Larynx (C32)	2	3.04	0.66 to 13.98	2.21	0.53 to 9.30	1.74	0.42 to 7.23	2.08	0.51 to 8.48
Lung and bronchus (C33-C34)	20	1.11	0.70 to 1.75	1.24	0.80 to 1.95	0.99	0.63 to 1.54	1.09	0.70 to 1.70
Bone (C40-C41)	2	5.80	1.11 to 30.32	3.56	0.83 to 15.27	3.07	0.72 to 13.09	3.62	0.88 to 14.87
Melanoma (C43)	2	0.62	0.15 to 2.56	0.51	0.13 to 2.04	0.32	0.08 to 1.29	0.42	0.11 to 1.69
Other cancer of skin (C44)	4	1.01	0.37 to 2.79	0.84	0.31 to 2.27	0.64	0.24 to 1.71	0.76	0.28 to 2.03
Soft tissue sarcoma (C49)	2	1.97	0.45 to 8.66	1.86	0.45 to 7.78	3.79	0.89 to 16.20	2.47	0.61 to 10.06
Breast (C50)	31	1.59	1.10 to 2.31	1.43	1.00 to 2.05	1.16	0.81 to 1.66	1.32	0.92 to 1.88
Vulva (C51)	1	2.96	0.34 to 25.58	4.03	0.50 to 32.36	3.18	0.41 to 24.61	3.11	0.42 to 22.90

Table 2 c (continued)

Cervix uteri (C53)	2	1.04	0.25 to 4.37	0.85	0.21 to 3.45	0.73	0.18 to 2.98	0.82	0.20 to 3.31
Uterus (C54-C55)	3	0.88	0.27 to 2.82	0.82	0.26 to 2.60	0.70	0.22 to 2.20	0.77	0.25 to 2.40
Ovary (C56-C57)	5	1.25	0.50 to 3.12	1.25	0.51 to 3.05	1.15	0.47 to 2.80	1.18	0.49 to 2.86
Prostate (C61)	29	1.37	0.93 to 2.00	1.16	0.80 to 1.68	1.05	0.72 to 1.52	1.12	0.78 to 1.62
Kidney (C64-C66)	5	0.83	0.34 to 2.04	0.67	0.28 to 1.62	0.79	0.33 to 1.92	0.75	0.31 to 1.82
Bladder (C67)	8	1.02	0.50 to 2.10	1.12	0.56 to 2.28	0.96	0.48 to 1.95	1.04	0.52 to 2.09
Brain and central nervous system (C70-C72, C75.1 and C75.3)	5	0.90	0.37 to 2.23	0.82	0.34 to 2.00	0.84	0.35 to 2.03	0.83	0.34 to 1.99
Thyroid gland (C73)	6	1.51	0.65 to 3.50	1.51	0.66 to 3.42	1.45	0.64 to 3.29	1.47	0.66 to 3.29
Cancer without specification of site (C80)	1	0.28	0.04 to 2.05	0.32	0.04 to 2.26	0.31	0.04 to 2.20	0.31	0.04 to 2.22
Lymphoid and haematopoietic tissue (C81-C96 and D45-D47)	18	1.64	1.00 to 2.66	1.53	0.95 to 2.46	1.40	0.87 to 2.24	1.49	0.94 to 2.38
Hodgkin's Lymphoma (C81)	1	1.50	0.19 to 11.61	1.03	0.14 to 7.56	1.28	0.17 to 9.44	1.21	0.17 to 8.71
Non-Hodgkin's Lymphoma (C82-C85)	12	3.25	1.73 to 6.07	3.21	1.77 to 5.82	2.53	1.40 to 4.55	2.92	1.64 to 5.20
Immunoproliferative diseases (C88)	1	2.00	0.24 to 16.40	1.31	0.18 to 9.76	1.61	0.22 to 12.01	1.49	0.21 to 10.75
Leukaemia (C91-C95 and D45-D47)	4	1.07	0.39 to 2.95	1.07	0.39 to 2.89	0.95	0.35 to 2.57	1.01	0.38 to 2.70
Chronic Lymphocytic Leukaemia (CLL)(C91.1)	1	0.70	0.09 to 5.24	0.76	0.10 to 5.54	0.88	0.12 to 6.43	0.75	0.11 to 5.40
Non-CLL (C91-C95 and D45-D47, except C91.1)	3	1.30	0.40 to 4.22	1.23	0.39 to 3.90	0.98	0.31 to 3.08	1.13	0.36 to 3.53
Not included in all cancers									
Basal Cell Carcinoma of the skin	30	1.61	1.10 to 2.35	1.37	0.95 to 1.97	0.93	0.64 to 1.33	1.13	0.79 to 1.63

Table 3 a | Model 1: Number of all cancers and selected cancer types among men in the high-temperature geothermal areas, hazard ratio (HR), 95% Confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, not adjusted. Statistically significant HRs are bolded.

