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Health and health service utilisation across geographic regions in Iceland

Sigríður Haraldsdóttir

Thesis for the degree of Philosophiae Doctor

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Heilsa í heimabyggð

Heilsufar og notkun heilbrigðisþjónustu eftir búsetusvæðum á Íslandi

Sigríður Haraldsdóttir

Ritgerð til doktorsgráðu

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Janúar 2016

UNIVERSITY OF ICELAND
SCHOOL OF HEALTH SCIENCES
FACULTY OF MEDICINE

ISBN 978-9935-9261-3-5

Háskólaprent ehf.

Reykjavik, Iceland 2016

Ágrip

Inngangur: Tilgangur þessarar rannsóknar var að kanna heilsufar og notkun heilbrigðisþjónustu eftir búsetusvæðum á Íslandi með það að markmiði að styðja við gagnreynda landfræðilega dreifingu á heilbrigðisþjónustu. Meginmarkmiðið var að kanna hvort munur væri á sjálfmetinni heilsu, tilteknum fæðingarútkomum og hjarta- og æðasjúkdómum eftir búsetu innan og utan höfuðborgarsvæðisins þar sem framboð á heilbrigðisþjónustu er mismunandi.

Efniviður og aðferðir: Í **rannsókn I** voru notuð gögn um sjálfmetna heilsu úr landskönnuninni "Heilsa og líðan Íslendinga" frá 2007. Könnunin náði til 5909 einstaklinga á aldrinum 18-79 ára. Í **rannsókn II** voru notuð gögn úr fæðingaskrá um fæðingarútkomur og heilsu mæðra úr 40982 fæðingum frá árunum 2000-2009. Aðhvarfsgreining var notuð til þess að kanna svæðisbundinn mun á útkomum í rannsóknum I og II. Reiknuð voru leiðrétt gagnlíkindahlutföll (LGH) og 95 % öryggisbil (ÖB). Í **rannsókn III** voru notuð gögn úr dánarmeinaskrá um 7113 dauðsföll vegna hjarta- og æðasjúkdóma á árunum 2000-2009, gögn úr vistunarskrá heilbrigðisstofnana um legur 14039 einstaklinga með hjarta- og æðasjúkdóma sem útskriftarsjúkdómsgreiningu á árunum 2008-2013 og gögn úr samskiptaskrá heilsugæslunnar um komur 58246 einstaklinga með hjarta- og æðasjúkdóma á heilsugæslustöðvar á árunum 2008-2012. Reiknuð var aldursstöðluð, árleg tíðni útskrifta af sjúkrahúsi, tíðni samskipta við heilsugæslu og dánartíðni vegna hjarta- og æðasjúkdóma á hverja 100000 íbúa og 95 % öryggisbil (ÖB).

Niðurstöður: Í **rannsókn I** kom í ljós að íbúar utan höfuðborgarsvæðisins meta bæði líkamlega (LGH 1.35; 95% ÖB 1.23-1.50) og andlega (LGH 1.17; 95% ÖB 1.06-1.30) heilsu sína verr en íbúar á höfuðborgarsvæðinu. Aftur á móti gáfu svör til kynna lægri tíðni tiltekinna langvinnra sjúkdóma utan höfuðborgarsvæðisins, t.d. krabbameins (LGH 0.78; 95% ÖB 0.60-0.99) og hjarta- og æðasjúkdóma (LGH 0.77; 95% ÖB 0.62-0.95). **Rannsókn II** leiddi í ljós lægri tíðni meðgöngusykursýki (LGH 0.68; 95% ÖB 0.59-0.78) og meðgönguháþrýstings (LBH 0.82; 95% ÖB 0.71-0.94) meðal kvenna sem búsettar voru utan höfuðborgarsvæðisins. Ekki reyndist svæðisbundinn munur á fæðingarþyngd, meðgöngulengd eða tíðni fyrirburа eða léttburа. Hins vegar reyndust meiri líkur á burðarmálsdauða (LGH 1.87; 95% ÖB 1.18-2.95) utan höfuðborgarsvæðisins á síðari hluta rannsóknar-

tímabilsins. Í **rannsókn III** kom í ljós lítilsháttar hærri dánartíðni vegna hjarta- og æðasjúkdóma meðal kvenna utan höfuðborgarsvæðisins (269.7 á 100000 íbúa), samanborið við konur innan höfuðborgarsvæðisins (253.5 á 100000 íbúa) (staðlað tíðnihlutfall [SRR] 1.06; 95% ÖB 1.05-1.07). Dánartíðni vegna hjartabilunar, gáttatifs og blóðþurrðarhjartasjúkdóma var einnig hærri meðal kvenna utan höfuðborgarsvæðisins. Tíðni útskrifta af sjúkrahúsi og samskipta við heilsugæslu vegna blóðþurrðarhjarta-sjúkdóma, gáttatifs, hjartabilunar og heilaæðasjúkdóma var einnig hærri meðal bæði karla og kvenna utan höfuðborgarsvæðisins. Tíðni nokkurra breytanlegra áhættuþátta var hærri utan höfuðborgarsvæðisins, einkum meðal kvenna.

Ályktun: Þessar niðurstöður leiða í ljós svæðisbundinn mismun á heilsu á Íslandi. Á búsetusvæðum utan höfuðborgarsvæðisins, þar sem lítið framboð er af heilbrigðisþjónustu í heimabyggð, eru ýmsar vísbendingar um óhagstæðara heilsufar en á höfuðborgarsvæðinu. Til þess að vinna gegn þessum mismun þurfa framtíðar rannsóknir og stefnumörkun að finna leiðir til að styrkja heilsugæslu utan höfuðborgarsvæðisins. Tryggja þarf virka vöktun heilsu þannig að borin séu kennsl á og brugðist sé við sjúkdómum, forstigum þeirra og áhættuþáttum, í meðgöngu og á öllum æviskeiðum.

Lykilorð:

Heilsa, búseta, notkun heilbrigðisþjónustu, mismunur, þéttbýli – dreifbýli

Abstract

Background and aims: With the motivation to support evidence-based spatial organisation of health care the overall aim of this thesis was to explore health and health service utilisation by geographic regions in Iceland. With focus on self-rated health, pregnancy outcomes and cardiovascular disease, the main objective of this work was to explore potential differences in these parameters across urban vs. rural areas, inside vs. outside the Capital Area (CA) with varying extent of health care supply.

Material and Methods: In **study I**, we used data on self-rated health from a national health survey, "Health and Well-being of Icelanders", including 5909 Individuals (18-79 years) conducted in 2007. In **study II**, we used data on maternal health and birth outcomes from 40982 pregnancies from 2000-2009 in the nationwide Medical Birth Register. Regression models were used to explore regional differences in outcomes in studies I and II. Adjusted odds ratios (aOR) and 95 percent confidence intervals (95% CI) were calculated. In **study III**, we used data on 7113 deaths from cardiovascular disease (CVD) 2000-2009 in the nationwide Causes of Death Register and data on 14039 individuals with CVD discharge diagnoses 2008-2013 in the Hospital Discharge Register and data on 58246 individuals with CVD contact diagnoses 2008-2012 in the Register of Primary Health Care Contacts. Age-standardised annual hospital discharge rates, primary health care contact rates and mortality rates for CVD with 95% CI were calculated per 100000 population in given areas.

Results: In **study I**, we found that residents outside the CA rate both their physical (aOR 1.35; 95% CI 1.23-1.50) and mental (aOR 1.17; 95% CI 1.06-1.30) health worse than residents in the CA. In contrast, we observed a lower prevalence of self-reported chronic diseases, including cancers (aOR 0.78; 95% CI 0.60-0.99) and cardiovascular disease (aOR 0.77; 95% CI 0.62-0.95) outside the CA. In **study II** we found a lower prevalence of gestational diabetes (aOR 0.68; 95% CI 0.59-0.78) and hypertension (aOR 0.82; 95% CI 0.71-0.94) among pregnant women residing outside the CA. We observed neither regional differences in mean birth weight, gestation length nor rate of preterm birth or low birth weight, yet higher odds of perinatal deaths (aOR 1.87; 95% CI 1.18-2.95) outside the CA in the second half of the study period. In **study III**, we observed slightly higher total CVD mortality rates among women outside

(269.7 per 100000 pop.) compared to inside (253.5 per 100000 pop.) the CA (standardised rate ratio [SRR] 1.06; 95% CI 1.05-1.07). Also higher heart failure, atrial fibrillation and ischemic heart disease mortality rates among women outside the CA. The rates of hospital discharges and primary care contacts for ischemic heart disease, atrial fibrillation, heart failure, and cerebrovascular disease were increased among both men and women living outside the CA. The prevalence of several modifiable risk factors was higher outside the CA, particularly among women.

Conclusion: These findings reveal regional health disparities in Iceland were rural areas – with low level of local healthcare provision – have less favourable health outcomes on a number of indicators. In order to counteract these disparities future research and policy needs to identify ways to strengthen primary health care outside the CA to ensure active monitoring, early identification and treatment of risk factors, pre-morbid symptoms and diseases in rural areas in pregnancy and across the lifespan.

Keywords:

Health outcomes, residence, health service utilisation, inequality, urban - rural

Acknowledgements

This doctoral thesis is the final product of a long journey. During my 25 years at the Directorate of Health, that have been devoted to all aspects of health information, I have worked with four excellent directors of health, Ólafur Ólafsson, Sigurður Guðmundsson, Geir Gunnlaugsson and Birgir Jakobsson and many intelligent and competent colleagues. The establishment and development of national, electronic health registers were a part of Sigurður Guðmundsson‘s future vision when he took over as a director of health. I got the challenging role of leading this development. As time passed my desire to further explore and exploit these public resources for the benefit of public health grew. The establishment of a doctoral program in public health sciences at the University of Iceland created an irresistible opportunity.

During my doctoral studies I have been extremely fortunate with my mentors. Unnur A. Valdimarsdóttir and Sigurður Guðmundsson have been an exceptional team. They have guided me and inspired through the whole process and showed me the way when I was lost. For this I extend my deepest gratitude. I also extend my appreciation to my two other committee members, i.e. Vilhjálmur Rafnsson and Sigrún Helga Lund for their guidance. I would like to thank my Ph.D. Evaluation Committee, Kristjana Einarsdóttir, Anthony Gatrell and Þórður Harðarson for accepting this thesis for public defence. I am grateful for the significant contribution of Ragnheiður I. Bjarnadóttir coauthor of paper II, Guðmundur Þorgeirsson coauthor of paper III and Sigrún Helga Lund coauthor of papers II and III.

I thank the Directorate of Health for its support and access to its substantial data sources. Special thanks to my colleagues at the Division of Health Information for their support. Kristinn and Hólmfríður get special thanks for assistance during data retrieval, Lilja Bjarklind for helping out with maps and Guðrún Kristín for encouragement and proofreading.

I am thankful for the financial support by RANNIS, the Icelandic research fund.

I wish to thank my fellow students and staff at the Centre of Public Health Sciences. Agnes, Arna, Álfheiður, Dóra Guðrún, Dóra R., Edda Björk, Elín, Gunnar, Halldóra, Helga, Hildur Guðný, Jóhanna Eyrún, Lára, Maríanna, Ólöf Elsa, Ragnhildur, Þrúður, Thor, Vilhjálmur and Örn thank you all for your

great company. I have learned a lot from you all and admire your skillfulness and resilience. I also wish to express my gratitude to my friend and colleague Anders Schærström for our valuable friendship and discussions.

The doctoral journey took place in time and space. Albeit most of the work was done in Reykjavík critical parts very completed elsewhere. As my research was carried out alongside my work at the Directorate of Health it was sometimes vital to take a few days off for intensive work. On two occasions I was allowed to stay in apartments belonging to hospitals distant from the Capital Area, i.e. at Hólmavík on the Westfjords and Egilsstaðir on the Eastfjords. These couple of weeks in each place were extremely productive and I found it both stimulating and informative to spend time in these remote and thinly populated areas. For these precious weeks I express my sincere gratitude to West and East Iceland Health Care Centres.

Finally I would like to extend my deepest gratitude to my family and friends. Their faith in me and encouragement was crucial. My children have inspired me and supported in many ways. My daughter Elín Inga Magnúsdóttir who graduated from the Technical College in Reykjavik last December and my son in law Brieve B. Lyon helped me with the maps. My son Baldur Karl Magnússon spent endless hours studying with me while finishing his Masters Degree at Reykjavík University and my daughter in law Merji Dalisay unburdened me during the final months of the work. My brothers and sisters and their families, my dear friends at Neskirkja Choir and my lifelong friends in the group Fjallkonur all helped me along the way by just being there and sharing their lives with me.

Very special thanks to my friend Rúnar Reynisson whose encouragement during the past year has been invaluable.

At the end of this journey I feel nothing but gratitude for the opportunity I was given to seek knowledge, to spend time on something so exciting that it still manages to speed up my heart beat. I have learned much more than I anticipated and gained skills and competence that I will utilise and further develop in the future.

This thesis is dedicated to my beloved parents Elín Ólafsdóttir (1929-2000) and Haraldur Karlsson (1922-2007) who always showed their faith in me and loved my unconditionally.

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List of abbreviations

95% CI	95% confidence interval
AHRQ	Agency for Healthcare Research and Quality
BMI	body mass index
CA	Capital Area
CVD	cardiovascular disease
aOR	adjusted odds ratio
GP	general practitioner
HDR	hospital discharge rate
ILO-ISCO	International Standard Classification of Occupations
ICD-10	International Statistical Classification of Diseases, 10th Rev.
ICPC	International Classification of Primary Care
LBW	low birthweight
N	number of cases
NICE	National Institute for Health and Health Care Excellence
NCSP	NOMESCO Classification of Surgical Procedures
NOMESCO	Nordic Medico-Statistical Committee
OR,	odds ratio
PHC CR	primary health care contact rate
PSS4	perceived stress scale - 4
PTB	preterm birth
SD	standard deviation
SPSS	Statistical Package for the Social Sciences
SR	standardised rate
SRR	standardised rate ratio
US	United States
WHO	World Health Organization

List of original papers

This thesis is based on the following original publications, which are referred to in the text by their Roman numerals (I-III):

I. Haraldsdóttir S, Valdimarsdóttir UA, Guðmundsson S. Poorer self-rated health in residential areas with limited healthcare supply. Scandinavian Journal of Public Health. 2014;42(3):310-8.

II. Haraldsdottir S, Gudmundsson S, Bjarnadottir RI, Lund SH, Valdimarsdottir UA. Maternal geographic residence, local health service supply and birth outcomes. Acta Obstetricia et Gynecologica Scandinavica. 2015;94(2):156-64.

III. [Submitted for publication] Haraldsdottir S, Gudmundsson S, Thorgeirsson G, Lund SH, Valdimarsdottir UA. Regional differences in mortality, hospital discharges and primary care contacts for cardiovascular disease.

Declaration of contribution

The doctoral student, Sigridur Haraldsdottir, planned the research work for Papers I, II and III of which she is the first author. She applied for the appropriate ethical and research approvals and obtained the relevant data. Statistical analyses were run in cooperation with her supervisor and advisor and she wrote the papers and responded to reviewer comments in collaboration with co-authors. The doctoral student wrote this thesis with the solid guidance of her supervisor, advisor and doctoral committee.

1 Introduction

Health inequalities have been defined as the difference in health status or the distribution of health determinants between different population groups. Some regional differences in health are unavoidable since they are influenced by fixed factors such as age, gender and heredity. Some are, however, avoidable since they are affected by modifiable factors. Health inequities are avoidable inequalities (EuroHealthNet, 2015).

Health inequalities or disparities across geographic regions, in terms of self-rated health, disease prevalence and mortality have been confirmed worldwide (Fogelholm et al., 2006; Hoffmann et al., 2014; Kroneman et al., 2010; Marí-Dell'Olmo et al., 2015; Yusuf et al., 2014). These inequalities are e.g. manifested in poorer self-rated health in rural than in urban areas (Monnat & Beeler Pickett, 2011), increased risk of adverse birth outcomes among infants born to women residing in rural areas (Bailey & Cole, 2009; Graham et al., 2007), different levels of avoidable mortality between neighbourhoods of European cities (Hoffmann et al., 2014) and in increasing geographical inequalities in mortality (Thomas et al., 2010). Despite improvements in health and living conditions in Europe health inequalities, both between and within countries, persist (Marmot et al., 2012).

Regional inequalites in health that can be explained by avoidable factors should be narrowed down as much as possible. These inequities may be attributed to regional differences in socioeconomic and behavioural risk factors, prevalence of disease and underlying risk factors and/or regional differences in quality, accessibility, utilisation and effectiveness of health services (Stang & Stang, 2014; Yusuf et al., 2014).

Reducing health disparities across geographic regions is an important aim and in accordance with WHO European policy for health, Health 2020 (Jakab & Marmot, 2012). This aim demands monitoring of disease incidence, modifiable risk factors, quality of health care services and of social determinants of health in general, on a regional level (Jakab & Marmot, 2012). Therefore the overall aim of the present work was to explore potential inequalities in health and health service utilisation by geographic regions in Iceland in relation to availability of local health services.

1.1 Geographical variations in health outcomes

The role of a place or residency in individual health has been debated and many studies have focused on establishing whether health variations from place to place exist because different sorts of people seek to live in different places (referred to as compositional effects) or because places themselves differ in terms of environmental quality or other attributes (contextual effects) (Davidson et al., 2008; Gatrell & Elliott, 2009). The question is whether regional differences in health can be fully explained by different characteristics of individuals that make up the populations involved, i.e. by age, gender, educational attainment, occupational groups and behavioural factors such as smoking, diet, obesity etc. In general, wide range of research has come to the conclusion that lifestyle factors only partially explain inequalities in health and structural factors and material conditions have direct impact on health (Gatrell & Elliott, 2009). There is strong and growing evidence that material circumstances are important determinants of health also in countries with socialised health care (Gatrell et al., 2002; Gatrell & Elliott, 2009). The social class gradient has been confirmed for mortality, morbidity and self-rated health and also a widening gap between the poorest and the most affluent regions (Gatrell & Elliott, 2009). The effect of risk factors such as low levels of education have also seemed stronger in poorer neighbourhoods, implying that health policies need to target areas as well as individuals. In the more recent years factors such as one´s social position throughout the life course has been emerging as a potential explanation for health inequalities (Gatrell & Elliott, 2009).

1.2 Health indicators

Various health indicators can and have been used to describe regional differences in health. They include self-rated health, various indicators on morbidity, quality of life, such as disability adjusted life years and mortality, both overall and disease specific.

1.2.1 General health status

In order to get a general overview of regional disparities in health a generic health status measure is appropriate. According to Idler and Benyamini (1997) self-rated health is a measure of global health that is predictive of morbitity and mortality. Being a common measure in population health surveys it is ideal for exploring potential health differences between population groups.

While effect sizes vary across studies and populations, studies on self-rated health have consistently found individual-level factors such as age, gender, race, nativity, education, income and employment (Lindström, 2009; Prus, 2011; Zhang et al., 2010) along with various health behaviours (Giatti et al., 2010; Molarius et al., 2007; Rohrer & Stroebel, 2009) to be important determinants of self-rated health. Furthermore, features of social capital, e.g. interpersonal trust and social participation appear consistently as independent predictors of self-rated health, even after adjusting for other well-known health determinants (Giordano & Lindstrom, 2010; Jen et al., 2010; Lee et al., 2008; Nummela et al., 2008; Verhaeghe & Tampubolon, 2012).

Evidence from studies of the relative contribution of contextual vs. compositional effects on self-rated health are mixed (Omariba, 2010). A study among older Canadians suggested that neighbourhood effects on self-rated health are modest and that individual-level factors are relatively more important determinants of health (Omariba, 2010). In England and Scotland, however, fair to very bad self-rated health was significantly associated with several neighbourhood attributes, e.g. poor physical quality of residential environment and high unemployment. Associations were independent of gender, age, social class, and economic activity (Cummins et al., 2005). Stafford et al. (2004) found that neighbourhood socioeconomic characteristics such as neighbourhood unemployment, proportion of residents in manual occupations, and proportion of single households were associated with poorer self-rated health, independent of individual socioeconomic characteristics in both London and Helsinki.

Six of thirteen reviewed articles focusing on urban-rural difference in self-rated health indicated urban-rural difference (Carlson, 2005; Eberhardt & Pamuk, 2004; Levin, 2003; Monnat & Beeler Pickett, 2011; Riva et al., 2009; Valle, 2009). Many indicators of population health were worse among rural residents in the US than among urban residents while self-rated health was more favourable in rural settings in England (Riva et al., 2009) and Scotland (Levin, 2003). Riva et al. (2009) found health differences between large cities and more rural areas to be largely accounted for by differences in socioeconomic conditions between poor urban localities and more affluent rural places. A recent study in the US (Monnat & Beeler Pickett, 2011) found that residents of remote rural counties had the greatest odds of reporting bad health. The study further investigated the roles of rurality, as measured by county population size and metropolitan adjacency, on self-rated health and the results indicated

worse health with increasing degree of rurality (Monnat & Beeler Pickett, 2011). Seven of the reviewed studies from the US, Canada, China, Australia and Finland, found no general urban-rural differences in health (Brown et al., 1999; Kelleher et al., 2003; Nummella et al., 2009; Rohrer & Borders, 2004; Rohrer et al., 2005; Shi et al., 2008; St. John, 2006).

The results of a systematic review by Riva et al. (2009) also confirm these contrasts in health across urban and rural areas. Generally the reviewed studies from Canada, Australia and US revealed rural disadvantage with respect to some indicators of morbidity and mortality; rural residents in Canada and the US were also more likely to report fair or poor health than their urban counterparts. In contrast, several studies showed mortality and illness to be less prevalent in rural areas than in urban areas in the UK.

Some of the reviewed studies point out that the urban-rural classification is too broad and attention also needs to be paid to the way in which rurality is measured. Rive et al. (2009) found e.g. significant variations in health across semi-rural areas, villages and urban areas. Levin (2003) defined rurality by clusters made up of two components, settlement size and remoteness.

1.2.2 Equal opportunities from the start

One of the most important objective in reducing health inequalities is to provide equal opportunities for every child to have the best start in life (Jakab & Marmot, 2012; Marmot et al., 2010). The Review of Social Determinants of Health and the Health Divide, that was comissioned to support the development of Health 2020, points out that children´s early and later development is influenced by the socioeconomic background of their families and their health-related lifestyle in general (Jakab & Marmot, 2012). This emphasis on start of life draws attention to potential regional variations in pregnancy and birth outcomes.

Adverse birth outcomes include low birthweight and preterm birth as both of these conditions have been reported to increase the risk of perinatal mortality and morbidity affecting health risks into adulthood (Beck et al., 2010). A number of studies have explored differences in adverse birth outcomes, e.g. low birthweight and preterm birth between urban and rural areas and with some exceptions (Hillemeier et al., 2007) found that infants born to women residing in rural and economically depressed or remote areas are at increased risk for these adverse birth outcomes (Bailey & Cole, 2009; Graham et al., 2007). Studies in Canada found increased risks of adverse birth outcomes, including perinatal

death, with increased distance to specialised hospital services (Grzybowski et al., 2011; Lisonkova et al., 2011) and in areas with weak or no metropolitan influence (Luo & Wilkins, 2008). Socioeconomic factors and smoking did not seem to fully explain the disadvantage of rural residence in these studies and access to high quality care was proposed as a potential contributing factor to adverse outcomes. Whether region-specific screening accessibility and uptake for maternal health problems contribute to variation in adverse birth outcomes across geographic regions needs further investigation (Cullinan et al., 2012).

1.2.3 Mortality

A reliable way to gain insight into health variations across regions is to look at mortality. Death is a final and well defined outcome that in many countries has a long tradition of accurate and standardised national registration. Within the health inequalites literature much attention has been paid to mortality due to diseases of the circulatory system. International comparison has revealed huge differences in mortality between countries that are difficult to explain (Gatrell & Elliott, 2009; Yusuf et al., 2014). These inequalities are e.g. manifested in lower rates of major cardiovascular diseases and deaths in high income countries despite a generally higher burden of cardiovascular risk factors in these countries (Yusuf et al., 2014). Variations in CVD mortality within countries have also frequently been reported, such as in England where age-standardised mortality has not decreased equally in all regions in recent years and has indeed increased in certain areas and for certain groups (Asaria et al., 2012).

Regional inequalities in mortality may be attributed to regional differences in prevalence of disease and underlying risk factors and/or to regional differences in quality, accessibility, utilisation and effectiveness of health services (Stang & Stang, 2014; Yusuf et al., 2014).

1.3 Geographical variations in access to health services

When looking at regional variations in health it is also important to look at regional variations in access to health services. Access to health services is a multidimensional concept that describes individuals' ability to use the services where it is needed and when it is needed (Aday & Anderson, 1981). Penchansky and Thomas (1981) define 5 important dimensions of access, namely: 1) Availability, defined by the supply of services in relation to need; 2) Accessibility, geographical barriers, e.g. distance, transportation, travel time and cost; 3) Accommodation,

identifying the degree to which services are organised to meet the needs of the consumers, e.g. hours of operation and waiting time; 4) Affordability, refers to the price of services in relation to individuals' ability to pay; 5) Acceptability, describes consumers´ views of health services and how service providers interact with clients.

A common goal of many health care systems is equity of services, implying that all citizens shall have equal access to or enjoy comparable services. When it comes to health care we know that our needs for services differ according to factors such as age, gender, behavioural factors and morbidity. Health service provision therefore needs to take into account population characteristics and distribution, disease prevalence and distribution of important risk factors. Poor health outcomes are tasks for health services and needs are greatest where the burden of disease and illness is high. A common definition by Aday and Andersen (1981) states that health services are just if individual access to services is in accordance with need.

When discussing delivery of health services it is useful to distinguish between different levels of service. Primary health care provides preventive care, general outpatient medical and nursing services. Secondary care includes more specialised health services provided by hospitals or private practice specialists. In many countries secondary services are accessed through primary health care when GPs refer patients to hospitals or private practice specialists for futher investigation or treatment. Patients requiring highly specialised care may need referral to tertiary care provided by the most specialised hospitals. As services of primary health care are generally accessed more frequently they need to be offered locally. In general we need services of secondary and particularly tertiary care less frequently, e.g. in relation to specialised treatment and we are therefore not as dependent upon close geographic proximity.

Access to health services can be viewed as an important marker of neighbourhood quality. Delivering adequate, efficient, effective and equal health services is challenging and undoubtedly more so in thinly populated rural areas than in densely populated urban areas. The role differential access across geographical areas plays in health is, however, not fully understood. As reviewed by Monnat & Beeler Pickett (2011) factors such as limited service provision, lack of physicians, remoteness from and difficulty in travelling to urban health services and inadequate health promoting infrastructure have been suggested to contribute to urban-rural health differences. An underlying assumption in these

studies is that health care access is positively associated with health outcomes. There is some evidence to support that. A literature review of 10 studies by Macinko et al. (2007), a study by Piérard (2009) and a study by Continelli (2010) suggest that primary care physician supply is associated with improved health outcomes, including self-rated health. Studies in Canada and the US as well as Sweden have found insufficient medical care to be related to worse health outcomes (Mohseni & Lindstrom, 2007; Prus, 2011).

