The Murmansk County Birth Registry (MCBR)

The implementation and applicability of a population-based medical birth registry in the Russian Arctic

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Preface

I would have liked to begin by saying that this Russian adventure started in the Kola Peninsula in 2004, but that is not really the case. Initially, my assignment was to establish a birth registry in the Komi Republic. To be honest, I had never heard of Komi in all my life. But there I was in the capital of Komi (Syktyvkar) two weeks after starting my new job as a PhD-student, without a clue. The reason for the specific locality of the new registry was that Komi had just been included in the Barents Region cooperation and Norwegian research funds had directed money there. Since this story is not really about Komi, let's just complete this chapter by stating that the project was terminated after one year and we were back to square one. Luckily, my supervisors Jon Øyvind Odland and Evert Nieboer had, over the years, built up extensive scientific links to other parts of North-West Russia, especially in the Kola Peninsula (or Murmansk County; or Murmanskaja Oblast). We approached them in May 2005 with a proposal for establishing the Murmansk County Birth Registry (MCBR). Even though this meant giving us access to sensitive data and human resources, they immediately agreed to our plans. By January 1st 2006, the MCBR was fully operational and up and running. Today, local legislation states that all deliveries must be registered in the MCBR.

Establishing the birth registry was the first step, and then we had to make sure that it actually worked and was of good quality. Several quality control exercises were conducted with very encouraging results, even though several changes (both large and small) had to be made over the next years.

After two publications, and being reasonably confident of the MCBR's validity as a medical birth registry, we felt secure in taking it further towards its two main objectives. First of all, the Murmansk Health Officials are to employ the registered data, outcome patterns and trends to improve maternal and perinatal health care. Second, the database is also available as a scientific tool such as for

conducting perinatal health research. Specifically, at the University of Tromsø it will serve as a research platform for environmental studies for adverse perinatal or maternal outcomes. The environmental medicine group, which has worked with contaminants in the Arctic for 20 years, provides an appropriate context.

For several obvious and some more obscure reasons, studying the effects of persistent organic pollutants in the Russian Arctic is challenging, at best. The Arctic Monitoring and Assessment Programme[a] (AMAP) provided the groundwork for collecting environmental samples and human tissues in Russia and their analyses. However in the context of human contaminant cohort studies some issues demanded further attention, such as: utilizing established research methods in conjunction with a birth registry; authenticating laboratory results; combining data from different laboratories; and identifying correct sampling times and tissues. Two publications (method papers; Papers III and IV) describe how some of these challenges were addressed.

[a] AMAP is an international working group of the Arctic Council, which is an intergovernmental forum established in 1996 by the 8 Arctic Countries. It implements components of the Arctic Environmental Protection Strategy (AEPS) and its current objective is *"providing reliable and sufficient information on the status of, and threats to, the Arctic environment, and providing scientific advice on actions to be taken in order to support Arctic governments in their efforts to take remedial and preventive actions relating to contaminants".* (www.amap.no)

Summary

The Murmansk County Birth Registry (MCBR) was initiated on January 1. 2006. Currently (April 2009) the MCBR has registered over 26 000 births. The registry covers a geographical area known as the Kola Peninsula in Northwest Russia, which is almost entirely located above the Arctic Circle. Murmansk County is about half the size of Norway and had 857 000 inhabitants in 2008. All the 15 delivery departments in the county are involved and their locations stretch from Nikel in the Northwest to Kandalaksha in the south. The Registry Office is located in the city of Murmansk with a trusted staff of four.

The MCBR annually registers over 99% of all deliveries in the region. Based on several measures such as quality control exercises and regional workshops, the registry seems to exhibit adequate validity. The registration of births in the MCBR is obligatory and embedded in regional legislation. It is a cooperative effort between the University of Tromsø and the Murmansk County Health Department. Together they have defined four major guidelines, or tasks for the registry:

- Monitor the health condition of mothers and their newborn;
- Monitor the availability of maternal and perinatal health care;
- Develop standards and guidelines for maternal and perinatal health care;
- Spawn new hypotheses and provide knowledge related to causal relationships for reproductive health risk factors.

Comparisons of selected pregnancy outcomes from Murmansk County with the northern regions of other Nordic countries (Norway, Sweden and Finland) revealed several interesting differences. First of all, there was the divergence of the demographic composition of the respective delivering populations. The pregnant women were much younger in Murmansk County (about 3.5 years), and the percentage of teenage mothers was about twice that of Northern Norway and 5 times higher than in Northern Sweden. Further each woman tended to

have fewer children in Murmansk County, the babies were lighter on average (about 200 g), and the proportion of children with a birth weight over 4500 g was 4.5 times higher in Northern Norway.

A study comparing the birth weights, perinatal mortality and gestational ages between Northern Norway and Murmansk County disclosed valuable information. Based on WHO-guideline-calculations, the perinatal mortality among the women with a known gestational age was 11.0/1000 in Murmansk County (2006-2007) and 5.4/1000 in Northern Norway (2004-2006). The risk of perinatal mortality was higher at all gestational ages and at all birth weight increments in Murmansk County. There were large disparities between the two regions in the optimal perinatal-survival weights and the small-for-gestational-age 10 percent cut-off weight for term deliveries.

Two further studies aimed to map out challenges related to the collection of human tissue samples in the Russian Arctic for the analyses of environmental contaminants. After all, a relevant and effective protocol is the core of any viable epidemiological study. It was concluded that relative to cord blood and breast milk, maternal plasma/blood is the most fundamental biomonitoring medium for organochlorines and toxic metals. Also, complicated statistical analyses will require a detection frequency of the individual contaminant levels in each sample to exceed 80%. And finally, the correlations between concentrations of different organochlorines in the body fluids (with a few exceptions) were sufficiently high so that measuring the levels of a few with high detection frequencies would give a suitable picture of the combined body burden of these contaminants.

In conclusion, the MCBR constitutes an invaluable tool for reproductive health studies in the future such as the studies of adverse effects of environmental contaminants.

Sammendrag

Murmansk County Birth Registry (MCBR) ble offisielt startet 1. januar 2006. Frem til i dag (april 2009) har MCBR registrert over 26 000 fødsler. Registeret dekker et geografisk område som kalles Kola halvøya lokalisert i nordvest Russland. Nesten hele området ligger nord for polarsirkelen. Murmansk fylke (eller Murmansk regionen) er omtrent halvparten så stort som Norge og hadde 857 000 innbyggere i 2008. Det finnes 15 fødemottak i fylket som alle er involvert og leverer data til registeret. Fødemottakene strekker seg fra Nikel (ved norskegrensen) og ned til Kandalaksha, sør i fylket. Selve registerkontoret ligger i Murmansk by og har i dag fire ansatte.

MCBR registrerer hvert år over 99% av alle fødsler i fylket og basert på resultater av flere kvalitetskontroller og plenumsmøter med alle involverte, ser registeret ut til å ha en validitet av tilfredsstillende omfang. Selve registreringen av fødsler er obligatorisk for alle kvinner og vedtatt gjennom regional lovgivning og er et samarbeidsprosjekt mellom Universitetet i Tromsø og helsedepartementet i Murmansk. Sammen har de definert flere retningslinjer og oppgaver som registeret skal oppfylle og utføre:

- Overvåke mor og barns helse;
- Overvåke tilgangen på helsetilbud;
- Utvikle standarder og retningslinjer for mor/barn helse;
- Generere nye hypoteser og frembringe kunnskap om kausale sammenhenger mellom risiko faktorer og perinatal helse.

Sammenligninger av svangerskapsutfall fra Murmansk fylke med andre nordlige deler av de nordiske landene (Norge, Sverige og Finland) resulterte i mange interessante oppdagelser. For det første var den demografiske sammensetningen av de fødende kvinnene veldig forskjellig i disse ulike populasjonene. De gravide hadde en mye lavere gjennomsnittsalder in Murmansk fylke (omtrent 3.5 år), prosentandelen av tenåringsmødre var dobbel

så høy som i Nord-Norge of fem ganger høyere enn i Nord-Sverige. Videre viste det seg at hver kvinne fikk færre barn gjennom livet i Murmansk fylke, de nyfødte hadde en lavere gjennomsnittlig fødselsvekt (omtrent 200 g) og andelen av barn med en fødselsvekt over 4500 g var fire og en halv gang høyere i Nord-Norge.

Den ene studien som sammenlignet fødselsvekter, perinatal dødelighet og svangerskapslengder mellom Nord-Norge og Murmansk Fylke ga oss mer nyttig informasjon. Basert på WHO sine retningslinjer for utregninger av perinatal dødelighet bland kvinner med kjent svangerskapslengde ble det funnet at den perinatale dødeligheten var 11.0/1000 i Murmansk fylke (2006-2007) og 5.4/1000 in Nord-Norge (2004-2006). Risikoen for perinatal dødelighet var høyere ved alle svangerskapslengder og i alle fødselsvektkategorier i Murmansk fylke. Det var også store forskjeller i den optimale perinatale overlevelsesvekten og i det som kunne oppfattes som ”liten for gestasjonsalder”, spesielt for de som ble født på termin.

To videre studier prøvde å finne løsninger på problemer relatert til innsamling av vevsprøver og miljøgifter i den arktiske delen av Russland. En skikkelig protokoll er tross alt hjørnesteinen i en hver ordentlig epidemiologisk studie. Det ble konkludert med at maternalt blod/plasma var det mest fundamentale bioovervåkningsmedium for organiske klorider og giftige metaller. Det viste seg også at avanserte statistiske utregninger krevde tilstedeværelse av målbare verdier av kontaminantene i over 80% av tilfellene. Til slutt ble det funnet at korrelasjonene mellom nivåene av de forskjellige organiske kloridene (med noen få unntak) var så høye at det å måle nivået av noen få av dem kunne gi et klart bilde av den kombinerte kroppsbelastningen av de respektive kontaminantene.

Konklusjonen er at MCBR kan bli et viktig og uunnværlig instrument for perinatale helsestudier i fremtiden.

Резюме

Регистр родов Мурманской области (РРМО) был официально начат 1 января 2006 года. До настоящего времени (до апреля 2009 г.) в РРМО зарегистрировано свыше 26000 родов. Регистр охватывает географическое пространство, известное как Кольский полуостров, расположенный на Северо-западе России. Это пространство почти полностью находится за Полярным кругом. Мурманская область составляет почти половину территории Норвегии. В 2008 г. в ней проживало 857 000 жителей. В области насчитывается 15 родильных отделений. Все они поставляют данные для регистра. Родильные отделения расположены на территории, которая простирается от г. Никеля (находящегося у норвежской границы) на Северо-западе до г. Кандалакши на юге. Офис Регистра находится в г. Мурманске. Его персонал составляет 4 человека.

Ежегодно в РРМО регистрируется свыше 99% всех родов области. Результаты различных измерений контроля качества, а также региональные семинары подтверждают надежность данных регистра. Регистрация родов в РРМО является обязательной, и это записано в региональном законодательстве. РРМО является плодом совместных усилий Университета Тромсё и Отдела Здравоохранения Мурманской области. Вместе они разработали четыре основные директивы, или задачи регистра:

- контролировать состояние здоровья матерей и их новорожденных детей;
- контролировать эффективность материнского и перинатального здравоохранения;
- разработать стандарты и директивы для материнского и перинатального здравоохранения;
- выдвинуть новые гипотезы и обеспечить знание о взаимосвязи между факторами риска и репродуктивным здоровьем.

Сравнение некоторых исходов беременностей Мурманской области с данными северных регионов скандинавских стран (Норвегия, Швеция и Финляндия) показало некоторые интересные различия. Прежде всего, это расхождение в демографическом составе соответствующих групп рожающего населения. Беременные женщины в Мурманской области были гораздо моложе (разница около 3,5 лет). Процент матерей-подростков был почти в два раза выше, чем в Северной Норвегии и в 5 раз выше, чем в Северной Швеции. Каждая женщина Мурманской области склонна иметь меньше детей, младенцы в среднем легче на 200 грамм. Доля детей с весом при рождении свыше 4500 грамм в 4.5 раза выше в Северной Норвегии.

Сравнение данных Северной Норвегии и Мурманской области по весу при родах, перинатальной смертельности и гестационному возрасту дало нам ценную информацию. На основе директивных расчетов ВОЗ перинатальная смертность среди женщин с известным гестационным возрастом в Мурманской области была 11.0/1000 (2006-2007 гг.) и 5.4/1000 в Северной Норвегии (2004-2006 гг.). Риск перинатальной смертности в Мурманской области был выше для всех гестационных возрастов и для любого веса при родах. Большое несоответствие в этих двух регионах было и по оптимальному перинатальному весу, при котором младенец выживал, и теми младенцами, которые были рождены в срок, но были рождены маленькими для своего гестационного возраста (10% ниже нормального веса).

Целью двух других исследований было найти решение проблем, касающихся отбора проб тканей и загрязняющих веществ окружающей среды в Российской Арктике. Основой любого эпидемиологического изучения является эффективный протокол. Были сделаны выводы, что материнская плазма/кровь является самой основной средой для биомониторинга органохлоридов и токсичных металлов по сравнению с кровью из пуповины и грудным молоком. Также для сложного статистического анализа необходимо, чтобы частота обнаружения концентраций отдельного загрязняющего вещества в каждом образце превышала 80%. И в заключение, корреляции между концентрациями различных органохлоридов в биологических жидкостях (за некоторым исключением) были достаточно высокими. Т.о. определение концентрации только нескольких органохлоридов, тех, у которых высокая частота обнаружения, даст соответствующую картину комбинированной нагрузки на организм этих загрязняющих веществ.

В заключение

Будем надеяться, что РРМО даст бесценный инструмент для изучения в будущем репродуктивного здоровья, например инструмент для изучения неблагоприятного эффекта от веществ, загрязняющих окружающую среду.

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Mostly, I am grateful for the participation of all the Russian women and men in the studies, from Chukotka in the East to Murmansk in the West.

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I. Anda EE, Nieboer E, Voitov AV, Kovalenko AA, Lapina YM, Voitova EA, Kovalenko LF, Odland JØ. Implementation, quality control and selected pregnancy outcomes of the Murmansk County Birth Registry (Russia). Int J Circumpolar Health. 2008; 67(4):318-34.

II. Anda EE, Nieboer E, Wilsgaard T, Kovalenko AA, and Odland JØ. Perinatal mortality in relation to birthweight and gestational age: A registry-based comparison for Northern Norway and Murmansk County, Russia. Submitted to Acta Obstet Gynecol Scand, 19.02.09.

III. Anda EE, Nieboer E, Dudarev AA, Sandanger TM and Odland JØ. Intra- and intercompartmental associations between levels of organochlorines in maternal plasma, cord plasma and breast milk, and lead and cadmium in whole blood, for indigenous peoples of Chukotka, Russia. J Environ Monit. 2007; 9: 884–93.

IV. Sandanger TM, Anda EE, Dudarev AA, Nieboer E, Konoplev AV, Vlasov SV, Weber JP Odland JØ and Chashchin VP. Case study of combining persistent organic pollutants (POPs) datasets in the context of a circumpolar environment-and-health study. Submitted to Science of the Total Environment (STOTEN), 17.02.09.

Abbreviations

AMAP- Arctic Monitoring and Assessment Programme

APGAR - Appearance, Pulse, Grimace, Activity, Respiration

BMI – Body mass index

CP – Cord plasma

CPAP- Continuous Positive Airway Pressure

DDT- Dichloro-Diphenyl-Trichloroethane

DEET - *N*,*N´*-Diethyl-*meta*-toluamide

DL- Detection limit

hb – Haemoglobin

ICD- International Classification of Diseases

IEA - International Epidemiological Association

KCMC- Kilimanjaro Christian Medical Centre

MBRN- Medical Birth Registry of Norway

MCBR- Murmansk County Birth Registry

MM – Mothers' milk

MO – Murmanskaja Oblast (Murmansk County)

MP- Maternal plasma

OPSW – Optimal perinatal survival weight

PCB - Polychlorinated biphenyl

QA/QC – Quality assurance/Quality Control

r - Pearson product-moment correlation coefficient

SGA – Small for gestational age

SIDS – Sudden infant death syndrome

β-HCH - β-Hexachlorocyclohexane

Introduction

The world-wide use of health-related registries has burgeoned and this must tell us something about their applicability and usefulness. They are not just helpful in themselves, but also in combination with other registries or databases. A birth registry might be considered especially relevant since it deals with the fragile issues of the health of mothers and their newborns. It is most likely that during the first trimester in life a fetus is most vulnerable. A huge array of factors can influence both the short-term and long-term health of a baby, ranging from parental diseases, diet, socioeconomic status, the perinatal care provided to environmental factors such as exposure to toxic metals and pesticides.

The term "register" is applied to the file of data that can be related to a population base. The register is the actual document (i.e., list of the information items), while the registry is the surrounding system of ongoing registration (1). The most common and well known registries are mortality and cancer registries. The cause of death has been registered in Sweden since 1751, and the oldest cancer register in the world is the Danish one (dating back to 1943) (2). A medical birth registry registers diseases and other medical information on both the mother and the newborn. This information can be anything from sex of baby, weight, length and gestational age to mother's age, maternal smoking habits and medical aspects. The recording of births in its simplest form goes back a long time in church records, but the first three medical birth registries were established in 1967 in South America, Atlanta (USA) and Norway (3). The Nordic countries were the first countries to create nation-wide medical birth registries, spurred on by the thalidomide-disaster in the 1960s (3): Norway in 1967 (1970) (3), Denmark in 1968 (4), Sweden in 1973 (5) and Finland in 1987 (6)

A birth registry can be more or less epidemiologically oriented depending on the type of information gathered. Simply registering the occurrence of disease would be interesting in itself, but information on risk- or beneficiary-factors

(such as smoking or vitamin supplements, respectively) for a certain outcome would be all the more valuable. The Nordic birth registries have both medical and epidemiological aspects to them and have been extremely valuable as research tools over the years (3-6). An example of a birth registry with a more epidemiological emphasis is that at the Kilimanjaro Christian Medical Centre (KCMC) in Tanzania (7), because they also register non-medical information such as: residential setting, occupation, tribal concurrence, source of drinking water and family planning.

In Russia, to our knowledge, only the MCBR constitutes an ongoing prospective population-based birth registry (8). Cohort studies concerning perinatal outcomes have been conducted in Severodvinsk in north-west Russia (Arkhangelskaja Oblast) (9), as well as careful collection of data concerning perinatal mortality in the Omskaya Oblast (West Siberia) (10). For the Tulskaja Oblast (Central Russia), Danishevski *et al*. (11) have described a computerized registry system involving all 22 delivery departments in the region. However, it is unclear whether this system is operational currently.

In the Murmanskaja Oblast, a regional birth registry (the Kola Birth Registry, KBR) was set up for use as a tool to investigate the adverse outcomes of ambient air or work-related nickel exposure (12-16). This registry covered the delivery department in the town of Monchegorsk, located in the central part of the Kola Peninsula. It gathered detailed information from the hospital delivery department and gynaecological clinic files in the period from 1973 until 2004 with a total of 25 258 singleton births registered (17). To our knowledge, as with Tulskaja Oblast, the KBR has been discontinued. However some of the very competent and resourceful staff from the KBR are today involved with the MCBR.

From the local KBR arose the idea of creating a prospective medical birth registry for the whole county of Murmansk in 2005. The initiation and creation of this registry is thoroughly documented in Article I. Briefly, the MCBR was structured after the model of the Medical Birth Registry of Norway; the

registration started January 1st 2006 and covered all the delivery departments in the county. To date, in excess of 25 000 deliveries (singleton and multiple) have been entered into the registry database (the data for 2008 are not yet fully available). The MCBR has two major goals: to provide information to health officials to improve perinatal care, and to generate health-related scientific research. The Medical Birth Registry of Norway has proved itself extremely useful in both aspects (18).

The MCBR also has a potential future research purpose, which is to link information from the perinatal period with previous or current environmental exposures to contaminants such as organochlorines and toxic metals.

A large number of environmentally persistent toxic substances are subject to long-range-transport and accumulate in the Arctic (19-22). The Arctic Monitoring and Assessment Programme (AMAP) has published several reports describing these issues in relation to both the general environment and human health (23, 24). In addition to exposure to contaminants from long-range transport, point sources of contamination have been identified in several communities in the Kola Peninsula. There are several heavy industries or installations of concern. Besides three nickel refineries (at Nikel, Zapolyarny and Monchegorsk; see Figure 1) there are: mining activities [nickel/copper at Zapolyarny, iron at Kovdor and Olenegorsk, lanthanide (rare earth) metals near Lowosero and apatite at Apatity, Kirovsk and Kovdor]; iron recovery plants at Kovdor and Olenegorsk; and aluminium refining at Kandalaksha. There is also a large nuclear power-generating station at Polyarnye Zory and a number of large naval bases along the northern coastline. Contrary to the practice today, these plants were built first and then towns or cities for the workers were built around them. In spite of obvious drawbacks, this provides a unique possibility to study possible effects on maternal and perinatal health. The Russian authorities are committed to document and reduce any possible ill effects. Nevertheless, there are still vast and pristine forests and people who rely on traditional diets such as that of a large fish-eating coastal population on the shores of the White Sea in the south. Obviously there are several challenges

linked to the studies of effects of pollutants on the health of an unborn child and their mothers such as: i) restricted availability of study subjects and tissues, ii) tissue choices, iii) limitations in the availability of information concerning the sample population and iv) as described in Papers III and IV, the uncertainties surrounding the analytical methods for the contaminants and laboratory performance issues. Inevitably these challenges are often linked to costs.

Articles I and II deal with the registry directly, Articles III and IV address in part the four above mentioned environment-and-health study challenges. Specifically Article III asks the questions: which of the readily available tissues (mothers' blood, mothers' milk or cord blood) is best suited for contaminant analysis? Further, it discusses in depth how to treat contaminant concentrations that are below that which can be accurately detected by the analytical methods (i.e., the method detection limit), and how many (per cent wise) of the samples can be below the detection limit (and consequently imputed) without compromising the integrity of any statistical method. Paper IV explores additional issues of concern or contention such as quality control and quality assurance (QA/QC), the importance of lipid values and lipid adjustments for lipid-soluble substances, and the feasibility of linking and analysing datasets from different laboratories. Well-planned sampling strategies and protocols and effective QA/QC procedures are clearly necessary when initiating new work such as the planned follow-up project; the Murmansk Region Contaminant Study, funded by the Norwegian Research Council.

Hopefully the MCBR will continue to run independently of these other activities for many years to come and aid in improving perinatal health.

