Nordic Council of Ministers

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Contents

Summary

Human biomonitoring (HBM) provides a powerful tool in risk and benefit assessment and policy making both for food safety and nutrition. HBM integrates exposure from all sources, can be used to demonstrate trends, to identify vulnerable groups and emerging risks. Limitations are e.g. that HBM does not provide any information on the source of exposure or how long a chemical has been in the body. There is a need to develop HBM to increase its usefulness in policy making.

This report maps HBM studies performed at or initiated by food safety authorities in the Nordic countries and discuss problems and options for further work. Traditionally authorities in the Nordic countries have not been using HBM in their work. The report shows that only few studies have been performed and it differs among the countries. There might be several reasons for this e.g. sampling blood and urine is demanding, there are ethical and privacy issues and analytical costs are high. Also, studies performed at other institutions can be used by the national authorities but such studies are not included in this report. One way forward is cooperation – with researchers and between authorities in different countries. Furthermore, food safety authorities have special responsibilities in cases of emergencies and disasters. In these cases HBM provides a good tool for exposure measurement but cooperation and infrastructure for sampling and handling of samples must be established beforehand.

1. Introduction

Human biomonitoring (HBM) can be defined as the systematic standardized measurement of a concentration of a substance or its metabolites in human tissues (such as blood, urine or milk) and is an important tool in evaluating exposure to chemicals (contaminants and nutrients) in the general population or in specific subgroups (Angerer, Ewers, & Wilhelm, 2007).

In May 2014 a seminar on the topic of "Human biomonitoring as a tool in policy making towards consumer safety" (Lagerqvist et al., 2015) was organized by the Swedish National Food Agency (NFA) in collaboration with the Norwegian Food Safety Authority, the Norwegian Institute of Public Health, the Unit for Nutrition Research at the University of Iceland, and Karolinska Institute, Sweden. The seminar was directed towards professionals involved in HBM programs, both at universities and authorities. It was agreed that HBM provides a powerful tool in policy making towards consumer safety. It was also concluded that there is interest among the attendants to develop the Nordic collaborative efforts within the area of HBM and that there would, unquestionably, be benefits from harmonization of this field. Also, the Nordic countries have long experience of collaboration on food safety, dietary surveys and nutrition recommendations.

In 2015 the Europeans Food Safety Authority (EFSA) published a comprehensive report on HBM (Choi, Mörck, Polcher, Knudsen, & Joas, 2015) focusing on its application towards chemical risk assessment, particularly in relation to food safety and pointed out work that needs to be done to improve the usability of human biomonitoring. One of the conclusions from EFSA is that HBM is the only available tool that integrates exposure from all sources. Furthermore HBM can demonstrate trends, establish distribution of exposure and identify vulnerable groups and populations with high exposure and emerging chemical risks. However, there are limitations e.g. HBM does not provide information about the source of exposure or how long a chemical has been in the body and there are ethical and privacy issues to consider since it involves human samples.

The aims of this report was to map human biomonitoring projects performed at the governmental authorities in the Nordic countries and to discuss problems and options to further develop the field of HBM.

2. Background

EFSA emphasize in their report the need for development of HBM and gives several important areas to develop e.g. health based guidance values, validated analytical methods, the inclusion of dietary data in studies to improve knowledge on exposure source, expanding monitoring to highly exposed and vulnerable groups (Choi et al., 2015).

There are several methods developed to analyse different contaminants and nutrients, e.g. vitamins, fats, heavy metals, PCB, and dioxins in blood and urine. But, some analysis of biomarkers is restricted to certain research laboratories, two examples are: a) the genotoxic effect is measured, and b) reactive chemicals bounded to certain proteins, i.e. haemoglobin adducts are measured. One of the most established short term tests for genotoxicity is the micronucleus (MN) assay (Abramsson-Zetterberg, 2003; Abramsson-Zetterberg, Vikström, Törnqvist, & Hellenäs, 2008). Electrophilic compounds/metabolites are often genotoxic and most of them are too short-lived in vivo to be possible to measure as the free compound. Therefore methods to measure their stable reaction products (adducts) with bio macromolecules have been developed. Measurement of adducts to haemoglobin and serum albumin in blood has been applied for studies of specific chemical exposures, e.g. in occupational settings (Rubino, Pitton, Di Fabio, & Colombi, 2009; Törnqvist et al., 2002). The best known example is the identification of acrylamide originating from heat-processing of food, a finding that has given rise to a large number of follow-up studies in a range of research fields (Tareke, Rydberg, Karlsson, Eriksson, & Törnqvist, 2002).