Supply of health services on a regional level provides important information on potential access to these services but real access to services should be explored by looking at utilisation of health services in relation to information on service need (Aday & Anderson, 1981). Records of individual contacts with the health care system can give valuable insight into prevalence of illness and disease, use of services and access to services in general when they include information about diagnoses and treatment. Such data is sometimes available on a national level or for some administrative regions within countries.

1.4 Areal units

A wide range of spatial scales have been used in studying health and disease. Studies of geographic health disparities have typically concentrated on either disparities between neighbourhoods, e.g. as defined by census tract areas, administrative boundaries, postal zones or between urban and rural areas and sometimes between different rural settings.

Administrative boundaries, such as municipalities, are often used for routine data collection. Their disadvantage is, however, that that they do not necessarily match residents' perceptions of their community and lived experience of their neighbourhood boundaries. Postal zones are also commonly used due to their availability but since they are created for the organisation of mail delivery they also do not necessarily represent communities as they are experienced by their residents.

1.5 Health care systems in the Nordic countries

In a broad international perspective the Nordic countries have obvious similarities in their approach to social welfare. The dominant role of the state in forming policies and a large public sector to implement these policies are common characteristics (Magnussen et al., 2009). The principles of universalism and equity are central features of the Nordic welfare model, including the health care system. The Nordic countries

thus have a long tradition for a public health care system striving for equal access for all citizens (Magnussen et al., 2009).

There are important differences between the Nordic countries in terms of health care services and health care systems that have been gradually developing during the past two decades. The roles of patients are slowly changing, from being primarily passive recepients of health care to assuming more active roles as informed consumers, with some choice of services (Magnussen et al., 2009). These changes, along with an ageing population and changes in disease and risk factor prevalence, affect the demand for health care services and types of services needed. Technological advances and increased focus on efficiency, quality and patient safety have resulted in fewer and larger hospitals, making it more difficult to maintain geographical equity (Magnussen et al., 2009). The Nordic countries have also been under the pressure of cutting down expenses or at least containing growing expenses due to more expensive interventions and more demands of the population. As a consequence user charges, with exemptions to preserve equity, have e.g. been introduced to varying degree in each country.

1.6 The Icelandic health care system

One of the main objectives of Icelandic health legislation is to ensure equal access to optimum health services for all people of Iceland (Alþingi (Parliament of Iceland), 2007a). The Icelandic health care system is based on the same main principles as health care systems in the other Nordic countries. This is evident from the existence, scope, structure and finance of the Icelandic system. The main characteristics of the Icelandic health system are summarised in table 1.

The Icelandic health care system is a comprehensive system, mostly financed by general taxation, with 82.5 per cent of the total expenditure publicly financed. The remaining 17.5 per cent are financed by out-of-pocket payments. Patients pay relatively small fees at the time of service but disabled and retired people pay a lower fee for health care services (Ásgeirsdóttir, 2009). Most institutions, hospitals and health care centres, receive a fixed budget from the state but medical specialists in private practice are financed on a fee-for-services basis by the government. Inpatient hospital care is financed without co-payments from patients but outpatient care is financed with the additional out-of-pocket co-payments by patients. That applies to primary health care centres, outpatient hospital services and outpatient services of physicians in private practice.

Table 1 Main characteristics of the Icelandic health care system

Governance	Minister of health		
Financing	Tax-funded national health system		
Regional planning	Seven health regions since 2007 – widespread merging of health institutions within regions in recent years		
	TYPES OF SERVICES		
	Primary health care	**Outpatient specialist care**	**Inpatient hospital care**
Delivery of service	In public health centres by a team of health professionals	In private group practice (60%) and in outpatient departm. of public hospitals	In public hospitals
Funding	Fixed yearly budget allocated by the ministry	Fee for service. Fees negotiated at central level	Fixed yearly budget allocated by the ministry. Not DRG based financing
Co-payments by patients	Small out-of-pocket co-payments per visit	Out-of-pocket co-payments per visit and cost sharing according to rules	Free at the point of care
Referral		GPs referral to access secondary care not required	Admissions determined by physicians
Geographical distribution	Distributed throughout the country	Private practice specialists mainly in Capital Area	Specialised hospitals in the Capital Area and at Akureyri. Small general hospitals in other health regions

The socialised health systems of the Nordic countries are widely supported by their residents. In a recent national survey in Iceland 94% of the respondents agreed that the state should spend more on health care and 81% stated that health services should first and foremost be run by the state (Vilhjálmsson, 2015). There are some important differences between the Icelandic system and those of the other Nordic countries. The Icelandic system is more centralised with the Minster of Health administering almost all health affairs, i.e. decision-making, enforcement and management. The role of local authorities in health care have therefore been very limited (Ásgeirsdóttir, 2009). Less emphasis on public health policy in Iceland as opposed to curative measures has also been pointed out (Ásgeirsdóttir, 2009). Finally, Iceland does not use "gatekeeping" by GPs, like some of the other Nordic countries and patients can choose to seek specialised services in privately run outpatient practices without having a referral from a GP (Ásgeirsdóttir, 2009). According to a survey by the Directorate of Health many private practice specialists choose, however, to see only patients referred by GPs (Gudlaugsson et al., 2014).

The Icelandic Health Service Act emphasises that general health services shall be locally provided and that primary health care centres should generally be the first point of contact (Alþingi (Parliament of Iceland), 2007a). Health care centres throughout the country, sometimes run

jointly with small hospitals, provide primary health care, including general medical services, infant and maternity care, school nursing, immunisations, emergency treatment, health protection and nursing care. Specialist outpatient care is provided by hospitals and private practice specialists, many of whom are also employed by state hospitals. Hospitals fall into two major categories according to Icelandic law. The first includes hospitals providing general services, including general internal medicine, nursing, casualty care and rehabilitation. These range from being primarily nursing homes to hospitals with limited specialisation. The second category includes hospitals with diverse specialised services, i.e. Landspitali University Hospital in the Capital Area (CA) and Akureyri hospital in North Iceland (Alþingi (Parliament of Iceland), 2007a). The distribution of health care centres and hospitals is, to a large extent, based on a geographical foundation and in accordance with patterns of settlement and population distribution, at least as it was when the services were first established. The geographic distribution of private practice specialists is, however, not strategically planned according to population need but rather determined by their own choice of location. The vast majority of private practice specialists are located in the CA.

It can be stated that two main groups define tasks for the health services in Iceland. The users themseleves decide whether to have contact with primary health care, private practice specialists, emergency rooms or those who offer alternative treatment. Physicians, on the other hand, are the only ones who can admit patients to hospitals and place individuals on hospital waiting lists for specific examinations, treatments or procedures. The role of health professionals, mainly physicians, in decisions regarding service use is consequently central and important. They make decisions, advise patients and many are familar with their patients' circumstances and advise accordingly. In Iceland a large proportion of medical specialists are both employed by state hospitals and participate in privately run health services. This situation probably influences the flow of patients between service levels.

1.6.1 The seven health regions

Iceland as a whole is sparsely populated with a total population of approximately 325000 1 January 2014 (Hagstofa Íslands [Statistics Iceland], 2014). The population distribution is limited to a narrow coastal belt and along valleys but it is also uneven, with 2/3 of the population residing in and around the capital of Reykjavík in the South West of Iceland. Akureyri is the largest town outside the CA with a population of

approximately 18000. Iceland was in 2007 divided into seven health regions which are supposed to serve as a foundation for the organisation of general health services (Reglugerð um heilbrigðisumdæmi 785/2007 [Regulation on health regions 785/2007],). Figure 1 displays the division of Iceland into the seven health regions and the location of healthcare centres and hospitals in 2008.

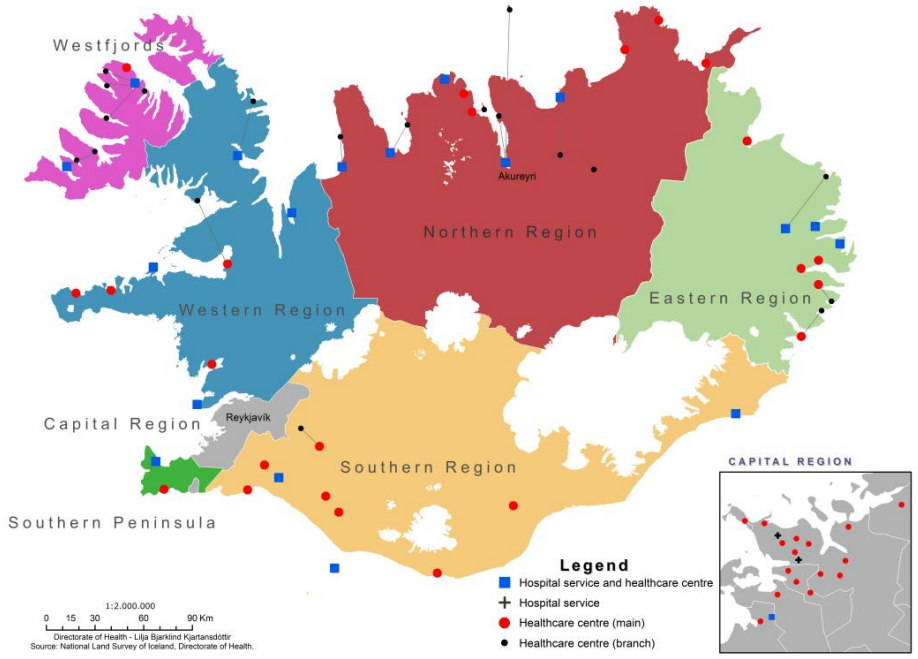

Figure 1. Health regions, location of primary health care centres and hospital beds

The purpose of the re-structuring was to induce and facilitate institutional mergers and increase cooperation within these areas. Mergers of institutions have systematically been taking place for the past two decades, resulting in larger and more competent institutions (Ásgeirsdóttir, 2009). Despite the division of the country into health regions, patients normally have the right to attend the healthcare centre or healthcare facility most accessible to them at any time. The seven health regions differ greatly in size and population. The Capital Region covers the smallest area in square kilometres but contains 2/3 of the total population. In contrast the vast Eastern Region only contains 3.4% of the total population (table 2) (Haraldsdóttir, 2014). There are notable demographic differences between health regions that are important for health and health services. The gender ratio shows some gender imbalances between regions; the male to female ratio is generally

higher outside the Capital Region, highest in the Eastern Region. The Southern Peninsula has the highest child dependency ratio and the lowest aged dependency ratio. The highest aged dependency ratio is however in the Northern Region. The age-standardised mortality rate (2008-2012 average) is slightly but significantly higher outside the Capital Region than inside and the rate varies between regions (Haraldsdóttir, 2014).

Table 2 Characteristics of the seven health regions.

District	Area square km[1)]	% of total popu-lation	Gender ratio[2)]	Child depend. ratio[3)]	Aged depend. ratio[4)]	Age standard. mortality rate[5)]	Hospital beds[6)]/ 1000	Nursing beds[6)]/ 1000	Doctors /1000[6)]	Nurses& midw./ 1000[6)]
Capital Region	**1706**	**67.4**	**0.99**	**30.47**	**18.19**	**745** (741-749)	**3.5**	**6.8**	**2.9**	**6.3**
Outside Capital Region	**101221**	**32.6**	**1.05**	**32.29**	**20.28**	**766** (762-771)	**2.9**	**9.0**	**1.6**	**4.1**
...Western Region	16686	5.8	1.05	32.95	21.03	798 (787-810)	3.6	10.8	1.4	3.8
...Westfjords	4783	2.0	1.04	28.66	20.67	775 (755-794)	3.0	8.0	1.1	3.6
...Northern Region	32198	11.6	1.01	32.50	22.52	751 (744-759)	4.0	10.2	2.5	6.2
...Eastern Region	16403	3.4	1.12	30.16	20.71	738 (724-752)	2.6	8.8	1.5	4.5
...Southern Region	30322	8.6	1.06	31.29	21.25	696 (688-705)	1.9	9.6	1.1	2.7
...Southern Peninsula	829	7.0	1.05	34.68	14.66	902 (890-915)	1.6	5.4	1.0	2.4
Total	**102927**	**100.0**	**1.00**	**31.02**	**18.81**	**753** (750-755)	**3.3**	**7.6**	**2.4**	**5.5**

1) Total area, including highlands
2) Gender ratio: Ratio of males to females
3) Child dependency ratio. Number of people aged 0-14 divided by the number of people aged 15-64 and multiplied by 100
4) Aged dependency ratio. Number of people aged 65 and over divided by the number of people aged 15-64 and multiplied by 100
5) Annual average number of deaths 2008-2012 per 100.000. Age standardisation according to Nordic standard with 95% CI
6) Figures on beds and health workers for 2011 from the Ministry of Health 2014. Doctors, nurses and midwives only in the public health sector. Calculated as man-years.

The Capital Region and the Northern Region have the highest number of hospital beds, physicians and nurses and midwives per 1000 population (table 2). The two most specialised hospitals are situated in these regions. They serve both as general regional hospitals and specialised tertiary hospitals with service areas reaching far beyond regional boundaries. The service area of Landspitali University Hospital, which is located in the Capital Region, in fact covers the whole country. Therefore it is not entirely just to divide the number of beds and physicians there with only the residents of the Capital Region. The number of nursing beds per 1000 population (table 2) seems to fit the differential aged dependency ratio reasonably well and is highest in the Western Region but lowest in the Southern Peninsula.

The observed differences in health service provision in health regions, as measured by number of hospital beds and physicians require further examination. Regional variations in health status need to be matched with appropriate and geographically accessible health services. Yet, knowledge on spatial variations in health in Iceland is lacking and it is uncertain whether geographic provision of health services is in accordance with local health status. As stated earlier primary healthcare

needs to be delivered locally since many people use these services frequently. It is however difficult to maintain an even distribution of primary healthcare to promote equality of access, in such a sparsely populated country.

1.7 Health inequalities in the Nordic countries

The socialised health systems in the Nordic countries have been successful and this type of system is considered to generate the best results in terms of public health (Elola et al., 1995). Despite their quality, success and emphasis on equality there is evidence of differences in standard of health care, health outcomes and health-related behaviour between socio-economic groups and across geographic regions. An analysis of the European Social Survey indicated that the Nordic countries do not have the smallest health inequalities as measured by self-rated health and social class (Shaw et al., 2014).

1.7.1 Risk factors

There has been a persistent socioeconomic gradient in obesity in the Nordic countries. An urban-rural gradient has also been observed in Sweden, Finland, Iceland and Norway, to some extent explained by lower educational attainment in rural areas (Magnusson et al., 2014). Residence outside the CA, along with daily smoking and non-university education, was found to be associated with increased risk of obesity among young women of childbearing ages in Iceland (Steingrímsdóttir et al., 2010). A recent study of urban-rural differences of BMI and diet in Iceland indicated that women's (18-80 y.o.) BMI is now less associated with residence than in former Icelandic studies and that men's BMI is not associated with residence. The total prevalence of overweight and obesity among Icelandic adolescents increased between 2000 and 2009. Geographic variation existed with higher rates in rural areas (Þórisdóttir et al., 2012).

1.7.2 Birth outcomes

Research into birth outcomes in the Nordic countries has occasionally focused on regional differences. A recent Finnish study revealed that among children weighing more than 2500 g at birth, perinatal mortality was similar for all hospital levels and that birth outcomes were not systematically better or worse for women living in municipalities served by higher level hospitals than for women living in areas served by small local hospitals (Hemminki et al., 2011). In contrast, a Swedish study indicated that the number of deliveries and availability of neonatal care might have some importance for a

newborn´s survival (Finnström et al., 2006). The differences were nevertheless small, indicating a relatively homogenous quality of care and an efficient system of referral (Finnström et al., 2006). A review of the epidemiological literature found evidence of social inequalities in stillbirths and perinatal mortality in Denmark, Finland and Norway (Jørgensen et al., 2008). The conclusions regarding Sweden were more uncertain and no studies were identified from Iceland.

Birth outcomes in Iceland are among the most favourable worldwide, reflected for example in one of the lowest infant mortality rates, even in comparison with the other Nordic countries (NOMESCO (Nordic Medico-Statistical Committee), 2011). However, studies on pregnancy characteristics and birth outcomes in Iceland by the mothers' geographic residence and health care service level are lacking.

High-risk pregnant women are referred to higher level hospitals in Iceland and therefore residency-based analysis of birth outcomes is needed in order to explore potential differences across geographic regions. The question is whether availability of health services in mothers´ local neighbourhood or distance from the most specialised health services is related to diagnoses of pegnancy complications or birth outcomes. Better understanding of regional variations in birth outcomes is essential for evidence-based organisation of maternity and obstetric health services.

1.7.3 Access to health care

There is evidence that socioeconomic differences in access to health services exist in the Nordic countries. A study in Sweden found that those in most need often refrain from seeking health care which contradicts the national goal of their health care system (Molarius et al., 2014).

A number of indications of inequality in access to health services have also emerged in Iceland, suggesting that the Icelandic health system is not equally accessible for all groups. Significant differences between groups in the use of medical services during illness have been observed, whereby e.g. younger age groups and those economically troubled were more likely to postpone or cancel a visit to the doctor they thought they needed (Vilhjalmsson, 2005). The results further indicated some regional differences and underutilisation of medical services among certain groups. Regional differences in the use of medications have been found among the older generation, showing an equal or a higher number of medications among urban residents as compared to rural residents, despite better socioeconomic status and fewer diagnosed diseases (Sigurdardottir et al., 2013).

A research into spatial inequities in access to specialised cardiac procedures in Iceland 1999-2003 demonstrated geographical variations in the use of these operations. Road distance from residence to service location did not seem to be a determining factor in the utilisation but there were indications that ubanisation was a stronger predictor of utilisation than both income and distance. The author concluded that the most promising corrective measures would be to promote better knowledge of these specialised operations in rural areas and to improve access to primary and specialist care in these areas (Þorsteinsdóttir, 2005).

1.8 Monitoring health inequalities

Despite the fact that equity is a fundamental issue in Icelandic law regular monitoring is lacking. It is important to develop methods to measure and monitor variations in health and access to health services since reforms aimed at equity are not likely unless basic information is accessible (Nolen et al., 2005). Routine monitoring of health inequalities is, however, often hampered by lack of appropriate data. Useful sources of data include national registration and regular updates such as vital regstration systems, health and social surveys and administrative health databases (Nolen et al., 2005). Some of the problems with national monitoring of inequites include lack of timely data pertaining to local neighbourhoods (Marmot et al., 2010). Although health surveys generally include socioeconomic data they cannot always provide routine data on the local level required by local health authorities, especially on small population subgroups. Additional data-sources are therefore needed for health monitoring.

1.9 National health registers in Iceland

Iceland has a strong basis for registration for administrative purposes as all other Nordic countries. Statistics Iceland, the national statistical institute dating back to 1914 is the centre for official statistics in Iceland (Statistics Iceland, 2015a). The Directorate of Health in Iceland dates back to 1760 and has, from its inception, been responsible for the collection, processing and dissemination of data on health and health care services (Directorate of Health, 2015).

Iceland has many population-based and continuously maintained health registers, some of which date back several decades. These include the National Cancer Register (1955), the National Death Register (1911) and the National Medical Birth Register (1972). Other registers are more recent, such as the National Hospital Discharge Register (1999) and the

Register of Contacts with Primary Health Care (2005). These two administrative databases are important sources of information on health and disease as they appear in hospitals and in primary health care. They constitute an important source of information on prevalence and incidence of major illnesses in the population and information on how these illnesses are treated by these types of health services. A legal basis for the national registers is provided by the Director of Health and Public Health Act (Alþingi (Parliament of Iceland), 2007b) and health professionals and health institutions are required by law to provide data for these registers. Provision of data is in accordance with national standards issued by the Directorate of Health (see also chapter 3.1). Private practicing medical specialists working outside hospitals are also required by law to register minimum standardised data and submit to the relevant national database operated by the Directorate of Health. Due to less coverage of electronic information systems and incomplete registration by private practice specialists, the national register on contacts with private practice specialists is at present incomplete and not suitable for research. Since a considerable proportion of outpatient contacts in Iceland are with private practice specialists it is essential to improve the coverage and quality of this register along with other health care contact registers.

The national health registers are extremely valuable resources that must be utilised as much as possible for the benefit of public health. The presence of personal id-numbers in Iceland and the other Nordic countries is also a major strength, enabling register-based linkage between registers and complete follow-up of an entire nation.

2 Aims

With the motivation to support evidence-based spatial organisation of health care services the overarching aim of this thesis is to explore potential differences in health and health service utilisation by geographic regions in Iceland. Taking into consideration settlement pattern, socioeconomic characteristics and availability of health services the objectives were to: (i) compare health indicators and health service utilisation inside and outside the Capital Area; (ii) compare health indicators and health service utilisation in communities in various distance zones from the Capital Area; and (iii) compare health indicators and health service utilisation in communities with varying availability of local health services.

The research was divided into three parts, or studies, each resulting in one paper. Specific aims for each paper were as follows:

I. To explore regional differences in self-rated health and self-reported disease by residence and local health service level.

II. To describe pregnancy complications (gestational diabetes and hypertension), intrapartum care (obstetrical interventions) and adverse birth outcomes (low birthweight, preterm birth, perinatal death) by maternal residence and local health service levels.

III. To i) explore differences in CVD mortality, ii) examine whether differences in CVD mortality are reflected in hospital discharges and primary healthcare utilisation and iii) to determine whether distribution of CVD risk factors are reflected in health service utilisation and mortality by geographic regions.

3 Materials and methods

The studies in the thesis utilise data from a national health survey of 2007 (I, III) and data from four national health registers, i.e. the Medical Birth Register (II), the Causes of Death Register (III), the Hospital Discharge Register (III) and the Register of Primary Health Care Contacts (III).

The following section lists and describes each data source.

3.1 Data sources

3.1.1 The Health and Well-being of Icelanders

In studies I and III we used data from a cross-sectional survey of the Icelandic population that was carried out in late 2007 by the Public Health Institute in Iceland. The survey collected various data on health, health-related behaviours, socioeconomic characteristics and area of residence. Participants were randomly selected from the National Population Register. The random sample was stratified, so that it consisted of a relatively higher number of residents outside the CA than the National Population Register indicates. The older age groups were also over-represented in the sample. The main reason for this stratification of the sample was to enable research into geographic and age variations in health and health behaviours (Jónsson et al., 2011).

Study I used items from the health survey measuring self-rated physical and mental health. A question on physician-diagnosed diseases was also utilised. In study III we used items from the health survey related to behavioural risk factors of cardiovascular disease, including questions on smoking, weight, height, alcohol use, sleeping and difficulties in making ends meet. As the questionnaire lacked applicable questions on physical activity, a question on sedentary lifestyle was utilised.

3.1.2 The Medical Birth Register (II)

Data from the Icelandic Medical Birth Register, that comprises all births in the country, was used for study II. The register dates back to 1972 and has been in electronic form since 1981. It contains individual-level data on pregnancy complications, obstetrical interventions and important adverse birth outcomes such as low birth weight, preterm birth and perinatal deaths. For our study we retrieved the following information

for every birth: birth year, maternal age, occupation, relationship status, parity, residence (postal code), place of delivery and maternal diseases according to ICD-10, mode of delivery, the newborn's gender, the infant´s diseases, Apgar score at 5 minutes, and perinatal death.

The Medical Birth Register relies on assessment and registration of numerous health professionals across the nation. The Directorate of Health is responsible for the register but has, from the outset, assigned operational responsibilities to the largest and most specialised obstetric unit in Iceland, the Department of Obstetrics and Gynaecology at Landspitali University Hospital. The register publishes an annual report, including detailed birth statistics, prepared and audited by an obstetrician, a paediatrician and other staff. Thus major systematic errors are unlikely, though the quality and standardisation for the register have not formally been assessed.

3.1.3 The Causes of Death Register (III)

Data from the Causes of Death Register was used for study III. This register comprises all deaths since 1911 and contains data in electronic form back to 1971. The register contains individual-level information from all death certificates and from autopsy reports if an autopsy was performed. Causes of death have been coded according to ICD-10 since 1996. Every death is coded manually by one specially trained coder and reviewed by one specially trained physician. If registration on death certificates is incomplete additional information is sought from the relevant physicians. The same coder and the same physician were responsible for coding in Iceland during the study period. In order to support the choice of underlying cause of death the ACME programme (Automatic Classification of Medical Entities) has been used in Iceland for several years to check manual coding (NOMESCO (Nordic Medico-Statistical Committee), 2014). For our study we retrieved the following information on every death; age, gender, residence (postal code), civil status, date of death and underlying cause of death (ICD-10 code).

3.1.4 The Hospital Discharge Register (III)

This national administrative register contains minimum data on all hospital discharges in Iceland, from 1999 and onwards. Since 2007 it also includes data on ambulatory and day care at hospitals. Registration of outpatient services of hospitals has been considered less accurate and less complete than inpatient registration but the situation is improving. As an example, Landspitali, University Hospital of Iceland, reported that

the proportion of ambulatory contacts registered without ICD-10 diagnostic codes declined from 49% to 11% between 2007 and 2013 (Landspitali University Hospital, 2014). All hospitals in Iceland are required to register minimum standardised data on admissions, discharges and ambulatory contacts, in accordance with instructions and definitions first published by the Directorate of Health in 2001 (Landlæknisembættið [Directorate of Health], 2011). The minimum standard registration includes ID number, institution number, service category, age, gender, residence (postal code), civil status, reasons for contact (International Classification of Primary Care, ICPC), type of service (inpatient, outpatient), date of admission and discharge, or date of contact, diagnoses (ICD-10) and procedures (including NCSP, NOMESCO Classification of Surgical Procedures).

All hospitals have used the same electronic patient record system for registration since 2007. The Directorate of Health collects the required minimum data, originating in the patient record system, from all hospitals in real time and compiles the data into a national register or database. During that process an effort is made to complement individual data by retrieving information on residence and civil status from the National Population Register if this information is missing or incomplete. Although the quality and standardisation of the Hospital Discharge Register has not been formally assessed its coverage is undoubtedly high, due to the full coverage of the electronic patient record system. For the past few years, especially since 2009 and with an increasing emphasis since 2012, the Directorate of Health has made an effort to scrutinise inpatient registration and guide and support hospitals in their registration. According to the Directorate of Health, ICD-10 codes were provided for 97.5-98.8 % of all hospital discharges in 2011-2013. The minimum registration requirements state that if more than one diagnosis is registered physicians are required to identify one of them as a main diagnosis, that reflects the main reason for examinations and treatment (Landlæknisembættið [Directorate of Health], 2011).