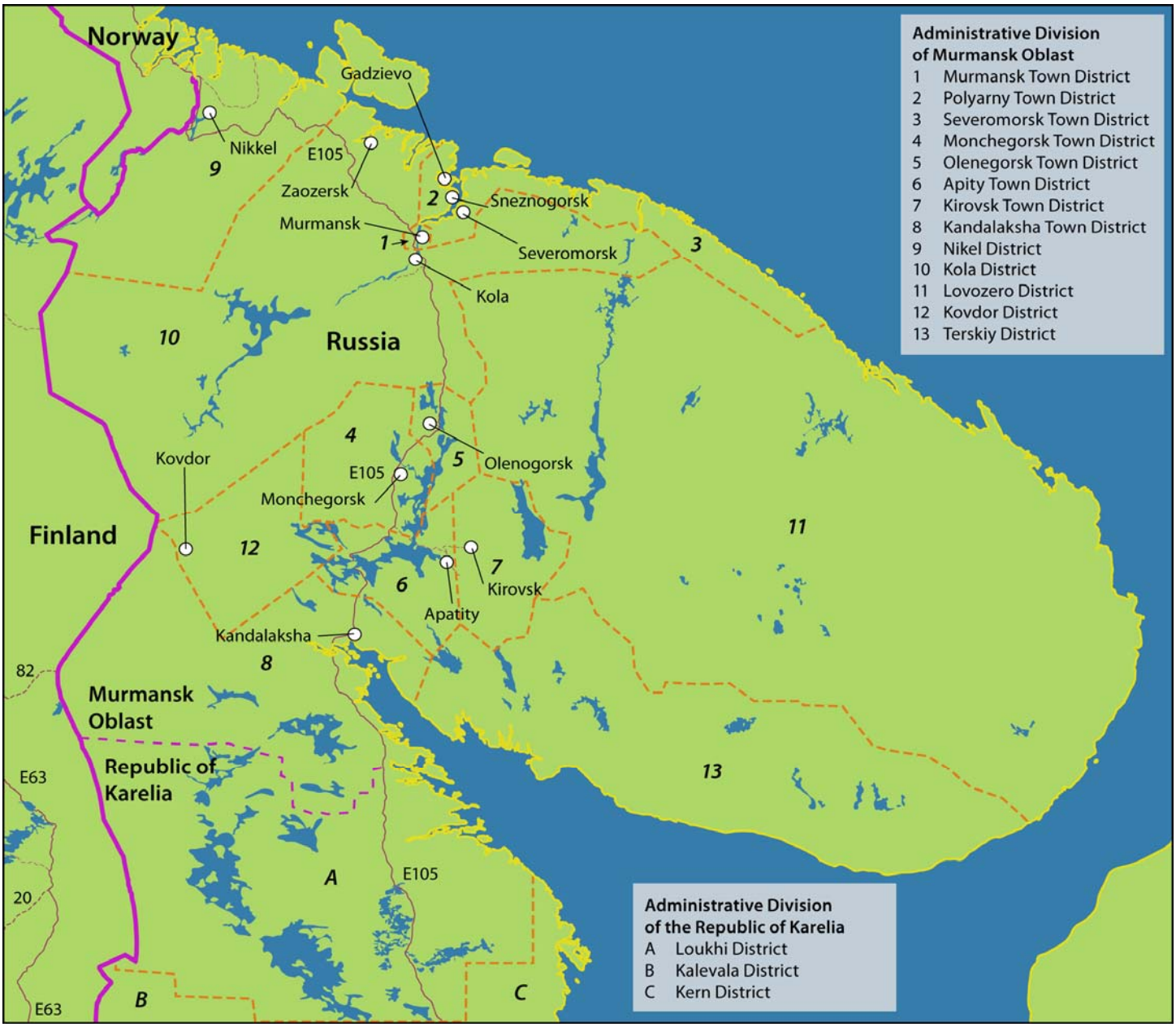

Figure 1. Map of the Kola Peninsula

Materials and Methods

Several geographical areas from Arctic Russia and the northern part of the Nordic Countries are depicted in Figures 2 and 3. Sampling locations for both the birth registries and the AMAP human health study (http://www.amap.no/) are discussed below and clearly marked on the maps. More detailed information on registered births recorded in the MCBR is provided in an annual report (Appendix A). Summary statistics and other demographic information concerning the birth registries in the Nordic countries is accessible online: the Norwegian Medical Birth Registry (http://mfr.no/), the Swedish Medical Birth Registry (http://www.socialstyrelsen.se/Statistik/statistikdatabas/) and the Finnish Medical birth registry (http://www.stakes.fi/EN/tilastot/statisticsbytopic/reproduction/parturients.htm).

Study populations

Paper I. All deliveries registered in the respective birth registries were considered: i) Murmansk County from 2006 (N = 8468); ii) Norway (Nordland, Troms and Finnmark counties) 2006 (N = 5269); iii) Sweden (Västerbotten and Norrbotten counties) 2005 (N = 4726); and iv) Finland (Lappi, Länsi-Pohja, Kainuu and Pohjois-Pohjanmaa counties) 2006 (N = 8109).

Paper II. All births from the Murmansk and Norwegian birth registries with available birth weight and gestational age data were included: Murmansk County in 2006 and 2007 (N = 17 141) and Norway (Nordland, Troms and Finnmark counties) 2004-2006 (N = 15 781).

Paper III. A selected cohort of pregnant indigenous women from the Chukotka Autonomous Okrug (Northeast Russia) in 2001 and 2002 (N = 48) was studied. The women were of different indigenous groups in the area and had an average

age of 24.2 years. Blood and milk samples were collected from the mother at the time of delivery, as well as umbilical cord samples for the determination of a selection of toxic metals and organochlorines (including pesticides). The laboratory analyses were carried out at the Center for Environmental Chemistry (CEC), Scientific Production Association (SPA) "Typhoon", Federal Service of the Russian Federation for Hydrometerology and Environmental Monitoring, Obminsk, Russia.

Paper IV. Cohorts from Arctic Russia in addition to one reference population from the Aral Sea (more southern location) were the focus. These cohorts consisted of both males and females from the general population, as well as pregnant women. The 48 women described in Paper III are a part of the cohort in Paper IV. In total, the N was 706; of these, there were 346 pregnant women, 238 women from the general population and 122 men from the general population. The overall average age was 32.4 years and 66.3% were women. Peripheral blood samples were collected as in Study III. The same suite of contaminants was determined in each of the four laboratories: 2 in Russia, one in Norway and the other in Canada.

Appendix A (Annual report on deliveries 2006). Selected summary statistics for all deliveries registered in Murmansk County during 2006 were presented in the appended annual report. Its main goal was to use it as a reference document at the annual conference in 2007 in addressing QA/QC measures. The cities with delivery departments participating in the MCBR are marked in Figure 1: Gadzievo, Sneznogorsk, Kola, Olenegorsk, Monchegorsk, Kovdor, Kirovsk, Apatity, Kandalaksha, three in Murmansk, Nikel, Zaozersk and Severomorsk.

Statistical analyses

The database management system Access (2003 Microsoft Corporation) was used for registering and storing data for the MCBR. For statistical tasks, both SPSS (version 14; SPSS Inc., Chicago, IL, USA) and SAS (version 9.2; SAS

Institute Inc., Cary, NC, USA) were utilized. In addition, we made use of a free internet program ("The Analysis of Birth Weight") for analyses of birth weight distributions obtained through the auspices of the U.S. National Institute of Environmental Health Sciences (NIEHS) (25). The specific statistical methods employed are described in detail in the individual papers. Statistical significance was reported as confidence intervals whenever possible, otherwise as p-values. For two of the papers (II and III), statistical power was of special concern. For Paper II the N appears large, but because the outcome variable perinatal mortality is rare (especially in Norway) even larger numbers would have been ideal. For Paper III the N is low, but the issue of power calculations in relation to regression analyses is addressed in the "Discussion" part of the paper. Another issue that needed special attention was the analytical uncertainties in relation to the low concentrations of some of the contaminants in plasma. Most of the contaminant distributions in plasma (and milk) were left-skewed (a normal distribution is a prerequisite for many statistical analyses) and thus needed log-transformation. A considerable fraction of the observed concentrations were below the levels detectable by the available analytical methods. The magnitude of the detection limit (DL) is dependent on the volume of the individual sample available for analysis, as well as on the sensitivity of the analytical equipment and different analytical procedures employed. In situations when values were below the DL, it was replaced by the DL/√2. The DL was selected for the lowest volumes (least sensitive) and/or the laboratory employing the least sensitive method (i.e. a conservative approach was adopted). The acceptable proportion of samples below the DL was set at 20% for any contaminant, thus the inclusion criteria in Paper III and IV was a detection frequency of 80%. Studies have shown that acceptance of a detection frequency below 90% may introduce bias (depending on the method of imputation and the type of statistical analyses that is to be performed) (26). However, any choice is always going to be a trade off with sample size (i.e., requirement for adequate statistical power).

Ethics approval

The respective studies were approved by the Regional Health Administration of the Murmansk County, and the Regional Ethical Committee of Northern Norway (Papers I and II); as well as the Regional Health Administrations of Narjan Mar Autonomous Okrug, Taimir Autonomous Okrug, the Chukotka County Regional Administration, and the Commander Island Regional Administration (Papers III and IV). In Murmansk County, special legislation was passed by the Regional Government to make registration of births to the Murmansk County Birth Registry mandatory for all delivering women. Special consent for the use of data from the respective Nordic Medical Birth Registries mentioned above was ascertained. All patient related data were anonymized for comparative and statistical purposes.

Figure 2. Study areas of Paper I and II

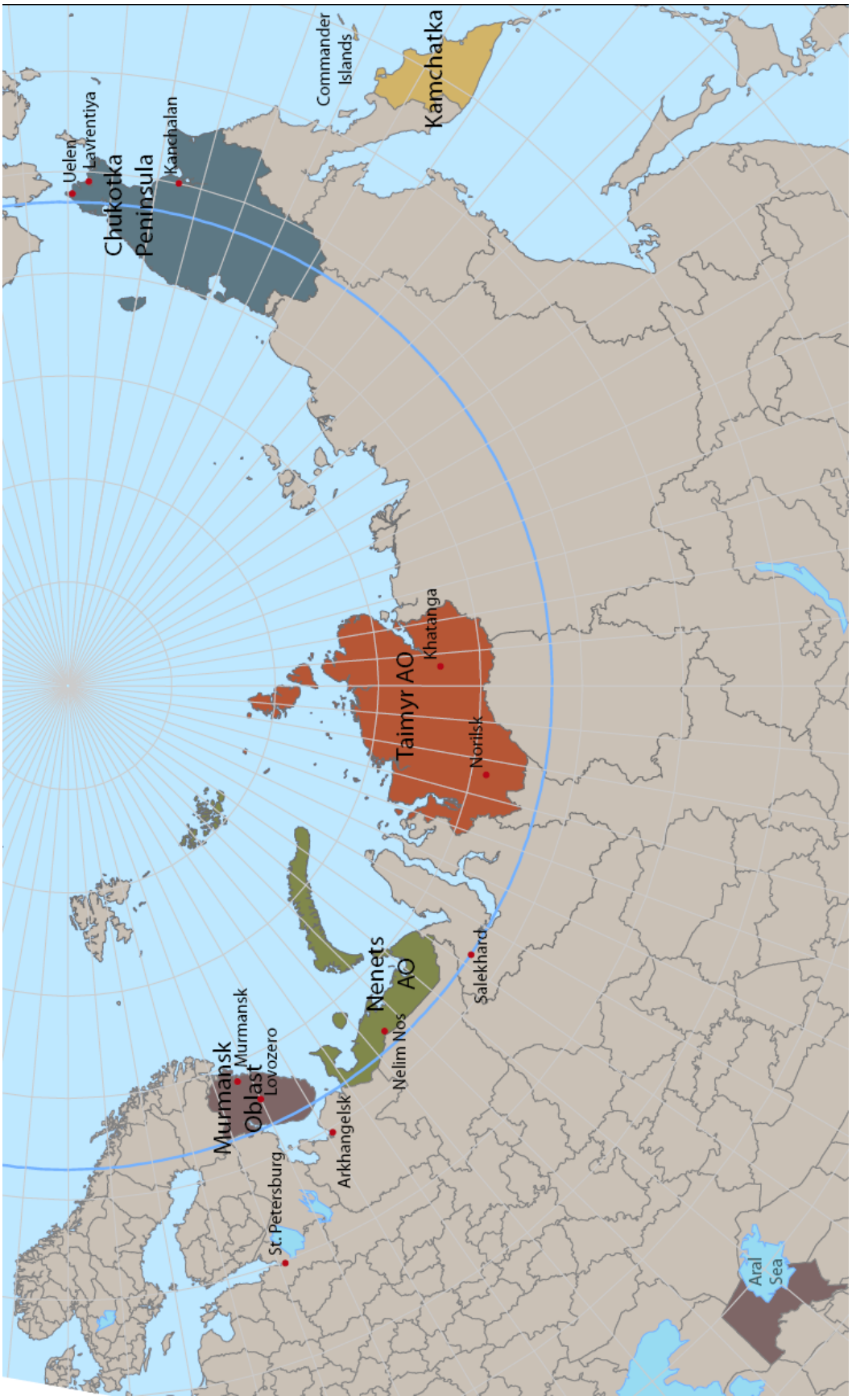

Figure 3. Study areas of Papers III and IV.

Main Results

Paper I. *Implementation, quality control and selected pregnancy outcomes of the Murmansk County Birth Registry in Russia.*

This study has two parts: i) Description of the initiation and quality of the Murmansk County Birth Registry (MCBR), and ii) a comparison of some selected pregnancy and delivery outcomes between Murmansk County and the northern part of three Nordic countries namely: Norway, Finland and Sweden. The counties selected in these countries had comparable populations and were geographically similar to Murmansk County and, were all within the Barents Region.

The completeness of the MCBR was 98.9% in 2006, i.e., 98.9% of all official deliveries was captured by and entered into the registry. Of all the mothers that gave birth that year, 93.4% considered themselves to be of Russian ethnicity. In 2006, 52.5% of all deliveries took place in one of the three delivery departments in Murmansk city even though this city has only 37.1% of the total population of Murmansk County. The number of births registered in the MCBR increased by 4.3% from 2006 to 2007 while the population in the region as a whole decreased. Quality control exercises were carried out in 2006 and 2007. Specifically in 2006, 410 files and in 2007, 547 files were checked for transfer errors (and missing information) from the hospital files to the registry form. Such errors decreased slightly from 0.89% in 2006 to 0.84% in 2007 while the proportion of missing information recorded on the registry forms decreased substantially from 1.1% in 2006 to 0.15% in 2007. In addition, for the same two years, the transfer of information from 600 registry forms to the registry database was checked. Incredibly there were no transfers errors (or information missing) in either year.

Crude birth rates were: 9.8/1000 (Murmansk County); 9.3/1000 (northern Sweden); 11.3/1000 (northern Finland); and 11.4/1000 (northern Norway). The women in Murmansk County were more likely to be primiparous, were younger, gave birth to lighter babies and had shorter mean gestational age. The perinatal mortalities from a gestational age of 28 completed weeks were 8/1000 (Murmansk County); 4/1000 (northern Sweden); 5/1000 (northern Finland); and 5/1000 (northern Norway).

Paper II. *Relationship of perinatal mortality to birth weight and gestational age: A registry-based comparison for Northern Norway and Murmansk County, Russia.*

Northern Norway was chosen as the region of comparisons both because of its geographical location and because of the known structural similarities of the Norwegian and Murmansk County birth registries.

The birth weight increased significantly (p=0.004) by 24 g from 2006 till 2007 in Murmansk County, but they were still about 200 g lighter than the children born in Northern Norway. Based on Wilcox's theory on predominant and residual distributions of birth weight (27), which in turn is related to perinatal mortality risk, proportionally more children were at risk in Murmansk County (3.9%) than in Northern Norway (3.2%). The observed perinatal mortality is higher in Murmansk County at all birth weights (500 g increments) and at all gestational ages (except the very preterm). The perinatal mortality rate (from 22^{+0} weeks, >=425 g or >= 25 cm until one week after delivery) was 11.0/1000 in Murmansk County and 5.4/1000 in Northern Norway. The risk (odds ratio; adjusted for gestational age, maternal age and parity and with NN as the reference group) for perinatal mortality between Murmansk County and Northern Norway for all gestational ages was 1.76 (1.31-2.36) and increased with gestational age. Small-for-gestational-age babies corresponding to the 10%

cut off weight at each gestational week were considerably lighter at term (about 500 g) in Murmansk County.

Paper III. *Intra- and intercompartmental associations between levels of organochlorines in maternal plasma, cord plasma and breast milk, and lead and cadmium in whole blood, for indigenous peoples of Chukotka, Russia.*

The population characteristics of this delivering population from the Chukotka Autonomous Okrug in North East Russia were as follows: the average age was 24.2 years (35% were under 21 years of age); 68.8% had finished secondary education, 31.3% were single, and 41.7% were primiparous. Of all the organochlorines that were tested for in maternal plasma (MP), mothers' milk (MM) and cord plasma (CP), many had a detection frequency lower than 80%, which in turn excluded them from further statistical manipulation. The AMAP-suite of contaminants that were tested include: α-HCH, β-HCH, γ-HCH, *p,p´*-DDE, *p,p´*-DDD, *p,p´*-DDT, *o,p´*-DDE, *o,p´*-DDD, *o,p´*-DDT; ToxP -26, -50,-62, heptachlor, cis-chlordane, trans-chlordane, oxy-chlordane, dieldrin, mirex, HCB; PCB congener numbers: 28/31, 52, 99, 101, 105, 118, 128, 138, 153, 156, 170, 180, 183, 187; as well as mercury, lead and cadmium. CP had more non-detects than MP and MM had the fewest. The correlation of concentrations of organochlorines between MM and MP was high ($r > 0.65$) for all compounds, except for PCB congeners 118 and 156, with respective r-values of 0.47 and 0.55. There were also high correlations between the different compounds within each tissue (or compartment). The exceptions were those involving *p,p´*-DDD and *p,p´*-DDT, and among the PCBs congener 118 displayed the lowest r-values. Log-transformation had little effect on the r-values. The study's sample size, n=48, might be considered limited, although our calculations showed that at the 95% level of confidence the power (1- β) exceeds 0.8 as long as the r-value is above 0.4.

Paper IV. *Case study of combining data sets of Organochlorines (OCs) in human plasma for the Russian Arctic.*

This study's aims were to share the critical appraisal guidelines that were used to evaluate the performances in analyses of organochlorines from different laboratories and the suitability of respective databases for the creation of a combined dataset. The levels of the organochlorines were not the main issue, but several hotspots for DDT and β-HCH were identified, suggesting recent use of both pesticides and also identifying the importance of the monitoring of organochlorines levels in people who rely heavily on marine mammals (28). Different laboratories had divergent detection limits because of variations in methods, available sample volume and instrumentation. The detection frequency also varied because the laboratories did not analyse samples from exactly the same cohorts. All in all, the most conservative approach was taken (i.e., the detection limit from the laboratory with the highest detection value was adopted). As a result, several of the AMAP-suite of contaminants (those with low detection frequencies) were excluded from further calculations. Lipid values in the plasma varied greatly and several of the samples displayed concentrations well below the normal human range (0.45-1.0% for fasting individuals). The ratios between the different organochlorines were taken as one of the indicators of the validity of the analyses in the different laboratories (the prominent PCB congener 153 was chosen as the reference). Another way to look for discrepancies between the laboratories was to check the harmony of correlations between the concentrations of selected compounds reported by the laboratories. There were only minor discrepancies between laboratories 1, 2 and 4, but one laboratory (number 3) did not seem to meet the standards of the others.

Appendix A. *Murmansk County Birth Registry (MCBR). Improving the health of mothers and babies. Annual report on deliveries 2006.*

This report was important to illustrate how the database could be translated into meaningful information in table-format. The results were discussed in relation to QA/QC measures at an annual conference in March 2007 organized for all parties involved in the MCBR. The report contains tables with information on: distribution of deliveries, maternal age, parity, gestational age, vitamin intake, smoking, maternal diseases, delivery types, complications during delivery, birth weight and congenital defects. All the variables were stratified by hospital, which allowed for individual hospital auditing and comparisons. Immediately it became evident that there were large differences between the hospitals. Examples are the proportion of smokers in Murmansk Hospital No 2 which was 8.5%, while it was 26.8% in the neighbouring Murmansk Hospital No 3; and folic acid (a vitamin B supplement) use during pregnancy displayed great inter-hospital variations from 10% to over 90%. The same magnitude of inter-hospital variations was found for some medical diagnoses as well. The main concern became to ascertain whether these variations were natural facts, systematic errors or a combination of both.

Discussion

Main objectives of the Murmansk County Birth Registry (MCBR).

There are several important achievements which should be expected from the use of a birth registry (18). These are discussed in turn below.

Monitor the health condition of mothers and their newborn, including congenital birth defects. The MCBR monitors these health conditions for the world's largest Arctic population. This fact is interesting in itself, but more importantly a system is now in place in the Russian Federation. Surveillance of perinatal conditions was not introduced to Murmansk County by the MCBR. Murmansk region along with other regions, republics, territories and administrative districts annually report basic statistics from the perinatal period to the Federal Russian Government. The MCBR introduces the possibility to follow more closely a much larger number of perinatal conditions than routinely reported. One limitation that will be discussed in more depth later is the fact that there is no personal identification number as of yet in Russia. Hence follow-up and linkage to other registries poses challenges that are not present in the Nordic countries. The registration of congenital birth defects is also linked to this problem, because a number of them are not evident at birth. A follow-up registry of children in Murmansk County would be a future priority. The current existence of separate children's polyclinics in all communities would no doubt facilitate the possibility of following these children over time (29). A summary of other types of variables pertinent to perinatal health (other than those described in Paper II), such as non-medical data on the mother, maternal diseases, delivery complications and congenital malformations is provided in the annual report for 2006 (Appendix A). In addition, a flexible computerized system like the MCBR can provide data fast and accurately and in stratified format to fit any need. Although monitoring and surveillance was the initial purpose of the Norwegian Medical Birth Registry (3), research was soon to follow.

Monitor the availability of medical care by the aid of carefully chosen indicators. Just observing the incidence of perinatal or maternal mortalities is not a sufficient international measure of a country's ability to provide medical care for the newborns and their mothers (30, 31). It could however be very useful when looking at year-by-year variations or by intercommunity-stratifications, provided that the N is big enough. Perinatal mortality in Murmansk region is after all a rare event and its incidence is sensitive to natural variations independent of perinatal health care. Some variables other than perinatal mortality are more suitable for year-by-year intercommunity and interhospital comparisons, such as the number of antenatal visits and the frequency of ultrasounds performed. Furthermore, several large medical reforms pertinent to maternal and perinatal health have been launched in Russia over the last couple of years, and some of their impacts should be possible to monitor in the foreseeable future. Surely, these reforms will have both successful and unsuccessful dimensions to them (32). International comparisons can be important simply because most countries have something to learn from other countries independently of their respective perinatal mortality rates. Surely, in-depth studies of prevalence and diagnostics of some perinatal and maternal conditions between Murmansk region and Norway will reveal both strengths and weaknesses on both parts. After all, the technical advances developed and the technical aspects used by the developed world for decades do not operate in isolation (31) (e.g., in the context of the training and availability of personnel, and time spent with each patient). While birth registries are often national, international surveillance collaboration on perinatal and maternal health also exists (33). Such cooperation is important for several reasons: i) to understand health inequalities among adults, monitoring perinatal health is an important component; ii) despite technological advances, giving birth still involves risk; and iii), to monitor effects of changing life-style factors. Numerous publications are available from the EURO-PERISTAT Project that discuss perinatal health indicators in Europe (33-36). Perhaps the MCBR will one day be able to provide valuable information to this project.