Metabolites of nutrient in plasma, blood or urine may be used as biomarkers for nutrient intake. Blood and urine are easy to collect, but the variability may be large. Different forms of the nutrient may have different times for turnover, be subject to homeostasis or be influenced by other factors than nutrient intake. Functional biomarkers such as hormone levels may be used as biomarkers for nutrient intake, but is usually influenced by several nutrients and/or other factors than diet. Sometimes indicators are used, for example carotenoids as a marker for fruit and vegetable intake. Biomarkers can be used to validate methods for assessing dietary intake. Biomarkers may be a more objective assessment than dietary methods; at least the errors are independent in the two types of assessment. In order to evaluate nutritional status, reference values and defined cut-off points for the population in question are necessary (Elmadfa & Meyer, 2014; Prentice, Sugar, Wang, Neuhouser, & Patterson, 2002). Also factors, other than food intake, could skew biomarker measures. Such factors include genetic variability, lifestyle/physiologic factors (e.g. smoking), dietary factors (e.g. nutrient-nutrient interaction) biological sample and analytical method (Hedrick et al.).

Metabolomics is an emerging field in human nutrition. The "Food metabolome" has been defined as the sum of all metabolites directly derived from the digestion of foods, their absorption in the gut, and biotransformation by host tissues and the mikrobiota (Scalbert et al., 2014). Metabolomics can be used to as biomarker for specific foods (Scalbert et al., 2014) or also for dietary patterns (O'Gorman & Brennan, 2015) by identifying molecules that vary between patterns.

3. Methods

In the spring of 2015 a letter and a template for reporting HBM surveillance programmes or other studies including HBM in the Nordic countries was sent out to all national food authorities, see Appendix 1 and 2. We limited the reporting to only include 1) studies performed by, or initiated and paid by, national governmental authority, and 2) studies with detailed dietary data, i.e. short questionnaires were not accepted. The working group at NFA selected the studies fulfilling these criteria from the information sent from the other countries. Research projects at universities are not included because the focus might differ from the needs of authorities and in addition mapping all projects at universities in the Nordic counties is a time-consuming task and not possible to solve within this project.

4. Country reports

4.1 Denmark

The Danish Veterinary and Food Administration (DVFA) is located in Copenhagen and is one out of four agencies belonging to the Ministry of Food, Agriculture and Fisheries. The agency is responsible for risk management in the field of food and feed safety. The DVFA coordinates governmental food and feed inspections. Risk assessments are separated from DCFA and are made at the National Food Institute and at the Technical University of Denmark. To our knowledge, no biomonitoring studies have been performed by the DVFA.

4.2 Finland

In 2009 The National Public Health Institute of Finland (KTL) was merged with STAKES, the National Research and Development Centre for Welfare and Health, to form a new research and development institute, the National Institute for Health and Welfare (THL). Finnish Food Safety Authority, Evira, is responsible for ensuring food safety.

In Finland, KTL/THL has performed several large population based cross-sectional studies with human biomonitoring. The studies include monitoring of nutritional status and levels of compounds with potential adverse effects. The studies have made it possible to analyse trends in the population and to monitor public health interventions.

4.2.1 FINRISK

FINRISK is a large Finnish population survey on risk factors for chronic, non-communicable diseases, see appendix 3A. The survey has been carried out since 1972, every fifth year using independent samples, representative of the adult population in different areas of Finland. Each cross-sectional survey contains at least 250 subjects of each sex- and 10-year age group (25–74 years of age) from each area. The cohort sizes are 6,000–8,800 per survey.