Cancers (ICD-10)	Geothermal areas	Cold area		Warm area		Capital and South West area		All areas exempt geothermal areas	
	p-yr 18 181	p-yr 300 297		p-yr 667 069		p-yr 1 303 573		p-yr 2 270 939	
	No of Cancer	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI
All sites (C00-C97 and D45-D47)	90	1.32	1.07 to 1.64	1.21	0.98 to 1.49	0.97	0.79 to 1.20	1.07	0.87 to 1.32
Lip, Oral cavity, and Pharynx (C00-C14)	2	1.29	0.31 to 5.44	1.20	0.29 to 4.92	1.48	0.37 to 6.01	1.36	0.34 to 5.49
Oesophagus (C15)	1	1.06	0.14 to 8.02	0.69	0.10 to 5.01	0.62	0.09 to 4.41	0.68	0.10 to 4.83
Stomach (C16)	4	0.89	0.33 to 2.43	1.17	0.43 to 3.72	0.94	0.35 to 2.53	0.99	0.37 to 2.65
Colon, Rectum, and Anus (C18-C21)	9	1.38	0.70 to 2.71	1.29	0.67 to 2.51	0.94	0.49 to 1.82	1.07	0.56 to 2.07
Bile and Liver (C22-C24)	1	1.66	0.21 to 12.99	0.75	0.10 to 5.44	0.83	0.12 to 5.93	0.86	0.12 to 6.14
Pancreas (C25)	5	4.17	1.57 to 11.12	2.84	1.14 to 7.04	1.91	0.79 to 4.65	2.30	0.95 to 5.57
Nasal cavity and middle ear (C30)	1	16.58	1.04 to 265.29	7.32	0.86 to 62.71	8.01	1.02 to 63.23	8.40	1.11 to 63.63
Larynx (C32)	2	4.86	1.01 to 23.41	2.93	0.70 to 12.39	2.18	0.53 to 8.89	2.56	0.63 to 10.38
Lung and bronchus (C33-C34)	9	1.11	0.57 to 2.19	1.09	0.56 to 2.11	0.80	0.41 to 1.54	0.90	0.47 to 1.74
Other cancer of skin (C44)	3	1.34	0.41 to 4.34	1.31	0.41 to 4.14	1.06	0.34 to 3.31	1.16	0.37 to 3.61
Soft tissue sarcoma (C49)	1	2.85	0.34 to 23.71	1.84	0.25 to 13.70	2.18	0.30 to 15.94	2.13	0.30 to 15.34
Prostate (C61)	29	1.60	1.10 to 2.35	1.40	0.97 to 2.03	1.13	0.78 to 1.63	1.25	0.87 to 1.80
Kidney (C64-C66)	2	0.62	0.15 to 2.54	0.51	0.13 to 2.04	0.49	0.12 to 1.96	0.51	0.13 to 2.03
Bladder (C67)	7	1.33	0.62 to 2.87	1.42	0.67 to 3.02	1.08	0.51 to 2.29	1.20	0.57 to 2.52
Brain and central nervous system (C70-C72, C75.1 and C75.3)	2	0.75	0.18 to 3.08	0.68	0.17 to 2.77	0.65	0.16 to 2.61	0.67	0.17 to 2.69

Table 3 a (continued)