Identification of special health issues among sub-populations. There is no doubt, that in spite of Norway and Russia being neighbouring countries their populations and medical practices differ greatly. Both in the articles and here as well, the issues of race or ethnicity have not been addressed to a large extent. After all, both populations are predominantly white Caucasian and the ethnic groups within each population are small. Only about 6% consider themselves being of non-Russian origin in Murmansk County (Table 1, Appendix A). The per cent of immigrants is slightly smaller in Northern Norway (about 5%) (37), of which a large proportion are in fact Russian. The only aspect that has been brought in to the discussion so far is the term indigenous (in Papers III and IV), which in turn is related to lifestyle issues, diet in particular. The size of the indigenous population in Northern Norway (Sami) is hard to estimate, but they are far more numerous than the Sami population in the Kola Peninsula. Only 24 mothers considered themselves Sami in 2006 out of a total of 8401 mothers (Table 1, Appendix A). Although there are bound to be genetic differences between these populations the issues involving racial issues as an explanatory factor for some of the differences, or outcomes will be left until the cohort size has grown substantially.

Develop standards and guidelines for medical care. Standards and guidelines in medical care are linked to quality control, which can be incorporated in registries via performance indicators (38) or the routine collection of data on treatment procedures and their effectiveness (39).

In Article II, the issue of small for gestational age (SGA) was briefly discussed. It is indefinite whether the Norwegian babies are “large for gestational age” or the Russian babies are “small for gestational age” when being compared with each other. What is apparent is that the two populations diverge in relation to the 10% cut-off weight as a definition of SGA at a gestational age of 37 weeks. Even though the term “small for gestational age” is purely descriptive and strongly dependent on reliable gestational age data, it can give valuable insight into the newborn population, especially in conjunction with birth weight distributions (40). In any case, separate small-for-gestational-age standards are

needed for the Murmansk Region. Other maternal and perinatal outcomes that differ greatly between the two countries are the prevalence of preeclampsia and the APGAR score at 1 and 5 minutes. The prevalence of mild and severe preeclampsia in Murmansk Regions in 2007 was 10.2% and 3.7% in Norway in 2004. The APGAR score for the same years were 7.0 (1 minute) and 8.2 (5 minutes) in Murmansk Region and 8.6 (1 minute) and 9.4 (5 minutes) in Norway. Clearly these differences are a result of deviations in diagnostic practices, but perhaps also in population characteristics. Both the prevalence of preeclampsia and the APGAR score are being examined further in 2009.

Provide knowledge related to causal relationships. In the 40 years that the Norwegian Medical Birth Registry has operated, the opportunity existed to study several causal factors based on suspicions from the surveillance part of the registry work (3, 41). Some examples are sudden infant death syndrome (SIDS), studies of effects from the Chernobyl disaster on maternal and perinatal health, and the link between spina bifida and the antiseizure-drug valproic acid, a known folate antagonist which is associated with neural-tube defects. In addition there have been numerous epidemiological studies, many which were linked to other Norwegian registries. As stated earlier, a person is particularly sensitive during the perinatal period and perhaps the only way to show the effect of exposure to contaminants during this period is by the use of a birth registry.

Spawn new hypotheses. How new ideas and hypotheses should be generated and promoted is an interesting subject, and an important part of keeping a registry alive and well-funded is through publications of important and interesting results.

Population characteristics in Murmansk County

The total population in Murmanskaja Oblast (MO) keeps declining. For the two years that the Murmansk County Birth Registry (MCBR) has collected data, the population has decreased from 865 000 to 857 000. In 2007 the life expectancy for a woman in MO was 71.7 years and 58.9 years for men. The average age of the population was 36.1 years (males 33.3 years, and females 38.8 years; Barentsinfo (42)). Interestingly the same Barentsinfo also reports that the nationalities in 2002 were: Russian 85.2%, Ukrainians 6.4% and other nationalities 8.4%. In 2006 when we asked the mothers, the situation appeared quite different: 93.4% considered themselves Russian, while Ukrainians constituted 2.1% and others 4.5%. Even though the population is decreasing, the annual number of births has increased for the last two years (Figure 4). However, the increasing birth rates cannot compete with the mortality rates and emigrations.

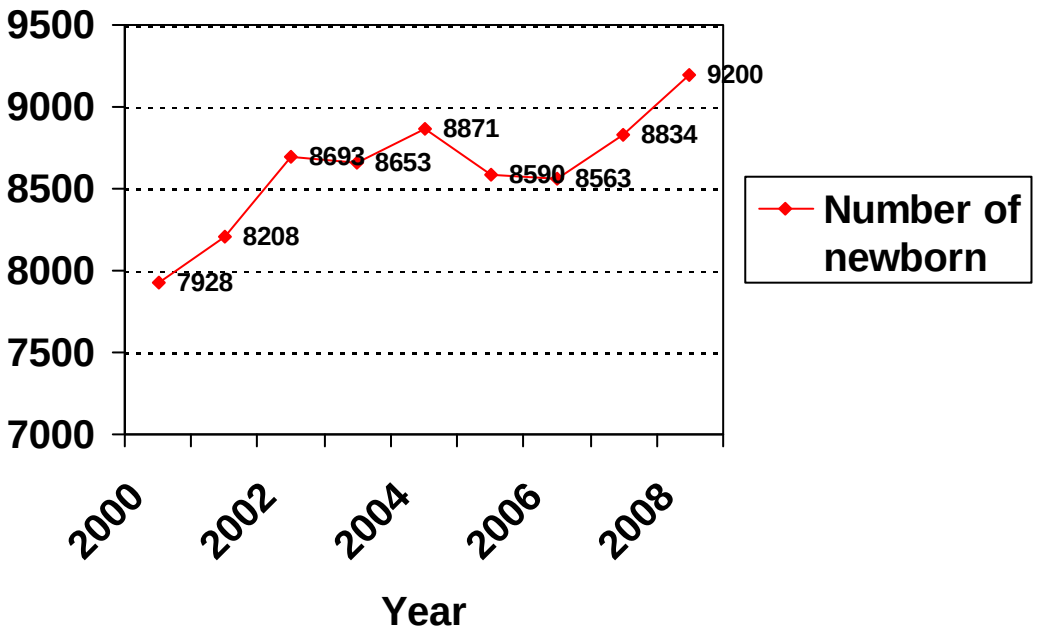

Figure 4. Annual numbers of newborn from 2000 until 2007. Source: the Murmansk County Health Department.
* The number of newborns in 2008 is a preliminary estimate and is subject to minor change

According to the data collected by the MCBR, the characteristics of the delivering population have changed from 2006 to 2007. Article I described the relationships between selected pregnancy outcome variables from the respective birth registries of the northern parts of three of the Nordic Countries (Norway, Sweden and Finland). Table 1 below shows the changes in MO over the last two years for selected pregnancy outcomes and newborn characteristics.

Table 1. Selected pregnancy outcomes and newborn characteristics in Murmansk County for 2006 and 2007.

	Murmansk County 2006 (N=8468)	Murmansk County 2007 (N=8834)	p-values†
Average age of the mothers (years)	26.0	26.3	0.02
Average age at first delivery (years)	23.7	23.9	0.02
Percentage of mothers under 20 years	8.9%	8.4%	0.25
Percentage of mothers over 35 years	4.8%	3.6%	<0.01
1st delivery (parity distribution)	60.6%	57.6%	<0.01
2nd delivery (parity distribution)	32.9%	34.6%	0.02
3rd delivery (parity distribution)	5.2%	6.1%	0.01
Smoking at the end of pregnancy	15.7%	18.5%	<0.01
Number of births	8468	8834	-
Gestational age (weeks)	39.0	39.0	-
Average birth weight (g)	3320	3344	<0.01
Proportion of children under 1500 g	1.0%	0.9%	0.56
Proportion of children over 4500 g	0.8%	1.1%	0.06
Proportion of children In the residual distribution	3.8%	3.9%	0.76
Perinatal mortality from 22 weeks*	12/1000	11/1000	0.56

* Perinatal mortality was only calculated for the women with available gestational age

† The p-values were calculated by chi-square (percentages) or t-test (averages)

Until there are more years available for comparison, it is difficult to say whether the changes depicted in Table 1 are part of a trend or are coincidental. Since there is coherence between the changes, a small discussion is called for. Based on this crude estimation of the age distributions of the mothers it is clear that the average ages are not increasing by much, but because of the relatively high N these changes are significant. Adverse pregnancy and delivery outcomes are related to both high and low maternal ages (43-46). A young maternal age can be a biological risk factor for preterm birth, but late fetal deaths and infant mortality which is associated with low maternal age is most likely an effect related to a poorer economic situation for these women. According to a European Perinatal Health Report (47), a proportion of teenage mothers exceeding 5% is considered high and in MO it is almost twice that. The proportion of mothers above 35 years of age has gone down considerably over those two years ($p<0.01$). Also evident is the fact that more women are giving birth to their second and third child ($p=0.02$ and 0.01). This is most likely a result of two factors: the general increase in economic prosperity in Russia during 2006 and 2007, and the government's attempt to boost birth rates by rewarding the birth of a second and third child with cash. (This new Russian policy has been described in Paper I and was implemented in 2007.) If the current Russian economy continues to stagnate in 2009, we will have some indication of the effect of the reform [i.e., if the numbers of annual births do not decline or continue to increase (given the same population numbers) in spite of a general economic recession, the reform more than likely has a positive effect on annual birth rates].

The per cent of smokers during pregnancy has increased ($p<0.01$). Obtaining reliable information about smoking, especially during pregnancy, is difficult (48-50). If we assume that the methods for collecting the information has not changed, an increase in smokers of almost three per cent in one year is alarming. Smoking has an array of ill effects on pregnancy outcomes (51). Birth weight has been discussed in length in Article II. An increase in birth weight alone is not necessarily a predictor for decreased perinatal mortality and

morbidity (52). There are not enough deliveries in MO each year to do a thorough year-by-year gestational age or weight-dependent mortality analysis (53), but an estimation of the residual distributions (as proposed by Wilcox) can supply a rough estimate (25). Wilcox argues that the distribution of birth weights is actually two distinct distributions instead of one, a residual and a predominant distribution. The proportion of deliveries in the residual distribution will tell us something about the per cent of children in a population who are at risk of perinatal mortality or morbidity. It is evident from Table 1 that the proportion in the residual distribution has not gone down from 2006 until 2007, despite the fact that the perinatal mortality has decreased. Possibly, since perinatal mortality is relatively low in MO and consequently rare, there are bound to be natural variations in the perinatal mortality from year to year.

Table 1 and Article I and II include some of the perinatal health indicators presented by EURO-PERISTAT in their report (47). EURO-PERISTAT has divided these health indicators into four major parts: i) fetal, neonatal and child health; ii) maternal health; iii) population characteristics/risk factors; and iv), health care services. Furthermore, indicators in each category are listed as core, recommended or needing further development. A breakdown of these health indicators can be found online (http://www.europeristat.com/project/Indicators/index.shtml). Evidently, conducting a full comparison between Murmansk County and other European countries containing all or most of these indicators would be most interesting at some later date. By doing so, a clearer picture of appropriate measures for improving perinatal and maternal health in Murmansk County would develop.

Potential effects of pollution on maternal, perinatal and neonatal health

The process of finding causal relationships between low-level exposures of for example pesticides and adverse pregnancy outcomes is arduous and expensive. The Arctic Monitoring and Assessment Programme (AMAP) (http://amap.no) has recognized this all too well through their work in the Arctic over the last 18

years. The Arctic holds a special position in relation to human exposure of persistent organic pollutants in particular related to long-range transport, bioaccumulation and consumption of traditional foods (23). AMAP has collected samples (in different human tissues) from all over the Arctic. While these studies have been informative and important in relation to exposure-risk assessment through establishing the levels of human exposures to known toxins and dietary patterns, the investigations have not been large enough to conduct detailed studies of causal relationships. The presence of a medical birth registry in the Arctic will hopefully be of great help in the continuation of this type of work, as well as research related to the impact of other pollutants.

Because reproductive health is an important scientific research area, studies have been conducted which evaluated the effects of environmental chemical contaminants. The first was the cause-effect relationship between smoking and human health, which was conducted in the United States in the 1960s. Today we know that it is not only the dose and potency of a given toxic substance that increase the risk of adverse pregnancies, but also the frequency and duration of low-level exposures (54). Known causes of adverse pregnancy outcomes are methyl mercury, PCBs and environmental tobacco smoke (ETS), while other relationships such as DDT/DDE, pesticides (insect repellents) such as DEET, fungicides, airborne industrial emissions and oil (oil products) are suspected reproductive health toxicants based on limited epidemiological evidence (55). Not only is the number of studies insufficient, some are lacking in statistical power, exposure quantification and specificity (55). Matters that complicate things further are the fact that there might be interactions (additive or antagonistic) between some of these toxicants (56), and that the extent and duration of exposure during the gestational period are important (57). Also, some of the emerging contaminants found for example in cosmetic products have very short half-lives and are only present in the body at high concentrations for short periods of time. Consequently, the maternal serum contaminant levels measured at birth alone might not be adequate in order to establish associations with adverse outcomes. Some of these issues concerning

sampling times and sampling matrices (milk, maternal blood or cord blood) became apparent from the AMAP exposure studies in the Russian Arctic (i.e., Papers III and IV). It became obvious that the establishment of some simple ground rules were required. The database in Paper III is unique (although rather limited in numbers) since it contains the levels of contaminants from three different compartments (mothers milk, mothers blood/serum and cord blood/serum) for maternal/neonate pairs. The main goal was to establish which of these compartments was the most appropriate for monitoring exposure. For several reasons listed in Paper III, mothers' blood was found to be most fundamental and suitable. This fits well with the planned environment-and-health objectives of the MCBR. Since the correlations of the organochlorines examined in Paper III between these three compartments were high, a simple blood test for the mother right after birth is sufficient. However, several samples throughout the pregnancy might be needed when considering the effects of old, new and emerging contaminants with short half-lives. For example, the blood compartment might also be sampled both early and late in the pregnancy and at birth. These considerations point in the direction of the need for an establishment of a bio-bank. Article III suggests that the blood samples do not need to be lipid-adjusted or be collected from fasting individuals as there were no apparent improvements in regression (r)-values with lipid adjustments of contaminant concentrations. That said, in Paper III and IV large variations in the lipid values were detected, both in the lipid levels and in the coefficients of variation. Whatever the reason for this variation (methodological or otherwise), it could explain why there were little improvements when conducting lipid adjustments. In any case, it would help tremendously not having to ask the mother to undergo fasting right after birth.

Some screening is necessary in order to establish whether the population in the Kola Peninsula is burdened with persistent organic pollutants. Table 6 in Article IV summarizes the contaminant levels of some well known organochlorines for 16 pregnant women. At least from this limited material, the levels appear low. More samples are needed before conclusions can be made and "newer" or

emerging contaminants need to be included in such screening. Low levels of contaminants in plasma pose a new set of challenges discussed in length in both Article III and IV. It is related to the individual laboratories ability to detect low levels accurately, which is dependent on the volume of the samples analyzed as well as the instruments and techniques employed in the laboratories. Taking blood samples out of Russia is no longer possible (nor legal), so there is a need to locate a Russian laboratory which can handle small sample volumes with high sensitivity. However good this laboratory may be, there is a need for proper quality control/quality assurance (QA/QC) measures including adequate replicate analyses and independent performance verification such as in inter-laboratory comparisons. Of the four laboratories that were evaluated in Paper IV, two were Russian and one of these two produced consistent and reliable results. The need for longitudinal studies of relatively large populations, such as made possible by birth registries, will be extremely valuable in relating children's health and environmental exposures, and would provide information on a variety of potential reproductive health outcomes (58). Thus far only Germany and the Unites States have implemented national population biomonitoring programs to track exposures to environmental contaminant levels (55), and very recently also in Canada (the Canadian Health Measures Survey; (http://www.statcan.gc.ca/)

QA/QC-measures for the implementation and continuation of the MCBR

One of the most important aspects of QA/QC exercises is training of and communication with the registry staff. Communication goes both ways and often the most valuable information comes from the persons handling data on a day-to-day basis. Since January 2006, three workshops have been held for all the persons involved in the MCBR. The first two took place in Murmansk in 2006 and 2007, and the last in 2008 in Kirkenes. The results from the 2006-registrations were presented at the workshop in March 2007 and the discussion evolving in the wake of that presentation was of crucial importance. Through the quality control exercises described in Paper I, it was only possible to

evaluate and detect the accuracy of the information transfer from the hospital files to the registry database. During the conferences there was the opportunity to communicate directly about the discrepancies as they were perceived by the staff, and how to amend obvious deficiencies among the stratified output variables.

Fortunately we did not have to start anew in designing the registry form and the electronic Access database. The Norwegian Medical Birth Registry supplied an Access-version used by the aforementioned KCMC in Tanzania, which in turn was changed to fit the MCBR. The final registry form has elements from several medical birth registries; specifically the KCMC and the medical birth registries from Sweden, Denmark and Norway.

During the implementation, the first major obstacle to deal with was the divergence in perinatal diagnostics, treatments and measures between Russia and Norway. While in 2005 in Norway the International Classification of Diseases (WHO, ICD-10 codes) was used, the Russians employed the so-called MKB-coding system. The MKB-system is similar to the ICD-system, but not comparable enough to use it interchangeably. There were a number of challenges. i) The registry form contains mostly written diagnoses with adherent tick-off boxes. For example, congenital anaemia existed in both countries, but with different haemoglobin (hb) thresholds. Subsequently, the Russian staff ticked off "yes" for the Russian values of hb<140 g/L, while the initial intention was to have the Norwegian standard of hb<135 g/L recorded. As this applied to other variables as well, a decision was made to display the actual values on the registry form. A comprehensive guidance document that included all the diagnoses and the ICD-10 codes was supplied to the staff. ii) Some of the fields that were noted on the original draft of the form and in the Access database simply did not apply. For example, the ethic group "Khozak" was not in use and "Azerbaijani", which was important, had been left out. iii) We had to add an extra field related to residence. Originally it was only the intention to register the town or area in which the women lived, but since the exposure to

environmental contaminants could be life-long it was necessary to record information on recent changes in residence. If a woman had moved within the last year, both the previous and current areas of residence were recorded. iv) Drugs administered during delivery were not the same. For example in Norway, the analgesic petidinhydrochlorid (Petidine) is commonly used, while 1,2,5-trimethyl-4-phenyl-4-piperidinol propionate (Promedol) is used in Murmansk Region. Other treatments were different as well; for instance, CPAP (Continuous Positive Airway Pressure) treatment for respiratory distress in the newborn is not used in Russia and had to be edited from the form. v) Terms that could easily be misinterpreted had to be removed and this included observations such as "discoloration" of the amniotic fluid. The translation of "discoloration" ended up meaning "any other color than normal", while the initial intention was "a color outside of the normal range which indicated a problem. vi) And finally, some measurements were simply different. In Norway the newborn is measured to the nearest gram, but in Russia only to the nearest 10 grams.

The second and third workshop brought about many changes and discussions and only the most pertinent are mentioned here. i) During the workshop in March 2007, we posed the question as to how the prevalence of "chronic sex tract and urinary infections" could vary from 1.5% in one hospital to over 22% in another. Our suspicion was that there was over-reporting in a few (three) of the hospitals, but after closer examination it was the other 11 delivery departments that under-reported the prevalence. ii) There was real concern among the hospital staff that there would be repercussions if information was missing on the registry forms and we went on to explain that missing information is better than the wrong information. iii) One of the longest and most animated discussions during any of the workshops was the question regarding "threatening intrauterine asphyxia". The discussion was whether this was the actual condition when intrauterine asphyxia was threatening the life of the baby, or there was an imminent threat of this asphyxia to occur. In the end it was decided that this would only apply to the actual condition which is also the standard practice in the Norwegian birth registry. iv) The 2006 report (see

Appendix A) showed that there were a much higher incidence of preeclampsia in Murmansk County than in Norway, 9.5% (Murmansk County 2006) and 3.7% (Norway 2004). The senior Russian gynaecologists present assured us that the diagnostics were straight forward and that the incidence in question was accurate. v) The reported incidence for "prolapse of cord" was suspiciously high and it was concluded that this variable had switched place with the adjoining variable in the database (the before mentioned "threatening intrauterine asphyxia"). vi) The place of work for both the mother and father had been recorded in order to estimate some potential toxic exposure during pregnancy. However the workplaces were often recorded as abbreviations instead of full names, which made it difficult to establish with certainty the actual workplace. Full names of the workplaces are now recorded. vii) Other seemingly trivial issues came up as well, such as the color of the registry form. The purple color was too dark and it was therefore sometimes difficult to read what was written in blue ink, and being able to interpret what is actually on the form is of crucial importance. viii) Sometimes the number of deliveries in the hospitals and the number of forms received did not match at the end of a year. To rectify this, it was decided that the hospitals should provide monthly reports on the number of births and the number of forms delivered so that it could be double checked with the registry. ix) Some mothers were registered with many ICD-10 diagnoses and it was concluded that the most serious ones should be recorded first. And finally, x) the first three years of recording the gestational age was estimated through the last menstrual period, but from 01.01.09 the clinically ultrasound estimated gestational age was also recorded. The gestational age in Russia is recorded as being an interval for example week 41-42, and this is easily transferrable to completed weeks.

Карта всех родов и провоцированных выкидышей после 12 полных недель беременности.