For our study we retrieved the following information on every discharge: ID-number, institution number, service category, age, gender, residence (postal code), civil status, date of admission, date of discharge, type of contact and main discharge diagnosis (ICD-10).

3.1.5 The Primary Health Care Contacts Register (III)

This is a national, administrative register that contains minimum data on all contacts with primary health care centres in Iceland from 2005 and

onwards. Primary health care centres are required to register minimum standardised data on all contacts, telephone, visits and house calls, in accordance with instructions and definitions by the Directorate of Health, first published 2003 (Landlæknisembættið [Directorate of Health], 2008a). The minimum standard registration includes ID number, institution number, age, gender, residence (postal code), civil status, reasons for contact (International Classification of Primary Care, ICPC), type of contact, date of contact, diagnoses (ICD-10) and procedures (including NCSP, NOMESCO Classification of Surgical Procedures).

All primary health care centres use the same electronic patient record system for registration and have done so since 1998. The Directorate of Health collects data from all primary health care centres once a year and compiles the data into the national database. During that process an effort is made to complement individual data by retrieving information on residence and civil status from the National Population Register if this information is missing or incomplete. Although the quality and standardisation of the primary health care contact have not been formally assessed its coverage is probably high due to the full coverage of the electronic patient record system. According to the Directorate of Health, ICD-10 codes were provided in 79.4-82.8% of contacts 2008-2012. The minimum registration requirements state that if more than one diagnosis is registered, physicians are required to identify one of them as a main diagnosis, that reflects the main reason for examinations and treatment (Landlæknisembættið [Directorate of Health], 2008a).

For our study we retrieved the following information on every contact; ID-number, institution number, age, gender, residence (postal code), civil status, date of contact, type of contact and main contact diagnosis (ICD-10).

3.1.6 National Population Register (III)

From the National Population Register we obtained demographic information on the study population for study III. We used information on the total population, employment status, working hours and education category, stratified by gender and age groups, living inside and outside the Capital Area. This information was retrieved from the website of Statistics Iceland. We also used information on the population by gender, age-categories and residence categories, for age standardisation.

3.1.7 Approvals

The first study was based on data from a national health survey carried out by the Public Health Institute in 2007 that was responsible for

obtaining approvals for its administration from the National Bioethics Committee (Vísindasiðanefnd) and the Data Protection Authority in Iceland (Persónuvernd). We obtained permissions from the same authorities to use data from the national health survey for our research.

Studies II and III were mainly register-based and observational. Neither of them involved direct contact with patients, as data for all of the national registers is compiled centrally by the Directorate of Health. The national registers have various purposes stated in the law, including quality surveillance and research, provided that all ethical and data protection requirements are met (Alþingi (Parliament of Iceland), 2007b). We received authorization for studies I, II and III, both from the National Bioethics Committee (VSNb2008090001/03-7) and the Data Protection Authority in Iceland (reference no. 2008090601).

This research did not involve any data linkages between the national databases. Individual data sets were obtained from each database and ID numbers replaced with a unique number for each individual within each dataset. This process was carried out at the Directorate of Health prior to delivery of data to the researchers. Therefore, the researchers did not at any stage of the research process have access to personal ID numbers or any other information with direct reference to the individual's identity.

3.2 Design and methods

The design and methods of our research follow here, described separately for each of the three studies.

3.2.1 Study I – Setting and population

Study I is a cross-sectional survey among the adult population of Iceland in 2007. Participants were randomly selected from the National Register. Residents outside the CA and the older age groups are overrepresented in the sample enabling research into geographic and age variations. A total of 9807 individuals received a questionnaire. The response rate was 60.3%, 57.6% in the CA and 61.9% outside the CA. A total of 5909 individuals between the ages of 18 and 79 participated in the survey and completed a self-administered questionnaire (Jónsson et al., 2011). Respondents were excluded if data on residence was missing (N=105).

3.2.2 Study I – Measures and statistical analysis

The main outcome measures for study I were self-rated physical health, self-rated mental health and self-reported, physician-diagnosed disease. Two questions on self-rated health were used; *In general, how would you rate your*

physical health? and *In general, how would you rate your mental health?* There were four response categories, i.e. very good, good, fair and poor.

As regards diseases, the respondents were provided with a list of 30 diseases (table 3) and asked; *Have you ever had any of the following diseases or symptoms?* (yes, have now; have had before but not now; no, have never had). They were further instructed to indicate whether or not a diagnosis of the condition had been made by a physician (yes; no).

Table 3 Diseases or conditions and their grouping

Disease category	N
Asthma and allgergy	1591
Asthma	*741*
Allergy, e.g. rhinitis, opthalmia and dermatitis	*850*
Chronic bronchitis or emphysema	297
Heart & circulatory diseases	442
Myocardial infarction	*300*
Cerebral haemorrhage or infarction	*142*
Hypertension	1611
Rheumatism	1614
Arthritis	*466*
Osteoarthritis	*813*
Fibromyalgia	*335*
Chronic fatigue syndrome	*260*
Chronic disorders of the back	1162
Cancer	259
Hyperthyroidism	360
Diseases of the eye	432
Common cold	1422
Alcoholism or drug abuse	217
Chronic anxiety/tension	655
Chronic depression	496
Other mental health problems	218
Angina and coronary heart disease	388
Chronic diseases of throat	225
Benign neoplasms	369
Severe headache, incl. migraine	591
Urinary incontinence	495
Spastic colon	528
Gastric ulcer	515
Diabetes	247
Excluded from further analysis	
Cirrhosis	*42*
Paralysis of upper limbs	*179*
Paralysis of lower limbs	*101*

Those who reported that they had (now or before) been diagnosed with a specific disease by a physician were assigned to one group while those never

diagnosed by a physician with that particular disease were assigned to another. If respondents neither checked off ”yes“ nor ”no“ their responses were treated as a ”no“. To preserve numbers for meaningful analyses, several related diseases were grouped into larger categories. If respondents had more than one disease or condition within the disease category they were only counted once. Three diseases (cirrhosis, paralysis of upper limbs and paralysis of lower limbs) were excluded from further analysis due to small numbers (less than 200). With these adjustments the analysis included nineteen diseases or disease categories.

Data are presented as proportion of participants in a given area reporting respective health outcome. Ordinal regression was used to explore differences in self-rated health by area of residence. Ordinal regression was chosen in order to preserve the observed variation in the dependent variable. Logistic regression was used to explore differences in physician-diagnosed diseases. Odds Ratios (OR) and 95 percent confidence intervals (95% CI) were calculated both crude and adjusted for age, gender, education, civil status and income.

Lifestyle factors are strong determinants of self-rated health (Molarius et al., 2007) and in order to examine to what extent lifestyle factors explained differences in health outcomes between residential areas we ran additional models adjusting for smoking, BMI and perceived stress (PSS4) (Cohen, 1983). Weights were not employed in logistic models since categories of geographical residence were presented and adjustments were made for age in accordance with the sampling procedure (18-29, 30-39, 40-49, 50-59, 60-69 and 70-79 years). With this approach the point estimates (odds ratios) corresponded to weighted estimates but the prevalence was slightly higher for outcomes that were more prevalent in the older age groups (that were overrepresented in the sample). Data were analysed using SPSS (version 17.0).

3.2.3 Study II – Setting and population

Study II was a register-based cohort study, using the Medical Birth Register. Data on births from 1 January 2000 to 31 December 2009 (N=44370) were scrutinised for this study. Women were excluded if they had a multiple pregnancy (N=1635), if they had legal residence abroad (N=186) or if data on residence were missing (N=1439). One stillborn infant and one infant that died in the first week of life with ICD-10 code P01.5 indicating that they had been a part of a twin pregnancy were excluded. Data on 40982 live births were thus used and additional 145 stillbirths were included only for calculations on perinatal death.

3.2.4 Study II – Measures and statistical analysis

The main outcomes measures were preterm birth (PTB), low birth weight (LBW), perinatal death, mode of delivery, gestational diabetes and hypertension.

PTB was defined as delivery prior to 37 completed gestational weeks (0-258 days of gestation). According to data from the Medical Birth Register length of gestation is based on ultrasound measurements before 21st week of gestation for 99.8% of births. LBW infants were considered as those weighing less than 2500 grams at birth. Perinatal death was defined according to the World Health Organization´s definition, that is, stillbirth after 22 completed weeks of gestation or death in the first week of life.

Hypertensive disorders in pregnancy were identified by ICD-10 codes O10-O14 and diabetes by O24.0-O24.9. The following obstetric information was used: mode of delivery (vaginal, caesarean and emergency caesarean (ICD-10: O82.1)), newborn's gender, Apgar score at 5 minutes, instrumental delivery (ICD-10:O81), congenital malformations, deformations and chromosomal abnormalities (ICD-10: Q00-Q99) and perinatal death.

Maternal occupation is not coded but written out in free text in the Medical Birth register, e.g. teacher, clerk, hairdresser, actress, social worker, etc. For this study the text was coded, classified and aggregated according to the International Standard Classification of Occupations (ILO-ISCO 08) into the following categories: managers, professionals, technicians, clerical workers, service and sales workers, skilled agricultural, forestry and fishery workers, craft workers, plant and machine operators and elementary occupations. Students, homemakers, disabled persons and unemployed persons were further added to the classification.

Data are presented as proportion of births or mothers in a given area reporting respective pregnancy complications or birth-related outcome. Chi-square was used for comparing proportions and t-test when comparing means. Logistic regression was used to explore differences in outcomes by area of residence while controlling for potential confounding variables. Odds Ratios (OR) and 95 percent confidence intervals (95% CI) were calculated, adjusting for maternal age (continuous), parity, infant's gender, maternal occupation and cohabitation with the child's father. In separate models we adjusted also for hypertension and diabetes. Additional analyses were carried out, categorizing mothers according to whether they lived inside or outside the CA and whether they gave birth in hospitals with the highest level of obstetric and neonatal services (two hospitals) or in other hospitals with less services. The study period was divided into two 5-year periods, 2000-2004

and 2005-2009, for further analysis of main outcomes. Data were analysed using SPSS (version 17.0).

3.2.5 Study III – Setting and population

Study III was an observational register-based study, using data from three nationwide databases, i.e. the Causes of Death Register, the Hospital Discharge Register and the Register of Primary Health Care Contacts. Data from a national health survey of 2007 was used to explore regional distribution of cardiovascular disease risk factors.

Data from the Causes of Death Register were aggregated over a period of ten years with 2009 being the latest available year at the time of analysis (2000-2009, N=18673). The main focus was on analysing deaths from cardiovascular disease (CVD) (ICD-10: I00-I99) from 1 January 2000 to 31 December 2009 (N=7094) but deaths from all causes were included to calculate total death rates. Deaths were excluded if data on residence was missing (N=183 for all deaths and N=19 for CVD deaths).

Data from the Primary Health Care Contact Register were aggregated over a period of five years with 2012 being the latest available year. All contacts, except telephone contacts, with primary health care centres were considered for analysis (2008-2012, N=7773114). The main focus was on analysing contacts having CVD as the primary contact diagnosis from 1 January 2008 to 31 December 2012 (N=223603) but all contacts were includeed to calculate total contact rates. Contacts were excluded if data on residence were missing (N=35328 for all contacts and N=3417 for CVD contacts).

The same time period was chosen for hospital discharge data as for data on primary health care contacts but as data for 2013 became available prior to data analysis 2013 was added to the data set (2008-2013, N=277326). As before, the main focus was on CVD discharges according to primary discharge diagnosis, from 1 January 2008 to 31 December 2013 (N=26087) but all discharges were included for total discharge rates. Discharges were excluded if data on residence were missing (N=8801 for all admissions and N=1195 for CVD admissions).

Data on CVD risk factors were from the 2007 national health survey (N=5909; response rate 60.3%). Respondents were excluded if data on residence was missing (N=105).

3.2.6 Study III – Measures and statistical analysis

The main outcome measures were age-standardised total and CVD mortality rates per 100.000 population and hospital discharge and

primary health care contact rates per 100.000 population.

Age-standardised annual hospital discharge rates, primary health care contact rates and mortality rates for CVD with 95% CI were calculated per 100.000 population in given areas. Standardised rate ratio was computed. Age-standardised annual rates were also calculated for five categories of CVD, taking into consideration ICD-10 subgroups and conditions commonly defined as ambulatory care sensitive conditions or potentially avoidable hospitalizations (Agency for Healthcare Research and Quality, 2013). The five categories were: hypertension (ICD-10: I10-I13), ischemic heart disease (I20-I25), atrial fibrillation (I48), heart failure (I50) and cerebrovascular disease (I60-I69). The Agency for Healthcare Research and Quality (AHRQ) definition of prevention quality indicators (Agency for Healthcare Research and Quality, 2013) was used only as a general reference to identify diseases and to group ICD-10 codes. All discharges were used for calculations instead of implementing AHRQ´s defined exclusions, the rationale being that the specific exclusions were not suitable for data on contacts with primary health care and data on deaths. All rates were age-standardised for men and women separately. Numbers on population size at approximately mid-term of study were used: 2005 when calculating annual mortalilty rates and 2010 when calculating annual discharge and contact rates. The Nordic standard population of 2000 was chosen for standardisation. Annual discharge rates and contact rates were based on the total number of individuals, where each unique person was counted only once within the observation time period and within the relevant disease category independent of which institution was providing the health services. If an individual was, e.g., discharged twice from hospital during 2008-2013, independent of which hospital in Iceland, with a primary diagnosis of hypertension he/she was counted only once in that disease category. If the same individual was also admitted twice during the same period with a primary diagnosis of atrial fibrillation he/she was also counted once within that disease category.

Logistic regression was used to explore differences in behavioural risk factors by area of residence while controlling for potential confounding variables. Odds ratios and 95% CI were calculated, adjusting for age, gender, education, civil status and income. SPSS (version 17.0) was used for logistic regression.

3.2.7 Residence grouping (I, II, III)

All data sources contained data on residence by postal codes. The 128 postal zones in Iceland are frequently used for data collection. Their disadvantage is, however, that that they do not necessarily match

residents' perceptions of their neighbourhood or community.

In order to assign the study populations to communities or localities rather than postal zones the postal codes were combined into urban nuclei (N=115) as defined by Statistics Iceland. A decision was made to use urban nuclei as the basic spatial units for this research. Statistics Iceland defines an urban nucleus as a town, village or other area where inhabitants live in houses standing in the vicinity of one another. The boundary between urban localities and rural areas is set at localities with 200 inhabitants or more. Localities with population below 200 are defined as rural, independent of the density of houses. The population of the urban nuclei in Iceland usually range from 200 to a few thousand, with the exception of the CA with close to 200.000 inhabitants.

For this research the communities, or the urban nuclei and rural farm areas, were further grouped according to population distribution, distance from CA and availability of health services. In that way the focus was on the first two dimensions in Penchansky´s and Thomas´ (1981) definition of the concept access, i.e. availability and accessibility, including geographical barriers such as distance, transportation, travel time and cost.

In our analyses we firstly contrasted the CA (the reference category) with all other areas. The CA consists of Reykjavik, the capital of Iceland and 7 urban nuclei around it, i.e. Kopavogur, Hafnarfjordur, Gardabaer, Alftanes, Mosfellsbaer, Seltjarnarnes and Grundarhverfi. A distinction between those living inside or outside the Capital Area, albeit broad, is justifiable in this research. The population distribution in Iceland, with its concentration of 2/3 of the population in the CA and the remaining 1/3 scattered around the country in small villages and rural areas, offers an opportunity for such a bisection. A further rationale is provided by the fact that supply of specialised health services is mainly limited to the CA. Two approaches were then used in categorising areas outside the CA. Firstly we focused on availability and geographic accessibility of the most diverse and specialised health services in the CA. We therefore classified settlement according to distance from the CA (table 4 and figure 2). The three distance zones were identified from a survey of domestic travel patterns (Reynarsson, 2006).

Study populations were assigned to distance zones based on road distance from the CA to their respective urban nuclei. Official road distance was retrieved from the Icelandic Road Administration website (Vegagerðin, 2009). If more than one route was available the shortest (excluding highland

roads closed during winter) was selected. For those who resided in rural farm areas road distance was measured from the CA to an approximate centroid of population distribution in the relevant health region.

Table 4 Distance categories

Distance from Capital Area	Frequency of contact with Capital Area[1)]	Travel time to Capital Area	Population[2)]
< 69 km	x 2 per week	< 1 hours	38000
70-249 km	x 1 per week or every 2nd week	1-3 hours	23000
≥ 250 km	x 4-6 per year	> 3 hours	56000

[1)] Average frequency of contact with Capital Areas according to a survey of domestic travel patterns (Reynarsson, 2006)

[2)] Approximated total population in each distance zone by the end of 2008. The total population of the Capital Areas was approximately 203000

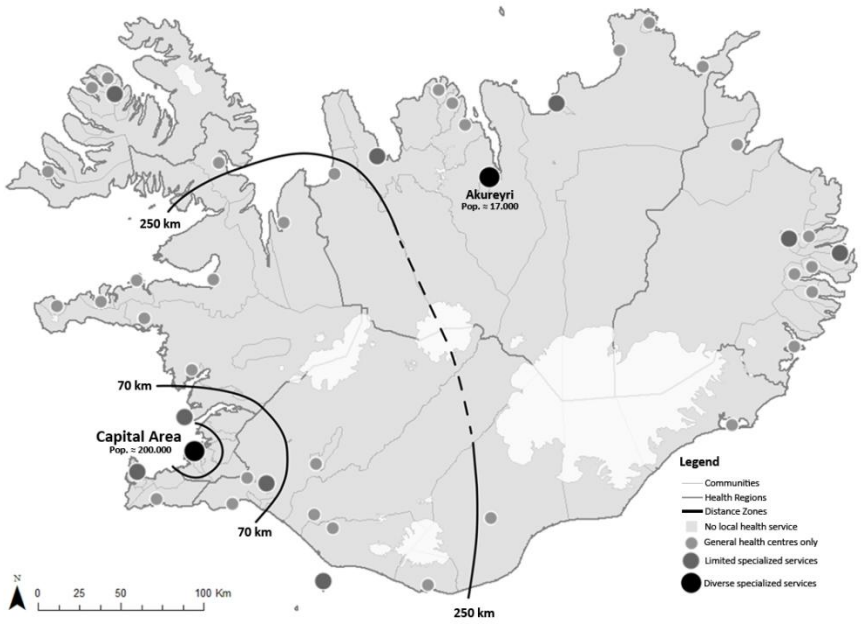

Figure 2 Approximate boundaries between distance zones from the Capital Area and categories of local health service levels in all communities.

Secondly we classified residency according to availability of local health services, assessed for each urban nucleus using information from an official register (Landlæknisembættið [Directorate of Health], 2009) (table 5 and figure 2). The following health services were considered: Primary health care centres, hospitals, nursing homes and physicians in private practice. For the purpose of this study four categories of local health service supply were identified. 1) Areas with diverse specialised services, including a specialised hospital, primary health care centres,

physicians in private practice, nursing homes, etc. (the reference category). The CA and Akureyri belong to this group. 2) Areas with only limited specialised services, including a small general hospital with limited specialities or access to limited specialities by means of service contracts with larger hospitals, primary health care centres and nursing homes. Some of the larger urban nuclei in Iceland, with a population of a few thousand, are in this group. 3) Areas with a local primary health care centre, with at least one permanent GP as well as other staff, and usually also a nursing home. Small urban nuclei, with a population of a few hundred up to 3000 fall into this category. 4) Areas where there are no health services in the local community, except perhaps primary health care branches with no permanent staff and limited opening hours. Rural farm areas and the smallest urban nuclei, where the population does not exceed 600 individuals, belong to this group.

Table 5 Categories of local health services

Categories of local health services[1)]	Communities in category	Population[2)]
Diverse specialised services	Capital Area and Akureyri	215000
Limited specialised services	Some of the larger urban nuclei	36000
Primary health care only	Small urban nuclei	28000
No local health services	Rural areas and the smallest urban nuclei	37000

[1)] Availability of local health services was assessed for each urban nucleus using information from an official register (Directorate of Health, 2009)

[2)] Aggregated population in areas belonging to each category. Approximate population by the end of 2008

4 Results

4.1 Study I – results

4.1.1 Self-rated health

In paper I we explored regional differences in self-rated health and found that residents outside the CA rate their own mental, and especially physical, health worse than those living in the CA (aOR 1.35; 95% CI 1.23-1.50 and aOR 1.17: 95% CI 1.06-1.30 respectively) (table II, paper I).

4.1.2 Diagnosed diseases

In paper I we also explored regional differences in self-reported physician-diagnosed disease. Of the 22 studied disease categories four were statistically significantly less reported outside the CA, i.e. heart and circulatory disease (aOR 0.77; 95% CI 0.62-0.95), cancer (aOR 0.78; 95% CI 0.60-0.99), diseases of the eye (aOR 0.73; 95% CI 0.59-0.90) and alcoholism and drug abuse (aOR 0.72; 95% CI 0.55-0.96) (table IV, paper I). Only one disease category, hyperthyroidism, was more reported outside the CA than within (aOR 1.25; 95% CI 1.00-1.57). No large differences were observed in self-reported disease prevalence between residents in different distance zones (table IV, paper I). Residents in areas with abundant supply of specialised health services were more likely than residents with limited health services to report that they had been diagnosed with: heart and circulatory diseases, cancer, benign neoplasm, other mental health problems, diseases of the eye and urinary incontinence (supplementary table A, paper I).

4.2 Study II - results

In paper II we explored pregnancy, intrapartum and adverse birth outcomes by maternal residence and found no association between mother´s area of residence and the risk of LBW and PTB (tables 2, 4 and S1 in paper II). Infants outside the CA were more likely to have been delivered with a cesarean section than infants in the CA (table 2, paper II). Compared to the CA, diagnoses of maternal gestational diabetes and pregnancy-induced hypertension were significantly less common outside the CA (aOR 0.68; 95% CI 0.59-0.78 and aOR 0.82: 95% CI 0.71-0.94 respectively) (table 2, paper II).

During 2000-2009 187 infants were stillborn or died during the first 7 days after birth (N=145 and N=42, respectively) (table 3, paper II). The adjusted

odds of perinatal deaths were not significantly higher outside the CA for the whole 10-year period but significantly higher in the second half of the observed period (aOR 1.87; 95% CI 1.18-2.95). These increased odds of perinatal death in the second part of the study period were mainly restricted to mothers residing outside the CA but giving birth at hospitals with the highest level of obstetric and neonatal services (two hospitals) (aOR 2.65; 95% CI 1.64-4.30), as compared to the reference group of mothers residing in the CA and giving birth at the same two specialised hospitals (table 6).

Table 6 Perinatal deaths by mother´s residence inside versus outside CA and by category of birth hospital, i.e. general hospitals versus hospitals with specialised obstetric care

	Res: Inside CA Birth: Spec. Hosp.	**Res: Inside CA Birth: Gen. Hosp.**	**Res: Outside CA Birth: Gen. Hosp.**	**Res: Outside CA Birth: Spec.Hosp.**
Perinatal deaths (<7 days)				
N	(104)	(1)	(18)	(64)
aOR	1.0	0.21 (0.03-1.56)	0.66 (0.38-1.13)	1.94 (1.35-2.80)*
N^1 & N^2	(55)&(49)	(0)&(1)	(6)&(12)	(26)&(38)
aOR^{00-04}	1.0	... ...	0.38 (0.15-0.94)*	1.26 (0.74-2.15)
aOR^{05-09}	1.0	0.55 (0.07-4.17)	1.02 (0.51-2.03)	2.90 (1.77-4.75)*

aOR adjusted for age, parity, infant´s gender, occupation group and partnership
N^1 & N^2 number of cases 2000-2004 and 2005-2009
*aOR significantly different from 1,0, 95% CI
Res: Residence
Birth: Spec.Hosp. Birth at a hospital with specialised obstetric care (Landspitali or Akureyri)
Birth: Gen.Hosp. Birth at a general hospital outside the CA

We found no association between distance of maternal residence from CA and risk of LBW and PTB. The risk of perinatal deaths was only significantly higher in areas most adjacent to the CA and in areas furthest away from the CA in the latter time period (table 7).

Table 7 Perinatal deaths (<7 days) by distance from CA (mother´s residence)

	Capital Area	**<69 km**	**70-249 km**	**≥250 km**
Perinatal deaths (<7 days)				
N	(105)	(31)	(10)	(41)
aOR	1.0	1.71 (1.09-2.67)*	0.90 (0.44-1.84)	1.43 (0.95-2.17)
N^1 & N^2	(55) & (50)	(9) & (22)	(6) & (4)	(17) & (24)
aOR^{00-04}	1.0	0.98 (0.46-2.08)	0.76 (0.29-1.98)	0.98 (0.53-1.81)
aOR^{05-09}	1.0	2.49 (1.40-4.43)*	1.03 (0.35-3.06)	2.08 (1.19-3.64)*

aOR adjusted for age, parity, infant´s gender, occupation group and partnership
N^1 & N^2 number of cases 2000-2004 and 2005-2009
*OR significantly different from 1,0, 95% CI
1) Road distance according to the Icelandic Road Administration

4.3 Study III

In paper III we i) explored differences in CVD mortality, ii) examined whether differences in CVD mortality were reflected in hospital discharges and primary health care utilisation, and iii) determined whether distribution of CVD risk factors were reflected in health service utilisation and mortality by geographic regions.

4.3.1 Age-standardised annual mortality rates

A total of 3733 men and 3361 women died from CVD in Iceland during 2000-2009. The annual age-standardised total CVD mortality rate was slightly, but significantly, higher for women outside compared to inside the CA. The greatest differences in rates were for atrial fibrillation and heart failure, with higher rates outside the CA (table 2, paper III). The mortality rate for men only differed significantly for atrial fibrillation, with a higher rate outside the CA and for hypertension, with higher rates inside the CA. The total number of deaths was low for both diseases.

4.3.2 Age-standardised annual contact rates with primary healthcare

A total of 28002 men and 30244 women with CVD contact diagnoses visited primary health care between 2008 and 2012.

The overall CVD contact rate was significantly higher outside the CA with a standardised rate ratio (SRR) of 1.27 (1.27-1.28) for males and 1.36 (1.35-1.36) for females and for all of the observed CVD subgroups for both gender. The greatest regional difference was for atrial fibrillation (SRR 1.70 (1.69-1.70) for males and 1.85 (1.85-1.85) for females) and for heart failure (SRR 1.73 (1.73-1.73) for males and 1.82 (1.82-1.82) for females) (table 3, paper III).