Thyroid gland (C73)	1	1.11	0.15 to 8.42	0.84	0.12 to 6.10	0.76	0.11 to 5.48	0.82	0.12 to 5.86
Lymphoid and haematopoietic tissue (C81-C96 and D45-D47)	11	1.78	0.96 to 3.31	1.74	0.95 to 3.18	1.50	0.83 to 2.73	1.60	0.88 to 2.90
Non-Hodgkin's Lymphoma (C82-C85)	7	2.89	1.29 to 6.43	3.46	1.59 to 7.49	2.86	1.35 to 6.09	3.01	1.42 to 6.38
Leukaemia (C91-C95 and D45-D47)	4	1.81	0.65 to 5.09	1.91	0.70 to 5.20	1.56	0.58 to 4.21	1.68	0.63 to 4.52
Chronic Lymphocytic	1	1.31	0.17 to 10.00	1.63	0.22 to 12.09	1.33	0.18 to 9.64	1.41	0.20 to 10.11
Non-CLL (C91-C95 and	3	2.08	0.63 to 6.92	2.02	0.63 to 6.45	1.66	0.53 to 5.21	1.80	0.58 to 5.63
Not included in all cancers									
Basal Cell Carcinoma of skin	15	2.08	1.22 to 3.55	1.75	1.05 to 2.94	1.03	0.62 to 1.72	1.27	0.77 to 2.12

Table 3 b | Model 2: Number of all cancers and selected cancer types among men in the high-temperature geothermal areas, hazard ratio (HR), 95% Confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, adjusted for age and gender. Statistically significant HRs are bolded.

Cancers (ICD-10)	Geothermal areas	Cold area		Warm area		Capital and South West area		All areas exempt geothermal areas	
	p-yr 18 181	p-yr 300 297		p-yr 667 069		p-yr 1 303 573		p-yr 2 270 939	
	No of Cancer	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI
All sites (C00-C97 and D45-D47)	90	1.14	0.92 to 1.41	1.04	0.84 to 1.28	0.90	0.73 to 1.11	0.97	0.78 to 1.19
Lip, Oral cavity, and Pharynx (C00-C14)	2	1.12	0.27 to 4.73	1.03	0.25 to 4.23	1.41	0.35 to 5.70	1.24	0.31 to 5.01
Oesophagus (C15)	1	0.90	0.12 to 6.79	0.59	0.08 to 4.18	0.56	0.08 to 4.04	0.60	0.08 to 4.26
Stomach (C16)	4	0.74	0.27 to 2.03	0.99	0.37 to 2.67	0.85	0.32 to 2.28	0.86	0.32 to 2.31
Colon, Rectum, and Anus (C18-C21)	9	1.17	0.59 to 2.32	1.11	0.57 to 2.15	0.86	0.45 to 1.67	0.96	0.50 to 1.84
Bile and Liver (C22-C24)	1	1.43	0.18 to 11.21	0.64	0.09 to 4.60	0.76	0.11 to 5.46	0.76	0.11 to 5.44
Pancreas (C25)	5	3.60	1.35 to 9.61	2.39	0.96 to 5.94	1.76	0.72 to 4.27	2.05	0.85 to 4.96
Nasal cavity and middle ear (C30)	1	11.20	0.70 to 180.17	6.28	0.73 to 53.95	7.15	0.90 to 56.50	7.33	0.97 to 55.54
Larynx (C32)	2	4.29	0.89 to 20.68	2.56	0.60 to 10.80	2.04	0.50 to 8.33	2.32	0.57 to 9.39
Lung and bronchus (C33-C34)	9	0.94	0.48 to 1.84	0.91	0.47 to 1.77	0.73	0.38 to 1.41	0.80	0.41 to 1.53
Other cancer of skin (C44)	3	1.12	0.34 to 3.62	1.11	0.35 to 3.51	0.93	0.30 to 2.91	1.00	0.32 to 3.12
Soft tissue sarcoma (C49)	1	2.76	0.33 to 22.92	1.66	0.22 to 12.40	2.17	0.30 to 15.89	2.07	0.29 to 14.92
Prostate (C61)	29	1.35	0.92 to 1.97	1.17	0.81 to 1.69	1.02	0.71 to 1.48	1.09	0.76 to 1.58
Kidney (C64-C66)	2	0.54	0.13 to 2.22	0.44	0.11 to 1.77	0.46	0.12 to 1.85	0.46	0.12 to 1.86
Bladder (C67)	7	1.12	0.52 to 2.42	1.21	0.57 to 2.57	0.99	0.47 to 2.09	1.06	0.50 to 2.23

Table 3 b (continued)