A – Персональные данные матери и отца

1. Название роддома	2. Роды вне роддома ☐ Дома ☐ Другое место ☐ Во время перевозки	3. Год (0000) и номер медицинского файла

4. Год рождения последнего живого ребенка (0000) Если дата не введена → клетка 4.1	4.1 Нет даты, так как: ☐ Ранее не было живого ребенка ☐ Нет информации	4.2 Год последнего аборта (0000) Если дата не введена → клетка 4.3	4.3 Нет даты, так как: ☐ Ранее не было абортов ☐ Нет информации

5. Дата рождения матери (день/месяц/год, 00.00.00)	6. Этническая принадлежность ☐ Саами ☐ Русская ☐ Азербайджанка ☐ Другая (уточните)	7. Место жительства (Район)	7.1 Город/поселок/село

8. Менялся ли официальный адрес матери во время беременности? ☐ Нет ☐ Да (если «Да», то откуда ->)	8.1 Область/Район	8.2 Город/поселок/село	9. Семейное положение Замужем: ☐ Да ☐ Гражданский брак ☐ Нет ☐ Другое

10.Образование, закончен. ☐ Никакого ☐ Начальное (1-9 класс) ☐ Среднее (10-11 класс) ☐ Среднее специальное ☐ Высшее	11. Профессия матери	11.1 Место работы матери	11.2 Цех, где она работает

Информация об отце 12. Возраст отца	13. Профессия отца	13.1 1 Место работы отца	13.2 Цех, где он работает	14. Этнич. принадлежность ☐ Саами ☐ Русский ☐ Азербайджанец ☐ Другая (уточните)

B – О беременности и здоровье матери

15. Срок бер-ти при первой явке в связи с этими родами (неделя, 00)	16. Рост (в см) 17. Вес (при первой явке) (в кг)	18. Последняя менструация, первый день кровотечения (д/м/г) ☐ уверена ☐ не уверена	19. Когда проведено первое ультразвуковое обследование ☐ ни разу не проводилось	B1. МКБ-10 код(ы)

19.1 Срок родов, прогнозир. ультразвуком д. м. г.	19.2 Патология, обнаруженная УЗИ у матери или ребенка ☐ Нет ☐ Да (уточните в клетке B1)	20. Патология, выявленная у ребенка, с помощью амниоцентеза, кордоцентеза, хорионбиопсии ☐ Нет ☐ Да (уточните в клетке B2)	B2. МКБ-10 код(ы)

21. Предыдущие беременности матери (исключая этого ребенка) Только целые недели	21.1 Рождение живого ребенка ____ Мертворождения >= 22 недель ____ Рожден живым, умер в течение 7 дней ____	21.2 Преждевременные роды (22-29 недель) ____ Преждевременные роды (30-36 недель)____ Кесарево сечение во время предыдущих родов ____	21.3 Спонтанные аборты 13-22 недель ____ =< 12 недель ____	B3.Уточните МКБ-10 коды по мед. показаниям: 1._____ 2._____

21.4 Медицинские аборты (по собственному желанию) =< 12 недель ____ была ли это мед причина? ☐ нет ☐ да	21.5 Медицинские аборты с (заполните 21.6) 13 недель _____	21.6 Социальные причины _____ Медицинские причины _____	22 Витамины/алкоголь/наркотики	24. Признаки злоупотребления алкоголем ☐ Нет ☐ Да 25. Признаки употребления наркотиков ☐ Нет ☐ Да

22. 1 Прием витаминов перед беременностью Поливитамины ☐ нет ☐ да Таблетки фолиевой к-ты ☐ нет ☐ да	22.2 Во время беременности Поливитамины ☐ нет ☐ да Таблетки фолиевой к-ты ☐ нет ☐ да	23. Курение до беременности ☐ Нет ☐ Да, сколько сигарет _____ в день	23.1 Курение во время беременности ☐ Нет ☐ Да, сколько сигарет _____ в день	B6. Фармацевтическое название препарата 1.Название С даты (д/м)

26. Болезни до беремен-ности ☐ Ничего особенного	☐ Хронич.инфекция мочеполового тракта ☐ Хронич. инфекц. заболевание почек ☐ Астма	☐ Хроническая гипертония ☐ Ревматоидный артрит ☐ Сердеч. забол.	☐ Эпилепсия ☐ Диабет, тип 1 ☐ Диабет, тип 2 ☐ Гепатит B ☐ Гепатит C ☐ другое (уточните в B4)	B4. Уточните МКБ-10 код (ы) 2. Название С даты (д/м)

27. Болезни во время беремен-сти (включая несчастные случаи) ☐ Ничего особенного	☐ Кровотечение< 13 нед. ☐ Кровотечение13-28нед. ☐ Кровотечение> 28 нед. ☐ Диабет беременной ☐ Тромбоз ☐ Легкая преэклампсия	☐ Тяжелая преэклампсия ☐ эклампсия беременной ☐ HELLP- синдром (гемолитич. ....) ☐ Легкая анемия ☐ Умеренная анемия	☐ Тяжелая анем. Hb > 135 г/л ☐ Угроза прерывания (O20.0) ☐ инфекции (B5) ☐ другое (B5) ☐ лекарства (B6)	B5. Уточните МКБ-10 код (ы) 3. Название С даты (д/м)

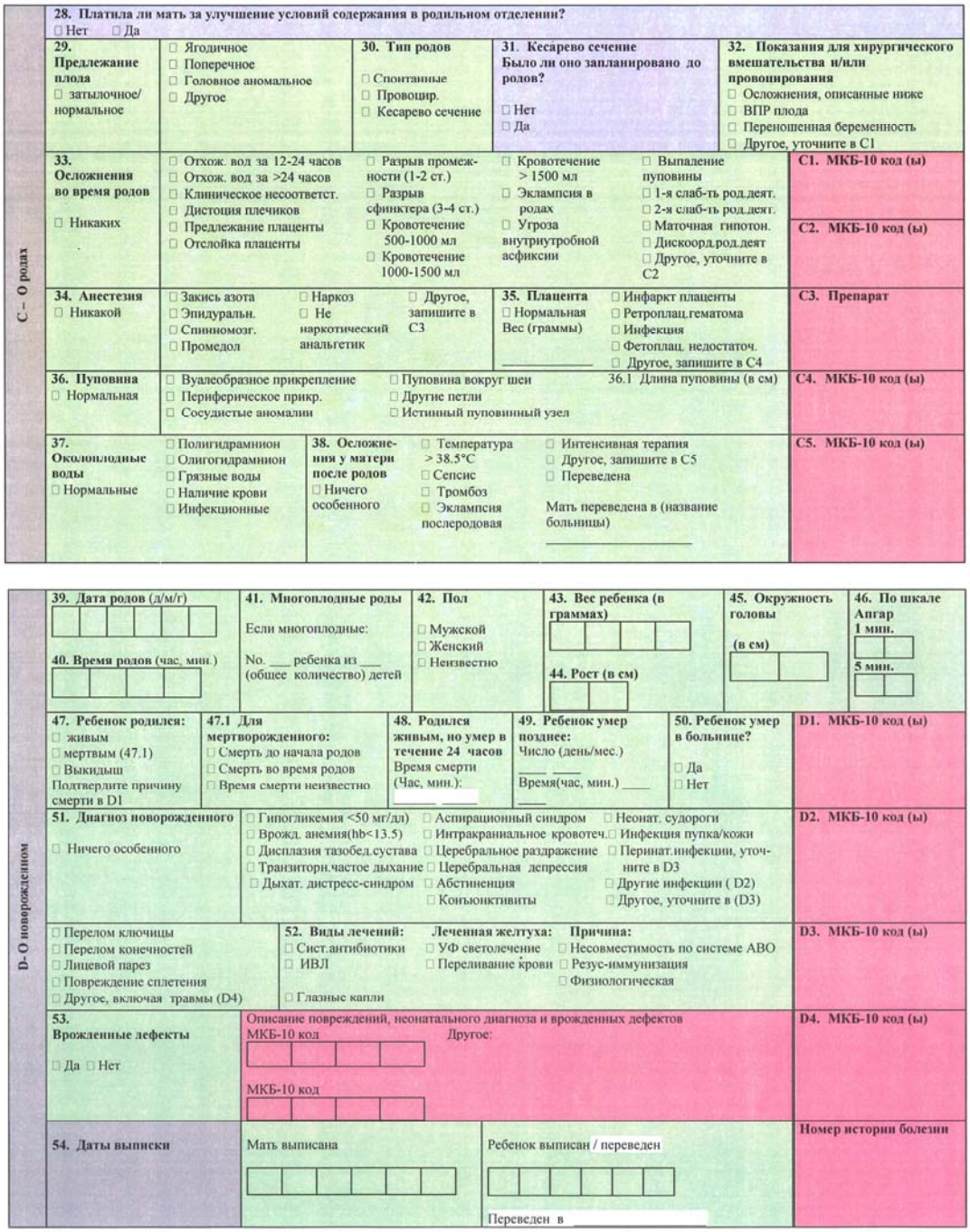

Figure 5. The registry form (2008 edition in Russian). Note that the 2006 edition in English is reproduced in Appendix B.

General limitations of the MCBR

Whether the fact that there is no personal identification numbers available in Russia is a limitation, or that the presence of these numbers is a strength in the Nordic countries' registries, is a matter of opinion. It is certainly regarded as a major advantage in the United Nations report: Register-based Statistics in the Nordic Countries (59). A personal identifier is not only regarded as an advantage during follow-up and linkage studies with other registries, but also ensures that multiparous women and their neonates are accurately and easily traced. Although the names of the women are not available in the MCBR, they would have been of little help if they had been included because of the manner people are named in Russia. The population proportions of the most common names in Russia are much higher than in Norway (e.g., Natalia Ivanova is going to occupy a substantial percentage in a phone directory). For now, this issue is resolved by linking several variables in the registry database to create a unique number for each woman. Variables included are date of birth, date of birth of last child, height as well as other variables that are constant over time. This is not an ideal solution, but the only one available so far. To our knowledge decisions have been made to establish a system of personal identification numbers in Russia, but it is not clear when. Linkage to other available public databases (of mortality, births, special disease surveillance such as HIV, hepatitis) is hard without this identifier, but the population-based prevalence and that recorded in the birth registry can be compared to establish coherence (60). The fact that we cannot follow up the cohorts of children over time is a limitation. As mentioned before, many of the congenital birth defects only become apparent some time after birth and the results of perinatal exposures such as mothers' life-style factors and diseases, will only become evident later in life (61, 62).

The N (or sample size) of over 8000 annual deliveries might seem large enough for statistical comparisons, and in some respects it is. For example in Table 1, the increase in the average age of the mothers of 0.3 years is significant. The ability to detect small differences for common outcomes is present, but at the

same time the dataset is not necessarily large enough to establish any causal relationships between rare outcomes and a specific risk factor. This becomes especially apparent when the statistical models have to take a large number of confounders into account. The complexity of factors (possible confounders) influencing birth weight for instance is nicely described by Spencer 2003 (63). He uses the term "biopsychosocial pathways" which are grouped into 5 major categories:

- Inheritance at birth (e.g., genetic disorders and birth weight);
- Socio-economic circumstances (e.g., housing and income);
- Education attitudes and beliefs;
- Behaviour (e.g., diet, smoking and exercise);
- Health of individual (e.g., disease, fitness and well-being).

When considering that the 30 individual factors listed by Spencer also interact, a seemingly large dataset of 8000 annual births will rapidly become insufficient in relation to statistical power when controlling for their potential contributions. Of course, multiple adjustments have their own limitations. In Paper II adjustments were limited to major risk factors. Specifically, for perinatal death rates in plots against gestational age adjustments were limited to maternal age and parity, and for the reported odds ratios gestational age was also included.

A confounding variable is one that is associated with both the risk factor and the outcome of interest. Of course there are other types of bias to be considered also. The two major types of systematic error that are relevant to this thesis are selection bias and information bias. Selection bias occurs when there is a systematic difference in a characteristic between those who take part in the study and those who do not. Information bias is a flaw in measuring exposure or assessing outcome data that result in different quality (accuracy) of information between the comparison groups (1). To a large extent selection bias does not apply to the MCBR, since about 99% of the deliveries in the region are registered each year. The main concern would be that the women (and subsequently children) not registered harboured characteristics or outcomes very different from the women or children that were actually registered.

Another potential information bias applies not to the mothers, but the fathers of the children in the MCBR since for 9.1% of the deliveries in 2007 the identity of the father was not known. Thus the information bias is not limited to mothers and infants. Underreporting of maternal smoking as discussed in Paper I also needs to be mentioned. As already indicated, measurement errors might have occurred in the estimation of gestational age (Paper II) and of the environmental contaminants (Papers III and IV). And finally, the quality assurance exercises helped to reduce misclassification bias (Paper I and Appendix A). Additional limitations of the four studies are discussed below.

Hopefully the personnel involved in the MCBR-system will continue to keep systematic and random errors to a minimum in order to ensure a satisfactory level of operational validity, so that it can maintain its major goals in relation to surveillance and science.

Limitations of the individual studies

Paper I is mostly a description of the creation of the MCBR, but some crude comparisons were made for selected perinatal outcomes for four countries in the Barents Region. Specifically, these were birth weight, proportion of low-weight babies and perinatal mortality. The unavailability of reliable information on personal risk factors related to these outcomes is a shortcoming. This circumvented controlling for demographic characteristics such as parity and maternal age, as well as for behavioural risk factors (e.g., on smoking, alcohol consumption) and other exposure factors such as environmental contaminants. In addition, we have assumed that the recorded information is gathered in the same way in all of the countries in explaining the differences between them. On the other hand, most of the perinatal outcomes mentioned in the paper are fairly easy to ascertain because they are absolute values (e.g., birth weight, age of mother and parity). The BMI-data are also sensitive to systematic error. The height of the mothers is constant during pregnancy, and the weight was estimated at the first antenatal visit. The timing of this visit could vary greatly

between the countries and the BMI would, off course, increase with increasing gestational age.

Paper I mentions the communication between the central MCBR office and the hospital staff as part of the quality assurance exercises conducted (see the Appendix A discussion above). If a number were missing, or if there was an obvious mistake, the office staff would contact the hospital staff to obtain the correct information. Both the aspect of deciding which missing information is worth pursuing, and which mistakes are actually "obvious", can be a matter of subjective opinion and could vary not only from day to day, but also from person to person. This could be a source of information bias, but in the absence of a workable alternative this practice will continue.

Paper II was somewhat more challenging in terms of the statistical methods that were used in Paper I. Before any of the figures or tables were created, several inclusion and exclusion criteria had to be decided upon. There were two criteria that were especially challenging. The method of estimating gestational age is discussed in the paper, and it was established that the difference between the Norwegian and the Murmansk County registries would possibly lead to systematic errors. The decision to compare the countries using a combination of two methods in establishing the gestational age was a trade-off between having a large enough sample size (i.e., statistical power) and introducing a possible systematic error. The other issue that poses an obvious question is the fact that multiple deliveries were in the first instance included in the dataset when estimations of the weight-specific perinatal mortality were done (Figures 2 and 3 in Paper II). Estimations with and without multiple deliveries were performed (data not shown), and it was demonstrated that the difference was not noticeable.

The fitted weight-specific mortality curves (Figure 3 in Paper II) have as a limitation the assumption of identical slopes (except for sign) to ascertain the optimal perinatal survival weight (OPSW). It is quite possible that this does not

reflect reality and that the Wilcox model might need to be improved to take this into account. Further in a number of figures in Paper II, 500 g increments for the birth weights are employed. This limits the magnitude of the outcome differences that can be observed. The relatively small sample size determined this choice.

Paper III and IV are method papers that focus on a discussion of limitations and possible systematic errors. Paper IV might be designated as a critical assessment paper. However, there are some issues not covered in the articles. There is some selection bias in Paper III. The women in the study were asked to participate only after having been admitted to a delivery department. This excludes those not able or willing to use these departments. Non-hospital births are generally few in Russia, but in the Chukotka region this might be different because of the large distances between a number of the communities and the delivery departments. Further, it is stated in the discussion of Paper III that the ethnic composition, age- or parity-distribution of the sample population is of little concern to this study. The reason being that it is in the first instance a comparison of the environmental contaminants in cord and maternal blood or plasma and breast milk, and thus the women themselves are not the main focus. However, one could argue that this affects the external validity of the study. If the sample of women in the survey is not representative of women in the Russian Arctic, some issues discussed in the article (e.g., lipid values and contaminant levels) could reflect specific characteristics and lifestyles of the particular sub-groups selected. Thereby the conclusions reached may not apply in general.

The sum of PCBs depicted in the tables in Paper III is not a real total sum because we used an 80% detection frequency for each individual congener as an inclusion criterion. PCB-105 had a much lower detection frequency and was discarded in the statistical comparisons, but was included in the sum of PCBs. Fundamentally this is inconsistent. The reason for including this sum in the study was to allow the readers to compare it to previously reported body

burdens using this summed concentration. The sum of PCBs was not included in Paper IV because of the dilemma described here.

Both Paper III and IV had outliers, and the manner in which the outliers were handled in the studies is prone to error. Outliers in relation to contaminant levels in humans are particularly difficult to assess unless they are far above what is humanly possible. The levels are very dependent on diet, age, gender, parity etc. Low-level outliers are impossible to detect as they will fall in the category of samples below the detection limit along with the other low values. Thus there is no normal distribution and testing for the presence of outliers is difficult. Both datasets had possible outliers, but only a few of the most unlikely data points were removed from the large dataset in Paper IV.

Paper IV has another obvious limitation, and that is a lack of multiple samples collected from the same donor. They were not omitted in the statistical analyses, they did not exist. Had there been such multiple sampling, testing the performances of the individual laboratories against each other would have been more straight forward.

Privacy and ethics

The four general principles of the Declaration of Helsinki (World Medical Association 2008) (64) have been followed, i.e. autonomy (respect for individuals), beneficence (do good), non-maleficience (do no harm) and justice. The adherence to the rules for good research practices as described in the IEA Guidelines for Proper Conduct of Epidemiological Research 2007 (65) are briefly discussed. i) A Russian ethics committee consisting of medical professionals from the Murmansk County Health Committee have formally approved our MCBR activities and continue to monitor them. ii) No overt personal identifiers such as names, addresses, phone numbers or social security numbers are recorded or used at any time. The only possibility to track a person, for example for the purpose of a quality control exercise, would be to use the

hospital file number recorded on the registry forms and then ask permission to access the files in the individual hospital. iii) No data are released to other parties unless approved by the Murmansk County Health Department and the University of Tromsø. iv) All files are stored in locked cabinets and no personal data is sent unless encrypted. And v), there are no sponsors with conflicting interests.

Human tissue samples, as well as personal information, were collected only after written consent had been given and approvals for the studies were obtained from Norwegian (through the Arctic Monitoring and Assessment Programme) and Russian authorities (Papers III and IV).

In the case of the MCBR, no written consent is obtained from the pregnant women. As discussed in Paper I, the Murmansk County has passed legislation making it obligatory for delivering women to be registered in the MCBR. However, personal information such as smoking and supplement intake is not recorded unless agreed upon by the women.

Finally, researchers working abroad on the behalf of a Norwegian institution or receiving data from abroad have to follow Norwegian laws and regulations. However, the MCBR does not require such special permission from Norwegian authorities because all the data are anonymous and without personal identifiers and there is no possibility of linking data-files to any specific person (Kvalheim V. Norsk Samfunnsvitenskapelig datatjeneste, pers. comm. 2009)

Conclusions

Main findings

- The MCBR seems to have reasonable internal validity based on completeness (e.g., comparisons with official Russian statistics) and quality control exercises. External validity derives primarily from its design similarity with the Norwegian birth registry.
- The MCBR can be used for surveillance of disease incidence, effectiveness of medical-care delivery, measuring the effects of health reforms, hypothesis testing and informing the public, among other applications.
- International comparisons and regional differences explored by the use of the MCBR will allow clinicians, epidemiologists and health officials improve and monitor perinatal and maternal health care in the region.
- The perinatal mortality is higher in Murmansk County than in Norway, Sweden and Finland. However, the perinatal mortality is lower in Murmansk County than in Russian as a whole.
- The odds ratio or risk of perinatal mortality was higher for all gestational ages in Murmansk County compared to Northern Norway.
- The risk of perinatal mortality is higher at all birth weight increments in Murmansk County compared to Northern Norway.
- There is a large difference in the weight of what should be considered a small-for-gestational-age baby in Murmansk County and Northern Norway, especially for term deliveries.
- Clinical ultrasound estimations of gestational age, instead of last menstrual period estimations, must be incorporated in the MCBR.
- Maternal plasma is the most fundamental biomonitoring medium for organochlorines.
- Maternal exposure to organochlorines, as measured by concentrations in maternal plasma, constitutes a suitable index of exposure for the unborn child.

- Lipid adjustments had little impact on the Pearson's regression coefficient when exploring the correlations between maternal plasma and mother's milk.
- An 80% detection frequency inclusion criteria might be too low for complicated statistical analyses, but in terms of statistical power, is too strict for simple comparisons of averages.
- Correlations between concentrations of the different organochlorines (with a few exceptions) in body fluids are high enough so that measuring the levels of a few with high detection frequencies would give a suitable picture of the combined body burden of these contaminants in most cases.
- The findings in Papers III and IV will be very valuable when creating protocols for future contaminant studies in Russia.
- The MCBR constitutes an invaluable tool for reproductive health studies of environmental contaminants.

Future activities

Ambient air pollution and other environmental hazards such as persistent organic pollutants are thought to have adverse effects on reproductive health and birth outcomes. At the root of investigations exploring such causal relationships, there should be a well-functioning medical birth registry. The fact that this is an arctic population is interesting in itself, especially in relation to predicted global environmental changes. As already mentioned, the Kola Peninsula features several unique settings, from large industrial areas to naval bases and remote fishing villages.

The Norwegian Research Council has recently funded further studies in the Kola Peninsula related to contaminants and perinatal health using the existing MCBR. Phase I will commence in the fall of 2009. It will be an intercommunity comparison of mothers' plasma environmental contaminants concentrations to establish whether the contaminants are community-specific. If they are, it should be possible to look at related community-specific adverse pregnancy

outcomes. These samples will also be used as a future reference in conjunction with observing trends of contaminant levels over time. Clearly, Phase I can only be used to explore possible associations and not causal relationships. To address this limitation, Phase II (planned for 2010 and 2011) is to involve conducting case-control studies within the birth cohort or "nested" case-control studies (i.e., mothers with adverse outcomes can be compared with mothers with healthy outcomes on the basis of contaminant exposure). Compared to cohort studies, these are cost-effective and with nearly the same levels of precision (66).

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Paper I

Paper II

Paper III

Paper IV

Appendix A

Murmansk County Birth Registry (MCBR)

Improving the health of mothers and babies

Annual report on deliveries 2006

October 2007

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Introduction

The MCBR started registering births in the Kola Peninsula in January of 2006. By August 2007, over 13 000 deliveries had been registered. The MCBR is, to our knowledge, the only operative birth registry in Russia, and certainly the only purely arctic birth registry in the world.
This report will present some of the findings from the first year of operations and will hopefully be helpful, especially for people working with maternal health care in this region. Represented here are 8 401 deliveries and 8 468 newborns. This constitutes more than 99.5% of all deliveries in Murmansk Oblast in 2006. The data are descriptive and stratified by hospital or place of delivery. This way of stratifying was chosen since the report is mainly intended to aid the delivery departments and the Health Care department in getting a good general overview of the situation in the region. For outcomes that would be considered rare, because of the limitations in size of the registry, no stratification was performed in order to avoid presenting unwarranted clusters. We have also included a small section on a quality control that was done in 2006. There will be yearly controls to assess the quality and validity of the MCBR.
Russia is going through a major transition fase and as the economy of the country is improving, the MCBR will closely monitor the effect of better personal and hospital economy.
Beside being a working tool for medical professionals, the MCBR is ment to work a a science platform and of special interest is the monitoring of the effect of pollution on this arctic population as well as the possibility to compare findings in North- West Russia and Northern Norway.

Major findings and comments from author

My first impression on analysing the results from the first year of operations of our Birth Registry was the good state of health of the Russian mothers and their babies. Much of this can probably be linked to the young age of the delivering population in comparison to European countries in the vicinity. There are however, many interesting differences between Russia and for example Norway as well as differnces between the individual delivery departments in MO that needs further attention. I am especially referring to certain points discussed below in the section below, perusal of tables and figures.

This presentation of frequencies and averages is brief and limited and does not even begin to scratch the surface of what information is possible to extract from a birth registry. I urge the Health Committee and health professionals to submit ideas for further investigation at the next conference that will be held in Kirkenes in March 2008.

Summary of Tables and Figures

Figures 1-4 and Table 2 have been supplied by the Murmansk Oblast Health Department and are included in order to give the readers a general overwiev.

- **Figure 1. Population of Murmanskaja Oblast (MO).** The population in MO has declined by 20.8% in 11 years. This is most likely a combination of three factors, namely reduction in stationed military personnel, emigration of workforce and a negative birth rate/death rate ratio.

- **Figure 2. Population of children.** The population of children between 0 and 14 years has been reduced by 18.8% and children 15-17 years by 8.2%. If we combine the numbers the reduction is 16.5%. In the same period (2000-2004) the precentwise reduction in the total population was 11.8%. The reduction in the number of children is therefore larger than in the population as a whole.

- **Figure 3. Total number of newborn.** There was a significant increase in the number of newborn from 2000 to 2004 by 10.6%, but then the number decreased again in 2005 and 2006. The reason for this might be that many of the families that decided to have their first child when the economy improved after the turn of the century have not produced a second child.