4.3.3 Age-standardised annual hospital discharge rates

A total of 8384 men and 5655 women were discharged from hospitals in Iceland during 2008-2013 with CVD as a primary diagnosis.

The total annual CVD discharge rate was higher among residents outside compared to inside the CA for both genders, with SRR 1.06 (1.06-1.07) for males and 1.25 (1.25-1.26) for females. The greatest difference in discharge rates for both genders inside versus outside the CA was for hypertension (SRR 2.67 (2.61-2.75) for males and 2.98 (2.93-3.04) for females) and atrial fibrillation (SRR 1.43 (1.43-1.45) for males and 1.64 (1.63-1.64) for females) (table 3, paper III).

4.3.4 Risk factors of cardiovascular disease

There were no differences in smoking prevalence inside compared to outside the CA but obesity was more prevalent outside the CA (table 4, paper III), particularly among young women. Short sleep duration was more common among residents outside the CA and a larger proportion of residents, especially the younger age groups outside the CA, found it difficult to make ends meet. Sedentary lifestyle and alcohol abuse was, however, less prevalent outside the CA.

There were also notable demographic differences between residents inside and outside the CA (table 1, paper III). The proportion of the population with a university degree was, e.g., twice as high inside compared to outside the CA and rose between 2005 and 2010.

4.3.5 Additional regional analyses

Comparing rates by distance from the CA revealed a significantly higher total mortality rate and CVD mortality rate for women residing in areas most adjacent to the CA (table 8). The total mortality rate for men was, however, slightly but significantly lower in areas furthest away.

Table 8 Age-standardised mortality rates (SR) per 100,000 inhabitants by distance zones from the Capital Area (CA), 2000-2009 annual average

	CA		<69 km		70-249 km		≥250 km	
Cause of death	N[1)]	SR[2)]	N[1)]	SR[2)]	N[1)]	SR[2)]	N[1)]	SR[2)]
All causes, male	5749	966.3 (952.3-980.3)	1044	1000.2 (967.9-1036.1)	832	955.7 (958.7-1032.7)	1909	927.2 (904.3-950.1)
All causes, female	5859	696.6 (686.5-706.7)	954	834.5 (805.5-863.5)	650	675.2 (646.0-704.4)	1676	700.3 (681.7-718.9)
CVD, male	2240	399.9 (391.1-408.7)	390	405.7 (384.3-427.1)	331	407.2 (383.9-430.5)	772	384.9 (370.4-399.4)
CVD, female	2153	253.5 (247.9-259.1)	366	339.9 (321.1-357.3)	215	218.3 (203.4.8-233.2)	627	259.6 (249.2-269.8)

[1)] N=total mortality 2000-2009
[2)] SR=standardised mortality rate, annual average 2000-2009

The adjusted odds of obesity, smoking, short sleep duration and of difficulties in making ends meet were significantly higher in areas closest to the CA (table 9).

Areas with low levels of local health services, i.e. only primary health care, had significantly higher CVD mortality rates and total mortality for both genders compared to areas with abundant health care supply (table 10).

We further observed 50% higher CVD contact rates and one third higher CVD discharge rates in areas with only local primary health care or with local primary health care and a limited supply of specialised services (small and large towns outside the CA) as compared to the reference group (table 11). CVD contact rates were, however, approximately 25% lower and discharge rates 45% lower in areas with no local health services (rural farm areas) for both genders.

Table 9 Differences in behavioural risk factors of CVD by distance from Capital Area in 2007

Capital Area		**<69 km**	**70-249 km**	**≥250 km**
Regular smoking (daily or less)				
(N) %	(566) 21.4	(227) 25.9	(113) 19.5	(284) 20.7
aOR	1.0	1.22 (1.02-1.47)*	0.88 (0.70-1.10)	0.90 (0.77-1.07)
Obesity (BMI ≥ 30)				
(N) %	(509) 18.2	(258) 27.7	(143) 23.4	(338) 23.1
aOR	1.0	1.71 (1.43-2.03)*	1.31 (1.06-1.63)*	1.35 (1.16-1.57)*
Sedentariness (sitting ≥8 hrs/day)				
(N) %	(949) 34.0	(226) 24.2	(104) 17.0	(264) 18.1
aOR	1.0	0.66 (0.55-0.78)*	0.43 (0.34-0.54)*	0.46 (0.39-0.54)*
Alcohol abuse (5 drinks or more at a time once a week or more)				
(N) %	(193) 6.9	(65) 7.0	(22) 3.6	(80) 5.5
aOR	1.0	0.95 (0.70-1.28)	0.46 (0.29-0.73)*	0.70 (0.53-0.92)*
Short sleep duration (sleeping ≤6 hrs)				
(N) %	(664) 23.8	(266) 28.5	(141) 23.0	(391) 26.8
aOR	1.0	1.24 (1.05-1.47)*	0.94 (0.76-1.16)	1.13 (0.97-1.31)
Difficult to make ends meet				
(N) %	(355) 12.7	(158) 16.9	(80) 13.1	(233) 15.9
aOR	1.0	1.37 (1.11-1.69)*	1.01 (0.77-1.32)	1.26 (1.05-1.52)*

aOR adjusted for age, gender, education, civil status and income
* aOR significantly different from 1.0, 95% CI

Table 10 Age-standardised mortality rate (SR) per 100,000 inhabitants by local health service supply, 2000-2009 annual average

	Diverse specialised services		**Limited specialised services**		**Primary health care only**		**No local health services**	
Cause of death	**N[1)]**	**SR[2)]**	**N[1)]**	**SR[2)]**	**N[1)]**	**SR[2)]**	**N[1)]**	**SR[2)]**
All causes, male	6225	960.3 (946.9-973.7)	1118	954.5 (923.1-985.9)	1101	1070.2 (1035.7-1104.7)	1090	910.8 (881.1-940.5)
All causes, female	6354	692.5 (682.8-702.2)	1029	726.6 (702.1-751.1)	946	799.4 (771.1-827.6)	810	714.6 (687.7-741.5)
CVD, male	2174	349.9 (341.9-357.8)	418	369.5 (350.2-388.8)	463	457.9 (435.5-480.3)	420	358.3 (339.8-376.7)
CVD, female	2080	225.2 (220.0-230.3)	369	265.3 (251.8-278.8)	332	280.5 (264.5-295.4)	282	253.0 (237.7-268.3)

[1)] N=total mortality 2000-2009
[2)] SR=standardised mortality rate, annual average 2000-2009

Table 11 Age-standardised primary healthcare CVD contact rates and CVD hospital discharge rates (SR) per 100,000 inhabitants, annual average 2008-2012/2013 by local health service supply and residence

Indication for service	**Diverse specialised services**		**Limited specialised services**		**Primary health care only**		**No local health services**	
CVD	**N[1)]**	**SR[2)]**	**N[1)]**	**SR[2)]**	**N[1)]**	**SR[2)]**	**N[1)]**	**SR[2)]**
PHC CR, male	17232	3793.5 (3765.5-3821.5)	4658	5755.6 (5674.1-5837.1)	3290	5782.3 (5692.5-5872.1)	2192	2759.9 (2702.7-2816.0)
PHC CR, fem.	19272	3820.0 (3792.7-3847.2)	4909	5893.4 (5810.3-5976.5)	3899	5980.4 (5884.5-6076.2)	2164	3021.1 (2957.2-3085.0)
HDR, male	5371	1092.2 (1080.8-1109.5)	1141	1270.6 (1234.7-1306.5)	1128	1449.6 (1408.0-1491.1)	516	579.9 (555.3-604.5)
HDR, fem.	3658	610.5 (600.8-620.2)	897	925.9 (896.6-964.1)	707	894.2 (862.4-926.1)	278	355.6 (355.6-375.6)

PHC CR Primary health care contact rate
HDR Hospital discharge rate
[1)] Total number of individuals 2008-2012 for primary care contacts and 2008-2013 for hospital discharges
[2)] Age standardised primary healthcare contact or hospital dishcarge rate

5 Discussion

5.1 Main findings

Our data reveal regional inequalities in health and health care utilisation in Iceland that can be summarised as follows:

- Self-rated health was generally reported poorer outside the CA.
- Less self-reported major chronic diseases outside the CA.
- Pregnant women living outside the CA were at reduced odds of being diagnosed with gestational diabetes and hypertension.
- Increased risk of perinatal death among mothers outside the CA during the latter period of the study.
- Prevalence of PTB and LBW was not related to mothers' area of residence.
- Data from three national health registers suggested higher CVD prevalence outside the CA, i.e.:
    - Higher primary healthcare CVD contact rate outside the CA
    - Higher CVD hospital discharge rate outside the CA
    - Higher CVD mortality among women outside the CA
- Burden of modifiable risk factors was higher outside the CA, especially among younger women.

5.2 General discussion

5.2.1 Regional health inequalities

Many studies suggest health disadvantages in rural and remote areas, e.g. as measured by self-rated health (Fogelholm et al., 2006; Monnat & Beeler Pickett, 2011), adverse birth outcomes (Bailey & Cole, 2009; Graham et al., 2007; Grzybowski et al. 2009; Lisonkova et al., 2011; Luo & Wilkins, 2008) and increased CVD mortality (Stang & Stang, 2014).

Our study I, of regional differences in health in Iceland, found evidence of poorer self-rated health outside the CA, indicating higher morbidity and mortality. That was, however, not the case, judging by a national health survey, as residents outside the CA were less likely to self-report some major chronic diseases, i.e. heart and circulatory disease, cancer, diseases of the eye and alcoholism and drug abuse. Initially we suggested that a potential explanation for these contradicting findings were that specialised health services were less accessible to residents outside the CA, resulting in less diagnostic activity. We further suggested that regional differences in health

care seeking behaviour, e.g. lower health care use might also contribute to lower rates of diagnosed diseases outside the CA (Gudmundsdottir & Vilhjalmsson, 2010). Alternatively, an explanation for why some self-reported chronic diseases were less prevalent outside the CA could be that those who suffered from those diseases had moved to the CA in order to gain better access to specialised services. Selective migration might therefore have contributed to lower rates of certain diseases outside the CA. The general trend in internal migration in Iceland for the past decades has been that people tend to move to the CA away from rural regions (Statistics Iceland, 2015b). Two-thirds of those who moved to the CA were under the age of 30 and 96% under the age of 60. Consequently, it could be argued that internal migration should have contributed to higher disease prevalence outside the CA.

Study II, using register data, also found evidence of less diagnosed diseases outside the CA, as there were less diagnoses of pregnancy-induced hypertension and gestational diabetes among pregnant women outside the CA. Again we suggested potentially lower diagnostic activity in more rural areas with less local health services, as discussed further in chapter 5.2.2.

In study III our analyses of data from three national health registers did, however, point in the opposite direction, i.e. indicating higher CVD prevalence outside the CA, which is in accordance with the poorer self-rated health shown in study I. A Dutch study, comparing urban – rural differences in disease prevalence using data from general practice, also found differences in prevalence that were always disadvantageous for rural areas (Kroneman et al., 2010). Likewise, the same study found discrepancy between self-reported illness and data from general practice where rural residents rated their own health better and reported less diseases than data from general practice suggested. By analysing register data on the total population we found a slightly higher total CVD mortality rate for women and also higher contact rate with primary health care and higher hospital discharge rate due to CVD for both genders outside the CA. The indication of lower self-reported CVD prevalence than portrayed by utilisation rates deserves further scrutiny as this could point to less disease awareness among residents outside the CA. Disease awareness is known to affect risk-related behaviour and health care utilisation (Mosca et al., 2006; Naweed Alzaman et al., 2013).

5.2.2 Regional inequalities in birth outcomes

Studies have typically found poorer birth outcomes, such as LBW, PTB and perinatal death, among infants born to mothers in rural areas (Bailey & Cole,

2009; Graham et al., 2007; Grzybowski et al., 2011; Lisonkova et al., 2011; Luo & Wilkins, 2008). Our study II found no indication of urban - rural differences in LBW and PTB but found increased risk of perinatal death among children born to mothers residing in more rural areas outside the CA. The overall rate of perinatal death was, however, very low (3.2/1000 in 2009) (NOMESCO (Nordic Medico-Statistical Committee), 2011).

According to regulation, maternity care and postnatal care is provided by midwives, nurses and GPs at primary health care centres, most often in women's local neighbourhoods. Pregnant women receive an average of 9 antenatal examinations (Embætti landlæknis [Directorate of Health], 2013), including an ultrasound screening at 19 to 20 weeks of pregnancy (Landlæknisembættið [Directorate of Health], 2008b). High-risk pregnancies are systematically referred to hospitals with the highest level of obstetric and neonatal services. This referral system became formal in 2007, with the publication of clinical guidelines (Landlæknisembættið [Directorate of Health], 2007). Informal guidelines, facilitating identification of high risk pregnancies were, however, available as early as 1983 (Landlæknisembættið [Directorate of Health], 2008b). The current guidelines identify four levels of delivery services within Iceland. The highest level of service is recommended for all premature infants of less than 34 weeks of gestation (Landlæknisembættið [Directorate of Health], 2007). The increased risk of perinatal death was largely confined to women outside the CA giving birth at specialised obstetric units. This finding may indicate an effective referral system, where high-risk pregnancies outside the CA are properly identified and referred to the most specialised delivery services. Despite the seemingly effective referral system, the risk of perinatal death was nevertheless greater among women outside the CA, which could indicate that undetected high-risk pregnancies were more prevalent outside than inside the CA. In agreement with this, diagnoses of gestational hypertension and diabetes seemed less common among mothers outside the CA in the second half of the study period. This may reflect reduced diagnostic activity or incomplete registration of these diseases outside the CA.

The current clinical guidelines in Iceland, based on the National Institute for Health and Care Excellence (NICE) guidelines, recommend screening for gestational diabetes if certain risk factors are present (National Institute for Health and Care Excellence (NICE), 2008). Whether regional differences in screening practices and detection of maternal health problems contribute to variation in adverse birth outcomes across geographic regions remains to be further elucidated. With considerably

higher BMI and higher prevalence of smoking among rural women of fertile age (Steingrímsdóttir et al., 2010), a likely explanation is that health professionals within the CA have, in recent years, become more conscious at assigning and recording antenatal diagnoses than their colleagues outside the CA. Thus, it is possible that undetected gestational hypertension and diabetes during pregnancy may have contributed to more high-risk deliveries of mothers outside the CA. The reasons for, and the consequences of, lower rates of infant and maternal diagnoses in rural areas therefore warrant further study.

Infants of mothers residing outside the CA were furthermore less likely to have been diagnosed with congenital malformations or 5 minute Apgar scores below 7. It is unclear why this is the case but similarly it is possible that less diagnostic activity or differences in registration may contribute to these differences.

A Finnish study found similar differences in Apgar scores between the smallest and the largest delivery units (Finnström et al., 2006). The authors concluded that the observed differences possibly reflected use of different diagnostic criteria.

5.2.3 Regional inequalities in health service utilisation

The observed regional differences in CVD mortality, hospital discharges and primary health care contacts are, as previously stated, indicative of variations in CVD prevalence and underlying risk factors. Findings of regional differences in CVD mortality, that coincide with regional variations in relevant risk factors, is consistent with previous studies (Stang & Stang, 2014). The regional differences in mortality and health care utilisation rates can, however, also indicate differences in availability, usage or effectiveness of health care services.

As stated in chapter 1.6.1 there are pronounced regional variations in local health service supply, not the least when it comes to the most specialised health care services. Specialised hospital and outpatient services are mostly concentrated in the CA, making specialised health services geographically less accessible to residents outside the CA. Due to these geographic variations in supply of specialised health services it is possible that some health problems are dealt with by means of hospital admissions outside the CA while taken care of with other resources, such as by specialists in private practice, in the CA. Alternatively, geographical circumstances might encourage inpatient services for patients from sparsely populated areas, where they can be more easily observed.

It cannot be ascertained whether higher CVD contact rates outside the CA are indicative of higher prevalence of CVD, since equivalent data on contacts with private practice specialists were not available for this study. Although their services are used by patients from all areas of the country they are probably used more by residents of the CA than by residents outside the CA. There were approximately 35000 contacts with cardiologists in private practice in 2012 (Sjúkratryggingar Íslands (Icelandic Health Insurance), 2013) as compared to approximately 45000 annual contacts with primary health care due to CVD. Thus, outpatient visits to cardiologists in private practice, that were of similar magnitude as all CVD contacts with primary health care, could partly explain higher CVD primary health care contact and hospital discharge rates outside the CA. An analysis of data from Icelandic Health Insurance revealed that residents of the CA and the West health region visited private practice cardiologists more than inhabitants of other regions, i.e. 128 visits per 1000 inhabitants in both regions. Inhabitants of the three regions farthest away from the CA, i.e. the North, East and Westfjords regions had the fewest visits, ranging from 9 to 38 per 1000 inhabitants (The Boston Consulting Group, 2011). In addition, Landspitali, the University Hospital of Iceland, located in the CA, operates the only specialised outpatient heart clinic in the country that manages cardiac emergencies. In 2013 this clinic served a total of 5130 emergency contacts (Landspitali University Hospital, 2014). The clinic receives referrals from primary health care in the CA, possibly reducing the need for hospital admissions among residents of the CA. This could be one of the reasons why the standardised hospital discharge rate for cardiovascular diseases was higher outside the CA.

In sum, it is difficult to determine from these administrative data whether there exist actual differences in CVD prevalence between geographic regions. The slightly higher age-standardised CVD mortality among women is nevertheless a clear indication of inequities that must be explored further. It is also clear that residents outside the CA use more primary healthcare services and hospital inpatient services due to CVD than residents of the CA when differences in age and gender have been accounted for. On the other hand, data from Icelandic Health Insurance, albeit not age-standardised, suggest that residents of the CA use services of private practising cardiologist more than residents outside the CA (The Boston Consulting Group, 2011). As GPs in Iceland do not have a gatekeeping role for secondary care it is impossible to investigate health differences by using only data from health care centres and inpatient data from hospitals.

5.2.4 Regional inequalities in modifiable risk factors

The higher burden of CVD risk factors outside the CA is in accordance with evidence from other studies (Gudjonsdottir, 2015; Steingrímsdóttir et al., 2010) and supports the notion of higher CVD prevalence outside the CA. The especially high burden of risk factors among younger women outside the CA and the slightly raised CVD mortality outside the CA is alarming and requires further attention. Studies have revealed that level of education is a strong, independent predictor of coronary heart disease mortality and higher education has also been associated with lowered mortality due to all causes (Gardarsdottir et al., 1998; Winkleby et al., 1992). Education is furthermore an important determinant of self-rated health (Prus, 2011) and is related to birth outcomes (Hemminki, 2009) and utilisation of health services (Kristenson et al., 2011). Therefore, the inequalities in education, with twice as high a proportion of the population having earned a university degree inside the CA compared to outside, are especially important from a public health point of view. The fact that the proportion of individuals with the highest level of education has in recent years increased more in the CA than outside deserves particular consideration. Other modifiable risk factors were also pronounced especially among women outside the CA, including risk of obesity, excessive work load and difficulty in making ends meet. These findings of poorer health among women outside the CA add to previous findings of higher prevalence of disability among women outside the CA (Thorlacius & Stefansson, 2007).

5.2.5 Availability of local health services outside the CA

The overall aim of the present work was to explore potential differences in health and health service utilisation by geographic regions in Iceland, in relation to availability of local health services. Such research is necessary to support evidence-based spatial organisation of health care aiming at reducing avoidable regional health disparities. Since specialised health care, is mainly concentrated in the CA, the main focus of our analyses was on differences in outcomes inside and outside the CA.

Our studies found several indications of generally poorer health outcomes outside the CA, in areas with limited supply of specialised local healthcare services. These indications were found using both self-reported health data and data generated by the healthcare services on the occasion of health services delivery. These poorer health outcomes coincided with a higher burden of risk factors outside the CA. The largest differences were typically when comparing small towns with only local primary healthcare with the

reference area with abundant and diverse health service supply. The highest CVD mortality, hospital discharge and primary healthcare contact rates were, e.g. found in small towns outside the CA.

In spite of clear indications of higher disease prevalence and a higher burden of important risk factors outside the CA we observed potentially lower diagnostic activities in maternal healthcare outside the CA. We also found evidence of less self-reported major chronic disease outside the CA, perhaps indicating lack of successful communication between physicians and patients. These poorer health outcomes outside the CA, indications of undetected maternal diseases and potential unawareness of major chronic disease diagnoses suggest regional inequties in content and quality of healthcare services that need to be addressed.

The fact that the CVD hospital discharge rate was halved in agricultural farm areas and that the primary healthcare contact rate was one third lower than in the reference group is notable. Particularly so since CVD mortality was not raised for men in agricultural areas and only slightly for women. Residents of farm areas are, therefore, an exception to the general finding of raised CVD service utilisation outside the CA. This finding, together with lower CVD mortality among male residents of farm areas, is consistent with previous reports of lower CVD mortality and morbidity among farmers (Thelin et al., 2009). The odds of reporting fair/poor self-rated physical health was, however, highest in agricultural farm areas, were physically demanding jobs can be expected.

Potentially avoidable hospitalizations have been used to give an indication of how well primary healthcare is performing, thus identifying regions of possible improvements (Gibson et al., 2013; Manzoli et al., 2013). Adequate primary health care has been associated with reduced potentially avoidable hospitalization. Deprivation, rurality, distance to hospital, propensity for hospitalization, unemployment, educational level and lifestyle are also important factors (Berlin et al., 2014; Burgdorf & Sundmacher, 2014; Gibson et al., 2013; Löfqvist et al., 2014; Purdy, 2013; Thygesen et al., 2015; van Loenen, 2014). Nearly threefold discharge rates for hypertension outside the CA could be indicative of insufficient primary healthcare, since hypertension can, in most cases, be adequately managed by primary healthcare. However, unfavourable risk factors and higher disease rates could also explain these differences. The definition of avoidable hospitalization, although beneficial, isn´t necessarily appropriate for all situations (Purdy, 2013). Regional characteristics, such as rurality, isolation and lack of secondary health care, might create

circumstances where hospital admissions are appropriate in some regions but inappropriate in others.

Access to health care has been the focus of a few Icelandic studies as discussed in chapter 1.7.3 and evidence of regional inequalities have been demonstrated. In 2011 the Boston Consulting Group rated the overall access to healthcare in Iceland as good, especially in specialised care although some concerns were raised about primary care access (The Boston Consulting Group, 2011). The Icelandic Health Service Act stipulates that general health services should be locally provided and that primary healthcare centres are generally supposed to be the first point of contact. Insufficient access to primary healthcare, especially in the CA has, however, lead to more visits to specialists in private practice and emergency units (The Boston Consulting Group, 2011). Private practice specialists and emergency units therefore provide a substantial amount of health service that can be classified as primary healthcare. Hence the declared aim of primary healthcare being the patient´s first point of contact with the health services has evidently not been reached in Iceland (Ásgeirsdóttir, 2009). Difficulties in recruiting GPs in the CA, predicted shortage of GPs in the future and insufficient productivity have encouraged reforms of primary health care in the CA. More rural areas outside the CA have also had difficulties in recruiting GPs and geographic imbalances in physician supply are in fact a challenge in most OECD countries (Ono et al., 2014). In 2012 approximately 75% of GPs positions outside the CA in Iceland were permanently staffed and 60% were staffed with specialists in primary care (Sigurjonsson, 2012). The conditions for GPs in rural areas are generally more difficult than those of their colleagues in the CA. They attend to more diverse health problems, work longer hours, have less access to consultations from other health specialists and service larger geographic areas. Their position is therefore very central in health service delivery in the more rural areas outside the CA. Thus difficulties in recruiting and retaining GPs outside the CA has major impact. Our studies show that although primary healthcare is more accessible outside the CA as measured by waiting time, (Landlæknisembættið (Directorate of Health), 2005) there are indications of inefficiency. We found evidence of potential under-diagnosing of important diseases and possibly inadequate management of hypertension outside the CA. Therefore it is important not to reduce primary healthcare services outside the CA and simultaneously scrutinise the content and quality of these services.

The geographic distribution of specialised health care is uneven. Specialised inpatient hospital care is provided in the CA, at Akureyri and to a limited extent in small regional hospitals. No clear standards have

been set as to what services should be provided by which hospital type and type of geographic area. The service that is currently offered in hospitals outside the CA is often based on historic service offering and on resources available at that particular time and in that particular location, e.g. sub specialties of doctors working in the relevant hospitals (The Boston Consulting Group, 2011). Nonetheless, the service area of Landspitali University Hospital covers the whole country and Akureyri hospital provides services for both the northern and the eastern regions to some extent. Specialised outpatient care, provided by these two hospitals and by private practice specialists is also very unevenly distributed with the majority located in the CA. Some areas of Iceland are undoubtedly over-serviced by specialist outpatient care while others are probably lacking in these services (Ásgeirsdóttir, 2009; The Boston Consulting Group, 2011). In comparison to the other Nordic countries there is an evident overweight of specialists to GPs in Iceland, especially specialists in internal medicine, surgeons and paediatricians (The Boston Consulting Group, 2011).

Our results support increased access to specialised outpatient services outside the CA, in order to support local primary healthcare in properly identifying and managing diseases.

5.3 Strengths and limitations

The overall strength of these three studies is that they leverage various sources of data to explore potential differences in health-related outcomes across geographic regions. The self-reported survey data provide information on self-perceived health and disease prevalence as well as health behaviours, while the national health registers, including registered obstetric outcomes and diagnoses made by physicians at the time of health service contact, provide a closer look at actual disease prevalence. Yet, an important difference between the survey data and the national health registers is the richer supply of potential covariates in the health survey that were used to control for confounding in the statistical models. These two different methodologies yield different results and should therefore be interpreted with caution; together these data sources provide a more comprehensive picture of specific parameters of health and disease.

The overall aim of this thesis was to explore potential differences in health and health service utilisation by geographic regions in Iceland. As discussed in chapter 3.2.7 residence was grouped into large groups for statistical analyses, based on either distance from CA or availability of

local health services. Another approach to residence grouping might yield different results. The entire CA is classified as one area and is the reference group in most analyses. There are, however, undoubtedly variations in health and health service utilisation within the CA, although they were not the focus of this thesis. The broad distinction between areas inside and outside the CA, where areas outside the CA are generally referred to as rural, is also an obvious simplification. Areas outside the CA include settlements ranging from farming areas to small villages and towns. Yet, the difference in local supply of specialised health services inside and outside the CA is profound and supports such bisection.

5.3.1 Study I (and III)

One of the strengths of study I is that it uses data from a large, nationwide survey allowing a meaningful inquiry into geographic variations in health (Jónsson et al., 2011). The response rate is also adequate and residence data is based on relatively small spatial units allowing various categorization of residence. The cross-sectional design of the survey, however, prevents analysis of processes behind spatial variations in health/health-behaviours.