Brain and central nervous system (C70-C72, C75.1 and C75.3)	2	0.70	0.17 to 2.88	0.65	0.16 to 2.61	0.63	0.16 to 2.52	0.64	0.16 to 2.83
Thyroid gland (C73)	1	1.05	0.14 to 7.97	0.74	0.10 to 5.37	0.73	0.10 to 5.25	0.76	0.11 to 5.46
Lymphoid and haematopoietic tissue (C81-C96 and D45-D47)	11	1.62	0.87 to 3.02	1.56	0.85 to 2.85	1.43	0.79 to 2.60	1.49	0.82 to 2.70
Non-Hodgkin's Lymphoma (C82-C85)	7	2.62	1.18 to 5.85	3.08	1.42 to 6.69	2.74	1.29 to 5.83	2.81	1.31 to 7.69
Leukaemia (C91-C95 and D45-D47)	4	1.63	0.58 to 4.58	1.69	0.62 to 4.62	1.47	0.55 to 3.97	1.55	0.58 to 4.15
Chronic Lymphocytic	1	1.08	0.14 to 8.23	1.41	0.19 to 10.47	1.25	0.17 to 9.00	1.27	0.18 to 9.10
Non-CLL (C91-C95 and	3	2.00	0.59 to 6.50	1.81	0.57 to 5.79	1.57	0.50 to 4.93	1.67	0.54 to 5.22
Not included in all cancers									
Basal Cell Carcinoma of skin	15	1.82	1.07 to 3.12	1.55	0.92 to 2.60	0.99	0.59 to 1.64	1.17	0.71 to 1.95

Table 3 c | Model 3: Number of all cancers and selected cancer types among men in the high-temperature geothermal areas, hazard ratio (HR), 95% confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, adjusted for age, gender, education, and type of housing. Statistically significant HRs are bolded.

Cancers (ICD-10)	No of Cancer	Geothermal areas		Cold area		Warm area		Capital and South West area		All areas exempt geothermal areas	
		p-yr 18 181		p-yr 300 297		p-yr 667 069		p-yr 1 303 573		p-yr 2 270 939	
		HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI
All sites (C00-C97 and D45-D47)	90	1.14	0.92 to 1.42	1.06	0.86 to 1.30	0.93	0.75 to 1.15	1.01	0.82 to 1.24		
Lip, Oral cavity, and Pharynx (C00-C14)	2	1.14	0.27 to 4.82	0.99	0.24 to 4.03	1.65	0.40 to 6.82	1.22	0.30 to 4.91		
Oesophagus (C15)	1	0.91	0.12 to 6.86	0.63	0.09 to 4.55	0.69	0.10 to 5.02	0.68	0.10 to 4.84		
Stomach (C16)	4	0.78	0.29 to 2.14	1.02	0.38 to 2.77	0.84	0.31 to 2.27	0.89	0.33 to 2.37		
Colon, Rectum, and Anus (C18-C21)	9	1.14	0.58 to 2.25	1.12	0.58 to 2.18	0.89	0.46 to 1.73	1.03	0.53 to 1.99		
Bile and Liver (C22-C24)	1	1.37	0.17 to 10.83	0.68	0.09 to 4.93	0.70	0.10 to 5.09	0.79	0.11 to 5.69		
Pancreas (C25)	5	3.66	1.37 to 9.82	2.52	1.01 to 6.28	2.11	0.85 to 5.21	2.39	0.98 to 5.82		
Nasal cavity and middle ear (C30)	1	13.08	0.79 to 215.51	6.46	0.75 to 55.75	8.81	0.96 to 80.79	7.92	1.02 to 61.67		
Larynx (C32)	2	4.30	0.89 to 20.84	2.78	0.65 to 11.81	1.93	0.46 to 8.05	2.46	0.60 to 10.05		
Lung and bronchus (C33-C34)	9	0.95	0.48 to 1.86	1.00	0.52 to 1.94	0.79	0.41 to 1.52	0.89	0.46 to 1.72		
Other cancer of skin (C44)	3	1.22	0.38 to 3.98	1.12	0.35 to 3.54	0.88	0.28 to 2.79	1.00	0.32 to 3.12		
Soft tissue sarcoma (C49)	1	2.52	0.30 to 21.04	1.62	0.22 to 12.13	2.88	0.38 to 22.05	2.18	0.30 to 15.87		
Prostate (C61)	29	1.37	0.93 to 2.00	1.16	0.80 to 1.68	1.05	0.72 to 1.52	1.12	0.78 to 1.62		
Kidney (C64-C66)	2	0.54	0.13 to 2.22	0.43	0.11 to 1.74	0.50	0.12 to 2.01	0.48	0.12 to 1.92		
Bladder (C67)	7	1.11	0.52 to 2.41	1.24	0.58 to 2.65	1.03	0.49 to 2.19	1.15	0.54 to 2.41		