Participants are clinically screened for environmental risk factors for cardiovascular disease. Background information on socioeconomic status, medical history, diet, exercise and anthropometric measures was collected by questionnaires and during a clinical visit. Detailed dietary assessment (48 hour-recall) has been performed for a subset of participants, for example about 1,600 in 2007 referred to as the FINDIET studies. Laboratory tests on a wide range of agents were carried out from serum and plasma samples. The cohorts are routinely linked to registry data. The Chronic Disease Prevention Unit at THL plans, implements and coordinates data analyses and reporting.

Next study is planned to take place in 2017.

4.2.2 Health 2000

The focus of Health 2000 was the major public health problems and their determinants as well as need for care and rehabilitation, see appendix 3B. The cross-sectional sample included 10,000 adults from 80 areas of Finland. Participants were visited in their homes for interviews. Of the persons aged 30 and over, 89% participated in the home interview and 85% in the clinical examination. Of the young adults (18–29) 80% were interviewed.

Samples of whole blood, serum, lithium heparin plasma and a spot urine sample were collected from all subjects. Faeces and saliva samples were obtained from a subsample of subjects.

Sub-populations were invited to attend in-depth studies where the methods were interviews, questionnaires, and clinical examinations. Laboratory tests of various nutrients, environmental contaminants and risk factors for disease were performed in blood, serum and urine. A semi-quantitative FFQ of 125 food items, mixed dishes and alcoholic beverages was used to estimate dietary intake. The National Public Health Institute of Finland (KTL) coordinated the study.

The Health 2011 survey included a new random sample of persons aged 18–28. Also, all persons who had been included in the representative sample of the Health 2000 survey were invited.

4.2.3 DILGOM

The focus of the DILGOM (DIetary, Lifestyle and Genetic factors on the development of Obesity and Metabolic syndrome) studies was to collect information on impact of lifestyle (including diet), psychosocial and socioeconomic factors, metabolism, exposure to environmental pollutants and genomics and their impact on the development of obesity and the metabolic syndrome.

The DILGOM study is a cross-sectional study of including Finnish participants aged 25–74 years. The study population consists of 5,024 men and women. The study measured anthropometrics, drew blood, and assessed concentrations of leptin, high-molecular-weight adiponectin, tumour necrosis factor α, interleukin 6, and high-sensitivity C-reactive protein (hs-CRP). A food frequency questionnaire was used to measure dietary intake over the past year.

The aims are to provide scientifically novel and clinically relevant information in five main areas:

1. Lifestyles: Impact of dietary factors, smoking, and physical activity;
2. Psychosocial: Effect of psychosocial factors on changes in proximal risk factors and the moderating role of socioeconomic position on their associations with weight gain;
3. Metabolism: Predictive value of inflammatory markers, dietary glycaemic load, and their interactions with diet, exercise and genetic factors on the development of obesity and metabolic syndrome;
4. Exposure to environmental pollutants: The role of chemicals with metabolic disrupting potential and their interactions with diet and lifestyle factors on the development of obesity and metabolic syndrome; and
5. Genomics: The role of genetic and genomic factors and their interactions with dietary, behavioural, psychosocial and metabolic factors in the development of obesity and metabolic syndrome in a large population based sample.

4.3 Iceland

The Islandic equivalent to Food Agency is "Matvælastofnun", which is a part of The Icelandic Food and Veterinary Authority, referred to as MAST. MAST is located in a village, Selfoss, about 60 kilometers from Reykjavik. The agency is responsible for food safety, fish and fish products, agriculture, and other food products. In collaboration with "Helsedirektoratet" and Island University, they perform dietary surveys. To our knowledge, no biomonitoring studies have been performed by the Food Agency.

4.4 Norway

Risk assessments are conducted by the Norwegian Scientific Committee for Food Safety (VKM) which carries out independent risk assessments for the Norwegian Food Safety Authority (Mattilsynet) and the Norwegian Environment Agency (Miljødirektoratet). The Scientific Panels comprise about 120 independent experts with broad interdisciplinary competence.

Risk management and risk-based inspections are performed by the Norwegian Food Safety Authority (Mattilsynet) working under three ministries (Ministry of Agriculture and Food, Ministry of Trade, Industry and Fisheries, Ministry of Health and Care services) with shared responsibility for shaping food policy and the management of foodstuffs from production to the consumer.