The risk of selection bias is always present in studies based on survey data. In this case it is possible that those who participated in the survey were generally more health-conscious than those who chose not to participate. The response rate was 57.6% in the CA and 61.9% outside the CA. Therefore, the slightly lower response rate within the CA cannot explain indications of higher prevalence of chronic disease in the CA.

This study relies solely on one source of information on health, i.e. self-rated health and self-reported diseases, albeit diseases that were supposedly diagnosed by physicians. This is obviously a source of information-bias as respondents may not recall all diseases they have been diagnosed with or have not quite understood that they have been diagnosed with a disease. In order to obscure these findings this source of misclassification needs to be differential across areas. However, we have no way of determining whether that is the case. Another potential source of bias relates to questions on diagnosed diseases. The questionnaire included a long list of diseases and respondents were instructed to check either “yes” or “no”, depending on whether they had been diagnosed with the relevant disease or not. In the survey, unchecked items in this grid ranged from 1.8-4.5% of responses of diseases. These were interpreted as a “no“ if the response style of the respondents indicated that they

normally only checked “yes” but left other diseases unchecked. Again, it is not likely that this source of error is systematic across health regions.

In study III we used data on BMI scores, calculated from self-reported data on height and weight. This is a source of bias, as respondents may overestimate (or underestimate) their height or weight. A study comparing self-reported and measured values of weight and height in three countries found that weight is generally under-reported, especially among women, and height is generally over-reported, especially among men. Differences were also found between age groups and countries. Italian men, e.g., overestimated their height more than men from the Netherlands and North America, while Dutch women underestimated their weight more than women from Italy and North America Heavier people are also more likely to underestimate weight and smaller people are more likely to overestimate their height (Krul et al., 2011). Again, for this misclassification to distort our findings it needs to be differential across geographic regions of Iceland.

5.3.2 Study II

The major strength of this study is the completeness of the nationwide Icelandic Medical Birth Register and the 10-year time period of the study, allowing analysis of spatial variations in different time periods. A few limitations should however be mentioned. First, the study relies on assessment and registration of numerous health professionals across the country. The quality and standardisation of the Icelandic Medical Birth Register has not been formally assessed but data is scrutinised on a regular basis in relation to annual statistical reports. The observed regional differences in rates of maternal and infant diseases may either be related to varying diagnostic practices or differential completeness of registration across regions; the latter being a potential source of bias in this study. If true, we have no way to disentangle the magnitude of this bias. In any case, the regional variations in diagnostic activity or registration of pregnancy complications merit further study. Secondly, we had access to several sources of potential confounders and adjusted our point estimates for maternal age, occupation group, employment status, cohabitation, parity and infant´s gender. When calculating perinatal death we also adjusted for maternal hypertension and diabetes in separate models. Data on other important confounders, e.g. maternal education, smoking during pregnancy and BMI were, however, not available as they are not recorded in the Icelandic Medical Birth Register. This is an important limitation as all of these factors may vary across regions

(Steingrímsdóttir et al., 2010) and are as well strongly associated with adverse pregnancy outcomes (Hemminki, 2009). Higher smoking prevalence among women in rural areas (Steingrímsdóttir et al., 2010) may for example be one explanation for lower prevalence of gestational hypertension (England & Zhang, 2007; England et al., 2002; Leeners et al. 2006). Yet, it is unclear whether the distinct change in prevalence of gestational hypertension during the latter half of the study period reflects similar change in smoking across areas. We attempted to compensate for the absence of data on maternal education by categorising occupation by the International Standard Classification of Occupations (ILO-ISCO 08). The ILO-ISCO 08 divides jobs into 10 major groups based on skill level and specialisation, closely related to education levels (International Labour Organization, 2012).

5.3.3 Study III

A major strength of study III is that it leverages rich, diverse and nationwide-complete data sources on causes of death, contacts with primary healthcare and hospital discharges, allowing analyses of spatial variations of deaths and health service utilisation by disease categories. These data were also used to give an indication of regional differences in disease prevalence. Recall bias is not an issue in these data and selection bias is not of major concern. Yet, selection bias in health service data cannot be ruled out, as regional differences in health seeking behaviour and availability of health services can influence outcomes.

Some limitations should be mentioned. First, although we set out only to explore contacts with primary health care and hospital discharges for CVD it would have been optimal to include also contacts with cardiologists in private practice. Data on contacts with private practice specialists were not available for this study, making it difficult to estimate the total volume of outpatient CVD contacts. Another important source of information on outpatient CVD contacts is data from hospital ambulatory care. In addition to discharge data the National Hospital Discharge Register has received data on ambulatory contacts during the more recent years. Ambulatory hospital data is, however, still considered less reliable, although improving, and therefore not included in this study. Considering all of the above, it is likely that prevalence rates in study III are underestimated in the CA; yet this is difficult to determine since residents outside the CA also use services of private practice specialists and hospitals in the CA.

Second, while the Icelandic Causes of Death Register undergoes strenuous quality assurance, with every death certificate thoroughly scrutinised, the same does not apply to the other two main data sources in this study. The data in the National Hospital Discharge Register and the Primary Health Care Contact Register are extensive (~45000 admissions per year and ~1680000 contacts per year) and cannot be scrutinised in the same manner as causes of death. National standards defining minimal mandatory registration are however, in effect for both hospitals and primary healthcare and most institutions monitor the quality of their data to some extent. ICD-10 codes were available for close to 99% of all discharges in our hospital discharge data set and for close to 83% of all contacts in our primary health care data sets. Yet, it is should be kept in mind that hospital discharge data and primary health care data include ICD-10 codes, determined by physicians that presumably differ in their knowledge and understanding of ICD-10 and also in accuracy when employing this disease classification system.

Third, we utilised data from three data sources, spanning a total of 14 years, with an overlap of two years between mortality data and data from hospitals and primary healthcare centres, assuming that changes in the exposed population were insubstantial and do not bias the results considerably. In 2008, however, Iceland experienced an economic and political crisis resulting, e.g., in increased unemployment and above average outmigration, mainly in the younger age groups (Aðalsteinsdóttir, 2012). Fourth, the observed regional difference in contact and discharge rates for CVD may be related to either varying diagnostic practices or differential completeness of registration across regions. This is a potential source of bias in this study but according to the Directorate of Health the coverage of ICD-10 codes was similar inside and outside the CA in both databases (Kjartansdottir, oral communication). Regardless of the potential reasons for the observed regional differences they warrant further study.

Finally, we did not have the rich supply of potential covariates in the health care utilisation data as we did in the survey data. This may indeed obscure our comparisons between geographic regions, as potential covariates may vary between regions. Yet, by calculating age-standardised rates for men and women separately we controlled for two important covariates. The regional distribution of other known risk factors of CVD, which may be seen as mediators rather than confounders, were displayed and discussed in relation to the main outcomes.

6 Conclusions

Our data lend suggestive evidence for regional inequalities in health and health care utilisation in Iceland. Residents outside the CA, with limited local supply of specialised health care, generally reported poorer self-rated health and data from three national registers, i.e. causes of death, hospital discharges and primary health care contacts, suggested higher CVD prevalence outside the CA. We furthermore found lower prevalence of diagnosed gestational diabetes and hypertension, as well as congenital malformations, outside the CA, while at the same time increased odds of perinatal death among infants born to mothers residing outside the CA. Our data also reveal notable regional differences in important risk factors, including health-related behaviours. The burden of modifiable risk factors seems higher outside the CA, especially among younger women. Based on these findings there is evidently room for improvement in order to reduce regional health disparities in Iceland.

Icelandic health authorities have been reconsidering provision of health services in different regions, as a factor in reducing health care spending, especially after the economic collapse in 2008. All health institutions have experienced considerable financial cuts. Further relocation of both general and specialised services away from sparsely populated areas is likely due to continued need to reduce health care spending. This study clearly indicates that residents in rural areas, outside the CA, constitute a vulnerable population. Our findings motivate interventions, including enhanced health care services in high risk areas to mitigate risk factors and to properly identify and manage chronic diseases and high-risk pregnancies. Preventive measures must take into account local settings and characteristics of the local population.

The implication of these finding is that to ensure regional equity the more rural population outside the CA needs maintained access to primary healthcare and increased access to specialised healthcare. Due to the small size of the Icelandic population, the uneven population distribution and the size of Iceland´s geographic region it is unlikely that we can locate much specialised healthcare services outside the CA. Locally provided primary health care of high quality with sufficient access to and support from specialised health services in the CA, is thus essential to reduce regional differences in health.

Last but not least, measures to increase education levels and applying health promotive interventions in disadvantaged areas could possibly improve health outcomes.

7 Future studies

The observed geographic differences in health in relation to local health service supply require further research, e.g. by using alternate indicators of health as well as other study designs. Only a longitudinal study design can explore the directionality of this association, as well as the contribution of potential confounders and effect-modifiers to this association.

With regard to pregnancy and birth outcomes it is particularly important to explore whether differences in screening practices and detection of maternal health problems across areas contribute to variation in adverse birth outcomes across geographic regions. Studies that look at inequalities and potential inequities that emerge later in live and are related to conditions in the perinatal period are also warranted.

The discrepancy between self-reported diseases and disease prevalence indicated by national registers also need scrutiny. A potential data source for such a study is the national prescription drugs register containing data on prescribed and dispensed drugs that can be used to explore active treatment of CVD.

Regional differences in utilisation of different types of health services need further exploration. The current study lacks information on contacts with private practice specialists and can therefore not give a complete picture of regional inequalities in the use of different types of services. A study, linking data from the hospital discharges register, the primary health care contact register and the private practice register would, in this respect, be ideal.

Our results indicating regional inequalities in health along with the uneven distribution of specialised health care in Iceland motivate research focusing on the ways in which rural primary health care can be supported by specialised health services in the CA to improve public health in these areas.

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Original publications

Paper I

Scandinavian Journal of Public Health, 42(3), 310-318
doi:10.1177/1403494814522147

Scandinavian Journal of Public Health, 2014; 42: 310–318

ORIGINAL ARTICLE

Poorer self-rated health in residential areas with limited healthcare supply

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Abstract

Aims: The aim of this study was to explore differences in self-rated health and physician-diagnosed disease across geographical regions in Iceland to better understand regional requirements for health services. *Methods*: Data on self-rated health and diagnosed disease from a 2007 national health survey (n=5909; response rate 60.3%) across geographic regions were analysed. Area of residence was classified according to distance from the Capital Area (CA) and availability of local health services. We used regression models to calculate crude and multivariable adjusted odds ratios (aOR) and corresponding 95% confidence intervals (95% CI) of self-rated health and diagnosed diseases by area of residence. Models were adjusted for age, gender, education, civil status, and income. *Results*: Residents in rural areas with no local health service supply rated their physical health worse than residents of areas with diverse supply of specialised services (aOR 1.40, 95% CI 1.21–1.61). Residents outside the CA rate both their physical (aOR 1.35, 95% CI 1.23–1.50) and mental (aOR 1.17, 95% CI 1.06–1.30) health worse than residents in the CA. In contrast, we observed a lower prevalence of several diagnosed chronic diseases, including cancers (aOR 0.78, 95% CI 0.60–0.99) and cardiovascular disease (aOR 0.77, 95% CI 0.62–0.95) outside the CA. ***Conclusions*: These findings from a national survey of almost 6000 Icelanders indicate that self-rated health is related to regional healthcare supply. The findings have implications for national planning of health services aiming at equality both in health and access to health services.**

Key Words: *Access, geography, health services, Iceland, inequality, place, residence, rural, self-rated health, urban*

Introduction

Health inequalities across geographic regions, both within and between countries, have frequently been reported [1,2] and reducing health inequalities across geographic regions is in accordance with the new World Health Organization European policy for health, Health 2020 [3]. Better understanding of regional variations in health is essential for evidence-based organisation of health services and health-promoting infrastructure on a national level.

Studies of geographic variations in health have typically concentrated on either disparities between neighbourhoods (e.g. as defined by census tract areas or between urban and rural areas and sometimes between different rural settings). Evidence from studies of the relative contribution of contextual vs. compositional neighbourhood effects on health is mixed [4–6]. Studies in both England and Finland have found significant association between poor self-rated health and several neighbourhood socioeconomic attributes, while a study in Canada found individual-level factors to be more important [4–6].

Access to health services can be viewed as an important marker of neighbourhood quality. Delivering adequate health services is more challenging in rural than urban areas and the influence of differential geographical access on health is not fully understood. Factors such as limited service provision, lack of physicians, remoteness from and difficulty in travelling to urban health services, and inadequate health-promoting infrastructure have

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(Accepted 7 January 2014)

DOI: 10.1177/1403494814522147

been suggested to contribute to urban–rural health differences [7]. An underlying assumption is that healthcare access is positively associated with health outcomes. A literature review of 10 studies indicates that primary care physician supply is associated with improved health outcomes, including self-rated health [8].

Studies on urban–rural differences in self-rated health show mixed results. A recent study in the USA [7] found, for example, that residents of remote rural counties had the greatest odds of reporting bad health and indications of worse health with increasing degree of rurality. A study among the elderly in Finland also found poorer health in rural communities [9]. Self-rated health was, however, more favourable in rural settings in England [10] and Scotland [11]. Health differences between large cities and more rural areas in England were found to be largely accounted for by differences in socioeconomic conditions between poor urban localities and more affluent rural places [10]. Some studies have found no general urban–rural differences in health [e.g. 12–14].

One of the main objectives of Icelandic health legislation is to ensure equal access to services. Iceland was recently divided into seven health regions which will serve as a foundation for the organisation of general health services [15]. Yet, knowledge on spatial variations in health in Iceland is lacking and it is uncertain whether geographic provision of health services is in accordance with local health status. With the motivation to support evidence-based spatial organisation of health care, the aim of this study is to explore potential differences in self-rated health and diagnosed chronic disease by geographic regions in Iceland. Taking into consideration settlement pattern and socioeconomic characteristics the objectives are to: (1) compare health indicators inside and outside the Capital Area; (2) compare health indicators in communities in various distance zones from the Capital Area; and (3) compare health indicators in communities with varying availability of local health service supply.

Materials and methods

The study protocol was approved by the National Bioethics Committee (VSNb2008090001/03-7) and the Data Protection Authority (2008090601).

Setting

The population of Iceland was approximately 320,000 by the end of 2008 [16], with two-thirds of the population residing in and around the Capital Area (CA). The Icelandic healthcare system is comprehensive and mostly financed through general taxes [17].

Healthcare centres throughout the country provide primary healthcare. Specialist outpatient care is provided by hospitals and self-employed healthcare practitioners who are unevenly distributed in Iceland (i.e. primarily concentrated in the CA).

Data from a national survey

The data for this study are from a cross-sectional health survey of the Icelandic population, carried out in late 2007. Data was collected with a self-administered questionnaire. Participants were randomly selected from the Population Register. In order to enable research into geographic and age variations in health, residents outside the CA and the older age groups are overrepresented in the sample [18]. A total of 9807 individuals received a questionnaire. The total response rate was 60.3%: 57.6% in the CA and 61.9% outside the CA; in total 5906 individuals aged between 18 and 79 years [18].

Measures of health

The following items were used to measure self-rated health. For the question 'In general, how would you rate your physical health? In general, how would you rate your mental health?', there were four response categories (very good, good, fair, and poor). The questionnaire also included questions on diagnoses of diseases. From a list of 30 diseases, the respondents were instructed to respond only "yes" to diagnoses made by their physicians. If respondents neither checked off "yes" nor "no" at a given disease category, their responses were treated as a "no". To preserve numbers for meaningful analyses, several related diseases were grouped into larger categories. Three diseases (cirrhosis, paralysis of upper limbs, and paralysis of lower limbs) were excluded from further analysis due to small numbers (<200).

Residence (area data)

The survey contained data on residence by postal codes and level of urbanisation. Data on location were missing for 105 individuals and they were consequently excluded from the analysis. Respondents were assigned to communities or localities by combining postal codes into urban nuclei (n=115) as defined by Statistics Iceland. An urban nucleus is a town, village, or other area where inhabitants live in houses standing in the vicinity of one another. Localities with population below 200 are defined as rural independent of density of houses.

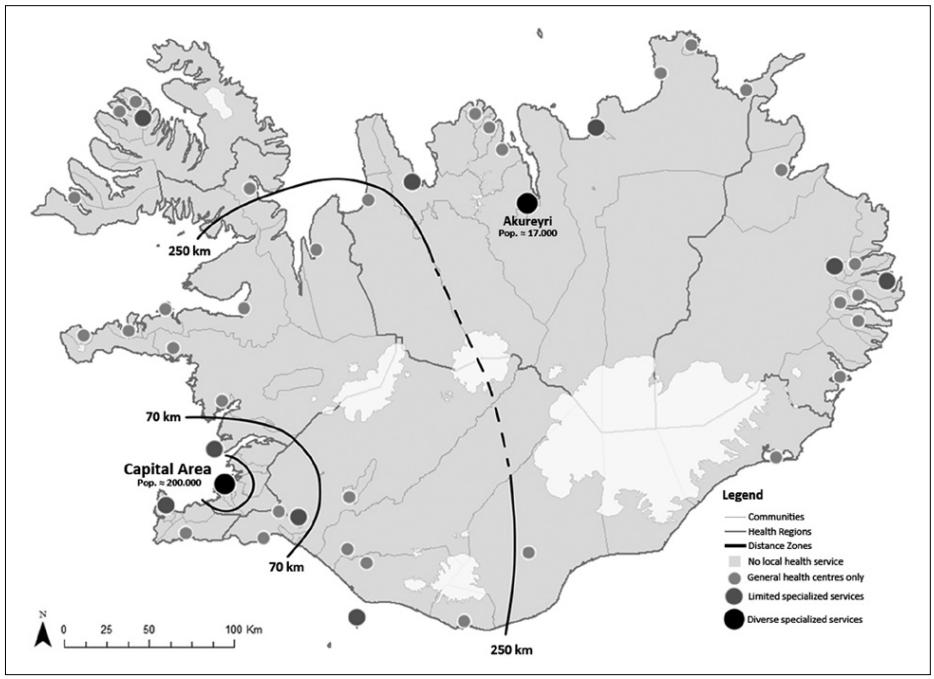

Figure 1. Map of Iceland displaying approximate boundaries between distance zones from the Capital Area and categories of local health service levels in all communities.

Communities were further classified according to population distribution and availability of health services. Firstly, by contrasting the CA (the reference category) with all other areas. Then two approaches were used in categorising areas outside the CA. First, we classified settlement according to distance from the CA; within 70 km from the CA (<1 hour driving time; ~38,000 inhabitants in total), 70–249 km (1–3 hours driving time; ~23,000 inhabitants in total), and more than 250 km (≥3 hours driving time; ~56,000 inhabitants in total). The three distance zones were identified from a survey of domestic travel pattern [19]. Secondly, residency was classified according to availability of local health services assessed for each urban nucleus using information from an official register [20]. For the purpose of this study, four categories of local health service supply were identified: (1) areas with diverse specialised services (the reference category); the CA and Akureyri belong to this group (~215,000 inhabitants in total); (2) areas with only limited specialised services; some of the larger urban nuclei in Iceland with a population of few thousands are in this group (~36,000 inhabitants in total); (3) areas where there is only a local healthcare centre and perhaps also a nursing home; small urban nuclei with a population of few hundred up to 3000 fall into this category (~28,000 inhabitants in total); and (4) areas where there are no health services in the local neighbourhood; rural areas and the smallest urban nuclei where population does not exceed 600 individuals belong to this group (~37,000 inhabitants in total). Figure 1 contains a map displaying distance zones and availability of health services in each community.

Statistical analyses

Data are presented as proportion of participants in a given area reporting respective health outcome. Ordinal regression was used to explore differences in self-rated health by area of residence and logistic regression was used to explore differences in physician-diagnosed diseases while controlling for socioeconomic characteristics. Odds ratios (OR) and 95% confidence intervals (95% CI) were calculated both crude and adjusted for age, gender, education, civil status, and income. Lifestyle factors are strong

Table I. Characteristics of participants (n=5906).

	Capital Area	Outside Capital Area	Total
Age (years)			
18–29	15.3 (425)	12.5 (371)	13.8 (796)
30–39	14.7 (407)	15.6 (463)	15.1 (870)
40–49	16.3 (452)	17.5 (522)	16.9 (974)
50–59	17.5 (487)	18.3 (546)	18.0 (1033)
60–69	18.6 (517)	18.0 (536)	18.3 (1053)
70–79	17.5 (487)	18.1 (539)	17.8 (1026)
Gender			
Male	43.5 (1206)	49.6 (1478)	46.7 (2684)
Female	56.5 (1565)	50.4 (1501)	53.3 (3066)
Education			
Primary	29.3 (820)	45.8 (1376)	37.9 (2196)
Secondary	38.2 (1068)	35.3 (1062)	36.7 (2130)
University	26.7 (747)	12.9 (388)	19.6 (1135)
Civil status			
Single/divorced	23.6 (660)	17.7 (532)	20.5 (1192)
Married/cohabiting	69.9 (1954)	76.1 (2287)	73.1 (4241)
Widowed	5.1 (143)	4.5 (135)	4.8 (278)
Income (ISK/month)			
<75,000	6.9 (192)	5.4 (162)	6.1 (354)
75,000–279,000	44.5 (1245)	56.5 (1698)	50.7 (2943)
280,000–529,000	32.3 (903)	25.3 (760)	28.7 (1663)
≥530,000	10.9 (306)	6.7 (201)	8.7 (507)
Smoking			
Daily or less	21.4 (566)	22.1 (624)	21.7 (1190)
Never smoked or quit	78.6 (2079)	77.9 (2203)	78.3 (4282)
Body mass index (kg/m^2)			
<18.5	0.9 (25)	0.8 (24)	0.9 (49)
18.5–24.9	39.6 (1074)	31.0 (901)	35.2 (1975)
25.0–29.9	40.7 (1102)	42.7 (1239)	41.7 (2341)
≥30	18.8 (509)	25.2 (739)	22.2 (1248)
Perceived stress score	4.13	4.34	4.24

Values are % (n) or mean.

determinants of self-rated health [21]; in order to examine to what extent lifestyle factors explain differences in health outcomes between residential areas, we ran additional models adjusting for smoking, body mass index (BMI), and perceived stress (PSS4) [22]. Weights were not employed in logistic models since categories of geographical residence are presented and adjustments are made for age in accordance with the sampling procedure (18–29, 30–39, 40–49, 50–59, 60–69, and 70–79 years). With this approach, the point estimates (odds ratios) correspond to weighted estimates but the prevalences are slightly higher for outcomes that are more prevalent in the older age groups (that are overrepresented in the sample). Data were analysed using SPSS version 17.0.

Results

Descriptive characteristics

Of the 5801 respondents, 3006 lived outside the CA (51.8 %) and 2795 in the CA (48.2 %). Age distribution was similar inside and outside the CA but there were slight but significant differences in terms of gender, civil status, and income. Considerable differences were, however observed with respect to level of education (Table I). While 26.7% of the residents of the CA had a university degree, 12.9% of residents outside the CA reported having an equivalent degree. The proportion of smokers was similar inside and outside the CA but there was a small but significant difference in the mean perceived stress score (4.13 inside the CA and 4.34 outside; p=0.008). There were substantial differences in BMI scores: 25.2% of participants outside the CA were obese (BMI >30.0 kg/m^2) as compared to 18.8% of residents inside the CA (p<0.001).

Self-rated health by distance from the Capital Area

Residents outside the CA rated their own health worse than those living in the CA (Table II). When potential socioeconomic confounders were accounted for, we observed increased odds of reporting poorer self-rated

Table II. Differences in self-rated health by distance from the Capital Area.

	Capital Area	Outside Capital Area			
		Total	≤69 km	70–249 km	≥250 km
How is your physical health in general?					
Fair/poor	22.3 (622)	29.3 (880)	28.8 (269)	27.3 (167)	30.4 (444)
OR	1.0	1.46 (1.32–1.61)*	1.41 (1.23–1.62)*	1.38 (1.17–1.63)*	1.52 (1.35–1.71)*
aOR	1.0	1.35 (1.23–1.50)*	1.35 (1.17–1.55)*	1.24 (1.05–1.47)*	1.41 (1.25–1.60)*
How is your mental health in general?					
Fair/poor	17.0 (474)	20.2 (606)	21.1 (197)	20.8 (127)	19.3 (282)
OR	1.0	1.23 (1.12–1.36)*	1.26 (1.10–1.45)*	1.18 (1.00–1.40)*	1.23 (1.09–1.38)*
aOR	1.0	1.17 (1.06–1.30)*	1.22 (1.06–1.41)*	1.12 (0.94–1.32)	1.17 (1.04–1.32)*

Values are % (*n*) or OR (95% CI). Road distance according to the Icelandic Road Administration.
*OR significantly different from 1.0.
aOR, odds ratio adjusted for age, gender, education, civil status, and income.

Table III. Difference in self-rated health by local health service.

	Diverse specialised services	Limited specialised services	General health centres only	No local health service supply
How is your physical health in general?				
Fair/poor	23.4 (774)	26.3 (258)	29.3 (195)	32.2 (275)
OR	1.0	1.18 (1.03–1.35)*	1.41 (1.21–1.65)*	1.54 (1.34–1.77)*
aOR	1.0	1.11 (0.96–1.27)	1.27 (1.08–1.49)*	1.40 (1.21–1.61)*
How is your mental health in general?				
Fair/poor	17.1 (563)	19.7 (193)	21.2 (141)	21.4 (183)
OR	1.0	1.21 (1.05–1.39)*	1.34 (1.15–1.57)*	1.13 (0.98–1.29)
aOR	1.0	1.14 (0.98–1.31)	1.27 (1.08–1.49)*	1.10 (0.96–1.27)

Values are % (*n*) or OR (95% CI). Categorization of local health service is based on data from the Directorate of Health and the Ministry of Health.
*OR significantly different from 1.0.
aOR, odds ratio adjusted for age, gender, education, civil status, and income.

physical health outside the CA (adjusted OR, aOR 1.35, 95% CI 1.23–1.50). Residents furthest away from the CA were most likely to rate their physical health as poor compared with residents of the CA (aOR 1.41, 95% CI 1.25–1.60). On the other hand, residents in areas adjacent to the CA were most likely to report poor mental health (aOR 1.22, 95% CI 1.06–1.41) compared with residents of the CA. Adding lifestyle factors to the model slightly reduced the odds of reporting worse self-rated health outside the CA. The difference between the CA and residential areas outside the CA became insignificant in self-rated mental health in this second model but remained statistically significant in terms of self-rated physical health.