Table 3 c (continued)

Brain and central nervous system (C70-C72, C75.1 and C75.3)	2	0.70	0.17 to 2.89	0.65	0.16 to 2.64	0.73	0.18 to 2.98	0.68	0.17 to 2.73
Thyroid gland (C73)	1	1.08	0.14 to 8.21	0.73	0.10 to 5.30	0.71	0.10 to 5.13	0.76	0.11 to 5.45
Lymphoid and haematopoietic tissue (C81-C96 and D45-D47)	11	1.62	0.87 to 3.02	1.59	0.87 to 2.91	1.40	0.77 to 2.57	1.52	0.84 to 2.76
Non-Hodgkin's Lymphoma (C82-C85)	7	2.58	1.16 to 5.78	3.12	1.43 to 6.78	2.56	1.19 to 5.54	2.83	1.33 to 6.02
Leukaemia (C91-C95 and D45-D47)	4	1.68	0.60 to 4.74	1.73	0.63 to 4.75	1.45	0.53 to 3.97	1.62	0.60 to 4.36
Chronic Lymphocytic	1	1.19	0.16 to 9.14	1.33	0.18 to 9.84	1.50	0.20 to 11.09	1.26	0.17 to 9.06
Non-CLL (C91-C95 and	3	2.00	0.60 to 6.66	1.95	0.61 to 6.25	1.43	0.45 to 4.56	1.80	0.57 to 5.63
Not included in all cancers									
Basal Cell Carcinoma of the skin	15	1.78	1.04 to 3.05	1.52	0.90 to 2.55	1.02	0.61 to 1.70	1.25	0.75 to 2.08

Table 4 a | Model 1: Number of all cancers and selected cancer types among women in the high-temperature geothermal areas, hazard ratio (HR), 95% Confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, not adjusted. Statistically significant HRs are bolded.

Cancers (ICD-10)	Geothermal areas	Cold area		Warm area		Capital and South West area		All areas exempt geothermal areas	
	p-yr 17 526	p-yr 271 213		p-yr 627 500		p-yr 1 328 454		p-yr 2 227 167	
	No of Cancer	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI
All sites (C00-C97 and D45-D47)	94	1.42	1.15 to 1.76	1.36	1.11 to 1.67	1.04	0.85 to 1.27	1.15	0.94 to 1.41
Stomach (C16)	3	1.81	0.55 to 5.97	1.41	0.45 to 4.47	1.53	0.49 to 4.79	1.52	0.49 to 4.74
Colon, Rectum and Anus (C18-C21)	7	1.35	0.62 to 2.91	1.30	0.61 to 2.77	0.89	0.42 to 1.86	1.02	0.49 to 2.15
Bile and Liver (C22-C24)	1	0.83	0.11 to 6.23	1.73	0.23 to 12.89	1.01	0.14 to 7.27	1.11	0.16 to 7.97
Pancreas (C25)	4	2.54	0.88 to 7.29	2.69	0.97 to 7.43	1.86	0.69 to 5.03	2.12	0.79 to 5.69
Lung and bronchus (C33-C34)	11	1.37	0.74 to 2.53	1.61	0.88 to 2.95	1.03	0.57 to 1.88	1.19	0.66 to 2.16
Bone (C40-C41)	2	7.97	1.46 to 43.52	7.89	1.70 to 36.50	6.60	1.56 to 27.98	7.08	1.71 to 29.42
Melanoma (C43)	2	0.90	0.22 to 3.74	0.85	0.21 to 3.45	0.59	0.15 to 2.38	0.68	0.17 to 2.73
Other cancer of skin (C44)	1	0.77	0.10 to 5.75	0.51	0.07 to 3.65	0.38	0.05 to 2.68	0.44	0.06 to 3.10
Soft tissue sarcoma (C49)	1	1.76	0.22 to 13.90	2.24	0.30 to 16.90	3.30	0.45 to 24.41	2.66	0.37 to 19.29
Breast (C50)	31	1.78	1.23 to 2.58	1.56	1.09 to 2.23	1.13	0.79 to 1.61	1.29	0.91 to 1.84
Vulva (C51)	1	3.12	0.36 to 26.72	4.04	0.51 to 31.91	2.81	0.38 to 20.68	3.12	0.43 to 22.69
Cervix uteri (C53)	2	1.07	0.26 to 4.50	0.82	0.20 to 3.34	0.67	0.17 to 2.69	0.74	0.19 to 2.98
Uterus (C54-C55)	3	1.02	0.32 to 2.29	0.94	0.30 to 2.96	0.71	0.23 to 2.22	0.80	0.26 to 2.48
Ovary (C56-C57)	5	1.35	0.54 to 3.37	1.30	0.53 to 3.18	1.05	0.44 to 2.54	1.14	0.47 to 2.76
Kidney (C64-C66)	3	1.43	0.44 to 4.65	1.17	0.37 to 3.70	1.23	0.39 to 3.83	1.23	0.39 to 3.83
Bladder (C67)	1	0.72	0.10 to 5.33	0.73	0.10 to 5.28	0.52	0.07 to 3.74	0.59	0.08 to 4.21