- **Figure 4. Rate of abortions.** The percentwise reduction in the rate of abortions per 1000 women of fertile age was 15.9%. It is not clear whether this is a true reduction or if more women chose to make use of private clinics for abortions. According to the Health Department in Murmansk, there is very limited use of private clinics for abortions. The trend line in the reduction in the abortion rate from 2000 – 2004 coincides well with an increase in the number of deliveries seen in Figure 4.

- **Table 1. Ethnicity of the delivering population.** The self-reported proportion of Russians for 2006 in MCBR was about 93.5%. In the 2002 Census [Всероссийская перепись населения 2002 года, October 9 through October 16, 2002. It was carried out by the Russian Federal Service of State Statistics (Rosstat)] this proportion was 85.2%. This could be that a lot of the foreign work force emigrated, but also a change in how people perceive themselves, ethnically.

- **Table 2. Birth rates and death rates.** During the last 11 years, the number of deaths has exceeded the number of births which is very alarming for MO. It is even more alarming since these numbers are the same all over Russia. In 2006, a total number of 1 476 200 babies were born and the number of deaths were 2 165 700 and this means that the number of deaths were 50% higher than the number of births.

- **Table 3. Hospital quality control (2006).** The average number of errors in the questions evaluated in the quality control was 0.9% while the number of data entry errors checked was 0. Many of the errors (7) in the registry form were contributed to question 28 (Maternity ward upgrade). Clarely this question harbours a quality problem and will be

omitted from further investigation and use. The reason being that a mother could, at any time, perform this upgrade without it being updated in the hospital files. If we exlude question 28 from the interpretation of the error proportion, the average error was 0.7%. The next quality control will be performed in October 2007 to evaluate whether this very acceptable error proportion will continue or even improve.

- **Table 4. Participating delivery departments.** By January 1. 2007, all the delivery departments in MO are operational and participating in collecting data for MCBR. For 2006, pregnant women otherwise destined to give birth at Severomorsk Hospital was routed to other delivery departments in the region.

- **Table 5. Distibution of deliveries by hospital.** 52.4 % of all deliveries in 2006 took place in one of the Murmansk city hospitals even though the population of Murmansk city (321 000) only constitutes 37.1% of the total population of MO. This means that many women travel to Murmansk city to deliver their babies either by choice or by recommendation from the obstetricians at their local delivery department. 121 random files were not picked up during the specified sampling time for 2006 deliveries. They are not included in these statistics, but the fact that they were random will not affect the averages presented here or introduce bias. These files will, however, be included in the upcoming publication of results.

- **Table 6. Gender distibutions.** The sex ratios vary quite a bit between the different cities and hospitals, but this fluctuation is natural and coincidental as can be seen by the total number of 51.5% boys and 48.5% girls, which is normal.

- **Table 7. Maternal age distribution.** The average age of the delivering women was 26 years, which by comparison is 4 years younger than in Norway (2004). A relatively young delivering population should be viewed as a healthy sign.

- **Table 8. Maternal age by parity.** If we compare the mean maternal age by parity between Russia and Norway the difference is also about 4 years. Interestingly, the variations between the different cities are small. One would perhaps expect the delivering women in more rural settlements to be younger than the women in the big cities.

- **Table 9. Number of births by parity.** For 60.5% of the women this was their first delivery while it was the second delivery for 32.8%, only 5.2% were giving birth to their 3rd child.

- **Table 10. Gestational Age (GA).** The average GA was 39.0 weeks. This was estimated using the last menstruation period (LMP). When using LMP, the GA tends to be overestimated as opposed to underestimated (Kramer *et al.,* 1988).

- **Table 11. Multivitamins and folic acid use.** The mothers are very diligent when it comes to the use of both multivitamins and folic acid during pregnancy, 89.9% and 65.6%, respectively. The use of multivitamins is only useful if the womans normal diet is insufficient in some way. Folic acid on the other hand is known to protect against certain congenital malformations, namely spina bifida and anencephaly (Smithells *et al*., 1983). However, the best protection against these malformations is obtained if folic acid is used prior to pregnancy (Czeizel and Dudas, 1992).

- **Table 12. Smoking.** With a completeness in registration on smoking habits of over 97%, there is definitely a representative sample, but since this information comes partly from the mothers themselves this self incriminating information tends to be underreported. The proportions of women that smoke before and during pregnancy appears not to have changed in the last 15 years (Odland *et al*., 1999). The validity of the smoking information can be evaluated by correlating the mean birthweight of singleton infants with reported maternal smoking. Indeed, the mothers that reported smoking delivered babies that were 200g lighter on average. The difference was significant (one sample t-test, $p < 0.001$).

- **Table 13a and b. Maternal disease before pregnancy**. There are some very interesting differences in disease frequency between hospitals. It is not known whether this is due to diagnostics or if it is real differences. For example 22.6% of the women in Murmansk Hospital number 1 are diagnosed with a chronic sex tract or urinary infection and 12.8% of the women in Gadzievo have goitre. Also worth mentioning is the fact that 7 women were diagnosed with HIV, which gives a prevalence of 83/100 000. Other information that we can extract from these tables to verify the accuracy of the registry, is the prevalence of ahstma and diabetes, which is known to be much lower than in Norway.

- **Table 14a and b. Maternal disease during pregnancy**. The most obvious thing that stands out in these tables is the occurrence of registration of threatened abortion. This point was addressed during the 2006 Birth Registry Conference in Murmansk and is known to be a misinterpretation of the diagnosis.The issue should be resolved for 2007. Another issue that might need some attention is the frequency of mild pre-eclampsia. A proportion of 9.2% seems high.

- **Table 15a and b. Delivery types.** The proportion of induced deliveries is lower in MO than in Norway and the proportion of spontaneous vaginal deliveries higher, but the percentage of caesarean deliveries is about the same. This means that more babies in MO are delivered naturally than in Norway. The relative number of induced deliveries because of late gestational age is 10 times lower in MO than in Norway. The percentage of caeasarean sections varies two-fold between hospitals.

- **Table 16a and b. Complications during delivery**. The numbers concerning perineal rupture can not be taken into account for 2006. There was for a large part of the year a misunderstanding whether episiotomy should be included here. Consensus was reached on the fact that episiotomy is a measure in order to avoid serious rupture and not a result of the delivery itself. Another diagnosis that need further attention is prolaps of cord, the number seems high for such a serious condition.

- **Table 17**. **Birth weight**. The birth weight distribution is fairly uniform between the different hospitals exept, of course Murmansk Hospital 3 which has a larger proportion of small babies because of its status as a speciality hospital for premature deliveries. As mentioned only a very limited number of births were induced because of late GA compared with Norway. Even so, the percentage of large babies (above 4500 grams), is 5 times lower in MO than in Norway.

- **Table 18**. **Perinatal mortality**. Perinatal mortality is one of the most significant measures of pregnancy health care. Using the WHO standard to calculate, the perinatal mortality rate in MO was 11/1000 in 2006. The birth registry as it is constructed today will not capture the few women that experience stillbirths after week 22, but does not visit the delivery

departments in conjunction with this. It is the goal to include these numbers for 2006 and on in order to get a real picture of what the actual perinatal mortality rate is in MO.

- **Table 19a and b**. **Neonatal conditions**. Percentages are not included in the table concerning neonatal conditions simply because they would be excessive due to the rarity of the conditions themselves. There are however a few conditions that stand out and should be given further attention. the fact that 10 out of 12 children with abstinence were born in Murmansk Hospital 1 is not surprising if it reflects the prequency of drug users in this demographic group. In fact, 31% of all registered drug users were admitted to this hospital. The same hospital also have a large overrepresentation of perinatal infections, which in turn, is consistent with the frequency of maternal infections in the same location. Cerebral irritability and cerebral depression as well as hypoglycaemia may also need some attention.

- **Table 20**. **Congenital malformations**. In total, the proportion of congenital defects is lower in MO than in Norway. However, the rates of some of the serious malformations is much higher in MO. Especially malformations of the heart, tounge and feet. There was a very significan cluster of tounge malformations in Sneznogorsk (20 cases). Children born with Downs syndrome was 6 times higher in Norway than in MO. This is probably a result of both a young delivering population and perhaps elective abortions.
- **Table 21**. **Anaesthetics/ analgetics**. The use of anaesthetics or analgetics is much less frequent in MO than for example Norway. If there is risk involved with the uses of these drugs, this is positive.

- **Table 22**. **Variables not listed elsewere.** Not too many comments needed here. the most interesting thing might be that the children stay at the hospital more than six days, on average.

Demographics

During the latter part of the 1980's the population, including military personell is said to have exceeded 2 million people (Voitov, personal communication), but these numbers have dwindled to 864 600 in 2006.

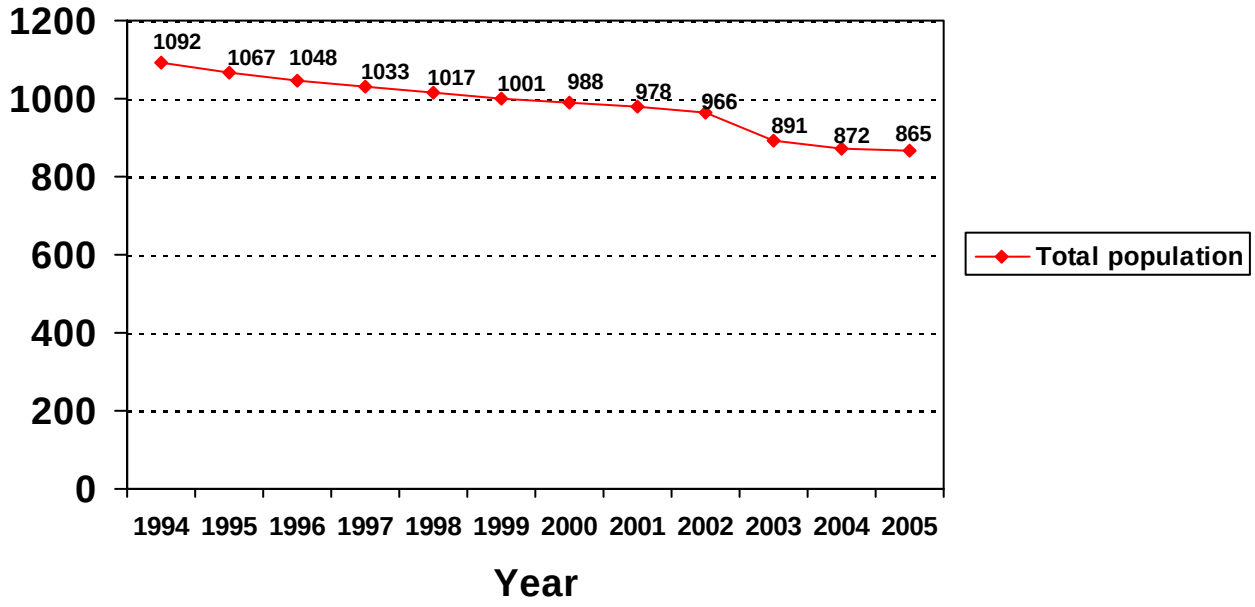

Figure 1. Population (in thousands) in Murmanskaja Oblast (1994 – 2005)

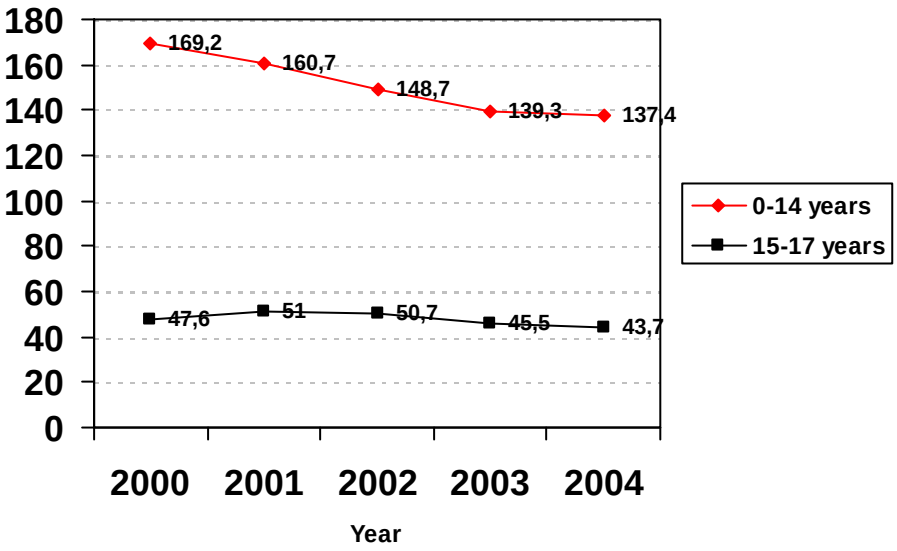

Figure 2. Population (in thousands) of children of two different age classes

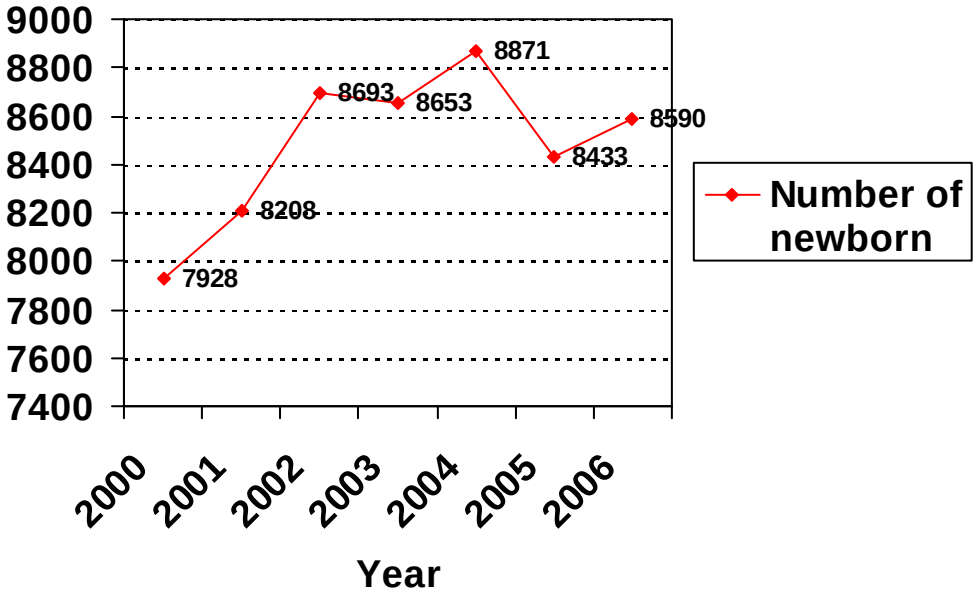

Figure 3. Total numbers of newborn

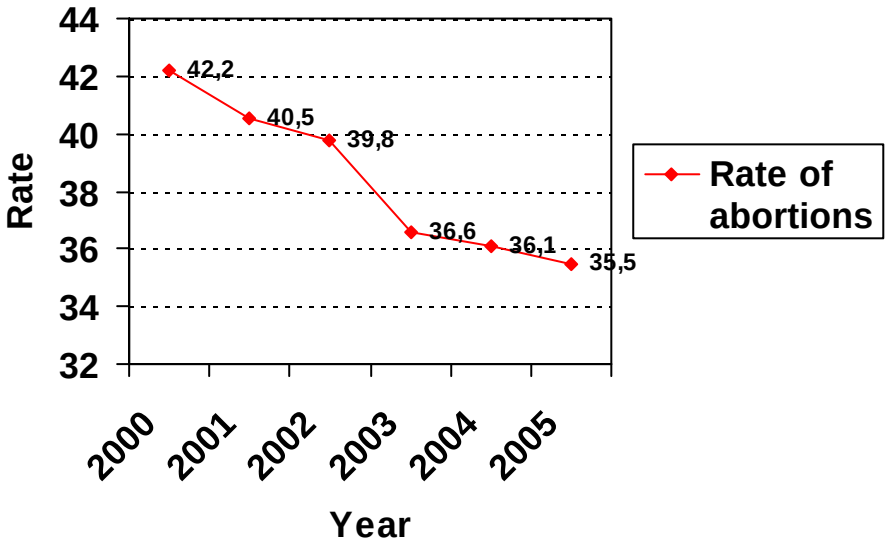

Figure 4. Rate of abortions per 1000 women of fertile age

The ethnic composition composition of the region has also changed over the years, especially because of emigration of military personnel and a work-force from all of the former USSR. Today, the ethnicity of the men and women registered in the MCBR are displayed in tables below.

Table 1. Ethnicity of the delivering population for 2006

Ethnicity	Frequency (mother)	Percent (mother)	Frequency (father)	Percent (father)
Armenia	17	0.2	14	0.2
Azerbaij	90	1.1	87	1.3
Belorus	43	0.5	19	0.3
Chuvash	11	0.1	7	0.1
Komi	13	0.2	7	0.1
Other	122	1.4	132	2.0
Russian	7847	93.4	6216	93.5
Sami	24	0.3	12	0.2
Tatarin	55	0.7	34	0.5
Ukraine	179	2.1	122	1.8
Total	8401	100.0	6650 (1751 missing)	100.0

In addition to emigration the annual death rate has exceeded the annual birth rate every year since 1995. This is in large part because of economic hardship. The Russian economy has, however, improved considerably since the turn of the millennia and is in rapid growth. Expectations are that the birth rate will increase both because of general improvement of the economy and as a result of a new social reform that will make families that give birth to their second or subsequent children elligeble for economic subsidation (should we add details?)

Table 2. Reported birth rate and death rate in MO over a ten year period

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Birth rate	8.1	8.3	7.9	8.1	7.6	8.2	8.6	9.2	9.9	10.2	9.7
Death rate	11.4	10.3	9.0	8.8	10.1	11.1	11.6	12.4	13.9	13.4	13.4
Difference	-3.3	-2.0	-1.2	-0.7	-2.5	-2.9	-3.0	-3.2	-4.0	-3.2	-3.7

Quality control

Yearly quality control reports

The 2006 quality controls consisted of two steps; (a) Accuracy and completeness of information copied from the original hospital files on to the registry form and (b) accuracy of information-transfer from the form into the database.

Site visits and controls

Between 01.07 and 25.09 2006 we visited as many of the delivery clinics as possible to assess the reliability of the registry. Some of the hospitals (n=2) are located in military zones or otherwise inaccessible areas, in which case the original hospital files were sent to the registry office for control. The aim was to control 10% or a minimum of 30 files/forms from each delivery department which had been entered into our system between 01.03 and 01.06 2006. We used a computer to randomly select file-numbers from each hospital which we, in turn, asked for upon arrival at the sites. Six questions with different characteristics were chosen to assess the general quality, namely; (1) mother's date of birth (date), (2) upgrade of maternity ward (yes/no), (3) delivery type (3 tick-off-boxes), (4) complications during delivery (21 tick-off-boxes and numerous ICD-10 codes), (5) weight of the newborn (integers) and (6) sex of the newborn (3 categories). A new special form was constructed to deem the information already registered as ok, missing or incorrect. 410 forms/files were controlled.

Database registration

The next step was to check the accuracy of the information which was transferred from the registry form into the database. File were selected randomly as described above, and five different questions, but with similar characteristics, were selected. A total of 300 forms were controlled.

Other sources for quality control

There are some limited official statistics available to check number of newborns, birth rate, and death rate and so on. Also a system called Monitoring 2.5 that records congenital birth defects is also present. In addition, all neonatal deaths (up to one year) have to be reported along with a detailed report on cause of death.

Of the 419 original hospital files scheduled for quality control. 9 were missing upon arrival at the hospitals. these files were absent because of other types of controls (insurance purposes) being administered from an official level.

Table 3. Hospital quality control

Question 5 (Mother's DOB)		**Question 28 (Maternity ward upgrade)**		**Question 30 (Delivery type)**		**Question 33 (Complications during delivery)**		**Question 42 (Sex of newborn)**		**Question 43 (Weight of newborn)**	
Missing	Errors	Missing	Errors	Missing	Errors	Missing	Errors	Missing	Errors	Missing	Errors
0	6	9	7	9	2	7	3	2	2	0	2
0%	1.46%	2.19%	1.71%	2.19%	0.49%	1.71%	0.73%	0.49%	0.49%	0%	0.49%

Of the 300 files checked for computer entry error in the registry office. 0 mistakes were found.

Tables and figures from MCBR 2006

Table 4. Overview of the delivery departments and hospitals working with MCBR

Hospital overview	
Hospital number	**Hospital name**
1	Gadzievo, Maternity Hospital
2	Sneznogorsk, Maternity Hospital
3	Kola, Regional Hospital, Obstetric Division
4	Olenegorsk, Regional Hospital, Obstetric Division
5	Monchegorsk, Regional Hospital, Obstetric Division
6	Kovdor, Regional Hospital, Obstetric Division
7	Kirovsk, Regional Hospital, Obstetric Division
8	Apatity, Regional Hospital, Obstetric Division
9	Kandalaksha, Regional Hospital, Obstetric Division
10	Murmansk, Maternity Hospital No 1
11	Murmansk, Maternity Hospital No 2
12	Murmansk, Maternity Hospital No 3
13	Nikel, Regional Hospital, Obstetric Division
14	Zaozersk, Regional Hospital, Obstetric Division
15	Severomorsk, Maternity Hospital[1]

[1] Severomorsk Hospital was renovated in 2006, included in all statistics from 2007. Patients from Severomorsk were directed to other hospitals in the region for 2006.

Table 5. Distribution of deliveries in the region (by hospital).