Self-rated health by local health service supply

Residents in areas with no local health service supply reported poorer physical health than residents of areas with the most diverse supply of specialised services (aOR 1.40, 95% CI 1.21–1.61; Table III). Individuals living in areas with only general health centres reported poorer mental health than those living in areas with at least some supply of specialised services (aOR 1.27, 95% CI 1.08–1.49). This difference was attenuated when adding lifestyle factors to the model but remained statistically significant except when comparing self-rated physical health in areas with only general health centres and areas with the most diverse supply of services.

Diagnosed diseases by distance from the Capital Area and by local health service supply

Of the 22 observed disease categories, four were significantly less prevalent outside the CA than within (heart and circulatory disease, cancer, diseases of the eye, and alcoholism and drug abuse; Table IV). When socioeconomic factors had been accounted for, the odds of reporting heart and circulatory diseases outside the CA were e.g. 0.77 (95% CI 0.62–0.95). The odds of reporting asthma and allergy, common cold, chronic anxiety/tension, other mental health problems, and benign neoplasm were also lower outside the CA but marginally or not statistically significant. Only one disease category, hyperthyroidism, was more prevalent outside the CA than within (aOR 1.25, 95% CI 1.00–1.57). No large

Table IV. Self-reported physician-diagnosed diseases and disorders according to distance from the Capital Area.

	Capital Area	Outside Capital Area			
		Total	≤69 km	70–249 km	≥250 km
Asthma and allergy	23.7 (663)	21.6 (649)	22.3 (208)	20.9 (128)	21.4 (313)
OR	1.0	0.88 (0.78–1.00)	0.92 (0.77–1.10)	0.85 (0.69–1.05)	0.88 (0.75–1.02)
aOR	1.0	0.92 (0.81–1.04)	0.95 (0.80–1.14)	0.91 (0.74–1.14)	0.91 (0.77–1.06)
Chronic bronchitis or emphysema	5.0 (140)	5.1 (152)	5.0 (47)	5.4 (33)	4.9 (72)
OR	1.0	1.01 (0.80–1.23)	1.00 (0.72–1.41)	1.10 (0.73–1.60)	0.98 (0.73–1.32)
aOR	1.0	0.96 (0.75–1.23)	1.00 (0.70–1.41)	1.04 (0.70–1.54)	0.91 (0.67–1.23)
Heart and circulatory disease[b]	7.2 (200)	6.8 (203)	6.6 (62)	6.2 (38)	7.0 (103)
OR	1.0	0.94 (0.77–1.15)	0.92 (0.69–1.24)	0.86 (0.60–1.23)	0.98 (0.77–1.26)
aOR	1.0	0.77 (0.62–0.95)*	0.82 (0.60–1.11)	0.66 (0.45–0.96)*	0.78 (0.60–1.01)
Elevated blood pressure (hypertension)	26.7 (747)	28.0 (842)	28.7 (268)	29.2 (179)	27.0 (395)
OR	1.0	1.07 (0.95–1.20)	1.10 (0.94–1.30)	1.13 (0.93–1.37)	1.02 (0.88–1.17)
aOR	1.0	1.02 (0.90–1.16)	1.09 (0.91–1.31)	1.06 (0.86–1.31)	0.96 (0.83–1.13)
Rheumatism[c]	21.3 (596)	21.9 (658)	21.7 (202)	21.6 (132)	22.2 (324)
OR	1.0	1.03 (0.91–1.17)	1.02 (0.85–1.22)	1.01 (0.82–1.25)	1.05 (0.90–1.22)
aOR	1.0	1.04 (0.90–1.19)	1.03 (0.85–1.24)	1.01 (0.81–1.27)	1.05 (0.89–1.24)
Chronic disorders of the back	19.2 (536)	20.4 (614)	20.7 (193)	20.3 (124)	20.3 (297)
OR	1.0	1.08 (0.95–1.23)	1.10 (0.91–1.32)	1.07 (0.86–1.33)	1.07 (0.92–1.26)
aOR	1.0	1.06 (0.93–1.15)	1.09 (0.90–1.31)	1.05 (0.84–1.31)	1.05 (0.89–1.23)
Cancer	4.8 (134)	3.9 (118)	5.0 (47)	3.6 (22)	3.4 (49)
OR	1.0	0.81 (0.63–1.04)	1.05 (0.75–1.48)	0.74 (0.47–1.17)	0.69 (0.50–0.96)*
aOR	1.0	0.78 (0.60–0.99)*	1.05 (0.73–1.49)	0.70 (0.43–1.11)	0.66 (0.47–0.94)*
Hyperthyroidism	5.5 (153)	6.6 (198)	7.1 (66)	5.4 (33)	6.8 (99)
OR	1.0	1.22 (0.98–1.51)	1.31 (0.97–1.77)	0.98 (0.67–1.45)	1.25 (0.97–1.63)
aOR	1.0	1.25 (1.00–1.57)*	1.35 (0.99–1.84)	1.01 (0.68–1.50)	1.29 (0.98–1.69)
Diseases of the eye	8.2 (229)	6.6 (198)	7.3 (68)	5.1 (31)	6.8 (99)
OR	1.0	0.79 (0.65–0.97)*	0.88 (0.66–1.17)	0.60 (0.41–0.88)*	0.81 (0.64–1.04)
aOR	1.0	0.73 (0.59–0.90)*	0.84 (0.62–1.12)	0.53 (0.36–0.79)*	0.74 (0.58–0.96)*
Common cold	25.4 (710)	23.1 (695)	24.4 (228)	23.4 (143)	22.2 (324)
OR	1.0	0.88 (0.78–0.99)*	0.95 (0.80–1.13)	0.89 (0.73–1.10)	0.84 (0.72–0.97)*
aOR	1.0	0.89 (0.79–1.01)	0.96 (0.80–1.14)	0.92 (0.74–1.13)	0.84 (0.72–0.98)*
Alcoholism and drug abuse	4.1 (115)	3.3 (98)	3.2 (30)	2.8 (17)	3.5 (51)
OR	1.0	0.78 (0.60–1.03)	0.77 (0.51–1.16)	0.67 (0.40–1.12)	0.84 (0.60–1.18)
aOR	1.0	0.72 (0.55–0.96)*	0.74 (0.49–1.12)	0.62 (0.37–1.05)	0.77 (0.54–1.08)
Chronic anxiety/tension	11.9 (333)	10.5 (316)	12.2 (114)	9.2 (56)	10.0 (146)
OR	1.0	0.87 (0.74–1.02)	1.02 (0.82–1.29)	0.74 (0.55–1.00)	0.82 (0.67–1.01)
aOR	1.0	0.88 (0.74–1.04)	1.04 (0.82–1.31)	0.77 (0.57–1.05)	0.82 (0.67–1.02)
Chronic depression	8.1 (227)	8.8 (264)	8.9 (83)	7.8 (48)	9.1 (133)
OR	1.0	1.09 (0.90–1.31)	1.10 (0.85–1.44)	0.96 (0.70–1.33)	1.13 (0.91–1.42)
aOR	1.0	1.11 (0.92–1.34)	1.11 (0.85–1.45)	1.02 (0.73–1.41)	1.14 (0.91–1.44)
Other mental health problems	4.1 (114)	3.4 (103)	4.0 (37)	2.3 (14)	3.6 (52)
OR	1.0	0.83 (0.64–1.09)	0.97 (0.66–1.42)	0.55 (0.31–0.97)*	0.87 (0.62–1.21)
aOR	1.0	0.84 (0.63–1.11)	0.98 (0.67–1.44)	0.58 (0.33–1.01)	0.86 (0.61–1.21)
Angina/coronary heart disease	6.9 (194)	6.2 (186)	6.7 (63)	5.5 (34)	6.1 (89)
OR	1.0	0.83 (0.63–1.11)	1.00 (0.67–1.53)	0.82 (0.50–1.37)	0.75 (0.53–1.06)
aOR	1.0	0.87 (0.63–1.19)	1.17 (0.74–1.85)	0.85 (0.49–1.48)	0.73 (0.50–1.07)
Chronic diseases of throat	3.8 (106)	3.8 (114)	4.1 (38)	4.4 (27)	3.3 (49)
OR	1.0	0.94 (0.68–1.31)	0.96 (0.60–1.52)	1.22 (0.70–2.11)	0.82 (0.54–1.25)
aOR	1.0	0.99 (0.70–1.39)	0.95 (0.59–1.53)	1.33 (0.75–2.34)	0.91 (0.59–1.40)
Diabetes	4.0 (111)	4.5 (134)	4.0 (37)	5.6 (34)	4.3 (63)
OR	1.0	1.13 (0.87–1.46)	1.0 (0.68–1.46)	1.42 (0.96–2.11)	1.09 (0.79–1.49)
aOR	1.0	1.05 (0.81–1.34)	0.95 (0.65–1.40)	1.30 (0.87–1.95)	1.01 (0.73–1.40)
Benign neoplasm	7.1 (199)	5.5 (167)	7.0 (65)	4.6 (28)	5.1 (74)
OR	1.0	0.67 (0.50–0.90)*	0.95 (0.63–1.45)	0.56 (0.33–0.95)*	0.57 (0.40–0.82)*
aOR	1.0	0.74 (0.55–1.00)	1.01 (0.65–1.56)	0.61 (0.35–1.06)	0.65 (0.44–0.95)*
Severe headache, including migraine	9.9 (278)	10.2 (306)	11.0 (103)	10.1 (62)	9.6 (141)
OR	1.0	0.98 (0.77–1.24)	1.12 (0.80–1.58)	0.94 (0.63–1.41)	0.91 (0.68–1.22)
aOR	1.0	1.02 (0.79–1.31)	1.21 (0.85–1.73)	1.00 (0.66–1.53)	0.91 (0.67–1.24)

Table IV. (Continued)

	Capital Area	Outside Capital Area			
		Total	≤69 km	70–249 km	≥250 km
Urinary incontinence	8.1 (227)	8.8 (264)	9.3 (87)	8.8 (54)	8.4 (123)
OR	1.0	0.99 (0.78–1.26)	0.95 (0.69–1.33)	1.02 (0.68–1.52)	1.00 (0.74–1.34)
aOR	1.0	0.99 (0.77–1.28)	1.00 (0.71–1.40)	0.99 (0.65–1.51)	1.00 (0.73–1.36)
Spastic colon	9.3 (261)	8.6 (260)	9.6 (90)	7.8 (48)	8.3 (122)
OR	1.0	0.87 (0.67–1.12)	0.92 (0.64–1.32)	0.94 (0.56–1.50)	0.81 (0.59–1.11)
aOR	1.0	0.98 (0.74–1.29)	1.00 (0.68–1.46)	0.99 (0.60–1.60)	0.96 (0.69–1.35)
Gastric ulcer	8.7 (244)	8.8 (266)	9.4 (88)	9.3 (57)	8.3 (121)
OR	1.0	1.03 (0.78–1.35)	1.04 (0.71–1.53)	1.18 (0.74–1.89)	0.96 (0.69–1.35)
aOR	1.0	1.11 (0.84–1.48)	1.11 (0.75–1.64)	1.31 (0.81–2.13)	1.05 (0.74–1.49)

Values are % (*n*) or OR (95% CI). Road distance according to the Icelandic Road Administration. Each individual is only counted once, but may have more than one disease within each category.
* OR significantly different from 1.0.
aOR, odds ratio adjusted for age, gender, education, civil status, and income, [b]heart attack, myocardial infarction, cerebral haemorrhage, cerebral infarction, [c]arthrosis, arthropathy, osteoarthritis, fibromyalgia, chronic fatigue syndrome.

differences were observed in disease prevalence between residents in different distance zones from the CA, but the lowest ORs were most frequent furthest away from the CA.

Similar results were obtained with regard to local health service supply (Supplementary Table A, available online). Residents in areas with abundant supply of specialised health services were more likely than residents with limited health services to report that they had been diagnosed with heart and circulatory diseases, cancer, benign neoplasm, other mental health problems, diseases of the eye, and urinary incontinence.

Adding lifestyle factors to the models generally resulted in similar or slightly reduced odds of reporting most disease categories outside the CA and in areas of less or no local health services, indicating that different levels of smoking, BMI, and stress did not mediate the differences between residential areas. Two disease categories (chronic anxiety/tension and angina/coronary heart disease) became significantly less prevalent outside the CA in this model including lifestyle factors (OR 0.79, 95% CI 0.66–0.95 and OR 0.74, 95% CI 0.56–0.97, respectively).

Discussion

The findings from this national survey of almost 6000 Icelanders indicate that self-rated health is generally reported poorer in rural areas with limited healthcare supply; individuals living outside the CA rate their own mental and, especially, physical health poorer than those living in the CA with easy access to specialised health services. In contrast, possibly reflecting differential diagnostic activity across regions or regional differences in healthcare use, the findings reveal that some chronic disease categories are less common outside the CA (i.e. heart and circulatory diseases, cancer, diseases of the eye, and alcoholism and drug abuse). Conversely, residents in areas with abundant supply of specialised health services are more likely to report that they had been diagnosed with diseases in three of the four aforementioned disease categories as well as psychiatric disorders than those living in areas with no local health service supply.

Previous research and mechanisms

Many studies suggest some health disadvantages in rural areas [7, 9]. This current study found indications of poorer self-rated health outside the CA, while there was a general tendency towards decreased odds of some self-reported major chronic diseases outside the CA. A potential explanation for these contradicting findings is that specialised health services are less accessible to residents outside the CA resulting in less diagnostic activity. Regional differences in healthcare-seeking behaviour (e.g. lower healthcare use) might also contribute to lower rates of diagnosed disease outside the CA. In support of this mechanism, a recent Icelandic study found that residents outside the CA used less mental health services whereas residents of the CA used psychologists and sometimes psychiatrists more often [23]. The authors conclude that access to services or attitudes towards these health problems or services might explain the observed regional differences in healthcare utilisation.

Alternatively, an explanation for why some chronic diseases are less prevalent outside the CA could be that those who suffer from those diseases have moved to the CA in order to gain better access to specialised services. Selective migration might therefore have contributed to lower rates of certain disease outside the CA. A longitudinal study in England and Wales revealed that over a 20-year period, the largest flow of migration was by healthy migrants moving away from more deprived areas towards less deprived areas, raising ill-health and mortality rates in the origins and lowering them in the destinations [24]. The CA of Iceland is a more affluent residential area in terms of education and income compared to the rest of the country. The general trend in internal migration in Iceland for the past decades has been that people tend to move to the CA away from rural regions [25]. Two-thirds of those who have moved to the CA have been under the age of 30, and 96% under the age of 60 [26]. Consequently, it could be argued that internal migration should have contributed to higher disease prevalence outside the CA but not the contrary. However, given that the availability of specialised services is to a large extent concentrated in the CA, it is still reasonable to assume that chronic disease sufferers are dependent on proximity to such services.

Alternative explanation of differences between self-rated health between residential regions could be differences in lifestyle or health-related behaviours. Lifestyle factors such as smoking and BMI along with stress have indeed been strongly related to self-rated health [21]. Controlling for these factors in the analysis did however not alter our point estimates to a large extent, particularly not with respect to self-rated physical health. Our findings therefore indicate that differences in self-rated physical and mental health across geographic areas with varying access to health care are only to a limited extent explained by these measured lifestyle or socioeconomic factors.

Validity and reliability

One of the strengths of the present study is that it uses data from a large, nationwide survey allowing a meaningful inquiry into geographic variations in health [18]. The response rate is moreover adequate and residence data is based on relatively small spatial units, allowing various categorisation of residence. The cross-sectional design of the survey prevents, however, analysis of processes behind spatial variations.

The study relies solely on one source of information on health: i.e. self-rated health and self-reported diseases, albeit diseases that were supposedly diagnosed by physicians. This is obviously a source of bias as respondents may not recall all diseases they have been diagnosed with. However, in order to obscure these findings, this source of misclassification needs to be differential across areas. Another potential source of bias relates to questions on diseases where unchecked diseases were always interpreted as a "no". Again, it is not likely that this source of error is systematic across health regions. Future studies should, however, explore other health indicators and mechanisms behind spatial differences in health.

Icelandic population pattern, albeit unique, has many characteristics in common with other countries, particularly neighbouring Nordic countries. A high and an increasing proportion of the total population living in the CA, uneven distribution of health services, difficulties in adjusting health services to changes in population distribution and financial difficulties. Nevertheless, our findings cannot be directly transferrable to other cultures or populations; thus, further studies in other settings are needed for testing the generalisability of these findings.

Conclusions

The findings of this study indicate that residents in rural areas with no local healthcare centre are most likely to report unfavourable physical health when compared with residents of areas with more supply of health services. Residents in areas with general health centres only were, however, most likely to report unfavourable mental health. Differences in lifestyle and stress between areas seem only to explain to a small extent the observed differences. In contrast, residents in areas with abundant supply of specialised health services were more likely to report major diagnosed diseases than those living in areas with no local health service supply. This could suggest differential diagnostic activity across areas, differences in healthcare-seeking behaviour, or selective migration of ill individuals, circumstances which could all be related to regional variations in health service supply. These geographic differences in health in relation to local health service supply require further research, for example by using alternate indicators of health as well as different study designs. Only a longitudinal study design can explore the causality of this association, as well as the contribution of potential confounders and effect-modifiers to this association.

Icelandic health authorities have been reconsidering provision of health services in different regions as an element in reducing healthcare spending, especially after the economic collapse in 2008. All health

institutions have experienced considerable financial cuts and they have adjusted to the best of their abilities. Revision of Icelandic health services is announced in the proposed 2020 Icelandic health policy [27]. Continued relocation of both general and specialised services from rural areas is probable due to continued demand to reduce spending. This study clearly indicates that residents in rural areas constitute a vulnerable population that report poorer self-rated health and yet have lower prevalence of diagnosed diseases. Thus, to ensure equity, healthcare policymakers should take into account that, beyond population size, the rural population may need more health-promoting efforts and prevention as well as maintained access to health care.

Acknowledgements

We thank the Directorate of Health for access to data, Sigrún Helga Lund for statistical advice and Lilja Bjarklind Kjartansdóttir and Elín Inga Magnúsdóttir for assistance in cartography.

Conflict of interest

There is no conflict of interest.

Funding

This work was supported by Rannis – the Icelandic Centre for Research (R10–0008 2010).

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Supplementary Table A. Diagnosed diseases and disorders[a] according to local health service supply[b]
Self reported, has a doctor ever diagnosed you with ...

	Diverse specialized services		Limited specialized services		General health centres only		No local health service supply	
	%	N	%	N	%	N	%	N
Asthma and allergy								
	23.8	(785)	21.3	(209)	20.2	(134)	21.5	(184)
OR	1.0		0.87 (0.73-1.03)		0.81 (0.66-0.99)*		0.88 (0.73-1.06)	
OR^{Adj}	1.0		0.91 (0.76-1.09)		0.83 (0.67-1.03)		0.94 (0.78-1.13)	
Chronic bronchitis or emphysema								
	5.0	(164)	5.0	(49)	4.8	(32)	5.5	(47)
OR	1.0		1.00 (0.72-1.39)		0.97 (0.65-1.43)		1.11 (0.80-1.55)	
OR^{Adj}	1.0		1.00 (0.72-1.39)		0.85 (0.57-1.27)		1.05 (0.75-1.48)	
Heart & circulatory disease (heart attack, myocardical infarct., cerebral haemorrhage, cerebral infarct.)								
	7.2	(237)	6.8	(67)	6.3	(42)	6.7	(57)
OR	1.0		0.95 (0.71-1.25)		0.87 (0.62-1.22)		0.92 (0.68-1.25)	
OR^{Adj}	1.0		0.81 (0.60-1.10)		0.66 (0.46-0.95)*		0.73 (0.53-0.99)*	
Elevated blood pressure (hypertension)								
	26.8	(886)	28.6	(281)	28.9	(192)	26.9	(230)
OR	1.0		1.09 (0.93-1.28)		1.11 (0.92-1.33)		1.00 (0.85-1.19)	
OR^{Adj}	1.0		1.05 (0.88-1.24)		0.99 (0.81-1.21)		0.92 (0.77-1.10)	
Rheumatism (arthrosis, arthropaties, osteoarthritis, fibromyalgia, chronic fatigue syndrome)								
	21.5	(711)	18.9	(185)	24.2	(161)	23.1	(197)
OR	1.0		0.85 (0.71-1.01)		1.16 (0.96-1.41)		1.09 (0.91-1.31)	
OR^{Adj}	1.0		0.85 (0.70-1.03)		1.09 (0.88-1.34)		1.06 (0.87-1.28)	
Chronic disorders of the back								
	19.6	(647)	18.0	(177)	20.8	(138)	22.0	(188)
OR	1.0		0.90 (0.75-1.09)		1.07 (0.87-1.32)		1.16 (0.96-1.39)	
OR^{Adj}	1.0		0.89 (0.74-1.07)		1.04 (0.85-1.29)		1.11 (0.92-1.34)	
Cancer								
	4.7	(154)	4.4	(43)	3.9	(26)	3.4	(29)
OR	1.0		0.94 (0.66-1.32)		0.83 (0.54-1.27)		0.72 (0.48-1.08)	
OR^{Adj}	1.0		0.90 (0.63-1.29)		0.76 (0.49-1.17)		0.66 (0.44-0.99)*	
Hyperthyroidism								
	6.0	(197)	6.2	(61)	5.7	(38)	6.4	(55)
OR	1.0		1.04 (0.78-1.40)		0.95 (0.67-1.37)		1.08 (0.80-1.45)	
OR^{Adj}	1.0		1.08 (0.80-1.47)		0.91 (0.63-1.31)		1.08 (0.79-1.50)	
Diseases of the eye								
	8.0	(263)	7.6	(75)	6.3	(42)	5.5	(47)
OR	1.0		0.96 (0.73-1.25)		0.78 (0.56-1.09)		0.67 (0.49-0.93)*	
OR^{Adj}	1.0		0.89 (0.67-1.18)		0.67 (0.47-0.95)*		0.59 (0.42-0.82)*	
Common cold								
	25.5	(841)	22.1	(217)	22.1	(147)	23.4	(200)
OR	1.0		0.83 (0.70-0.98)*		0.83 (0.68-1.01)		0.89 (0.75-1.07)	
OR^{Adj}	1.0		0.84 (0.71-1.00)		0.83 (0.67-1.01)		0.91 (0.76-1.09)	

Alcoholism and drug abuse								
	4.0	(133)	2.9	(28)	3.3	(22)	3.5	(30)
OR	1.0		0.70 (0.46-1.06)		0.81 (0.51-1.29)		0.87 (0.60-1.30)	
OR^{Adj}	1.0		0.67 (0.44-1.01)		0.79 (0.50-1.26)		0.81 (0.54-1.21)	
Chronic anxiety/tension								
	11.7	(386)	10.4	(102)	12.0	(80)	9.5	(81)
OR	1.0		0.87 (0.70-1.10)		1.03 (0.80-1.33)		0.79 (0.61-1.02)	
OR^{Adj}	1.0		0.90 (0.72-1.14)		1.05 (0.81-1.37)		0.81 (0.63-1.05)	
Other mental health problems								
	4.2	(137)	4.0	(49)	3.5	(23)	2.1	(18)
OR	1.0		0.96 (0.66-1.37)		0.83 (0.53-1.30)		0.49 (0.30-0.82)*	
OR^{Adj}	1.0		0.98 (0.67-1.41)		0.84 (0.53-1.34)		0.51 (0.31-0.84)*	
Angina/coronary heart disease								
	6.7	(221)	6.4	(63)	5.7	(38)	6.8	(58)
OR	1.0		1.04 (0.69-1.56)		0.75 (0.47-1.19)		0.80 (0.54-1.19)	
OR^{Adj}	1.0		1.03 (0.66-1.60)		0.84 (0.50-1.39)		0.76 (0.49-1.18)	
Chronic diseases of the throat								
	3.8	(126)	3.8	(37)	4.2	(28)	3.4	(29)
OR	1.0		1.05 (0.66-1.68)		1.07 (0.63-1.81)		0.65 (0.40-1.05)	
OR^{Adj}	1.0		1.09 (0.68-1.77)		1.16 (0.67-1.99)		0.73 (0.44-1.20)	
Diabetes								
	3.9	(129)	5.4	(53)	4.4	(29)	4.0	(34)
OR	1.0		1.40 (1.01-1.95)*		1.10 (0.74-1.69)		1.02 (0.69-1.50)	
OR^{Adj}	1.0		1.34 (0.96-1.87)		1.0 (0.66-1.52)		0.91 (0.61-1.35)	
Benign neoplams								
	6.7	(223)	6.4	(63)	5.6	(37)	5.2	(43)
OR	1.0		1.03 (0.68-1.56)		0.58 (0.36-1.56)		0.55 (0.35-0.85)*	
OR^{Adj}	1.0		0.72 (0.73-1.76)		0.61 (0.38-0.99)*		0.63 (0.40-0.99)*	
Severe headache, incl. migraine								
	9.9	(326)	9.8	(96)	11.8	(78)	9.8	(84)
OR	1.0		1.09 (0.78-1.54)		1.10 (0.75-1.60)		0.82 (0.59-1.16)	
OR^{Adj}	1.0		1.09 (0.77-1.56)		1.22 (0.82-1.80)		0.93 (0.65-1.32)	
Urinary incontinence								
	8.4	(279)	8.3	(82)	9.9	(66)	7.5	(64)
OR	1.0		0.93 (0.67-1.30)		1.02 (0.71-1.48)		0.70 (0.49-0.99)*	
OR^{Adj}	1.0		0.97 (0.69-1.37)		1.04 (0.71-1.53)		0.68 (0.47-0.97)*	
Spastic colon								
	9.0	(298)	9.1	(89)	11.3	(75)	6.9	(59)
OR	1.0		0.94 (0.66-1.34)		1.39 (0.92-2.12)		0.68 (0.46-1.01)	
OR^{Adj}	1.0		1.04 (0.71-1.51)		1.51 (0.97-2.35)		0.79 (0.53-1.19)	
Gastric ulcer								
	8.7	(288)	9.2	(90)	9.3	(62)	8.2	(70)
OR	1.0		1.06 (0.72-1.56)		1.01 (0.65-1.56)		0.73 (0.50-1.08)	
OR^{Adj}	1.0		1.12 (0.76-1.66)		1.09 (0.69-1.70)		0.80 (0.54-1.19)	

* OR significantly different from 1.0, CI 95%

OR^{Adj} Adjusted for age, gender, education, civil status and income

[a] With one or more disease within each category. Each individual is only counted once.

[b] Based on data from the Directorate of Health and the Ministry of Health

Paper II

Acta Obstetricia et Gynecologica Scandinavica, 2015; 94(2): 156-64 doi: 10.1111/aogs.12534

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AOGS MAIN RESEARCH ARTICLE

Maternal geographic residence, local health service supply and birth outcomes

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Key words
Birth outcomes, residence, access, health services, rural health, gestational diabetes, hypertension, pregnancy

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Conflict of interest
The authors have stated explicitly that there are no conflicts of interest in connection with this article.