Table 4 a (continued)

Brain and central nervous system (C70-C72, C75.1 and C75.3)	3	1.20	0.37 to 3.87	1.05	0.33 to 3.31	0.83	0.26 to 2.57	0.91	0.29 to 2.85
Thyroid gland (C73)	5	1.75	0.69 to 4.40	2.02	0.82 to 4.96	1.80	0.74 to 4.37	1.85	0.76 to 4.47
Cancer without specification of site (C80)	1	0.58	0.08 to 4.26	0.58	0.08 to 4.19	0.65	0.09 to 4.65	0.62	0.09 to 4.42
Lymphoid and haematopoietic tissue (C81-C96 and D45-D47)	7	1.75	0.80 to 3.82	1.58	0.74 to 3.36	1.41	0.67 to 2.97	1.49	0.71 to 3.13
Hodgkin's Lymphoma (C81)	1	3.94	0.44 to 35.26	2.27	0.30 to 17.13	4.00	0.54 to 29.84	3.29	0.45 to 23.92
Non-Hodgkin's Lymphoma (C82-C85)	5	5.27	1.92 to 14.51	3.41	1.36 to 8.51	2.88	1.18 to 7.02	3.19	1.31 to 7.74
Immunoproliferative diseases (C88)	1	15.73	0.98 to 251.59	4.10	0.52 to 32.37	3.45	0.47 to 25.62	4.01	0.55 to 29.37
Not included in all cancers									
Basal Cell Carcinoma of skin	15	1.59	0.93 to 2.70	1.35	0.81 to 2.26	0.82	0.49 to 1.36	0.99	0.59 to 1.64

Table 4 b | Model 2: Number of all cancers and selected cancer types among women in the high-temperature geothermal areas, hazard ratio (HR), 95% Confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, adjusted for age and gender. Statistically significant HRs are bolded.