Deliveries 2006 (n= 8 401)			
Hospital number	**Hospital name**	**Number of deliveries (n)**	**Number of deliveries (%)**
1	Gadzievo	298	3.5
2	Sneznogorsk	291	3.5
3	Kola	329	3.9
4	Olenegorsk	366	4.4
5	Monchegorsk	592	7.0
6	Kovdor	185	2.2
7	Kirovsk	445	5.3
8	Apatity	592	7.0
9	Kandalaksha	541	6.4
10	Murmansk No 1	1741	20.7
11	Murmansk No 2	1382	16.5
12	Murmansk No 3	1280	15.2
13	Nikel	263	3.1
14	Zaozersk	96	1.1

Table 6. Number of births and sex proportions

Sex ratios (total births 2006, n= 8 468)				
Hospital number	**Hospital name**	**Number of births (n)**	**Boys (number and %)**	**Girls (number and %)**
1	Gadzievo	301	145 (48.2)	156 (51.8)
2	Sneznogorsk	292	154 (52.7)	138 (47.3)
3	Kola	332	170 (51.2)	162 (48.8)
4	Olenegorsk	367	200 (54.5)	167 (45.5)
5	Monchegorsk	593	296 (49.9)	297 (50.1)
6	Kovdor	190	95 (50.0)	95 (50.0)
7	Kirovsk	450	213 (47.3)	237 (52.7)
8	Apatity	599	292 (48.7)	307 (51.3)
9	Kandalaksha	543	287 (52.8)	256 (47.2)
10	Murmansk No 1	1756	918 (52.3)	838 (47.7)
11	Murmansk No 2	1393	734 (52.7)	659 (47.3)
12	Murmansk No 3	1292	670 (51.9)	622 (48.1)
13	Nikel	263	131 (49.8)	132 (50.2)
14	Zaozersk	96	56 (58.3)	40 (41.7)
Total		8467[1]	4361 (51.5)	4106 (48.5)

[1] 1 missing

Table 7. Maternal age (MA)[1]

Stratified maternal age distribution by hospital									
Hospital number	Hospital name	Number/ proportion of deliveries	MA<15	MA 16-20	MA 21-25	MA 26-30	MA 31-35	MA 36-40	MA> 40
1	Gadzievo	298	1	33	113	93	39	18	1
2	Sneznogorsk	291	0	46	109	81	43	11	1
3	Kola	329	2	87	105	77	43	14	1
4	Olenegorsk	366	0	70	143	98	41	13	1
5	Monchegorsk	592	0	94	205	182	82	25	4
6	Kovdor	184	0	39	71	50	18	4	2
7	Kirovsk	445	1	87	168	107	60	21	1
8	Apatity	592	3	132	183	171	78	23	2
9	Kandalaksha	540	0	114	188	133	84	20	1
10	Murmansk No 1	1741	0	193	596	557	302	79	14
11	Murmansk No 2	1382	3	204	475	420	216	61	3
12	Murmansk No 3	1280	1	142	434	391	239	66	7
13	Nikel	263	1	38	99	68	46	8	3
14	Zaozersk	96	0	20	38	22	15	1	0
Total (n)		8399[2]	12	1299	2927	2450	1306	366	39
Total (%)		100	0.2	15.5	34.7	29.2	15.5	4.4	0.5

[1] Calculated by using the difference (in years) between mothers date of birth and delivery date.
[2] Two missing

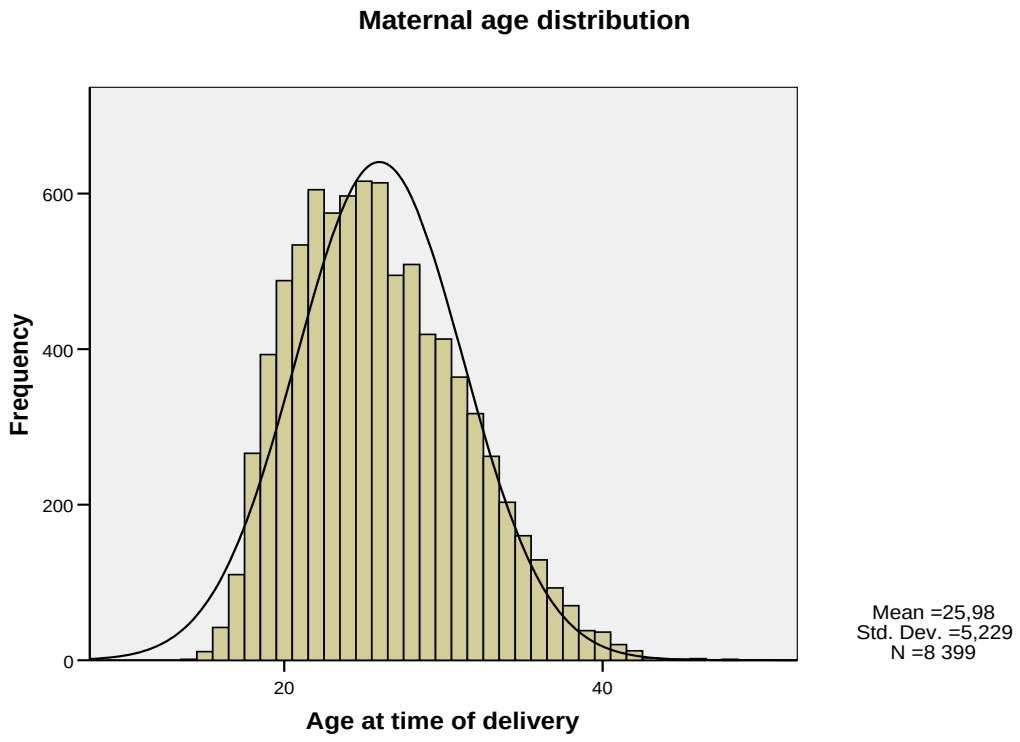

Fig. 7. Maternal age distribution for all deliveries in the region. One bar equals one year.

Table 8. Mean maternal age by parity according to place of delivery

Hospital number	Hospital name	Number of deliveries with parity information	Total (mean age)	1st delivery	2nd delivery	3rd delivery	4th delivery	5th delivery
1	Gadzievo	298	26.2	23.5	28.4	31.9	31.3	29.0
2	Sneznogorsk	291	25.7	23.1	28.4	33.1	34.0*	-
3	Kola	329	24.8	22.0	27.7	28.9	34.0*	31.5*
4	Olenegorsk	366	25.2	22.6	27.8	30.4	33.0	-
5	Monchegorsk	592	25.9	23.5	29.1	30.4	33.3*	30.0*
6	Kovdor	184	24.9	22.7	28.1	29.9	30.0*	-
7	Kirovsk	444	25.4	22.8	29.2	32.4	33.5*	-
8	Apatity	591	25.4	23.0	28.6	32.2	29.5	30.0*
9	Kandalaksha	539	25.3	22.8	27.9	30.7	32.3	31.4
10	Murmansk No 1	1741	26.6	24.6	29.8	32.0	35.8	32.7
11	Murmansk No 2	1381	26.1	24.1	29.0	30.6	30.8	34.0*
12	Murmansk No 3	1276	26.7	24.5	29.8	32.1	33.2	34.0
13	Nikel	262	26.0	23.0	28.4	32.6	32.0*	36.0*
14	Zaozersk	96	24.7	22.6	28.0	29.3*	37.0*	-
Total (n)		8390[1]	26.0	23.7	29.0	31.4	32.7	32.2

[1] 11 cases were excluded
* Observations fewer than n=5

Table 9. Parity

Number of births by parity and place of delivery									
Hospital number	Hospital name	Total number of deliveries	1st delivery	2nd delivery	3rd delivery	4th delivery	5th delivery	6th delivery	7th+ delivery
1	Gadzievo	298	152	120	19	4	2	0	1
2	Sneznogorsk	291	166	106	16	3	0	0	0
3	Kola	329	181	123	18	2	2	2	1
4	Olenegorsk	366	193	149	19	5	0	0	0
5	Monchegorsk	592	352	199	31	4	3	1	2
6	Kovdor	184	114	57	12	1	0	0	0
7	Kirovsk	444	285	129	25	4	0	1	0
8	Apatity	591	369	181	30	8	1	1	1
9	Kandalaksha	539	307	185	33	9	5	0	0
10	Murmansk No 1	1741	1118	530	78	12	3	0	0
11	Murmansk No 2	1381	842	459	64	12	3	1	0
12	Murmansk No 3	1276	807	380	71	13	5	0	0
13	Nikel	262	134	108	17	1	1	1	0
14	Zaozersk	96	61	31	3	1	0	0	0
Total (n)		8390	5081	2757	436	79	25	7	5

Table 10. Gestational age (GA)

Gestational age by place of delivery									
Hospital number	Hospital name	Number of deliveries with GA[2] (certain)	< 22 weeks	22^{+0} – 27^{+6} weeks	28^{+0} – 36^{+6} weeks	37^{+0} – 39^{+6} weeks	40^{+0} – 42^{+6} weeks	> 43 weeks	Mean
1	Gadzievo	287	0	2	21	148	111	5	38.9
2	Sneznogorsk	276	0	1	19	121	130	5	39.2
3	Kola	280	0	1	12	118	145	4	39.3
4	Olenegorsk	278	1	3	18	100	144	12	39.4
5	Monchegorsk	569	1	4	30	283	236	15	39.1
6	Kovdor	165	1	2	12	64	78	8	39.3
7	Kirovsk	410	0	1	29	206	164	10	39.0
8	Apatity	533	0	4	62	235	210	22	38.9
9	Kandalaksha	486	0	2	33	196	243	12	39.3
10	Murmansk No 1	1638	1	4	122	732	736	43	39.1
11	Murmansk No 2	1183	5	9	97	555	482	35	39.9
12	Murmansk No 3	1203	2	16	104	536	507	38	38.9
13	Nikel	249	0	0	14	117	112	6	39.3
14	Zaozersk	91	0	1	5	32	51	2	39.5
Total (n)[1]		7648	11	50	578	3443	3349	217	39.0

[1] 744 deliveries were excluded because there was uncertainty around the LMP and another 9 cases were excluded because of illogical values.
[2] GA was estimated by LMP, only completed weeks were used.

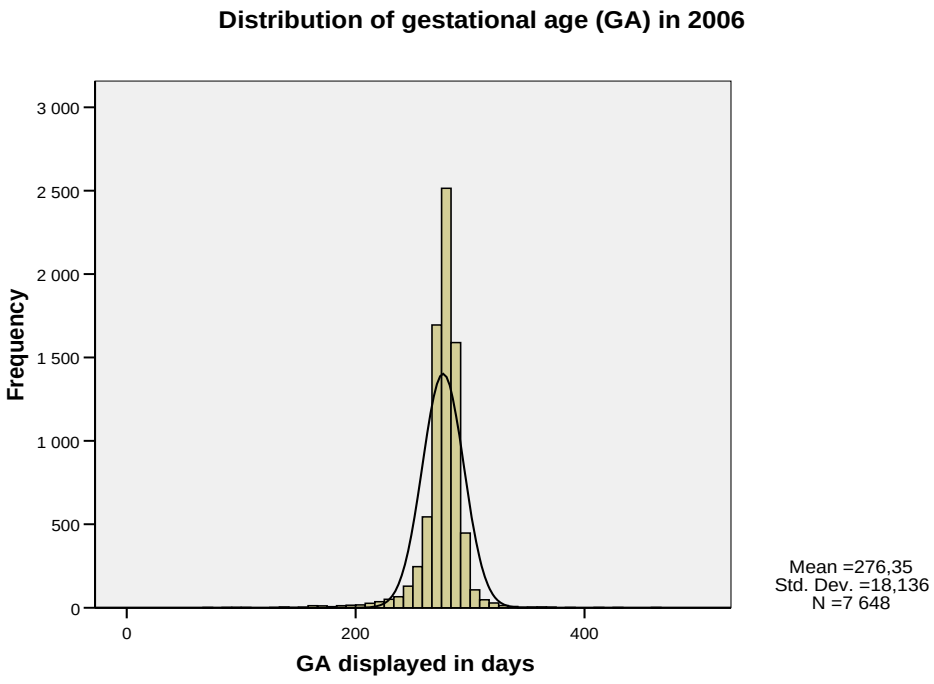

Figure 8. Gestational age distribution

Table 11. Multivitamins or folic acid use before and during pregnancy

Hospital number	Hospital name	Number of observations (Total)	Before pregnancy (%)		During pregnancy (%)	
			Multi	Folic	Multi	Folic
1	Gadzievo	294	56.0	11.4	96.3	80.2
2	Sneznogorsk	287	1.4	2.4	95.5	80.4
3	Kola	319	1.2	1.2	86.6	48.3
4	Olenegorsk	354	10.9	10.9	92.9	93.2
5	Monchegorsk	247	0.5	0	86.5	32.1
6	Kovdor	185	0.5	0	91.4	40.0
7	Kirovsk	440	15.5	0.2	96.2	10.3
8	Apatity	588	14.4	14.2	93.8	93.4
9	Kandalaksha	529	3.3	0.9	87.4	68.2
10	Murmansk No 1	1727	9.5	4.8	85.2	73.6
11	Murmansk No 2	1175	5.3	0.6	93.3	86.3
12	Murmansk No 3	1229	0.1	0.1	86.9	52.8
13	Nikel	249	14.4	0	94.7	42.6
14	Zaozersk	94	2.1	2.1	92.7	42.7
Total (n)[1]		7717	8.0	3.2	89.9	65.6

[1] The completeness was 91.9% of total deliveries (684 cases missing)

Table 12. Smoking

Hospital number	Hospital name	Number of observations (Total)	Before pregnancy (%)	During pregnancy (%)
			Smokers	Smokers
1	Gadzievo	298	33.6	15.4
2	Sneznogorsk	290	17.2	16.5
3	Kola	327	39.8	31.6
4	Olenegorsk	360	28.7	26.5
5	Monchegorsk	544	15.7	15.4
6	Kovdor	185	24.9	23.2
7	Kirovsk	442	30.1	16.9
8	Apatity	589	24.7	18.6
9	Kandalaksha	535	38.3	28.3
10	Murmansk No 1	1733	23.3	11.1
11	Murmansk No 2	1254	8.5	6.3
12	Murmansk No 3	1257	26.8	14.0
13	Nikel	262	28.5	25.9
14	Zaozersk	95	40.6	24.0
Total (n)[1]		8171	23.7	15.7

[1] The completeness was 97.3% of total deliveries (230 cases missing).

Table 13a. Maternal disease before pregnancy

Hospital number	Hospital name	Number of deliveries	Chr. sex tract or urinary inf.	Chr. kidney inf.	Asthma	Chr. hypertension	Rhreumatoid arthritis	Heart disease	Epilepsy	Diabetes Type 1	Diabetes Type 2
1	Gadzievo	298	45 (15.1)	30 (10.1)	3 (1.0)	3 (1.0)	0	0	1 (0.3)	0	0
2	Sneznogorsk	291	30 (10.3)	71 (24.4)	3 (1.0)	21 (7.2)	1 (0.3)	3 (1.0)	1 (0.3)	0	0
3	Kola	329	4 (1.2)	52 (15.8)	6 (1.8)	4 (1.2)	2 (0.6)	17 (5.2)	0	0	0
4	Olenegorsk	366	5 (1.4)	59 (16.1)	3 (0.8)	2 (0.5)	0	7 (1.9)	0	0	6 (1.6)
5	Monchegorsk	592	6 (1.0)	99 (16.7)	10 (1.7)	19 (3.2)	1 (0.2)	25 (4.2)	3 (0.5)	1 (0.2)	0
6	Kovdor	185	3 (1.6)	18 (9.7)	1 (0.5)	1 (0.5)	0	1 (0.5)	0	0	0
7	Kirovsk	445	6 (1.3)	31 (7.0)	0	6 (1.3)	0	1 (0.2)	1 (0.2)	0	3 (0.7)
8	Apatity	592	10 (1.7)	11 (1.9)	2 (0.3)	0	1 (0.2)	11 (1.9)	0	0	4 (0.7)
9	Kandalaksha	541	7 (1.3)	66 (12.2)	7 (1.3)	5 (0.9)	2 (0.4)	0	4 (0.7)	0	3 (0.6)
10	Murmansk No 1	1741	394 (22.6)	98 (5.6)	7 (0.4)	3 (0.2)	1 (0.1)	16 (0.9)	5 (0.3)	1 (0.1)	0
11	Murmansk No 2	1382	96 (6.8)	216 (15.6)	4 (0.4)	1 (0.1)	1 (0.1)	30 (2.2)	0	2 (0.1)	1 (0.1)
12	Murmansk No 3	1280	9 (0.7)	145 (11.3)	5 (0.4)	41 (3.2)	0	3 (0.2)	3 (0.2)	2 (0.2)	0
13	Nikel	263	8 (3.0)	51 (19.4)	2 (0.8)	2 (0.8)	0	2 (0.8)	1 (0.4)	0	0
14	Zaozersk	96	4 (4.2)	1 (1.0)	0	0	0	0	0	0	0
Total (n)		8401	625 (7.4)	948 (11.3)	54 (0.6)	108 (1.3)	9 (0.1)	116 (1.4)	19 (0.2)	6 (0.1)	17 (0.2)

Table 13b. Maternal disease before pregnancy

Hospital number	Hospital name	Number of women	Hep. A Acute	Hep. B Acute	Hep. C Acute	Hep. B chronic	Hep. C chronic	Nontoxic diffuse goitre	Nephritis (chronic)	Salpingitis and oophoritis	Trophic ulcer of cervix
1	Gadzievo	298	1 (0.3)	0	0	0	0	38 (12.8)	1 (0.3)	0	1 (0.3)
2	Sneznogorsk	291	11 (3.8)	2 (0.7)	2 (0.7)	0	2 (0.7)	1 (0.3)	2 (0.7)	8 (2.7)	16 (5.5)
3	Kola	329	12 (3.6)	9 (2.5)	14 (4.3)	0	0	2 (0.6)	1 (0.3)	4 (1.0)	15 (3.8)
4	Olenegorsk	366	19 (5.2)	9 (2.5)	6 (1.6)	0	0	23 (6.3)	1 (0.3)	4 (1.1)	5 (1.4)
5	Monchegorsk	592	14 (2.4)	28 (4.7)	43 (7.3)	0	1 (0.2)	2 (0.3)	1 (0.2)	26 (4.4)	62 (10.5)
6	Kovdor	185	0	0	0	1 (0.5)	4 (2.2)	0	0	0	0
7	Kirovsk	445	2 (0.4)	0	0	13 (2.9)	8 (1.8)	14 (3.1)	0	23 (5.2)	36 (8.1)
8	Apatity	592	31 (5.2)	20 (3.4)	26 (4.4)	0	0	0	71 (12.0)	17 (2.9)	153 (25.8)
9	Kandalaksha	541	19 (3.5)	8 (1.5)	2 (0.4)	0	2 (0.4)	0	7 (1.3)	5 (0.9)	4 (0.7)
10	Murmansk No 1	1741	0	0	0	4 0.2)	20 (1.1)	0	0	33 (1.9)	0
11	Murmansk No 2	1382	33 (2.4)	0	0	29 (2.1)	75 (5.4)	17 (1.2)	0	174 (12.6)	288 (20.8)
12	Murmansk No 3	1280	6 (0.5)	0	0	0	15 (1.2)	2 (0.2)	0	1 (0.1)	1 (0.1)
13	Nikel	263	13 (4.9)	2 (0.8)	0	2 (0.8)	13 (4.9)	5 (1.9)	3 (1.1)	21 (7.9)	26 (9.8)
14	Zaozersk	96	0	0	0	0	0	0	0	0	0
Total (n)		8401	161 (1.9)	78 (0.9)	93 (1.1)	49 (0.6)	140 (1.7)	104 (1.2)	87 (1.0)	318 (3.8)	607 (7.2)

ICD-10 codes: B15 Acute hepatitis A, B16 Acute hepatitis B, B17.1 Acute hepatitis C, B18.1 Chronic viral hepatitis B , B18.2 Chronic viral hepatitis C, E04.0 Nontoxic diffuse goitre and E04.9 Nontoxic goitre, unspecified, N11.9 Chronic tubulo-interstitial nephritis, unspecified, N70.0 Acute salpingitis and oophoritis, N70.1 Chronic salpingitis and oophoritis and N70.9 Salpingitis and oophoritis, unspecified and
N86 Erosion and ectropion of cervix uteri

Table 14a . Maternal disease during pregnancy

Hospital number	Hospital name	Number of deliveries	Haemorrhage < 13 weeks	Haemorrhage 13^{+0} - 28^{+6} weeks	Haemorrhage > 28 weeks	Pregnancy diabetes	Thrombosis	Mild pre-eclampsia	Severe pre-eclampsia	Eclampsia	HELLP-Syndrome
1	Gadzievo	298	26 (8.7)	6 (2.0)	0	0	0	0	0	0	0
2	Sneznogorsk	291	29 (10.0)	2 (0.7)	1 (0.3)	0	0	46 (15.8)	3 (1.0)	0	0
3	Kola	329	5 (1.5)	3 (0.9)	2 (0.6)	0	0	15 (4.6)	2 (0.6)	0	0
4	Olenegorsk	366	3 (0.8)	0	1 (0.3)	0	0	6 (1.6)	1 (0.3)	0	0
5	Monchegorsk	592	0	0	0	1 (0.2)	2 (0.3)	69 (11.7)	0	0	2 (0.3)
6	Kovdor	185	6 (3.2)	2 (1.1)	1 (0.5)	0	4 (2.2)	3 (1.6)	0	0	0
7	Kirovsk	445	51 (11.5)	64 (14.4)	32 (7.2)	0	4 (0.9)	23 (5.2)	5 (1.1)	0	0
8	Apatity	592	0	0	0	0	1 (0.2)	15 (2.5)	2 (0.3)	0	0
9	Kandalaksha	541	1 (0.2)	0	1 (0.2)	0	1 (0.2)	1 (0.2)	0	0	0
10	Murmansk No 1	1741	4 (0.2)	0	0	1 (0.1)	2 (0.1)	115 (6.6)	5 (0.3)	1 (0.1)	0
11	Murmansk No 2	1382	5 (0.4)	2 (0.1)	0	0	0	394 (28.5)	3 (0.2)	0	0
12	Murmansk No 3	1280	0	0	0	1 (0.1)	3 (0.2)	31 (2.4)	0	0	0
13	Nikel	263	5 (1.9)	3 (1.1)	0	0	2 (0.8)	21 (8.0)	3 (1.1)	0	0
14	Zaozersk	96	8 (8.3)	6 (6.3)	2 (2.1)	0	0	14 (14.6)	0	0	0
Total (n)		8401	143 (1.7)	88 (1.0)	40 (0.5)	3 (0)	19 (0.2)	776 (9.2)	24 (0.3)	1 (0.1)	2 (0)

Table 14b. Maternal disease during pregnancy

Hospital number	Hospital name	Number of women	Gestational oedema	Threatened abortion	Kidney infections	Gential tract infections	Poor fetal growth	Polyhydra-mnios	Oligohydramnios	Inf. of amniotic sac	False labour (< 37 weeks)
1	Gadzievo	298	44 (14.7)	144 (48.3)	9 (3.0)	17 (5.7)	7 (2.3)	1 (0.3)	0	0	116 (38.9)
2	Sneznogorsk	291	32 (11.0)	8 (2.7)	28 (9.6)	0	4 (1.4)	4 (1.4)	0	0	76 (26.1)
3	Kola	329	80 (24.3)	56 (17.9)	25 (7.6)	11 (3.3)	33 (10.0)	0	12 (3.6)	51 (15.5)	46 (14.0)
4	Olenegorsk	366	59 (16.1)	8 (2.2)	53 (14.5)	14 (3.8)	7 (1.9)	0	1 (0.3)	0	0
5	Monchegorsk	592	185 (31.2)	17 (2.9)	100 (16.9)	181 (30.6)	0	2 (0.3)	0	0	1 (0.2)
6	Kovdor	185	12 (6.5)	45 (24.3)	7 (3.8)	19 (10.3)	17 (9.2)	10 (5.4)	0	0	20 (10.8)
7	Kirovsk	445	40 (8.9)	28 (6.3)	16 (3.6)	19 (4.3)	7 (1.6)	0	0	0	0
8	Apatity	592	76 (12.8)	171 (28.8)	1 (0.2)	63 (10.6)	20 (3.4)	11 (2.8)	31 (5.2)	0	2 (0.3)
9	Kandalaksha	541	104 (19.2)	174 (32.2)	9 (1.6)	24 (4.4)	28 (5.2)	14 (2.6)	2 (0.4)	0	47 (8.7)
10	Murmansk No 1	1741	100 (5.7)	449 (25.8)	6 (0.3)	2 (0.1)	1 (0.1)	0	0	4 (0.2)	72 (4.1)
11	Murmansk No 2	1382	312 (22.6)	506 (36.6)	62 (4.5)	6 (0.4)	0	0	3 (0.2)	2 (0.2)	303 (21.9)
12	Murmansk No 3	1280	214 (16.7)	428 (33.4)	16 (1.3)	9 (0.7)	28 (2.2)	0	0	0	294 (22.9)
13	Nikel	263	47 (17.8)	160 (60.8)	0	10 (3.8)	9 (3.4)	0	2 (0.8)	0	75 (28.5)
14	Zaozersk	96	1 (1.0)	0	2 (2.0)	0	16 (16.7)	0	0	0	1 (1.0)
Total (n)		8401	1306 (15.5)	2194 (26.1)	334 (3.9)	375 (4.5)	177 (2.1)	42 (0.5)	51 (0.6)	57 (0.7)	1053 (12.5)