4.4.1 *Norwegian Fish and Game Study (Fisk- og viltundersøkelsen)*

The Norwegian Institute of Public Health has estimated the consumption of foods containing environmental pollutants, see appendix 4A.

The study has three parts:

- Part A. Participants answered a Food Frequency Questionnaire (FFQ) focused on foods that contribute to exposure of mercury, cadmium and PCBs/dioxins. A total of 6,015 (60% response rate) individuals drawn at random from the total population database filled in the questionnaire;
- Part B. This study was targeted at high consumers of foods with potentially high levels of heavy metals and POPs e.g. coastal areas with easy access to fish and

inland communities with access to game. As in part A, 10 000 people were invited to participate in our study. This time the response rate was 55% (n = 5,400). The FFQ was slightly enlarged; and

- Part C was an in-depth study of a sub-population of the high consumers participating in part B. Information on food habits were collected and blood was drawn for the analyses of a wide range of compounds.

4.4.2 Norwegian lead and game study (Hjortevilt- og blyrisikoundersøkelsen)

In 2012 The Norwegian Institute of Public Health performed a study on the association between lead-shot cervid meat and lead concentration in blood, see appendix 4B. Of the 147 participants, 103 were recruited through hunting teams and 44 participants were recruited in-house at the institute to ensure a wide range of exposure to lead shot cervid meat.

The participants filled in questionnaires on consumption of game, alcoholic beverages and hunting habits as well as background information. Blood samples were drawn for analyses of lead, vitamin D and iron.

The study showed that high consumption of cervid meat, especially minced cervid meat, was associated with higher concentrations of lead in blood. Other factors that contributed to the variation in lead in blood were: age, sex, smoking, self-production of lead bullets, number of bullets shoot, years of game consumption and wine drinking. Vitamin D status or iron status did not contribute to the explanation of variation in lead in blood in this study. The authors discuss possible explanations for these findings.

4.5 Sweden

In Sweden the National Food Agency (NFA) under the Minister for Rural Affairs at the Ministry of Enterprise and Innovation is responsible for food safety and nutrition including both risk-benefit assessment and risk/benefit management. NFA has carried out several HBM studies. Support from mainly the Swedish Environmental Protection Agency and the Swedish Civil Contingencies Agency have made collection of biological samples and laboratory analyses possible.

4.5.1 POPUP (Persistent Organic Pollutants in Uppsala Primiparas)

The POPUP study was started to improve the collection of data for risk assessments of POPs in food, see appendix 5A. It is a cohort of first-time mothers recruited in Uppsala County from 1996 and onwards. The study is still ongoing. During the first part of the study (1996–1999) a total of 325 women donated blood samples in early and late pregnancy and 211 women donated breast milk and hair after delivery. In addition, blood samples were taken from 160 infants at 3 weeks and 138 infants at 3 months after delivery.

During the second part of the study (2000 and ongoing) 30 first-time mothers have been randomly recruited (after delivery) every 1–2 years. A total of 330 women have been recruited in 2000–2014 and they have donated breast milk, blood, hair and urine (from 2009) 3 weeks after delivery. Information on lifestyle and diet (consumption of fish and other foods of animal origin) has been gathered from all participants by in-person interviews and self-administered questionnaires. The study is coordinated by the NFA with support from the Swedish Environmental Protection Agency.

4.5.2 Riksmaten adults 2010–11 (Riksmaten vuxna 2010–11)

The Riksmaten 2010–11 survey, carried out between May 2010 and July 2011, is the latest national dietary survey in adults in Sweden, see appendix 5B. A total of 5,000 men and women between the age of 18 and 80 years were randomly selected from Swedish' national population register. All participants recorded food and drinks for four consecutive days in a web-based food record and completed a questionnaire on lifestyle, weight, height, socio-economy and frequencies of some key foods. A sub-sample group of 1,000 individuals were randomly selected to provide blood and urine samples. Approximately 300 out of the 1,000 participants in the sub-sample group provided blood and urine samples. Heavy metals, organic contaminants, ftalates, mycotoxins and nutrition biomarkers have been analysed. The biological sample collection was carried out by Occupational and Environmental Medicine clinics in Sweden and the sample collection, the chemical analyses and the scientific writing was partly supported by the Swedish Environmental Protection Agency.