Please cite this article as: Haraldsdottir S, Gudmundsson S, Bjarnadottir RI, Lund SH, Valdimarsdottir UA. Maternal geographic residence, local health service supply and birth outcomes. Acta Obstet Gynecol Scand 2014; DOI: 10.1111/aogs.12534

Received: 3 July 2014
Accepted: 13 October 2014

DOI: 10.1111/aogs.12534

Abstract

Objective. To describe pregnancy complications, mode of delivery and neonatal outcomes by mother's residence. *Design.* Register-based cohort study. *Setting.* Geographical regions of Iceland. *Population.* Live singleton births from 1 January 2000 to 31 December 2009 (n = 40 982) and stillbirths ≥22 weeks or weighing ≥500 g (n = 145). *Methods.* Logistic regression was used to explore differences in outcomes by area of residence while controlling for potential confounders. Maternal residence was classified according to distance from Capital Area and availability of local health services. *Main outcome measures.* Preterm birth, low birthweight, perinatal death, gestational diabetes and hypertension. *Results.* Of the 40 982 infants of the study population 26 255 (64.1%) were born to mothers residing in the Capital Area and 14 727 (35.9%) to mothers living outside the Capital Area. Infants outside the Capital Area were more likely to have been delivered by cesarean section (adjusted odds ratio 1.28; 95% CI 1.21–1.36). A lower prevalence of gestational diabetes (adjusted odds ratio 0.68; 95% CI 0.59–0.78), hypertension (adjusted odds ratio 0.82; 95% CI 0.71–0.94) as well as congenital malformations (adjusted odds ratio 0.55; 95% CI 0.48–0.63) was observed outside the Capital Area. We observed neither differences in mean birthweight, gestation length nor rate of preterm birth or low birthweight across Capital Area and non-Capital Area. The odds of perinatal deaths were significantly higher (adjusted odds ratio 1.87; 95% CI 1.18–2.95) outside the Capital Area in the second half of the study period. *Conclusion.* Lower prevalence of gestational diabetes and hypertension outside the Capital Area may be an indication of underreporting and/or lower diagnostic activity.

Abbreviations: aOR, adjusted odds ratio; CA, Capital Area; ICD 10, International Classification of Disease 10th revision; LBW, low birthweight; PTB, preterm birth.

Introduction

Reducing health inequalities across geographic regions is an important aim for improving child health and in accordance with the new World Health Orgnaization European policy for health, Health 2020 (1,2). These objectives draw attention to potential regional variations in pregnancy and birth outcomes.

Key Message

The prevalence of preterm birth and low birthweight was not related to the mothers' area of residence. However, increased odds of perinatal death with lower odds of diagnoses of gestational diabetes, hypertension and congenital malformations were observed outside the Capital Area.

Adverse birth outcomes include low birthweight (LBW) and preterm birth (PTB) which increase the risk of perinatal morbidity and mortality and are associated with later health risks (3). Numerous studies have explored differences for such adverse outcomes between urban and rural areas and with some exceptions (4) found that infants born to women residing in rural and economically depressed or remote areas are at increased risk (5,6). Studies in Canada have shown increased risks for adverse birth outcomes, including perinatal death, with increased distance to specialized hospital services (7,8) and in areas with weak or no metropolitan influence (9). Socioeconomic factors and smoking do not seem to fully explain the disadvantage of rural residence in these studies and reduced access to high-quality care has been proposed as one potential contributing factor. This hypothesis deserves additional research.

The Nordic countries have a long tradition for a public healthcare system aiming at equal access for all citizens (10). A recent Finnish study revealed that among children weighing more than 2500 g at birth, perinatal mortality was similar for all hospital levels, and birth outcomes were not better or worse for women living in municipalities served by higher-level hospitals compared with communities served by small local hospitals (11). In contrast, a Swedish study indicated that the number of deliveries and availability of neonatal care might be important for newborn survival, although the differences were small (12). Evidence for social inequalities in perinatal mortality have indeed been reported from Denmark, Finland and Norway (13).

Birth and infant outcomes in Iceland are among the most favorable worldwide, even in comparison with the other Nordic countries (14), but studies on birth outcomes by maternal residence and healthcare service level are lacking. Among rural women of childbearing age higher BMI and smoking prevalence have been noted (15), but it is not known whether health services availability or distance from specialized health services is related to pregnancy complications or birth outcomes. The aim of this study was to describe pregnancy complications (gestational diabetes, hypertension in pregnancy), intrapartum care (obstetrical interventions) and adverse birth outcomes (LBW, PTB, perinatal deaths) by maternal residence and local health service level.

Material and methods

The population of Iceland was approximately 320 000 in 2009 (16) with two-thirds of the population residing in and around the Capital Area (CA). The Icelandic healthcare system is comprehensive and mostly financed through general taxation. Maternity care is provided by midwives, nurses and general practitioners at public healthcare centres. Pregnant women receive on average nine antenatal examinations (17), including ultrasound screening at 19–20 weeks of pregnancy.

The data were obtained from the Icelandic Medical Birth Register comprising all births in the country. Births from 1 January 2000 to 31 December 2009 (n = 44 370) were considered. Women were excluded if they had a multiple pregnancy (n = 1635), if they had legal residence abroad (n = 186) or if data on residence were missing (n = 1439). One stillborn infant and one infant that died in the first week of life with International Classification of Disease 10th revision (ICD-10) code P01.5 indicating that they had been a part of a twin pregnancy were excluded. Data on 40 982 live births were used and an additional 145 stillbirths were included only for calculations on perinatal death. Stillbirth was defined as ≥22 weeks of gestation or weighing ≥500 g if length of gestation was unknown. PTB was defined as delivery before 37 completed gestational weeks (0–258 days). Length of gestation was in 99.8% of births based on ultrasound measurement before the 21st week of gestation. LBW infants were those weighing <2500 g at birth. Perinatal death was defined according to the World Health Organization's definition, i.e. stillbirth and death in the first week of life.

Data on maternal characteristics were obtained from the register, i.e. maternal age, occupation, relationship status, parity, residence, place of delivery and maternal diseases according to ICD-10. Maternal occupation was classified according to the International Standard Classification of Occupations (ILO-ISCO 08) into the following categories; managers, professionals, technicians, clerical workers, service and sales workers, skilled agricultural, forestry and fishery workers, craft workers, plant and machine operators and elementary occupations. Students, homemakers, invalids and unemployed were added to the classification.

Hypertensive complications in pregnancy were identified by ICD-10 codes O10–O14 and diabetes by O24.0–O24.9. The following obstetric information was used: mode of delivery [vaginal, cesarean and emergency cesarean (ICD-10: O82.1)], newborn's gender, Apgar score at 5 min, instrumental delivery (ICD-10: O81), congenital malformations and chromosomal abnormalities (ICD-10: Q00–Q99) and perinatal death.

Data analysis

Residence was grouped in three ways. First we contrasted the CA (the reference category) with all other geographical areas. Then we classified settlement according to road distance from the CA. Three distance zones were identified from a survey of domestic travel pattern (18) (Figure 1). Finally, residence was classified according to

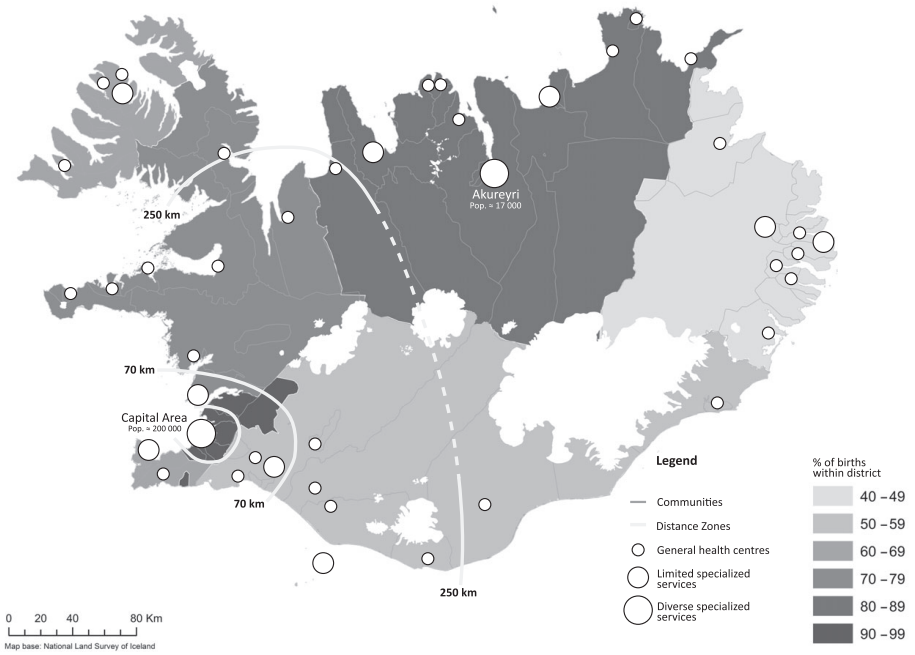

Figure 1. Map of Iceland displaying approximate boundaries between distance zones from the Capital Area, categories of local health service levels in communities and proportion of births taking place within mothers' health district 2000–2009.

availability of local health services assessed for each urban nucleus using information from an official register (19). For the purpose of this study four categories of local health service supply were identified; (i) areas with diverse specialized services (the reference category); (ii) areas with limited specialized services; (iii) areas with a local healthcare centre; (iv) areas where there are no local health services (Figure 1).

Data are presented as proportion of births or mothers in a given area reporting respective pregnancy complications or birth-related outcome. Chi-squared test was used for comparing proportions and Student's *t*-test when comparing means. Logistic regression was used to explore differences in outcomes by area of residence while controlling for potential confounding variables. Odds ratios and 95% confidence intervals (95% CI) were calculated adjusting for maternal age (continuous), parity, infant's gender, maternal occupation and cohabitating with the child's father (Table 1). In separate models we adjusted also for hypertension and diabetes. Additional analyses were carried out categorizing mothers according to whether they lived inside or outside the CA and whether they gave birth in hospitals with the highest level of obstetric and neonatal services (two hospitals) or in other hospitals. The study period was divided into two 5-year periods, 2000–2004 and 2005–2009 for further analysis of main outcomes. Data were analysed using SPSS version 17.0 (SPSS, Inc., Chicago, IL, USA).

The study protocol was approved by the National Bioethics Committee (VSNb2008090001/03-7) and the Data Protection Authority (reference no. 2008090601).

Results

Between 2000 and 2009 the number of hospitals offering delivery services decreased by 33% while the number of births increased by 16%. The proportions of births occurring at hospitals outside the mothers' area of residence, as defined by the seven official health districts, varied between districts (Figure 1). The proportion of births at university/teaching hospitals ranged from 25.9 to 97.0% between maternal residential health districts.

Table 1. Maternal characteristics in live births 2000–2009 by maternal residence.

	Total (n = 40 982)		Capital Area (n = 26 255)		Outside CA (n = 14 727)	
	%	n	%	n	%	n
Mean (SD) maternal age	28.8 (5.56)		29.1 (5.49)		28.3 (5.69)	
Age group						
<20 years old	4.1	1662	3.3	869	5.4	793
20–34 years old	79.1	32 431	79.0	20 749	79.3	11 682
≥35 years old	16.8	6889	17.7	4637	15.3	2252
Parity						
Nulliparous	40.3	16 521	43.0	11 299	35.5	5222
Primi-/multiparous	52.9	21 689	51.8	13 598	55.0	8091
Missing	6.8	2772	5.2	1358	9.5	1414
Maternal employment status						
Employed	71.4	29 071	71.3	18 613	71.6	10 458
Not employed	9.7	3950	8.0	2083	12.8	1867
Student	14.4	5850	15.6	4076	12.1	1774
Missing	4.5	1827	5.1	1319	3.5	508
Maternal occupation group						
Managers/specialists	16.6	6825	20.1	5243	10.8	1582
Tech/office/service	43.5	17 838	43.9	11 531	42.8	6307
Farm/craftsmen/machine	4.7	1908	3.1	813	7.4	1095
Unskilled labour	6.1	2500	3.9	1026	10.0	1474
Students	14.3	5850	15.5	4076	12.0	1774
Unemployed/invalid	9.6	3949	7.9	2083	12.7	1866
Missing	5.2	2112	5.6	1483	4.3	629
Cohabitation						
Cohabiting	44.0	18 038	45.0	11 821	42.2	6217
Not cohabiting	54.9	22 508	54.0	14 167	56.6	8341
Missing	1.1	436	1.0	267	1.2	169

Obstetric characteristics and birth outcomes of mothers living inside and outside the CA

Of the 40 982 live born infants of the study population, 26 255 (64.1%) were born to mothers residing in the CA and 14 727 (35.9%) to mothers living outside the CA. Compared with mothers in the CA, mothers outside the CA were significantly younger, had higher parity and were more likely to be unemployed or unskilled labourers (Table 1).

Infants outside the CA were more likely to have been delivered with cesarean section [both elective – adjusted odds ratios (aOR) 1.49; 95% CI 1.37–1.62) and emergency – aOR 1.11; 95% CI 1.04–1.20)] than infants in the CA while less likely to have had an instrumental delivery, i.e. with forceps or vacuum extractor. Infants outside the CA were significantly less likely than infants of mothers in the CA to have an Apgar score at 5 min of less than 7 and be diagnosed with congenital malformations (Table 2). Compared with the CA, diagnoses of maternal gestational diabetes were significantly less common outside the CA. The same applied to diagnoses of pregnancy-induced hypertension. The prevalence of pregnancy-induced hypertension diagnoses was only significantly lower outside the CA during the latter time period ($aOR_{2005–2009}$ 0.72; 95% CI 0.59–0.87). The rate of pregnancy-induced hypertension diagnoses per 1000 births was similar inside and outside the CA until 2007 when the rate started to rise in the CA while dropping outside the CA (Figure 2a). The rate of gestational diabetes diagnoses was higher inside the CA for most of the study period (Figure 2b). We observed no differences in mean birthweight, duration of gestation or the risk of PTB or LBW across CA and non-CA area, or distance zones from CA.

During the study period 187 infants were stillborn or died during the first 7 days after birth (n = 145 and n = 42, respectively) (Table 3). The adjusted odds of perinatal deaths were not significantly higher outside the CA for the whole 10-year period but were significantly higher in the second half of the observed period (Table 3). Adding hypertension and diabetes to the model resulted in slightly lower odds of perinatal death outside the CA ($aOR_{2005–2009}$ 1.63; 95% CI 1.01–2.65). These increased odds of perinatal death in the second part of the study period were mainly restricted to mothers residing outside the CA but giving birth at hospitals with the highest level of obstetric and neonatal services (two hospitals) (aOR 2.60; 95% CI 1.57–4.29).

Table 2. Obstetric characteristics in live births 2000–2009 by maternal residence.

	Total (n = 40 982)		Capital Area (n = 26 255)		Outside CA (n = 14 727)	
	%	*n*	%	*n*	%	*n*
Mode of delivery						
Vaginal	83.5	34 231	84.4	22 146	82.1	12 085
aOR			1.0		0.78 (0.74–0.82)*	
Cesarean section (total)	16.5	6742	15.6	4104	17.9	2638
aOR			1.0		1.28 (1.21–1.36)*	
Instrumental delivery	7.9	3260	8.8	2305	6.5	955
aOR			1.0		0.89 (0.82–0.97)*	
Infant's gender						
Male	51.2	20 992	51.0	13 390	51.6	7602
Female	48.8	19 986	49.0	12 865	48.4	7121
Apgar at 5 min <7	2.5	1034	2.8	732	2.1	302
aOR			1.0		0.77 (0.67–0.89)*	
Congenital malformations	3.0	1214	3.6	932	1.9	282
aOR			1.0		0.55 (0.48–0.63)*	
Gestational diabetes	2.6	1051	2.9	764	1.9	287
aOR			1.0		0.68 (0.59–0.78)*	
Pregnancy-induced hypertension	2.3	956	2.6	676	1.9	280
aOR			1.0		0.82 (0.71–0.94)*	
Mean birthweight (g) (SD)	3.68 (0.57)		3.67 (0.57)		3.70 (0.56)	
Low birthweight (<2500 g)	2.5	1039	2.6	674	2.5	365
aOR			1.0		0.96 (0.84–1.10)	
Mean gest. length (days) (SD)	279.31 (14.00)		279.42 (13.83)		279.11 (14.29)	
Preterm birth (<37 weeks)	4.5	1827	4.5	1187	4.4	640
aOR			1.0		0.95 (0.85–1.05)	

Missing information: Gestational length = 6; Mode of delivery = 9; Infant's gender = 4 aOR, odds ratio adjusted for age, parity, infant's gender, maternal occupation group, maternal employment status and cohabitation.
*aOR significantly different from 1.0; 0.95% CI.

We found no association between distance of maternal residence from CA and risk of LBW and PTB (Table 4). The risk of perinatal deaths was only significantly higher in areas most adjacent to the CA and in areas furthest away from the CA in the latter time period ($aOR_{2005–2009}$ 2.16; 95% CI 1.19–3.90 and $aOR_{2005–2009}$ 1.93 95% CI 1.10–3.40, respectively). Adding hypertension and diabetes to the model resulted in slightly reduced odds.

Obstetric characteristics and birth outcomes by local health service supply

The odds of elective cesarean section were statistically significantly higher in all categories of areas with less local health services than the reference area with high health service supply (see Supporting information, Table S1). The odds of elective cesarean sections were highest in areas of some but limited specialized services while the odds of emergency cesarean section were highest in areas with general health centres only.

When comparing areas with diverse specialized health services and areas with less local health services the prevalence of congenital malformations was lower in all categories of less local health services.

We found no association between availability of health services in mother's area of residence and risk of LBW and PTB (see Supporting information, Table S1). Compared with regions of the most diverse specialized health services the risk of perinatal death was significantly greater in maternal residence regions with some but limited specialized health services. The risk was also greater, but not statistically significant, in regions of no local health service supply. The risk was however not greater in regions with general health centres only. The adjusted odds of perinatal deaths were only significantly greater in the latter period 2005–2009 in areas of limited specialized health services ($aOR_{2005–2009}$ 2.47; 95% CI 1.41–4.31). Adjusting also for hypertension and diabetes resulted in similar odds ratio ($aOR_{2005–2009}$ 2.43; 95% CI 1.36–4.32).

Discussion

The findings from this study including almost 41 000 births over a 10-year period indicate that pregnant

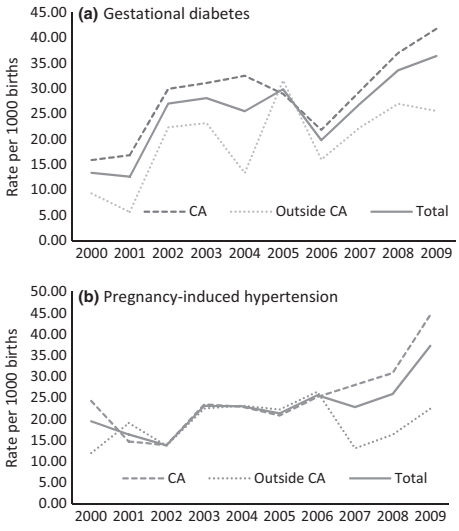

Figure 2. Diagnoses of (a) gestational diabetes and (b) pregnancy-induced hypertension per 1000 births 2000–2009, alive, single births included.

women living outside the CA experience increased odds of delivery by cesarean section, while they are at reduced odds of being diagnosed with gestational diabetes and hypertension. Mothers residing outside the CA had an increased risk of perinatal death during the latter period of the study. While the prevalence of PTB and LBW was not related to mothers' area of residence during the study period, we found that mothers outside the CA were consistently less likely to have given birth to an infant diagnosed with congenital malformations.

Several studies have found that infants born to women residing in rural and remote areas are at increased risk for poor birth outcomes (5–9). As in other Nordic countries (14) the overall rate of perinatal death was very low in Iceland (3.2/1000 in 2009) but the risk of this adverse event seemed increased among mothers residing outside the CA. The odds increased with calendar time and were largely confined to rural women giving birth at specialized obstetric units. This finding may reflect an effective referral system where high-risk pregnancies outside the CA are referred to the most specialized delivery services. This referral system became formal in 2007 with the publication of clinical practice guidelines but informal guidelines were available as early as 1983 (20).

The risk of perinatal death was nevertheless greater among women outside the CA that could indicate that undetected high-risk pregnancies were more prevalent outside than inside the CA. In line with this, diagnoses of gestational hypertension and diabetes seemed less common among mothers outside the CA in the second half of the study period. This may reflect reduced diagnostic activity or incomplete registration of these diseases outside the CA. Clinical guidelines, based on the National Institute for Health and Care Excellence (NICE) guidelines, recommend screening for gestational diabetes if certain risk factors are present (21). Whether differences in screening practices and detection of maternal health problems across areas contribute to variation in

Table 3. Perinatal deaths (<7 days) 2000–2009 by maternal residence.

	Total		Capital Area		Outside CA	
	Rate	*n*	Rate	*n*	Rate	*n*
Stillbirths		145		79		66
Death within 7 days		42		26		16
Total 2000–2009	4.5	187	4.0	105	5.5	82
aOR			1.0		1.33 (0.96–1.86)	
2000–2004	4.6	87	4.7	55	4.4	32
aOR			1.0		0.93 (0.57–1.51)	
2005–2009	4.5	100	3.4	50	6.6	50
aOR			1.0		1.87 (1.18–2.95)*	
Infant disease category (ICD-10)						
Impaired fetal growth (P05–P07)		94		55		39
Fetal asphyxia (P20–P21)		3		1		2
Other diagnoses		20		11		9
Missing		17		4		13
Unkown		53		35		18

Rate, deaths per 1000 births; aOR, odds ratio adjusted for age, parity, infant's gender, maternal occupation group, maternal employment status and cohabitation.
*aOR significantly different from 1.0; 0.95% CI.

Table 4. Differences in infant outcomes by distance of maternal residence from Capital Area.

	Capital Area		<69 km		70–249 km		>250 km	
	%	*n*	%	*n*	%	*n*	%	*n*
Low birthweight (<2500 g)	2.6	674	2.4	131	2.3	62	2.6	173
aOR	1.0		0.94 (0.77–1.14)		0.90 (0.69–1.18)		1.01 (0.85–1.20)	
Preterm birth (<37 weeks)	4.5	1187	4.6	246	4.5	119	4.1	276
aOR	1.0		0.98 (0.85–1.13)		0.98 (0.80–1.12)		0.90 (0.79–1.04)	
	Rate	*N*	Rate	*N*	Rate	*N*	Rate	*N*
Perinatal deaths (<7 days)	4.0	105	5.7	31	3.7	10	6.1	41
aOR	1.0		1.54 (0.97–2.43)	0.85 (0.41–1.74)	1.36 (0.90–2.06)			

Rate, deaths per 1000 births; aOR, odds ratio adjusted for age, parity, infant's gender, maternal occupation group, maternal employment status and cohabitation.

adverse birth outcomes across geographic regions remains to be further elucidated (22). With considerably higher body mass index and higher prevalence of smoking among rural women of fertile age (15) a likely explanation is that health professionals in the CA have in recent years become more vigilant at setting and recording antenatal diagnoses than their colleagues outside the CA. In support of potentially lower diagnostic activity in rural areas, we noted clearly lower prevalence of diagnosed diseases in regions outside the CA while poorer self-rated health in the same areas in a nationwide survey from 2007 (23). Hence, it is possible that undetected gestational hypertension and diabetes during pregnancy may have contributed to more high risk deliveries of mothers outside the CA.

Infants of mothers residing outside the CA were furthermore less likely to have been diagnosed with congenital malformations or 5-min Apgar score below 7. It is unclear why this is the case but similarly it is possible that less diagnostic activity or difference in registration may contribute to these differences. A Finnish study found similar differences in Apgar scores between the smallest and the largest delivery units (12). The authors concluded that the observed differences possibly reflected use of different diagnostic criteria.

Undetected hazards in utero may indeed contribute to adverse birth outcomes. Hence, the reasons for and consequences of lower rate of infant and maternal diagnoses in rural areas warrant further study.

One of the important strengths of the present study is that it leverages a rich and nationwide complete data source on all births over a 10-year period, allowing analysis of spatial variations in different time periods. A few limitations should however be mentioned. First, the study relies on assessment and registration of numerous health professionals across the nation. The quality and standardization of the Icelandic Medical Birth Register has not been formally assessed. The observed regional difference in rates of maternal and infant diseases may either be related to varying diagnostic practices or differential completeness of registration across regions; the latter being a potential source of bias in this study. We have no way to disentangle the magnitude of bias, if any. In any case, the regional variations in diagnostic activity or registration of pregnancy complications warrant further study. Second, we had access to several sources of potential confounders and adjusted our point estimates for maternal age, occupation group, employment status, cohabitation, parity and infant's gender and results on perinatal death were also adjusted for hypertension and diabetes. Data on other important confounders, e.g. maternal education, smoking during pregnancy and body mass index, were however not available as they are not recorded in the Icelandic Medical Birth register. This is an important limitation because all of these factors may vary across regions and are also strongly associated with adverse pregnancy outcomes (24). Higher smoking prevalence among women in rural areas (15) may for example be one explanation for lower prevalence of gestational hypertension (25). Yet, it is unclear whether the distinct change in prevalence of gestational hypertension during the latter half of the study period reflects a similar change in smoking across areas.

Third, this study only considers outcomes related to the pregnancy and first days after birth in a distinct population and time period. The findings cannot be generalized to other populations or time periods. Studies that look at inequalities that emerge later in life and are related to conditions in the perinatal period are therefore warranted.

Conclusions

The findings of this study indicate firstly minimal differences in gestational length and birthweight across regions of maternal residence. Second, our data suggest increased odds of perinatal death in the latter time period among infants born to mothers residing outside the CA while at the same time lower prevalence of diagnosed gestational diabetes and hypertension as well as congenital malformations outside the CA.

Together these findings raise concern and encourage further study of the quality of maternal care in rural areas as a healthcare system that in a timely fashion and properly identifies and intervenes in high-risk pregnancies is considered a key factor in reducing perinatal deaths and improving birth outcomes (26,27).

Funding

This work was supported by Rannís – the Icelandic Centre for Research (R10-0008 2010).

Acknowledgments

We thank the Directorate of Health and the National University Hospital for access to data, Kristinn Jónsson for assistance during data retrieval and Lilja Bjarklind Kjartansdóttir and Elín Inga Magnúsdóttir for assistance in cartography.

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Supporting information

Additional Supporting Information may be found in the online version of this article:

Table S1. Obstetric characteristics and birth outcomes by local health service and maternal residence.