Cancers (ICD-10)	Geothermal areas	Cold area		Warm area		Capital and South West area		All areas exempt geothermal areas	
	p-yr 17 526	p-yr 271 213		p-yr 627 500		p-yr 1 328 454		p-yr 2 227 167	
	No of Cancer	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI
All sites (C00-C97 and D45-D47)	94	1.28	1.04 to 1.59	1.26	1.02 to 1.28	1.08	0.88 to 1.11	1.15	0.93 to 1.40
Stomach (C16)	3	1.53	0.46 to 5.05	1.25	0.39 to 3.96	1.61	0.51 to 5.04	1.49	0.48 to 4.66
Colon, Rectum and Anus (C18-C21)	7	1.17	0.54 to 2.54	1.17	0.55 to 2.48	0.94	0.44 to 1.97	1.01	0.48 to 2.13
Bile and Liver (C22-C24)	1	0.72	0.10 to 5.37	1.58	0.21 to 11.75	1.08	0.15 to 7.75	1.10	0.15 to 7.90
Pancreas (C25)	4	2.21	0.77 to 6.34	2.36	0.86 to 6.53	1.97	0.73 to 4.31	2.08	0.77 to 5.59
Lung and bronchus (C33-C34)	11	1.21	0.65 to 2.24	1.47	0.80 to 2.69	1.09	0.60 to 1.98	1.18	0.65 to 2.14
Bone (C40-C41)	2	7.55	1.38 to 41.31	7.83	1.69 to 36.27	6.64	1.57 to 28.16	7.09	1.71 to 29.44
Melanoma (C43)	2	0.88	0.21 to 3.68	0.84	0.21 to 3.40	0.59	0.15 to 2.39	0.68	0.17 to 2.73
Other cancer of skin (C44)	1	0.68	0.09 to 5.09	0.46	0.06 to 3.32	0.40	0.06 to 2.88	0.44	0.06 to 3.11
Soft tissue sarcoma (C49)	1	1.70	0.22 to 13.42	2.08	0.28 to 15.66	3.40	0.46 to 25.18	2.66	0.37 to 19.28
Breast (C50)	31	1.64	1.13 to 2.38	1.44	1.01 to 2.08	1.18	0.82 to 1.68	1.28	0.90 to 1.83
Vulva (C51)	1	2.60	0.30 to 22.30	3.71	0.47 to 29.35	2.91	0.40 to 21.41	3.10	0.43 to 22.55
Cervix uteri (C53)	2	1.07	0.26 to 4.50	0.82	0.20 to 3.31	0.67	0.17 to 2.71	0.74	0.19 to 2.97
Uterus (C54-C55)	3	0.90	0.28 to 2.90	0.87	0.28 to 2.73	0.75	0.24 to 2.33	0.79	0.25 to 2.45
Ovary (C56-C57)	5	1.23	0.49 to 3.07	1.21	0.50 to 2.95	1.09	0.45 to 2.63	1.13	0.47 to 2.74
Kidney (C64-C66)	3	1.26	0.39 to 4.11	1.06	0.34 to 3.35	1.29	0.41 to 4.03	1.22	0.39 to 3.79
Bladder (C67)	1	0.65	0.09 to 4.80	0.66	0.09 to 4.80	0.55	0.08 to 3.96	0.58	0.08 to 4.16

Table 4 b (continued)

Brain and central nervous system (C70-C72, C75.1 and C75.3)	3	1.07	0.33 to 3.47	0.99	0.31 to 3.12	0.85	0.27 to 2.66	0.91	0.29 to 2.83
Thyroid gland (C73)	5	1.68	0.67 to 4.24	1.96	0.80 to 4.82	1.83	0.76 to 4.45	1.85	0.76 to 4.46
Cancer without specification of site (C80)	1	0.49	0.07 to 3.60	0.52	0.07 to 3.75	0.69	0.10 to 4.96	0.61	0.09 to 4.37
Lymphoid and haematopoietic tissue (C81-C96 and D45-D47)	7	1.55	0.71 to 3.38	1.46	0.68 to 3.10	1.48	0.70 to 3.12	1.48	0.70 to 3.11
Hodgkin's Lymphoma (C81)	1	4.01	0.45 to 35.90	2.28	0.30 to 17.18	4.08	0.55 to 30.47	3.29	0.45 to 23.94
Non-Hodgkin's Lymphoma (C82-C85)	5	4.64	1.68 to 12.78	3.13	1.25 to 7.82	3.00	1.23 to 7.33	3.17	1.30 to 7.69
Immunoproliferative diseases (C88)	1	13.09	0.82 to 209.38	3.59	0.45 to 28.33	3.65	0.49 to 27.06	3.95	0.54 to 28.94
Not included in all cancers									
Basal Cell Carcinoma of skin	15	1.45	0.85 to 2.46	1.26	0.76 to 2.12	0.87	0.52 to 1.44	0.99	0.60 to 1.65

Table 4 c | Model 3: Number of all cancers and selected cancer types among women in the high-temperature geothermal areas, hazard ratio (HR), 95% confidence intervals (CI) according to references to the populations in Cold area, Warm area, Capital and South West area, and all areas (total census) except the high-temperature geothermal areas, adjusted for age, gender, education, and type of housing. Statistically significant HRs are bolded.