Table 15a. Delivery types

Presentation and induction of labor										
Hospital number	Hospital name	Number of deliveries	Presentation					Delivery type		
			Normal	Breech	Transverse	Abnormal cephalic	Other	Spontaneous	Induced	Caesarean
1	Gadzievo	298	292 (98.0)	5 (1.7)	0	0	4 (0.3)	249 (83.6)	0	49 (16.4)
2	Sneznogorsk	291	282 (96.9)	3 (1.0)	1 (0.3)	5 (1.7)	0	235 (80.8)	26 (8.9)	30 (10.3)
3	Kola	329	317 (96.4)	10 (3.0)	0	0	2 (0.6)	236 (71.7)	58 (17.6)	35 (10.6)
4	Olenegorsk	366	347 (94.8)	13 (3.6)	0	4 (1.1)	2 (0.5)	311 (85.0)	2 (0.5)	53 (14.5)
5	Monchegorsk	592	569 (96.1)	13 (2.2)	1 (0.2)	7 (1.2)	2 (0.3)	475 (80.2)	59 (10.0)	58 (9.8)
6	Kovdor	185	181 (97.8)	3 (1.6)	0	1 (0.5)	0	160 (86.5)	4 (2.2)	21 (11.4)
7	Kirovsk	445	408 (91.7)	17 (3.8)	1 (0.2)	9 (2.0)	10 (2.2)	318 (71.5)	56 (12.6)	71 (16.0)
8	Apatity	592	558 (94.3)	30 (5.1)	2 (0.3)	1 (0.2)	1 (0.2)	474 (80.1)	2 (0.3)	116 (19.3)
9	Kandalaksha	541	510 (94.3)	16 (3.0)	3 (0.6)	5 (0.9)	7 (1.3)	401 (74.1)	47 (8.7)	93 (17.2)
10	Murmansk No 1	1741	1676 (96.3)	59 (3.4)	2 (0.1)	2 (0.1)	2 (0.1)	1373 (78.9)	81 (4.7)	287 (16.5)
11	Murmansk No 2	1382	1325 (95.9)	50 (3.6)	2 (0.1)	1 (0.1)	4 (0.3)	1103 (79.8)	21 (1.5)	258 (18.7)
12	Murmansk No 3	1280	1225 (95.7)	53 (4.1)	0	2 (0.2)	0	965 (75.4)	15 (1.2)	300 (23.4)
13	Nikel	263	247 (93.9)	8 (3.0)	0	8 (3.0)	0	189 (71.9)	14 (5.3)	60 (22.8)
14	Zaozersk	96	94 (97.9)	1 (1.0)	0	1 (1.0)	0	76 (79.2)	2 (2.1)	18 (18.8)
Total (n)		8401	8031 (95.6)	281 (3.3)	12 (0.1)	46 (0.5)	31 (0.4)	6565 (78.1)	387 (4.6)	1449 (17.2)

Table 15b. Delivery types

Planned caesarean and reason for induction							
Hospital number	Hospital name	Number of deliveries	Caesarean planned		Indication for surgery/induction		
			No	Yes	Other complications	Fetal malformations	Late gestational age
1	Gadzievo	298	29	18	23	0	4
2	Sneznogorsk	291	19	11	19	0	24
3	Kola	329	11	24	8	0	33
4	Olenegorsk	366	32	21	32	0	1
5	Monchegorsk	592	43	16	67	1	10
6	Kovdor	185	10	11	5	1	0
7	Kirovsk	445	35	36	35	0	3
8	Apatity	592	44	71	26	0	0
9	Kandalaksha	541	36	56	9	0	35
10	Murmansk No 1	1741	116	158	142	0	8
11	Murmansk No 2	1382	75	183	21	0	5
12	Murmansk No 3	1280	182	117	144	0	2
13	Nikel	263	28	31	27	0	5
14	Zaozersk	96	17	0	13	0	1
Total (n)		8401	677	753	571	2	131

Table 16a. Complications during delivery

Hospital number	Hospital name	Number of deliveries	Membrane rupture		Mechanical problems	Complicated shoulder delivery	Placenta previa	Abruptio placentae	Perineal* rupture	Sphincter rupture
			$12^{+0} - 23^{+59}$ hrs	> 24 hrs						
1	Gadzievo	298	7 (2.3)	0	7 (2.3)	7 (2.3)	0	5 (1.7)	0	0
2	Sneznogorsk	291	11 (3.8)	4 (1.4)	10 (3.4)	1 (0.3)	1 (0.3)	2 (0.7)	23 (7.9)	0
3	Kola	329	8 (2.4)	1 (0.3)	2 (0.6)	0	1 (0.3)	1 (0.3)	85 (25.8)	0
4	Olenegorsk	366	89 (24.3)	2 (0.5)	4 (1.1)	7 (1.9)	2 (0.5)	9 (2.5)	50 (13.7)	1 (0.3)
5	Monchegorsk	592	44 (7.4)	13 (2.2)	12 (2.0)	28 (4.7)	1 (0.2)	11 (1.9)	74 (12.5)	0
6	Kovdor	185	7 (3.89	1 (0.5)	0	0	0	0	22 (11.9)	0
7	Kirovsk	445	1 (0.2)	1 (0.2)	12 (2.7)	1 (0.2)	2 (0.4)	3 (0.7)	12 (2.7)	0
8	Apatity	592	34 (5.7)	3 (0.5)	6 (1.0)	0	1 (0.2)	10 (1.7)	3 (0.5)	0
9	Kandalaksha	541	29 (5.4)	1 (0.2)	5 (0.9)	1 (0.2)	1 (0.2)	3 (0.6)	0	0
10	Murmansk No 1	1741	28 (1.6)	13 (0.7)	37 (2.1)	1 (0.1)	7 (0.4)	69 (4.0)	330 (19.0)	0
11	Murmansk No 2	1382	107 (7.7)	8 (0.6)	52 (3.8)	1 (0.1)	6 (0.4)	3 (0.2)	13 (0.9)	0
12	Murmansk No 3	1280	11 (0.9)	9 (0.7)	59 (4.6)	4 (0.3)	2 (0.2)	11 (0.9)	170 (13.3)	0
13	Nikel	263	1 (0.4)	2 (0.8)	16 (6.1)	0	0	5 (1.9)	16 (6.1)	0
14	Zaozersk	96	5 (5.2)	0	9 (9.4)	0	0	2 (2.1)	2 (2.1)	0
Total (n)[1]		8401	382 (4.5)	57 (0.7)	231 (2.7)	50 (0.6)	24 (0.3)	134 (1.6)	800 (9.5)	1 (0)

* Perineal rupture was for a larger part of 2006 grouped with the small insition (episiotomy) made to avoid the rupture itself, a new field was made for the 2007 form in order to rectify this

Table 16 B. Complications during delivery

Hospital number	Hospital name	Number of deliveries	Haemmorhage			Eclampsia during labour	Prolaps of cord	Thr. intrauterine asph.	First stage red. contarctions	Second stage red. contarctions	Other complicatios
			500 – 1000 mL	1000-1500 mL	> 1500 mL						
1	Gadzievo	298	6 (2.0)	4 (1.3)	0	0	9 (3.0)	0	21 (7.0)	42 (14.1)	16 (5.4)
2	Sneznogorsk	291	5 (1.7)	0	0	0	23 (7.9)	0	15 (5.2)	22 (7.6)	19 (6.5)
3	Kola	329	8 (2.4)	0	1 (0.3)	0	6 (1.8)	1 (0.3)	22 (6.7)	11 (3.3)	39 (11.9)
4	Olenegorsk	366	3 (0.8)	0	0	1 (0.3)	16 (4.4)	0	23 (6.3)	12 (3.3)	74 (20.2)
5	Monchegorsk	592	7 (1.2)	0	1 (0.2)	0	46 (7.8)	2 (0.3)	31 (5.2)	13 (2.2)	338 (57.1)
6	Kovdor	185	4 (2.2)	0	0	1 (0.5)	34 (18.4)	1 (0.5)	10 (5.4)	7 (3.8)	69 (37.3)
7	Kirovsk	445	7 (1.6)	0	1 (0.2)	1 (0.2)	48 (10.8)	2 (0.4)	70 (15.7)	6 (1.3)	92 (20.7)
8	Apatity	592	10 (1.7)	1 (0.2)	1 (0.2)	1 (0.2)	15 (2.5)	1 (0.2)	4 (0.7)	48 (8.1)	12 (2.0)
9	Kandalaksha	541	6 (1.1)	1 (0.2)	1 (0.2)	0	61 (11.3)	1 (0.2)	50 (9.2)	20 (3.7)	119 (22.0)
10	Murmansk No 1	1741	33 (1.9)	1 (0.1)	1 (0.1)	2 (0.1)	57 (3.3)	1 (0.1)	162 (9.3)	75 (4.3)	85 (4.9)
11	Murmansk No 2	1382	2 (0.1)	0	0	1 (0.1)	109 (7.9)	2 (0.1)	237 (17.1)	39 (2.8)	301 (21.8)
12	Murmansk No 3	1280	22 (1.7)	6 (0.5)	0	0	54 (4.2)	0	253 (19.8)	81 (6.3)	150 (11.7)
13	Nikel	263	11 (4.2)	0	0	0	6 (2.3)	3 (1.1)	25 (9.5)	5 (1.9)	94 (35.7)
14	Zaozersk	96	1 (1.0)	0	0	0	7 (7.3)	0	13 (13.5)	7 (7.3)	4 (4.2)
Total (n)[1]		8401	125 (1.5)	13 (0.2)	6 (0.1)	5 (0.1)	491 (5.8)	14 (0.2)	936 (11.1)	388 (4.6)	1412 (16.8)

Table 17. Birth weight

Hospital number	Hospital name	Total number of births with reported birth weight	Weight group in grams (%)			Mean weight	Standard deviation
			<1500	<2500	4500+		
1	Gadzievo	301	2	11	6	3340	540
2	Sneznogorsk	292	0	14	1	3400	489
3	Kola	332	1	16	1	3290	508
4	Olenegorsk	367	3	18	4	3350	574
5	Monchegorsk	593	1	28	3	3300	493
6	Kovdor	190	4	19	1	3220	663
7	Kirovsk	450	4	22	1	3320	496
8	Apatity	599	11	52	1	3250	608
9	Kandalaksha	543	4	28	9	3340	552
10	Murmansk No 1	1756	18	98	13	3340	549
11	Murmansk No 2	1393	12	90	9	3320	567
12	Murmansk No 3	1292	24	96	16	3320	619
13	Nikel	263	0	6	1	3340	430
14	Zaozersk	96	0	1	1	3530	499
Total (n)		8467	84 (1.0%)	499 (5.9%)	67 (0.8%)	3320	559

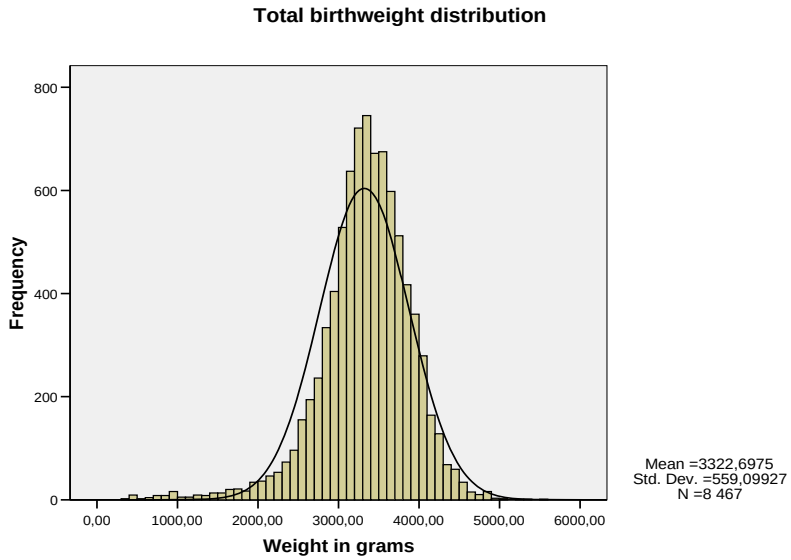

Fig. 9. Birth weight distribution for 2006.

Table 18. Perinatal mortality

Hospital number	Hospital name	Number of births[1]	Perinatal mortality	
			Stillbirths[2]	Perinatal deaths[3]
1	Gadzievo	301	2	4
2	Sneznogorsk	292	0	1
3	Kola	332	4	4
4	Olenegorsk	367	5	6
5	Monchegorsk	593	3	3
6	Kovdor	190	4	4
7	Kirovsk	450	3	5
8	Apatity	599	8	9
9	Kandalaksha	543	6	7
10	Murmansk No 1	1756	10	16
11	Murmansk No 2	1393	11	14
12	Murmansk No 3	1292	15	19
13	Nikel	263	0	0
14	Zaozersk	96	0	1
Total (n)[1]		8467	71	93

[1] Total among all live births and still births >= 22 weeks, or birth weight >= 425g, or length >= 25 cm.
[2] Children classified as dead at time of delivery
[3] Stillborn and children that died 0 days through 6 days

Table 19a. Neonatal conditions

Hospital number	Hospital name	Number of births	Hypoglycemia	Congenital anemia	Hip joint dysplasia	Transit. tachypnoe	Resp. distress syndrome	Aspiration syndrome	Intracranial haemorrhage	Cerebral irritability	Cerebral depression
1	Gadzievo	301	9	0	0	0	0	2	0	0	0
2	Sneznogorsk	292	0	0	0	1	3	5	0	3	7
3	Kola	332	0	0	0	0	6	2	2	19	1
4	Olenegorsk	367	0	2	0	0	10	1	4	3	0
5	Monchegorsk	593	9	0	0	0	2	0	0	2	0
6	Kovdor	191	0	0	0	0	2	1	0	3	1
7	Kirovsk	450	1	0	0	1	4	1	3	13	12
8	Apatity	599	0	3	0	1	3	3	0	1	0
9	Kandalaksha	543	0	0	0	0	1	4	0	40	24
10	Murmansk No 1	1756	2	2	2	0	9	1	0	14	12
11	Murmansk No 2	1393	2	0	0	0	1	0	0	2	1
12	Murmansk No 3	1292	0	0	0	0	4	4	0	1	0
13	Nikel	263	1	0	0	0	0	3	0	0	0
14	Zaozersk	96	0	0	0	0	2	1	0	14	1
Total (n)		8468	19	7	2	3	49	25	9	115	60

Table 19b. Neonatal conditions

Hospital number	Hospital name	Number of births	Abstinence	Conjuctiva treated	Neonatal cramps	Navel/skin infection	Perinatal infections	Fracture claviculae	Plexus damage
1	Gadzievo	301	0	0	0	0	0	0	0
2	Sneznogorsk	292	0	0	0	0	3	6	0
3	Kola	332	1	0	0	3	4	9	0
4	Olenegorsk	367	0	0	3	0	2	1	0
5	Monchegorsk	593	0	1	0	0	4	11	0
6	Kovdor	191	0	1	0	1	1	1	1
7	Kirovsk	450	0	0	1	0	3	12	0
8	Apatity	599	0	0	3	0	1	14	0
9	Kandalaksha	543	0	0	0	0	2	4	0
10	Murmansk No 1	1756	10	8	1	1	31	3	1
11	Murmansk No 2	1393	1	0	0	0	2	4	0
12	Murmansk No 3	1292	0	0	1	0	4	1	0
13	Nikel	263	0	0	0	0	2	0	0
14	Zaozersk	96	0	0	1	1	1	0	0
Total (n)		8468	12	10	10	6	56	66	2

Table 20. Congenital malformations

Hospital number[1]	Total number of birth defects	Number of births	Q00-Q07	Q21	Q38	Q53	Q54	Q62	Q63
Total (n)	244 (2.9%)	8468	12 (15/10000)	24 (28/10000)	22 (26/10000)	14 (16.5/10000)	9 (10.6/10000)	9 (10.6/10000)	10 (12/10000)

Congenital malformations of the nervous system (Q00-Q07), Q21 Congenital malformations of cardiac septa, Q38 Other congenital malformations of tongue, mouth and pharynx, Q53 Undescended testicle, Q54 Hypospadias, Q62 Congenital obstructive defects of renal pelvis and congenital malformations of ureter, Q63 Other congenital malformations of kidney

Hospital number[1]	Total number of birth defects	Number of births	Q65	Q66	Q90
Total (n)	244 (2.9%)	8468	5 (6/10000)	29 (34/10000)	3 (3.5/10000)

Q65 Congenital deformities of hip, Q66 Congenital deformities of feet, Q90 Down's syndrome

Table 20. Anaesthetics/analgetics

Hospital number	Hospital name	Number of deliveries	Use of Anaesthetics /analgetics	Nitros oxide	Epidural	Spinal	Narcosis	Non-narcotic analgesic	Promidol	Other	
1	Gadzievo	298	128 (43.0)	1 (0.3)	27 (9.1)	31 (10.4)	12 (4.0)	12 (4.0)	32 (10.7)	21 (7.0)	
2	Sneznogorsk	291	68 (23.4)	1 (0.3)	0	30 (10.3)	6 (2.1)	0	26 (8.9)	5 (1.7)	
3	Kola	329	51 (15.5)	0	0	0	0	38 (11.6)	13 (4.0)	0	
4	Olenegorsk	366	136 (37.2)	0	1 (0.3)	2 (0.5)	33 (9.0)	54 (14.8)	50 (13.7)	1 (0.3)	
5	Monchegorsk	592	259 (43.8)	0	0	1 (0.2)	213 (36.0)	62 (10.5)	17 (2.9)	19 (3.2)	
6	Kovdor	185	101 (54.6)	1 (0.5)	0	0	41 (22.2)	20 (10.8)	3 (1.6)	38 (20.5)	
7	Kirovsk	445	170 (38.2)	0	0	1 (0.2)	0	76 (17.1)	99 (22.2)	3 (0.7)	
8	Apatity	592	220 (37.2)	0	1 (0.2)	10 (1.7)	33 (5.6)	106 (17.9)	34 (5.7)	77 (13.0)	
9	Kandalaksha	541	323 (59.7)	0	0	0	34 (6.3)	93 (17.2)	35 (6.5)	184 (34.0)	
10	Murmansk No 1	1741	449 (25.8)	0	110 (6.3)	4 (0.2)	30 (1.7)	308 (17.7)	3 (0.2)	4 (0.2)	
11	Murmansk No 2	1382	916 (66.3)	2 (0.1)	243 (17.6)	24 (1.7)	450 (32.6)	170 (12.3)	39 (2.8)	128 (9.3)	
12	Murmansk No 3	1280	854 (66.7)	3 (0.2)	362 (28.3)	21 (1.6)	201 (15.7)	173 (13.5)	39 (3.0)	98 (7.7)	
13	Nikel	263	115 (43.7)	3 (1.1)	28 (10.6)	18 (6.8)	6 (2.3)	33 (12.5)	19 (7.2)	12 (4.6)	
14	Zaozersk	96	55 (57.3)	0	0	4 (4.2)	7 (7.3)	15 (15.6)	35 (36.5)	1 (1.0)	
Total (n)		8401	3845*	6	772	141	1066	1160	444	590	

*Some mothers may have received more than on type of anaesthetics/analgetics

Table 21. Variables not listed elsewere

Hospital number	Hospital name	Number of deliveries	BMI for mothers[1]	BMI for children	GA at first visit to clinic[2]	Average placenta weight (g)[3]	1 min APGAR[4]	5 min APGAR	Length of hospital stay[5]		
1	Gadzievo	298	23.6	12.1	13.8	465	6.9	8.1	5.8		
2	Sneznogorsk	291	24.0	12.7	16.8	618	6.8	8.5	5.1		
3	Kola	329	23.6	12.2	15.2	483	7.4	8.6	5.4		
4	Olenegorsk	366	23.2	13.0	15.0	550	7.0	8.2	5.8		
5	Monchegorsk	592	23.4	12.3	15.1	601	7.4	8.6	6.5		
6	Kovdor	185	22.7	12.2	21.5	502	8.5	9.0	5.4		
7	Kirovsk	445	23.2	12.6	13.5	625	7.6	8.7	5.3		
8	Apatity	592	23.0	12.5	13.3	555	6.9	7.9	4.9		
9	Kandalaksha	541	23.8	12.7	14.1	629	7.2	8.4	5.8		
10	Murmansk No 1	1741	22.6	12.2	16.8	470	6.9	8.0	7.3		
11	Murmansk No 2	1382	23.4	12.3	14.7	487	6.7	7.9	7.2		
12	Murmansk No 3	1280	23.4	12.0	16.3	474	7.0	8.0	7.0		
13	Nikel	263	22.9	11.6	14.9	519	5.8	7.8	4.9		
14	Zaozersk	96	22.8	12.8	12.6	539	7.3	8.5	5.5		
Total (n)[1]		8401 (8468)	23.2	12.3	15.5	511	7.0	8.2	6.4		

[1] The weight was estimated at the first visit to delivery department in conjunction with the pregnancy, 358 or 4.2% of the women were not registered with weight or height.
[2] 1241 cases or 14.7% were removed due to the following reasons: (i) weight not estimated at the first gyneological visit, (ii) mother not sure about LMP and (iii) illogical time estimates. All estimates were done using completed weeks only.
[3] 1541 cases were not registered
[4] 51 cases missing
[5] 278 children were moved to a different hospital during the perinatal period. 128 cases had one of the dates missing.