4.5.3 *The School Children Study (Skolbarnsstudien)*

In case of emergencies and disasters it is important to be able to identify potential subgroups at risk of being exposed to unwanted substances. The School children study was therefore carried out as an exercise to develop protocols and to test the organisation and methods to collect blood and urine in Swedish school children, see appendix 5C. Children in grade 5 (11–12 years old) were recruited in Swedish schools from the six different regions (Linköping, Lund, Stockholm, Umeå, Uppsala, and Örebro) during February–May 2014. The school children provided blood and urine samples and height and weight were measured. The children also recorded all food and drinks for four days in the same web application as in the Riksmaten 2010–11 survey and they completed a questionnaire on lifestyle, living conditions and frequencies of irregularly consumed foods. Blood and urine are available from 234 children. The participation rate was 50% and blood and urine are available from 234 children. The study was supported by the Swedish Civil Contingencies Agency.

4.5.4 *The Hunter Study (Jägarstudien)*

The aim of the Hunter Study was to assess exposure to lead in hunters and their families. Participants were recruited by advertisements in a hunting journal during the spring 2013.

Families were eligible for participation if they lived in one of five Swedish cities and at least one family member was an active hunter. Furthermore at least one the family members should consume game at least twice per week. Underweight and obese subjects were excluded from the study. Participants should be between 18–65 years old, children could participate voluntary.

Participants provided blood and urine samples and completed a questionnaires with questions on consumption of alcohol, vegetables and fruits. The participants also completed detailed questions on game meat consumption. In total 213 participants from 74 families were included in the study. Results from study were compared with the results of the 273 participants providing blood and urine in the Riksmaten 2010–11 survey study. The results showed that among adults there was a correlation between high intake of game meat and the lead levels in blood. However the correlation was not strictly dose related. The participating children did not have any higher lead levels in blood than a corresponding control group. The study was supported by the Swedish Civil Contingencies Agency.

4.5.5 Riksmaten adolescents (Riksmaten ungdom)

The aim of the Riksmaten adolescents survey is to collect national information on Swedish adolescents' food habits. Recruitment took place in schools selected to provide a nationally representative sample of 3,000 adolescents, evenly divided by age group (grade 5 [11–12 years old], grade 8 [14–15 years old], and second year at gymnasium [17–18 years old] and sex. Height and weight was measured and the adolescents wore accelerometers for seven days to measure physical activity level. Diet was recorded in the newly developed web-based 24 h recall application RiksmatenFlex. The participants reported food intake three days, the day before the examination day, the examination day and one day 2–7 days later. In addition the adolescents were asked to complete on-line questionnaires on demographics, health, dietary supplements and frequencies of foods unfrequently eaten and not captured in the 24 h web-recall. A sub-sample of 1,105 adolescents donated blood (not fasting blood samples) and spot urine for chemical analyses of heavy metals, organic contaminants, mycotoxins, pesticides and nutrition biomarkers.

The study was carried out over one school year in 2016 and 2017.

A pilot study to test the study protocol was carried out in the autumn of 2015. The RiksmatenFlex-method has been validated against 24 h recall interviews and the biomarkers carotenoids (fruit-vegetables), fatty acids (fish and milk) and alkylresorcinol (wholegrain) within the pilot study.

5. Discussion

In May 2014 a seminar with the topic "Human biomonitoring as a tool in policy making towards consumer safety" was held in Stockholm. The conclusion was that HBM provides a powerful tool in policy making both within food safety and nutrition (Lagerqvist et al., 2015). Traditionally authorities in the Nordic countries have not been using HBM in this work and the seminar was also a start of collaboration and harmonization. This report shows that only a few HBM studies are performed through the initiatives of authorities and there are differences between the Nordic countries. There might be several reasons for this e.g. sampling blood and urine is demanding, there are ethical and privacy issues and analytical costs are high.