Cancers (ICD-10)	Geothermal areas	Cold area		Warm area		Capital and South West area		All areas exempt geothermal areas	
	p-yr 17 526	p-yr 271 213		p-yr 627 500		p-yr 1 328 454		p-yr 2 227 167	
	No of Cancer	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI
All sites (C00-C97 and D45-D47)	94	1.30	1.05 to 1.61	1.27	1.03 to 1.56	1.10	0.90 to 1.35	1.19	0.97 to 1.46
Stomach (C16)	3	1.55	0.46 to 5.14	1.33	0.42 to 4.22	1.65	0.52 to 5.25	1.52	0.49 to 4.76
Colon, Rectum and Anus (C18-C21)	7	1.24	0.57 to 2.70	1.16	0.54 to 2.46	0.93	0.44 to 1.96	1.06	0.50 to 2.24
Bile and Liver (C22-C24)	1	0.82	0.11 to 6.17	1.54	0.21 to 11.56	1.10	0.15 to 8.04	1.15	0.16 to 8.24
Pancreas (C25)	4	2.26	0.78 to 6.52	2.68	0.96 to 7.45	1.92	0.70 to 5.26	2.20	0.81 to 5.94
Lung and bronchus (C33-C34)	11	1.26	0.68 to 2.33	1.56	0.85 to 2.86	1.26	0.69 to 2.30	1.34	0.74 to 2.44
Bone (C40-C41)	2	7.20	1.30 to 39.96	7.95	1.70 to 37.23	6.09	1.34 to 27.66	7.33	1.73 to 31.09
Melanoma (C43)	2	0.85	0.20 to 3.53	0.85	0.21 to 3.46	0.55	0.14 to 2.22	0.70	0.17 to 2.82
Other cancer of skin (C44)	1	0.66	0.09 to 4.91	0.48	0.07 to 3.43	0.35	0.05 to 2.47	0.43	0.06 to 3.09
Soft tissue sarcoma (C49)	1	1.62	0.20 to 12.90	2.21	0.29 to 16.90	5.56	0.69 to 44.67	2.82	0.38 to 20.69
Breast (C50)	31	1.62	1.12 to 2.36	1.46	1.02 to 2.09	1.17	0.82 to 1.67	1.33	0.94 to 1.90
Vulva (C51)	1	2.96	0.34 to 25.58	4.03	0.50 to 32.36	3.18	0.41 to 24.61	3.11	0.42 to 22.90
Cervix uteri (C53)	2	1.04	0.25 to 4.37	0.85	0.21 to 3.45	0.73	0.18 to 2.98	0.82	0.20 to 3.31
Uterus (C54-C55)	3	0.88	0.27 to 2.82	0.82	0.26 to 2.60	0.70	0.22 to 2.20	0.77	0.25 to 2.40
Ovary (C56-C57)	5	1.25	0.50 to 3.12	1.25	0.51 to 3.05	1.15	0.47 to 2.80	1.18	0.49 to 2.86
Kidney (C64-C66)	3	1.27	0.39 to 4.16	1.04	0.33 to 3.29	1.33	0.42 to 4.21	1.21	0.39 to 3.78
Bladder (C67)	1	0.65	0.09 to 4.85	0.67	0.09 to 4.85	0.63	0.09 to 4.54	0.62	0.09 to 4.47

Table 4 c (continued)

Brain and central nervous system (C70-C72, C75.1 and C75.3)	3	1.11	0.34 to 3.62	1.01	0.32 to 3.20	0.96	0.31 to 3.03	0.99	0.32 to 3.08
Thyroid gland (C73)	5	1.65	0.65 to 4.18	1.92	0.78 to 4.74	1.80	0.73 to 4.42	1.79	0.74 to 4.34
Cancer without specification of site (C80)	1	0.56	0.08 to 4.11	0.55	0.08 to 4.01	0.66	0.09 to 4.79	0.62	0.09 to 4.43
Lymphoid and haematopoietic tissue (C81-C96 and D45-D47)	7	1.66	0.76 to 3.63	1.46	0.68 to 3.12	1.38	0.65 to 2.94	1.45	0.69 to 3.06
Hodgkin's Lymphoma (C81)	1	4.42	0.49 to 39.63	2.13	0.28 to 16.22	5.23	0.65 to 42.44	3.22	0.44 to 23.72
Non-Hodgkin's Lymphoma (C82-C85)	5	5.20	1.87 to 14.45	3.31	1.32 to 8.34	2.57	1.03 to 6.38	3.12	1.28 to 7.62
Immunoproliferative diseases (C88)	1	11.92	0.72 to 197.59	4.38	0.54 to 35.34	4.41	0.55 to 35.46	4.83	0.64 to 36.26
Not included in all cancers									
Basal Cell Carcinoma of the skin	15	1.45	0.85 to 2.47	1.24	0.74 to 2.08	0.85	0.51 to 1.41	1.03	0.62 to 1.72