Supplementary table 1. Obstetric characteristics and birth outcomes by local health service[a] and maternal residence

	Diverse specialized services		Limited specialized services		General health centres only		No local health services	
	%	N	%	N	%	N	%	N
Single births	70.0	(28 677)	13.2	(5411)	8.2	(3442)	8.6	(3351)
Cesarean section								
Elective	5.6	(1604)	8.6	(465)	7.7	(259)	7.6	(270)
aOR	1.0		1.61 (1.44-1.79)*		1.38 (1.20-1.58)*		1.29 (1.12-1.48)*	
Emergency	10.1	(2892)	10.0	(540)	10.9	(364)	9.8	(348)
aOR	1.0		1.11 (1.01-1.23)*		1.25 (1.11-1.41)*		1.16 (1.03-1.31)*	
Instrumental delivery	8.7	2495)	6.6	(358)	5.8	(196)	5.9	(211
aOR	1.0		0.89 (0.79-1.01)		0.82 (0.70-0.96)*		0.89 (0.76-1.03)	
Apgar 5 min. <7	2.7	(764)	2.3	(126)	2.2	(75)	1.9	(69)
aOR	1.0		0.96 (0.72-1.14)		0.90 (0.72-1.14)		0.89 (0.71-1.12)	
Congenital malformation	3.4	(981	1.7	(93)	2.3	(76)	1.8	(64)
aOR	1.0		0.52 (0.42-0.64)*		0.69 (0.55-0.88)*		0.55 (0.42-0.71)*	
Mean birth weight (g) (SD)								
	3.67	(0.57)	3.7	(0.56)	3.71	(0.58)	3.71	(0.56)
Low birthweight (<2500 g)	2.6	(734)	2.5	(134)	2.5	(83)	2.5	(89)
aOR	1.0		1.01 (0.84-1.21)		0.95 (0.75-1.12)		1.06 (0.86-1.31)	
Mean gest. length (days) (SD)	279.06	(16.69)	278.82	(16.23)	278.47	(19.42)	278.23	(23.30)
Preterm birth (<37 weeks)	4.5	(1282)	4.3	(233)	4.4	(148)	4.7	(165)
aOR	1.0		0.97 (0.84-1.12)		0.98 (0.82-1.16)		1.05 (0.89-1.24)	
Perinatal deaths (<7 days)	**Rate**	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**	**N**
	4.0	(115)	6.4	(35)	4.2	(14)	6.4	(23)
aOR	1.0		1.68 (1.10-2.59)*		0.90 (0.48-1.68)		1.50 (0.90-2.52)	

Rate; deaths per 1000 births

aOR adjusted for age, parity, infant´s gender, maternal occupation group, maternal employment status and cohabitation

*aOR significantly different from 1.0; 0,95% CI

[a]Categorization of local health service is based on data from the Directorate of Health and the Ministry of Health

Paper III

Submitted for publication

Appendix

Letters of approval from the Data Protection Authority

Letters of approval from the National Bioethics Committee

Letters of approval from the Data Protection Authority (in Icelandic)

Námsbraut í Lýðheilsuvísindum HÍ
Unnur A. Valdimarsdóttir
Stapa v. Hringbraut
101 REYKJAVÍK

Persónuvernd

Rauðarárstíg 10 105 Reykjavík
sími: 510 9600 bréfasími: 510 9606
netfang: postur@personuvernd.is
veffang: personuvernd.is

Reykjavík, 29. október 2008
Tilvísun: 2008090601 LSL/--

Heimild skv. 3. mgr. 15. gr. laga nr. 74/1997 til aðgangs að sjúkraskrám og til samkeyrslu skráa með viðkvæmum persónuupplýsingum, sbr. 1. tölul. 1. mgr. 7. gr. reglna nr. 698/2004, sbr. 33. gr. laga nr. 77/2000

I.
Umsókn

1.
Persónuvernd hefur borist umsókn frá Unni A. Valdimarsdóttur, dósent við Miðstöð Háskóla Íslands í lýðheilsuvísindum, dags. 28. október 2008, um leyfi til aðgangs að skrám vegna rannsóknar sem ber yfirskriftina „Aðgengi að heilbrigðisþjónustu á Íslandi eftir búsetu".

Samkvæmt umsókninni verða upplýsingar sóttar í skrár sem landlæknir rekur skv. 8. gr. laga nr. 41/2007, þ.e. samskiptaskrá heilsugæslustöðva og vistunarskrá um einstaklinga sem legið hafa á sjúkrahúsum landsins á fimm ára tímabili frá árinu 2003 til ársins 2007. Verður safnað upplýsingum um samskipti einstaklinga við heilsugæslustöðvar og um innlagnir á sjúkrahús, s.s. dagsetningu samskipta eða innlagna, hvaða stofnun á í hlut, persónuauðkenni sjúklinga, sjúkdómsgreiningar og aðgerðarnúmer.

Á upphaflegri umsókn var landlæknir umsækjandi auk yðar. Hann hafði og, sem ábyrgðaraðili, samþykkt aðgang að skránum. Persónuvernd benti þá á að þegar litið væri til 1. töluliðar 1. mgr. 3. gr. stjórnsýslulaga nr. 37/1993 yrði að telja hann vanhæfan til þess að lýsa afstöðu embættisins til eigin umsóknar.

Nú hefur hann fallið frá umsókninni og eruð þér ein tilgreind sem umsækjandi á nýrri umsókn, auk vinnsluaðila Sigríðar Haraldsdóttur.

2.
Í umsókn kemur og fram að fyrirhugað sé að samkeyra ofangreindar heilbrigðisskrár við þjóðskrá í því skyni að afla upplýsinga um rétta búsetu hinna skráðu eftir byggðarlögum.

Segir í umsókn að um leið og gögn úr heilbrigðisskrám landlæknis hafi verið samkeyrð við þjóðskrá til þess að fá vitneskju um búsetu verði öll persónuauðkenni afmáð og gögn merkt rannsóknarnúmerum. Síðari úrvinnsla rannsóknargagna fer fram í húsnæði Landlæknisembættisins og verða gögnin varðveitt þar meðan á ransókninni stendur.

Af framangreindu er ljóst að í rannsókninni felst öflun upplýsinga úr heilbrigðisskrám skv. 8. gr. laga nr. 41/2007. Samkvæmt 8. mgr. þessarar greinar fer um aðgang að heilbr igðisskránum eftir ákvæði 3. mgr. 15. gr. laga nr. 74/1997, um réttindi sjúklinga. Samkvæmt ákvæðinu þarf leyfi Persónuverndar til aðgangs að heilbrigðisskrám í þágu vísindarannsókna. Þá kemur fram að samkeyra á persónuupplýsingarnar við þjóðskrá. Samkvæmt 1. tölul. 1. mgr. 7. gr. reglna nr. 698/2004, sbr. 33. gr. laga nr. 77/2000, er samkeyrsla skráa háð leyfi Persónuverndar, ef a.m.k. ein hinna samkeyrðu skráa hefur að geyma viðkvæmar persónuupplýsingar.

II.
Leyfi og leyfisskilmálar

Persónuvernd hefur nú ákveðið, m.a. að virtum ákvæðum 29., 33. og 34. gr. í formálsorðum persónuverndartilskipunarinnar nr. 95/46/EB, sem og ákvæði 9. tölul. 1. mgr. 9. gr. laga nr. 77/2000 um persónuvernd og meðferð persónuupplýsinga, að veita yður umbeðið leyfi til aðgangs að sjúkraskrám vegna rannsóknarinnar: „Aðgengi að heilbrigðisþjónustu á Íslandi eftir búsetu".

Leyfi þetta gildir til 31. desember 2011 og er bundið eftirfarandi skilyrðum:

1. Ábyrgðaraðilar að vinnslu persónuupplýsinga
Unnur A. Valdimarsdóttir, dósent (sem hér eftir kallast leyfishafi), telst vera ábyrgðaraðili vinnslunnar í skilningi 4. tölul. 2. gr. laga nr. 77/2000. Fer Unnur A. Valdimarsdóttir með allt fyrirsvar gagnvart Persónuvernd um alla þætti er varða þetta leyfi, þ.á m. álitaefni, er upp kunna að rísa, um það hvort vinnsla persónuupplýsinga hafi verið í samræmi við lög, reglur og ákvæði þessa leyfis.

2. *Lögbundnir leyfisskilmálar*
a. Þegar leyfishafi fer þess á leit við ábyrgðarmenn skráa, sbr. reglugerð nr. 227/1991, að fá aðgang að viðkomandi skrám, ber honum að framvísa leyfi þessu.
b. Leyfi þetta er bundið því skilyrði að ábyrgðarmenn umræddra skráa hafi lýst því yfir að þeir séu því samþykkir fyrir sitt leyti að leyfishafi fái aðgang að þeim.
c. Leyfi þetta er bundið því skilyrði að siðanefnd, eða eftir atvikum vísindasiðanefnd, hafi lagt mat á rannsóknina og látið í té skriflegt álit sitt þess efnis að hvorki vísindaleg né siðfræðileg sjónarmið mæli gegn framkvæmd hennar, sbr. 3. mgr. 15. gr. laga nr. 74/1997, sbr. 4. mgr. 2. gr. sömu laga.

3. Lögmæt vinnsla persónuupplýsinga og þagnarskylda
a. Leyfishafi ber ábyrgð á því að vinnsla persónuupplýsinga vegna rannsóknarinnar fullnægi ávallt kröfum 1. mgr. 7. gr. laga nr. 77/2000.
b. Farið skal með upplýsingar úr sjúkraskrám, sem skráðar eru vegna rannsóknarinnar, í samræmi við lög nr. 77/2000, lög nr. 74/1997, læknalög nr. 53/1988 og reglugerð nr. 227/1991. Hvílir þagnarskylda á leyfishafa og öðrum þeim sem koma að rannsókninni um heilsufarsupplýsingar sem unnið er með, sbr. 15. gr. laga nr. 53/1988. Þagnarskylda helst þótt látið sé af störfum við rannsóknina.
c. Taki háskólanemar eða aðrir, sem ekki teljast til löggiltra heilbrigðisstétta, þátt í

framkvæmd rannsóknarinnar skulu þeir undirrita sérstaka þagnarskylduyfirlýsingu, þar sem þeir m.a. ábyrgjast að tilkynna leyfishafa ef í rannsóknargögnum eru viðkvæmar persónuupplýsingar um þá sem eru eða hafa verið maki viðkomandi, skyldir eða mægðir honum í beinan legg eða að öðrum lið til hliðar eða tengdir honum með sama hætti vegna ættleiðingar. Er viðkomandi þá óheimilt að kynna sér gögn um þá einstaklinga. Leyfishafa eða fulltrúa hans ber að votta rétta undirskrift hlutaðeigandi og dagsetningu slíkrar yfirlýsingar og koma henni til Persónuverndar innan tveggja vikna frá útgáfu leyfis þessa eða frá því að viðkomandi hefur störf við rannsóknina. Þagnarskyldan er byggð á 3. mgr. 35. gr. laga nr. 77/2000. Á heimasíðu Persónuverndar er að finna staðlað eyðublað fyrir þagnarskylduyfirlýsingu. Ef þagnarskylduyfirlýsingum er ekki skilað innan tilskilins frests getur Persónuvernd afturkallað leyfi þetta.

d. Leyfi þetta heimilar einvörðungu að safnað verði úr sjúkraskrám þeim heilsufarsupplýsingum sem gildi hafa fyrir rannsókn leyfishafa og samrýmast markmiðum hennar.ennar.

4. Auðkenning rannsóknargagna

a. Í rannsóknargögn má skrá upplýsingar um fæðingarmánuð, fæðingarár og kyn hvers sjúklings ásamt búsetu eftir byggðarlagi.
b. Óheimilt er að skrá í rannsóknargögn upplýsingar um nöfn sjúklinga, nafnnúmer, heimilisföng, símanúmer, fax-númer, tölvupóstföng eða annað sambærilegt.
c. Í ljósi þess að samkeyra þarf upplýsingar úr heilbrigðisskrám Landlæknis við þjóðskrá til þess að finna rétta búsetu þátttakenda eftir byggðalagi er heimilt við framkvæmd rannsóknar þessarar að skrá og varðveita *tímabundið* sérstaka skrá, greiningarlykil, sem tengir saman upplýsingar um kennitölur einstaklinga og rannsóknarnúmer á meðan verið er að undirbúa rannsóknargögn. Slíka skrá/greiningarlykil skal ávallt varðveita aðskilda frá öðrum rannsóknargögnum.
d. Þegar þær heilbrigðisupplýsingar, sem leyfi þetta tekur til, hafa verið skráðar í rannsóknargögn, og eftir atvikum verið staðreynt að þær séu réttar, og gögnin að öðru leyti verið fullgerð, skal tryggja að þar liggi ekki fyrir auðkenning á því frá hvaða einstaklingi upplýsingarnar stafa, s.s. með eyðingu kennitalna. Skal það gert eigi síðar en 31. desember 2011.

5. Öryggi við vinnslu persónuupplýsinga

Leyfishafa ber að gera viðeigandi tæknilegar og skipulagslegar öryggisráðstafanir til að vernda persónuupplýsingar gegn óleyfilegum aðgangi í samræmi við 11. og 12. gr. laga nr. 77/2000. Þar er meðal annars áskilið að:

a. beita skuli ráðstöfunum sem tryggja nægilegt öryggi miðað við áhættu af vinnslunni og eðli þeirra gagna sem verja á, með hliðsjón af nýjustu tækni og kostnaði við framkvæmd þeirra, og
b. tryggja skuli að áhættumat og öryggisráðstafanir við vinnslu persónuupplýsinga séu í samræmi við lög, reglur og fyrirmæli Persónuverndar um hvernig tryggja skal öryggi upplýsinga, þ.m.t. þá staðla sem hún ákveður að skuli fylgt.

Leyfishafi ber ábyrgð á því að hver sá er starfar í umboði hans og hefur aðgang að persónuupplýsingum vinni aðeins með þær í samræmi við skýr fyrirmæli sem hann gefur og að því marki að falli innan skilyrða leyfis þessa, nema lög mæli fyrir á annan veg, sbr. 3. mgr. 13. gr. laga nr. 77/2000.

6. Almennir skilmálar

a. Ávallt skal tryggt að rannsóknargögn séu varðveitt á tryggum stað og aðeins þar sem lögum samkvæmt er heimilt að varðveita þau.
b. Leyfishafi ber ábyrgð á að farið sé með öll persónuauðkennd gögn sem sjúkragögn í

samræmi við lög, reglur og ákvæði þessa leyfis.

c. Leyfishafi skal ábyrgjast að engir aðrir en hann fái í hendur persónugreinanleg gögn sem sérstaklega verður aflað í þágu þessarar rannsóknar.
d. Óski leyfishafi þess að hætta rannsókn ber honum að leggja þetta leyfi inn til Persónuverndar á skriflegan og sannanlegan hátt. Skal þá tilgreina hvort þeim persónuupplýsingum, sem unnar voru á grundvelli þessa leyfis, hafi verið eytt. Að öðrum kosti úrskurðar Persónuvernd um hvort persónuupplýsingunum skuli eytt eða þær varðveittar með ákveðnum skilyrðum.
e. Leyfishafa ber að veita Persónuvernd, starfsmönnum og tilsjónarmönnum hennar allar umbeðnar upplýsingar um vinnslu persónuupplýsinga sé eftir því leitað í þágu eftirlits. Brot á ákvæði þessu getur varðað afturköllun á leyfinu.
f. Persónuvernd getur látið gera úttekt á því hvort leyfishafi fullnægi skilyrðum laga nr. 77/2000 og reglna sem settar eru samkvæmt þeim eða einstökum fyrirmælum. Getur Persónuvernd ákveðið að hann skuli greiða þann kostnað sem af því hlýst. Persónuvernd getur einnig ákveðið að leyfishafi greiði kostnað við úttekt á starfsemi, við undirbúning útgáfu vinnsluleyfis og annarrar afgreiðslu. Persónuvernd skal þá gæta þess að sá sérfræðingur, sem framkvæmir umrædda úttekt, undirriti yfirlýsingu um að hann lofi að gæta þagmælsku um það sem hann fær vitneskju um í starfsemi sinni og leynt ber að fara eftir lögum eða eðli máls. Brot á slíkri þagnarskyldu varðar refsingu samkvæmt 136. gr. almennra hegningarlaga. Þagnarskyldan helst þótt látið sé af starfi.
g. Leyfi þetta er háð því skilyrði að einungis verði safnað þeim upplýsingum sem *nauðsynlegar* eru vegna rannsóknarinnar.

Virðingarfyllst

Sigrún Jóhannesdóttir

Háskóli Íslands
Unnur A. Valdimarsdóttir
Stapi v. Hringbraut
101 REYKJAVÍK

Persónuvernd

Rauðarárstíg 10 105 Reykjavík
sími: 510 9600 bréfasími: 510 9606
netfang: postur@personuvernd.is
veffang: personuvernd.is

Reykjavík, 8. mars 2011
Tilvísun: 2008090601AT/--

Efni: Viðbótarleyfi vegna rannsóknarinnar „Aðgengi að heilbrigðisþjónustu á Íslandi eftir búsetu"

Persónuvernd vísar til erindis yðar, dags. 3. mars 2011, þar sem þér óskið eftir leyfi til að gera breytingar á rannsókninni „Aðgengi að heilbrigðisþjónustu á Íslandi eftir búsetu", en með bréfi, dags. 29. október 2008, veitti Persónuvernd yður leyfi til vinnslu persónuupplýsinga vegna doktorsrannsóknar Sigríðar Haraldsdóttur. Óskið þér nú eftir því að gera eftirfarandi breytingar á framkvæmd rannsóknarinnar:

> í fyrsta lagi er fyrirhugað að gera breytingar á rannsóknartímabili rannsóknarinnar. Upphaflega var áætlað að vinna með gögn fyrir tímabilið 2003-2007 en nú er óskað eftir að nota gögn fyrir tímabilið **2005-2009**.
>
> Í öðru lagi er óskað eftir aðgangi að bæta við rannsóknargögn upplýsingum úr **Fæðingarskrá** Landlæknisembættisins til að kanna hvort munur sé á fæðingarþyngd barna eftir búsetu móður. Í erindi yðar kemur fram að þörf sé á upplýsingum um aldur móður, póstnúmer, stöðu á vinnumarkaði, hjúskaparstöðu, meðgöngulengd, fæðingarþyngd og sjúkdóma á meðgöngu.
>
> Í þriðja lagi er óskað eftir að framlengja gildistíma leyfisins, dags. 29. október 2008, um eitt ár eða til **31. desember 2012** en upphaflegt leyfi gilti til 31. desember 2011.

Persónuvernd heimilar aðgang að upplýsingum úr sjúkraskrá og heilbrigðisskrám Landlæknis vegna vísindarannsókna samkvæmt 3. mgr. 15. gr. laga nr. 74/1997 um réttindi sjúklinga sbr. einnig 8. mgr. 8. gr. laga nr. 41/2007 um landlækni. Vinnsla viðkvæmra persónuupplýsinga er

háð leyfi Persónuverndar sbr. 7. tölul. 1. mgr. 4. gr. reglna Persónuverndar nr. 712/2008 um tilkynningarskylda og leyfisskylda vinnslu persónuupplýsinga, sbr. einnig 33. gr. laga nr. 77/2000, um persónuvernd og meðferð persónuupplýsinga.

Það tilkynnist yður hér með að Persónuvernd gerir ekki athugasemdir við fyrirhugaðar breytingar á framkvæmd rannsóknarinnar, þ.e. að gögnum verði safnað fyrir tímabilið 2005-2009, að gögnum verði safnað úr Fæðingarskrá landlæknis og að gildistími leyfis frá 29. október 2008 verði framlengt til 31. desember 2012 enda sé farið að öllum þeim skilmálum sem mælt er fyrir um í upphaflegu leyfi stofnunarinnar frá 29. október 2008.

Virðingarfyllst

Alma Tryggvadóttir

Letter of approval from the Data Protection Authority (in Icelandic)

VÍSINDASIÐANEFND

Vegmúla 3, 108 Reykjavík,

Sími: 551 7100, Bréfsími: 551 1444

netfang: visindasidanefnd@vsn.stjr.is

Háskóli Íslands, heilbrigðisvísindasvið,
læknadeild,
Unnur Anna Valdimarsdóttir, dósent
v/Suðurgötu
101 Reykjavík

Reykjavík 9. september 2008
Tilv.: VSNb2008090001/03-7

Efni: Varðar: 08-122-afg Aðgengi að heilbrigðisþjónustu á Íslandi eftir búsetu. Doktorsverkefni.

Á fundi sínum 09.09.2008 fjallaði Vísindasiðanefnd um umsókn þína dags. 29.08.2008, vegna ofangreindrar rannsóknaráætlunar. Meðrannsakendur þínir eru Sigurður Guðmundsson, landlæknir, Vilhjálmur Rafnsson, prófessor, Birgir Hrafnkelsson, dósent og Sigríður Haraldsdóttir, doktorsnemi við Háskóla Íslands, en rannsóknin er námsverkefni hennar.
Markmið rannsóknar er að meta hvort og að hvaða marki íbúar landsins hafa jafnt aðgengi að heilbrigðisþjónustu eftir því hvar á landinu þeir búa. Rannsóknin er skipt í fjóra meginhluta.
Í fyrsta hluta verður landfræðileg dreifing á heilbrigðisþjónustu kortlögð og þjónustuþörf áætluð. Kannað verður hvort framboð á heilbrigðisþjónustu sé í samræmi við þörf á hverju svæði og hvort mismunur sé á milli svæða.
Í öðrum hluta rannsóknarinnar verða skoðaðar vísbendingar um aðgengi að þjónustu heilsugæslustöðva. Notkun á þjónustu heilsugæslustöðva verður kortlögð og kannað hvort notkunin sé mismunandi eftir svæðum (fjöldi samskipta) þegar tekið hefur verið tillit til ætlaðrar þarfar. Jafnframt verður kannað hvert íbúar byggðarlaga sækja heilsugæsluþjónustu, fjarlægð í þjónustuna, misræmi milli landshluta og hvort fjarlægð í þjónustu kunni að tengjast notkun hennar.
Í þriðja hluta rannsóknarinnar verða skoðaðar vísbendingar um aðgengi að þjónustu sjúkrahúsa (innlagnir). Athugað verður hvaða sjúkrahúsþjónustu einstaklingar fá í heimabyggð og hvaða þjónustu þeir sækja um lengri veg og hugsanlegt misvægi á milli byggðarlaga.
Í fjórða hluta rannsóknarinnar verður kannað hvort landfræðilegt ójafnræði í aðgengi að heilbrigðisþjónustu hafi haft áhrif á stigun við sjúkdómsgreiningu, meðferð og/eða dánarlíkur tiltekins sjúkdóms. Þessi hluti rannsóknarinnar verður fullmótaður síðar og verður þá sérstaklega sótt um leyfi fyrir honum.

Vísindasiðanefnd gerir eftirfarandi athugasemdir við rannsóknaráætlunina:

1. Það er meginregla Vísindasiðanefndar að öllum rannsóknargögnum verði eytt innan fimm ára frá rannsóknarlokum, nema rökstuðningur fyrir annarri skipan þar á liggi fyrir. Óskað er eftir nánari upplýsingum varðandi eyðingu gagna sbr. 19. lið umsókna s.s hvenær og hvernig þeim verður eytt.
2. Þar sem Sigurður Guðmundsson landlæknir er samkvæmt 4. lið umsóknarinnar meðal rannsakenda getur hann ekki, skv. 1. tl. 1. mgr. 3. gr. laga nr. 37/1993, um stjórnsýslu, sjálfur veitt leyfi um vinnslu þriðja aðila úr þeim skrám Landlæknisembættisins sem afla á gagn úr. Nefndin kallar því eftir afriti af undirrituðu leyfi þess sem skv. 6. gr. laganna er til þess bær.

Rannsóknin verður tekin til frekari afgreiðslu innan Vísindasiðanefndar þegar henni hafa borist svör við ofangreindum athugasemdum. Upplýsingar um skilafresti má nálgast á heimasíðu nefndarinnar, www.visindasidanefnd.is. Vinsamlegast athugið að óheimilt er að hefja framkvæmd rannsóknar fyrr en endanlegt samþykki Vísindasiðanefndar fyrir henni hefur verið veitt.

Með kveðju,
f.h. Vísindasiðanefndar,

dr. Eiríkur Baldursson, framkvæmdastjóri

VÍSINDASIÐANEFND

Vegmúla 3, 108 Reykjavík,

Sími: 551 7100, Bréfsími: 551 1444

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Háskóli Íslands, Læknagarður
Unnur Anna Valdimarsdóttir, dósent
Vatnsmýrarvegi 16
101 Reykjavík

Reykjavík 22. mars 2011
Tilv.: VSNb2008090001/03.7

Efni: Varðar: 08-122-V1 Aðgengi að heilbrigðisþjónustu á Íslandi eftir búsetu.
Doktorsverkefni.

Á fundi sínum 22.03.2011 fjallaði Vísindasiðanefnd um umsókn þína dags. 03.03.2011, vegna viðbótar við ofangreinda rannsóknaráætlun.

Rannsakendur óska eftir leyfi til að breyta rannsóknaráætluninni eftirfarandi:

1. Í upprunalegri umsókn og í heimild Vísindasiðanefndar er gert ráð fyrir að notuð séu gögn á fimm ára tímabilinu frá 2003-2007. Nú er farið fram á heimild til að nota frekar gögn fimm ára tímabilsins frá 2005-2009.
2. Í upprunalegri umsókn og í heimild VSN er gert ráð fyrir að notuð séu gögn úr tveimur af heilbrigðisskrám landlæknis, þ.e. úr Vistunarskrá sjúkrahúsa og Samskiptaskrá heilsugæslustöðva. Nú er óskað eftir heimild nefndarinnar til þess að bæta við gögnum úr Fæðingarskrá Íslands. Tilgangur þess er að kanna hvort munur er á fæðingarþyngd barna eftir búsetu móður þegar tekið hefur verið tillit til ýmissa áhrifaþátta. Óskað er eftir einstaklingsbundnum, en ópersónugreinanlegum gögnum þar sem kennitölu hefur verið skipt út fyrir einkvæm auðkennisnúmer. Þörf er á upplýsingum um aldur móður og póstnúmer, búsetu, stöðu á vinnumarkaði og hjúskaparstöðu, meðgöngu lengd, fæðingarþyngd og sjúkdóma á meðgöngu.

Vísindasiðanefnd hefur farið yfir bréf þitt og innsend gögn og gerir ekki athugasemdir við tilgreindar breytingar. Viðbót nr. 1 ásamt fylgigögnum við ofangreinda rannsókn, er endanlega samþykkt af Vísindasiðanefnd.

Með kveðju,
f.h. Vísindasiðanefndar,

dr. med., Björn Rúnar Lúðvíksson, læknir, formaður