The needs for authorities might differ from that of researchers. Authorities need to define exposure on representative national levels e.g. the prevalence of vitamin D deficiency within the country while researchers might work with research questions that are not dependent on national representative samples. However, the cooperation with researchers is important because researchers develop the techniques and explore the possibilities in the field (Scalbert et al., 2014). Researchers also provide data and the collaboration opens possibilities to the best available samples for HBM at the time. A good example of collaboration between Nordic countries and between authorities and researchers is the project "Iodine status among vulnerable groups in the Nordic countries – cooperation in human biomonitoring" (NORJOD) financed by NKMT. NORJOD aims at harmonising analytical methods and investigate iodine status in different population subgroups in the Nordic countries. Iodine and iodine status was identified as a potentially emerging nutrient deficiency in all Nordic countries and more information on status was important. National authorities from all Nordic countries as well as top researchers on iodine make a collaborative effort to harmonize analyses from all five countries (Nyström et al., 2016).

Food safety authorities have special responsibilities in cases of emergencies and disasters. In these cases HBM provides a good tool for exposure measurement but cooperation and infrastructure for sampling and handling of samples must be established beforehand. Experiences from Sweden highlights that networking facilitates better use of the collective resources within the country and can strengthen both regional and national preparedness for emergencies (Kotova, Burgaz & et.al., 2017/22). The same benefits might be true for networking between countries since disasters do not follow geographical borders.

5.1 Limitations

There are limitations in this report. One limitation is the selection of the included. It is not always obvious which studies that were initiated by the authorities or if detailed dietary data was included. Thus, we might have missed HBM studies that fulfil the selection criteria. A clear definition on study selection from the beginning would have saved time for all involved parts. Another limitation is the timeframe; only studies performed, or planned, before the beginning of 2016 are included.

5.2 Conclusions

Although there are limitations in the methods, results in this report show that HBM is infrequently used at food authorities in the Nordic countries and that it differs between countries. This report does not show to what extent such information is available from HBM studies performed without the support from national food authorities. However, at the workshop in 2014 a need for more HBM data was expressed and more Nordic collaboration suggested. HBM may provide information on total exposure of nutrients and other chemical compounds and may be a useful tool to monitor emerging risks with increased levels of a contaminant or inadequate intakes of a nutrient. Furthermore, the comprehensive report from EFSA (Choi et al., 2015) gives directions for the development of HBM as a future tool in risk and benefit assessment. HBM is a promising tool but development is needed and collaborating might advance the use of HBM at the Nordic food authorities.

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Sammanfattning

Biomonitorering är ett kraftfullt verktyg för att mäta exponering inom risk- och nytta värderingar och beslutsfattande. Biomonitorering integrerar exponering från alla källor och kan användas bl.a. till visa på trender i exponering, identifiera sårbara grupper och nya risker. Begränsningar är t.ex. att biomonitorering inte ger någon information om källan till exponering eller hur länge kemikalien har funnits i kroppen. Biomonitorering behöver utvecklas för att bli än mer användbar för beslutsfattande.

Denna rapport kartlägger biomonitoreringsstudier utförda vi eller initierade av livsmedelsmyndigheterna i de nordiska länderna och diskuterar problem och möjligheter för fortsatt arbete. Traditionellt så har de nordiska myndigheterna inte använt biomonitorering i sitt arbete. Rapporten visar på att bara ett fåtal studier har utförts och att det skiljer mellan länderna. Det finns flera möjliga orsaker till detta, de tär t.ex. krävande att organisera provtagning av blod och urin. Det finns flera olika etiska aspekter och analyserna är mycket dyra. Dessutom kan myndigheterna använda biomonitoreringsstudier från andra institutioner t.ex. universitet men sådana studier är inte kartlagda i denna rapport. I framtiden är det viktigt med samarbete mellan myndigheter och forskare och mellan myndigheter i olika länder. Dessutom har livsmedelsmyndigheter speciellt ansvar i kriser och katastrofer. I sådana situationer kan biomonitorering vara användbart för att mäta exponering men samarbeten och infrastruktur för provtagning och hantering av prover behöver arbetats upp i förväg.

Appendix

1. Letters with instructions
2. Reporting template
3. Finland study descriptions
4. Norway study descriptions
5. Sweden study descriptions

1. Letter with instruction

”Hej alla!

Tack för ett bra samarbete i biomonitoreringsprojektet under 2014 och hoppas att allt är bra med er. Nu kommer äntligen lite uppdatering om projektet och arbetet under 2015.