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Appendix B

Record of all births, induced and spontaneous abortions after 12 completed weeks

A – Personal information about mother and father

1. Name of hospital

2.Birth outside of hospital
☐ At home ☐ Other
☐ During transport

3. Year (yyyy) and medical file number
_____

4. Year of last live birth (yy yy)
If date not entered → box 4.1

4.1 No date available because:
☐ No previous live births
☐ No information available

4.2 Year of last abortion (yy yy)
If date not entered → box 4.3

4.3 No date available because:
☐ No previous abortions
☐ No information available

5. Date of birth (dd mm yy)

6. Ethnicity
☐ Sámi
☐ Russian
☐ Azerbaijani
☐ Other (specify)
_____

7. Residence (Rajon)

7.1 City/town/settlement

8. Did the mother officially change address during pregnancy?
☐ No
☐ Yes (if yes from where ->)

8.1 Oblast/Rajon

8.2 City/town/settlement

9. Civil status
Married:
☐ Yes ☐ Cohabitant
☐ No ☐ Other

10. Education (completed)
☐ None
☐ Primary (class 1-9)
☐ Secondary (class 10-11)
☐Technical school
☐ Higher education

11. Mother's occupation

11.1 Mother's workplace

11.2 Mother's department in workplace

Information on father

12. Father' age

13. Father's occupation

13.1 Father's workplace

13.2 Father's department in workplace

14. Ethnicity
☐ Sámi
☐ Russian
☐ Azerbaijani
☐ Other (specify)
_____

B – About the pregnancy and mother's health

15. Week pregnant when first visit to gynaecologist in conjunction with this birth was made (ww)
_____

16. Height (in cm)

17. Weight at first gynaecological visit (in kg)
_____

18. Last menstrual period, first day of bleeding (dd mm yy)
☐ certain ☐ uncertain

19. First ultrasound carried out
☐ No
☐ Yes (date)

B1. ICD-10 Code(s)

19.1 Date of delivery predicted by ultrasound
dd mm yy

19.2 Ultrasound evidence for problem in child or mother
☐ No
☐ Yes (specify box B1)

20. Pathological findings based on amniocentesis, corioncentesis or biopsy
☐ No
☐ Yes (specify in box B2)

B2. ICD-10 Code(s)

21. Mothers previous pregnancies (not including this child)
All weeks must be completed weeks

21.1
Live births (total number) _____
Stillbirths >= week 22 _____
Live births dead within 7 days) _____

21.2
Preterm deliveries (week 22-29)____
Preterm deliveries (week 30-36)____
Caesarian section during previous deliveries _____

21.3 Spontaneous abortions
Week 13-22 ____
Week =< 12 ____

B3. Specify ICD-10 codes for medical reasons:
1._____
2._____

21.4 Induced abortions
Week =< 12 ____
Was it medical reason? ☐ No ☐ Yes

21.5 Induced abortions from
week 13_____
(fill out 21.6)

21.6
Social reasons _____
Medical reasons_____
(specify in box B3)

22 Supplements/Alcohol/ Drugs

24. Evidence of alcohol abuse
☐ No
☐ Yes

25. Evidence of drug abuse
☐ No
☐ Yes

22.1 Supplement intake before pregnancy
Multivitamins
☐ no ☐ yes
Folic acid
☐ no ☐ yes

22.2 During pregnancy
Multivitamins
☐ no ☐ yes
Folic acid
☐ no ☐ yes

23. Cigarette smoking before pregnancy
☐ No
☐ Yes, if yes how many cigarettes_____per day

23.1 Cigarette smoking during pregnancy
☐ No
☐ Yes, if yes how many cigarettes _____ per day

B6. Pharmaceutical name of medication(s)
1.Name
From date (dd mm)
2. Name
From date (dd mm)
3. Name
From date (dd mm)

26. Disease before pregnancy
☐ **Nothing particular**
☐ Chronic sex tract or urinal infection
☐ Chronic kidney infection
☐ Asthma
☐ Chronic hypertension
☐ Rheumatoid arthritis
☐ Heart disease
☐ Hep. B
☐ Hep. C
☐ Epilepsy
☐ Diabetes type 1
☐ Diabetes type 2
☐ Other (specify in box B4)

B4. Specify ICD-10 code(s) (4 digits)

27. Disease during pregnancy (including accidents)
☐ **Nothing particular**
☐ Bleeding< 13 weeks
☐ Bleeding 13-28 week
☐ Bleeding> 28 weeks
☐ Pregnancy diabetes
☐ Thrombosis
☐ Mild Pre-eclampsia
☐ Severe Pre-eclampsia
☐ Eclampsia in pregnancy
☐ HELLP-syndrom
☐ Mild Anemia
☐ Moderate Anem
☐ Hep. B
☐ Hep. C
☐ Severe Anem. ☐Hb > 135
☐ infections (B5)
☐ Threatened abortion (O.20.0)
☐ other (B5)
☐ Medications(B6)

B5. Specify ICD-10 code(s)

C – About the birth

28. Did mother pay to upgrade maternity ward
☐ No ☐ Yes

29. Presentation
☐ Occipital/ normal
☐ Breech
☐ Transverse
☐ Abnormal cephalic
☐ Other

30. Delivery type
☐ Spontaneous
☐ Induced
☐ Caesarean

31. Caesarean section
Was the section planned prior to delivery?
☐ No
☐ Yes

32. Indication for surgery and/or induction
☐ Complications as described below
☐ Congenital malformation
☐ Induced due to over term of preg.
☐ Other, specify in C1

33. Complications during delivery
☐ None
☐ Water break 12-24 hours before
☐ Water break >24 hours before
☐ Mechanical problems
☐ Shoulder dystocia
☐ Placenta previa
☐ Abruptio placenta
☐ Perineal rupture (grade 1-2)
☐ Sphincter rupture (grade 3-4)
☐ Haemorrhage 500-1000 ml
☐ Haemorrhage 1000-1500 ml
☐ Haemorrhage > 1500 ml
☐ Eclampsia in labour
☐ Threatening intrauterine asphyxia
☐ Prolaps of cord
☐ First stage reduced contractions
☐ Second stage reduced contractions
☐ Discordination
☐ Uterine hypertonia
☐ Uterine atony
☐ Other, specify C2

C1. ICD-10 Code(s)

C2. ICD-10 Code(s)

34. Anaesthesia
☐ None
☐ Nitros oxide
☐ Epidural
☐ Spinal
☐ Promidol
☐ Narcosis
☐ Non-narcotic analgesic
☐ Other, specify in C3

35. Placenta
☐ Normal
Weight (grams) _____
☐ Placental infarction
☐ Retro placental haematoma
☐ Infection
☐ Fetoplacental insufficiency
☐ Other, specify in C4

C3. Name of medication

36. Umbilical cord
☐ Normal
☐ Velamentous attachment
☐ Peripheral attachment
☐ Vessel anomalies
☐ Neck loop
☐ Other loops
☐ Real cord knot
36.1 Length of umbilical cord (in cm)

C4. ICD-10 Code(s)

37. Amniotic fluid
☐ Normal
☐ Polyhydramnios
☐ Oligohydramnios
☐ Discoloration (dirty)
☐ Mekonial fluid
☐ Haemorrhagic
☐ Infected

38. Post delivery maternal complications
☐ Nothing particular
☐ Fever > 38.5 C
☐ Sepsis
☐ Thrombosis
☐ Eclampsia in the puerperium
☐ Intensive care
☐ Other C5
☐ Mother was transferred to other hospital (name):
_____

C5. ICD-10 Code(s)

D-About the child

39. Date of birth (dd mm yy)

40. Time of birth (hh mm)

41. Multiple delivery
If multiple delivery:
No. ___ of total___

42. Sex
☐ Male
☐ Female
☐ Undetermined

43. Infant's weight (in grams)
0

44. Total length (in cm)

45. Head circumference (in cm)

46. Apgar score
1 min.
5 min.

47. The child was:
☐ Live born
☐ Stillborn (47.1)
☐ Miscarriage
Confirm cause of death in D1

47.1 For stillborn:
☐ Dead before start of delivery
☐ Dead during delivery
☐ Time of death unknown

48. Live birth,dead within 24 hours
Time (hh mm):

49. Child died at a later date:
Date (dd mm)____ ___
Time (hh mm) ____ ____

50. Did the child die in the hospital?
☐ Yes
☐ No

D1. ICD-10 Code(s)

51. Neonatal diagnosis
☐ Nothing particular
☐ Hypoglyc. (<50 mg/dL)
☐ Cong.anaemia (hb<13.5)
☐ Hip joint dysplasia
☐ Transit. Tachypnoe
☐ Resp. distress syndrome
☐ Aspiration-syndrome
☐ Intracranial haemorrhage
☐ Cerebral irritability
☐ Cerebral depression
☐ Abstinence
☐ Conjunctivities
☐ Neonatal cramps
☐ Navel/skin infection
☐ Other infections (D2)
☐ Perinatal infections specify in D3
☐ Other, specify in (D3)

D2. ICD 10 Code(s)

☐ Fracture claviculae
☐ Extremety fracture
☐ Facialis paresis
☐ Plexus damage
☐ Other, incl. injuries (D4)

52. Treatment codes:
☐ Syst.antibiotics
☐ Respirator treatment
☐ Physiological
☐ Dripping of eyes

Icterus treated:
☐ UV-light treatment
☐ Transfusion of blood

Cause:
☐ ABO incompatible
☐ RH immunisation

D3. ICD 10 Code(s)

53. Birth defects
☐ Yes ☐ No

Specification of injuries, neonatal diagnosis and birth defects
ICD-10 Code Other:

ICD-10 Code

D4. ICD 10 Code(s)

54. Discharge dates

Mother discharged

Child discharged

Child Transferred (date and location)

Repeat year and mothers medical file number from box 3.

ISM SKRIFTSERIE - FØR UTGITT:

1. Bidrag til belysning av medisinske og sosiale forhold i Finnmark fylke, med særlig vekt på forholdene blant finskættede i Sør-Varanger kommune.
Av Anders Forsdahl, 1976. (nytt opplag 1990)

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Av Anders Forsdahl, 1977.

3. Hjerte-karundersøkelsen i Finnmark - et eksempel på en populasjonsundersøkelse rettet mot cardiovasculære sykdommer. Beskrivelse og analyse av etterundersøkelsesgruppen.
Av Jan-Ivar Kvamme og Trond Haider, 1979.

4. D. The Tromsø Heart Study: Population studies of coronary risk factors with special emphasis on high density lipoprotein and the family occurrence of myocardial infarction.
Av Olav Helge Førde og Dag Steinar Thelle, 1979.

5. D. Reformer i distriktshelsetjenesten III: Hypertensjon i distriktshelsetjenesten.
Av Jan-Ivar Kvamme, 1980.

6. Til professor Knut Westlund på hans 60-års dag, 1983.

7.* Blodtrykksovervåkning og blodtrykksmåling.
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8.* Merkesteiner i norsk medisin reist av allmennpraktikere - og enkelte utdrag av medisinalberetninger av kulturhistorisk verdi.
Av Anders Forsdahl, 1984.

9. "Balsfjordsystemet." EDB-basert journal, arkiv og statistikksystem for primærhelsetjenesten.
Av Toralf Hasvold, 1984.

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Av Georg Høyer, 1986.

11. D. The use of self-administered questionnaires about food habits. Relationships with risk factors for coronary heart disease and associations between coffee drinking and mortality and cancer incidence.
Av Bjarne Koster Jacobsen, 1988.

12.* Helse og ulikhet. Vi trenger et handlingsprogram for Finnmark.
Av Anders Forsdahl, Atle Svendal, Aslak Syse og Dag Thelle, 1989.

13. D. Health education and self-care in dentistry - surveys and interventions.
Av Anne Johanne Søgaard, 1989.

14. Helsekontroller i praksis. Erfaringer fra prosjektet helsekontroller i Troms 1983-1985.
Av Harald Siem og Arild Johansen, 1989.

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16. D. Diagnosis of cancer in general practice. A study of delay problems and warning signals of cancer, with implications for public cancer information and for cancer diagnostic strategies in general practice.
Av Knut Holtedahl, 1991.

17. D. The Tromsø Survey. The family intervention study. Feasibility of using a family approach to intervention on coronary heart disease. The effect of lifestyle intervention of coronary risk factors.
Av Synnøve Fønnebø Knutsen, 1991.

18. Helhetsforståelse og kommunikasjon. Filosofi for klinikere.
Av Åge Wifstad, 1991.

19. D. Factors affecting self-evaluated general health status - and the use of professional health care services.
Av Knut Fylkesnes, 1991.

20. D. Serum gamma-glutamyltransferase: Population determinants and diagnostic characteristics in relation to intervention on risk drinkers.
Av Odd Nilssen, 1992.

21. D. The Healthy Faith. Pregnancy outcome, risk of disease, cancer morbidity and mortality in Norwegian Seventh-Day-Adventists.
Av Vinjar Fønnebø, 1992.

22. D. Aspects of breast and cervical cancer screening.
Av Inger Torhild Gram, 1992.

23. D. Population studies on dyspepsia and peptic ulcer disease: Occurrence, aetiology, and diagnosis. From The Tromsø Heart Study and The Sørreisa Gastrointestinal Disorder Studie.
Av Roar Johnsen, 1992.

24. D. Diagnosis of pneumonia in adults in general practice.
Av Hasse Melbye, 1992.

25. D. Relationship between hemodynamics and blood lipids in population surveys, and effects of n-3 fatty acids.
Av Kaare Bønaa, 1992.

26. D. Risk factors for, and 13-year mortality from cardiovascular disease by socioeconomic status. A study of 44690 men and 17540 women, ages 40-49. **Av Hanne Thürmer, 1993.**

27. Utdrag av medisinalberetninger fra Sulitjelma 1891-1990. **Av Anders Forsdahl, 1993.**

28. Helse, livsstil og levekår i Finnmark. Resultater fra Hjerte-karundersøkelsen i 1987-88. Finnmark III. **Av Knut Westlund og Anne Johanne Søgaard, 1993.**

29. D. Patterns and predictors of drug use. A pharmacoepidemiologic study, linking the analgesic drug prescriptions to a population health survey in Tromsø, Norway. **Av Anne Elise Eggen, 1994.**

30. D. ECG in health and disease. ECG findings in relation to CHD risk factors, constitutional variables and 16-year mortality in 2990 asymptomatic Oslo men aged 40-49 years in 1972. **Av Per G. Lund-Larsen, 1994.**

31. D. Arrhythmia, electrocardiographic signs, and physical activity in relation to coronary heart risk factors and disease. The Tromsø Study. **Av Maja-Lisa Løchen, 1995.**

32. D. The Military service: mental distress and changes in health behaviours among Norwegian army conscript. **Av Edvin Schei, 1995.**

33. D. The Harstad injury prevention study: Hospital-based injury recording and community-based intervention. **Av Børge Ytterstad, 1995.**

34.* D. Vilkår for begrepsdannelse og praksis i psykiatri. En filosofisk undersøkelse. **Av Åge Wifstad, 1996.** (utgitt Tano Aschehoug forlag 1997)

35. Dialog og refleksjon. Festskrift til professor Tom Andersen på hans 60-års dag, 1996.

36. D. Factors affecting doctors´ decision making. **Av Ivar Sønbø Kristiansen, 1996.**

37. D. The Sørreisa gastrointestinal disorder study. Dyspepsia, peptic ulcer and endoscopic findings in a population. **Av Bjørn Bernersen, 1996.**

38. D. Headache and neck or shoulder pain. An analysis of musculoskeletal problems in three comprehensive population studies in Northern Norway. **Av Toralf Hasvold, 1996.**

39. Senfølger av kjernefysiske prøvespreninger på øygruppen Novaya Semlya i perioden 1955 til 1962. Rapport etter programmet "Liv". Arkangelsk 1994.
Av A.V. Tkatchev, L.K. Dobrodeeva, A.I. Isaev, T.S. Podjakova, 1996.

40. Helse og livskvalitet på 78 grader nord. Rapport fra en befolkningsstudie på Svalbard høsten 1988. **Av Helge Schirmer, Georg Høyer, Odd Nilssen, Tormod Brenn og Siri Steine, 1997.**

41.* D. Physical activity and risk of cancer. A population based cohort study including prostate, testicular, colorectal, lung and breast cancer.
Av Inger Thune, 1997.

42. The Norwegian - Russian Health Study 1994/95. A cross-sectional study of pollution and health in the border area.
Av Tone Smith-Sivertsen, Valeri Tchachtchine, Eiliv Lund, Tor Norseth, Vladimir Bykov, 1997.

43. D. Use of alternative medicine by Norwegian cancer patients
Av Terje Risberg, 1998.

44 D. Incidence of and risk factors for myocardial infarction, stroke, and diabetes mellitus in a general population. The Finnmark Study 1974-1989.
Av Inger Njølstad, 1998.

45. D. General practitioner hospitals: Use and usefulness. A study from Finnmark County in North Norway.
Av Ivar Aaraas, 1998.

45B Sykestuer i Finnmark. En studie av bruk og nytteverdi.
Av Ivar Aaraas, 1998.

46. D. No går det på helsa laus. Helse, sykdom og risiko for sykdom i to nord-norske kystsamfunn.
Av Jorid Andersen, 1998.

47. D. The Tromsø Study: Risk factors for non-vertebral fractures in a middle-aged population.
Av Ragnar Martin Joakimsen, 1999.

48. D. The potential for reducing inappropriate hospital admissions: A study of health benefits and costs in a department of internal medicine.
Av Bjørn Odvar Eriksen, 1999.

49. D. Echocardiographic screening in a general population. Normal distribution of echocardiographic measurements and their relation to cardiovascular risk factors and disease. The Tromsø Study.
Av **Henrik Schirmer, 2000.**

50. D. Environmental and occupational exposure, life-style factors and pregnancy outcome in artic and subartic populations of Norway and Russia.
Av Jon Øyvind Odland, 2000.

50B Окружающая и профессиональная экспозиция, факторы стиля жизни и исход беременности у населения арктической и субарктической частей Норвегии и России
Юн Ойвин Удлан 2000

51. D. A population based study on coronary heart disease in families. The Finnmark Study 1974-1989.
Av Tormod Brenn, 2000.

52 D. Ultrasound assessed carotid atherosclerosis in a general population. The Tromsø Study.
Av Oddmund Joakimsen, 2000.

53. D. Risk factors for carotid intima-media thickness in a general population. The Tromsø Study 1979-1994.
Av Eva Stensland-Bugge, 2000.

54. D. The South Asian cataract management study.
Av Torkel Snellingen, 2000.

55. D. Air pollution and health in the Norwegian-Russian border area.
Av Tone Smith-Sivertsen, 2000.

56. D. Interpretation of forearm bone mineral density. The Tromsø Study.
Av Gro K. Rosvold Berntsen, 2000.

57. D. Individual fatty acids and cardiovascular risk factors.
Av Sameline Grimsgaard, 2001.

58. Finnmarkundersøkelsene
Av Anders Forsdahl, Fylkesnes K, Hermansen R, Lund E, Lupton B, Selmer R, Straume E, 2001.

59. D. Dietary data in the Norwegian women and cancer study. Validation and analyses of health related aspects.
Av Anette Hjartåker, 2001.

60. D. The stenotic carotid artery plaque. Prevalence, risk factors and relations to clinical disease. The Tromsø Study.
Av Ellisiv B. Mathiesen, 2001.

61. D. Studies in perinatal care from a sparsely populated area.
Av Jan Holt, 2001.

62. D. Fragile bones in patients with stroke? Bone mineral density in acute stroke patients and changes during one year of follow up.
Av Lone Jørgensen, 2001.

63. D. Psychiatric morbidity and mortality in northern Norway in the era of deinstitutionalisation. A psyhiatric case register study.
Av Vidje Hansen, 2001.

64. D. Ill health in two contrasting countries.
Av Tom Andersen, 1978/2002.

65. D. Longitudinal analyses of cardiovascular risk factors.
Av Tom Wilsgaard, 2002.

66. Helseundersøkelsen i Arkangelsk 2000.
Av Odd Nilssen, Alexei Kalinin, Tormod Brenn, Maria Averina et al.,2003.

67. D. Bio-psycho-social aspects of severe multiple trauma.
Av Audny G. W. Anke, 2003.

68. D. Persistent organic pollutants in human plasma from inhabitants of the artic.
Av Torkjel Manning Sandanger, 2003.

69. D. Aspects of women's health in relation to use of hormonal contraceptives and pattern of child bearing.
Av Merethe Kunmle, 2003.

70. Pasienterfaringer i primærlegetjenesten før og etter fastlegereformen.
Av Olaug Lian, 2003.

71. D. Vitamin D security in northern Norway in relation to marine food traditions.
Av Magritt Brustad, 2004.

72. D. Intervensjonsstudien i Finnmark. Evaluering av lokalsamfunns basert hjerte- og kar forebygging i kystkommunene Båtsfjord og Nordkapp.
Av Beate Lupton, 2004.

73. D. Environmental factors, metabolic profile, hormones and breast and endiometrial cancer risk.
Av Anne-Sofie Furberg, 2004.

74. D. Det skapende mellomrommet i møtet mellom pasient og lege.
Av Eli Berg, 2004.

75. Kreftregisteret i Arkhangelsk oblast i nordvest Russland. Med en sammenligning av kreftforekomst i Arkhangelsk oblast og Norge 1993 – 2001.
Av Vaktskjold Arild, Lebedintseva Jelena, Korotov Dmitrij, Tkatsjov Anatolij, Podjakova Tatjana, Lund Eiliv, 2004

76. D. Characteristics and prognosis of long-term stroke survivors. The Tromsø Study.
Av Torgeir Engstad, 2004

77. D. Withdrawal and exclusion. A study of the spoken word as means of understanding schizophrenic patients.
Av Geir Fagerjord Lorem, 2005.

78. ”Søkelys på safunnsmedisinene.” Evaluering av kommunal samfunnsmedisinsk legetjeneste, offentlig legearbeid og de forebyggende oppgaver i Fastlegeordningen.
Av Betty Pettersen og Roar Johnsen, 2005.

79. **Prosjekt egenmelding Kristiansand kommune.** Evaluering av kontrollert intervensjonsforsøk i stor skala, med utvidet rett til egenmelding i kombinasjon med økt og formalisert samhandling mellom arbeidstaker og arbeidsplassen ved sykefravær.
Av Nils Fleten og Roar Johnsen, 2005.

80. D. Abdominal aortic aneurysms:Diagnosis and epidemiology. The Tromsø study.
Av Kulbir Singh, 2005.

81. D. A population based study on cardiovascular diseases in Northwest Russia.The Arkhangelsk study 2000.
Av Maria Averina, 2005.

82. D. Exposure to exogenous hormones in women: risk factors for breast cancer and molecular signature.
Av Vanessa Dumeaux, 2005.

83. D. Repeated ultrasound measurements of carotid artery plaques in a general population. The Tromsø Study 1994-2001.
Av Stein Harald Johnsen, 2005.

84. D. Risk Factors For Fractures In Tromsø. The Tromsø Study.
Av Luai Awad Ahmed, 2005.

85. D. The quality and use of two health registries in Russia. The Arkhangelsk Cancer Registry and the Kola Birth Registry
Качество и использование двух медицинских регистров в России. Архангельск регистр рака и Кольский регистр родов
Av Arild Vaktskjold, 2005.

86. D. Haemoglobin, anaemia and haematological malignancies.
Av Tove Skjelbakken, 2006

De som er merket med D er doktorgradsarbeid.
De som er merket med * har vi dessverre ikke flere eksemplar av.

87. D. The sick-listed – an under-recognised resource in handling sickness absence.
Av Nils Fleten, 2006.

88. D. Longitudinal changes in forearm bone mineral density in women and men from 25 to 84 years.
The Tromsø Study.
Av Nina Emaus, 2006.

89. D. Asthma and allergy in children. An epidemiological study of asthma and allergy in schoolchildren living in Northern Norway and Russia with respect to prevalence trends 1985-1995-2000, geographic differences in prevalence and biomarkers.
By Anders Selnes, 2006.

90. D. "Nå ska du høre ka æ mene med arv." Samisk forståelse av arv som en utfordring i medisinsk genetikk.
Av Valeria Marton, 2006 –
Senter for Samisk Helseforskning

91. D. Sex steroids, bone loss and non-vertebral fractures in women and men.The Tromsø Study.
By Åshild Bjørnerem, 2007.

92. D. Substance use behaviour among ethnic diverse young people in North Norway in the 1990s.
"The North Norwegian Youth Study": A cross-cultural longitudinal study comparing smoking and drinking rates and patterns among young indigenous Sami and non-indigenous peers
Av Anna Rita Spein, 2007.
Senter for Samisk Helseforskning

93. D. Infection, inflammation and atherosclerosis.
Av Dag S. Halvorsen, 2007.

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