Det är delvis ny organisation i Sverige. Irene Mattisson ersätter Natalia Kotova som projektledare, i projektgruppen ingår också Anna Karin Lindroos, Hanna Eneroth och Lilianne Abrahamsson. Vi kommer att fortsätta arbetet och ha kontakterna i fortsättningen.

Rapporten från workshopen vi hade i Stockholm i maj 2014 kommer att tryckas i Nordiska Ministerrådets rapportserie. Planen är att den blir klar i maj.

Det är nu dags för ett steg till i NKMTs biomonitoreringsprojekt. Förra året påbörjade vi inventeringen av biomonitoreringsstudier i Norden och några rapporterade in i en Excelfil, som bifogas.

Detta var grunden till rapport 2 i projektet som kommer att omfatta inventering av HBM-studier i Norden.

SE tar fram en mall som skall användas för beskrivning av studierna. *Vi skickar ut mallen i slutet av april och ni behöver rapportera tillbaka före 15/6.*

För att göra rapporteringen enklare så skall endast studier som myndigheten utför eller beställer rapporteras. Ni får mera information när vi skickar ut mallen. Vi kommer också att kontakta de nationella kostundersökningarna med frågor om HBM.

SE ansvarar för att sammanställa slutrapporten, detta gör vi under sommaren och hösten 2015. Efsa har nyligen gjort en kartläggning av HBM studier på europeisk basis, där finns mycket intressant läsning som är till nytta för vårt projekt. Om ni inte redan läst rapporten så finns den här http://www.efsa.europa.eu/en/supporting/pub/724e.htm

Har ni frågor om projektet så kontakta Irene Mattisson.

Många hälsningar
Natalia och Irene”

2. Reporting template 21 April 2015

- Cohort name / Contact person: [...]
- Initiator/study conducted by: [...]
- Funded by: [...]
- Study design/Duration/Population/Participation rate/Recruitment: Sampling period, year(s) of sampling: [...]
- Investigated biomarkers/Matrices/Analytical methods and Laboratory where analyses were performed: [...]

Table 1: Investigated biomarkers

Biomarker (substance/ group of substances)	Matrices	Year of sampling	Analytical method	Laboratory

- Results: [...]
- Dissemination of data, Scientific publications, Grey literature (Reports, PM etc.), Information/feedback to participants, Access to data: [...]
- Comments: [...]

3. Finland study descriptions

3A FINRISK

Cohort name / Contact person

FINRISK studies.

Initiator/study conducted by

Institute for Health and Welfare (THL).

Funded by

THL, Ministry of Health and Social Affairs.

Study design/Duration/Population/Participation rate/Recruitment

Sampling period, year(s) of sampling: Cross sectional, Adult population, every five years up to 2012, next one planned 2017. FINRISK is a large Finnish population survey on risk factors on chronic, noncommunicable diseases. The Chronic Disease Prevention Department plans and implements it and coordinates the data analyses and reporting. The survey has been carried out for 40 years since 1972 every five years using independent, random and representative population samples from different parts of Finland. In 2012, 6,424 persons participated. The FINRISK Study is also known as the North Karelia Project and it was part of the World Health Organization MONICA Project (FINMONICA) in 1982–1992. The over 40 years of research from 1972 is called the National FINRISK Study.

Investigated biomarkers/Matrices/Analytical methods and Laboratory where analyses were performed

Table 2: FINRISK

Biomarker (substance/ group of substances)	Matrices	Year of sampling	Analytical method	Laboratory
Vitamin C	Stabilized plasma	1992–2007	HPLC	THL
Vitamin D	Serum	2012	Architect CMIA	THL
Iodine	Urine	2002–2012	Fotometric Sandell-Kolthoff	THL
Sodium	Urine	1982–2012	Architect ISE	THL
Potassium	Urine	1982–2012	Architect, ISE	THL
Creatinine	Urine	2002–2012	Fotometric	THL
Cotinine	Serum	1992–2012	GC	THL
HbA1C	Blood	2002–2012	Immune turbidometric	THL
Various cardiovascular and diabetes related biomarkers see full publication list	Serum	up to 2012		THL
Environmental contaminants (parabens, BPA)	Urine	2012, sub-sample of 400 individuals	LC/MSMS triplequadrupole	THL

Results

[...]

Dissemination of data

Scientific publications:

- Kastarinen M, Laatikainen T, Salomaa V, Jousilahti P, Antikainen R, Tuomilehto J, Nissinen A, Vartiainen E. Trends in lifestyle factors affecting blood pressure in hypertensive and normotensive Finns during 1982–2002. J Hypertens. 2007, Feb;25(2):299–305.
- Borodulin K, Vartiainen E, Peltonen M, Jousilahti P, Juolevi A, Laatikainen T, Männistö S, Salomaa V, Sundvall J, Puska P. Forty-year trends in cardiovascular risk factors in Finland. Eur J Public Health. 2015, Jun;25(3):539–46.
- Paalanen L, Prättälä R, Alfthan G, Salminen I, Laatikainen T. Vegetable and fruit consumption, education and plasma vitamin C concentration in Russian and Finnish Karelia, 1992–2002. Public Health Nutr. 2014, Oct;17(10):2278–86.

Full publication list of FINRISK studies available at:

- https://www.thl.fi/documents/10531/862648/FR+julkaisut/2cb2ec29-88e8-45f5-8bab-f86a6bd008c8

Grey literature (Reports, PM etc.):

- http://www.ravitsemusneuvottelukunta.fi/files/attachments/en/vrn/vrn_jodi_toimenpidesuositus_10_2.2015_english.pdf

Information/feedback to participants:

- Participants received the results of the health examination and basic clinical chemistry results.

Access to data:

- May be possible.

Comments

The latest vitamin D and iodine studies are in publication phase.

More biomarker analyses are being performed, including folate from women of childbearing age in FINRISK 2012 Study (part of the FINDIET Substudy) (300 samples)

3B. Health 2000

Cohort name / Contact person

Health 2000 Survey, Health 2011 Survey.

Initiator/study conducted by

Institute for Health and Welfare (THL) had the main responsibility for the surveys. THL was previously called National Public Health Institute (KTL).

Funded by

THL, Ministry of Health and Social Affairs mainly, for environmental contaminants also the Academy of Finland funding was available.

Study design/Duration/Population/Participation rate/Recruitment: Sampling period, year(s) of sampling

Health 2000 was a health interview/examination survey carried out in Finland from fall 2000 to spring 2001. Cross-sectional study, 5,300 adults, 30–79 years of age.

The Health 2011 survey included a new random sample of persons aged 18–28. Also, all persons who had been included in the representative sample of the Health 2000 survey were invited.

Investigated biomarkers/Matrices/Analytical methods and Laboratory where analyses were performed

Table 3: Health 2000 Survey, Health 2011 Survey

Biomarker(substance/ group of substances)	Matrices	Year of sampling	Analytical method	Laboratory
Vitamin D	Serum	2000/2001 2011	RIA and CMIA	THL
Iodine	Urine	2000/2001	Sandell-Kolthoff	THL
Sodium	Urine	2000/2001	Architect ISE	THL
Potassium	Urine	2000/2001	Architect ISE	THL
Creatinine	Urine	2000/2001	Fotometric	THL
Thyroid hormones and antibodies (TSH, fT4, fT4, TPOab)	Urine	2000/2001	CMIA	THL
Cotinine	Serum	2000/2001	RIA	THL
HbA1c	Blood	2000/2001	Immuno-turbido-metric	THL
Caffeine and metabolites	Serum	2000/2001	HPLC	THL
Fatty acids	Serum	2000/2001	GC	THL
Various biomarkers related to cardiovascular disease and diabetes (inflammation, lipids, glucose metabolism)				
Environmental contaminants (HCB, beta-HCH, oxychlordane, transnonachlor, p,p'-DDT, p,p'-DDE, PCBs 118, 153, 138, 156, 180, 170 and BDE47)	Serum	2011, subsample of 1,000 individuals	GC/MSMS triplequadrupole	THL

Results

Information of the study and results available at http://www.terveys2000.fi/indexe.html

Dissemination of data

Scientific publications:

- Jääskeläinen T, Knekt P, Marniemi J, Sares-Jäske L, Männistö S, Heliövaara M, Järvinen R. Vitamin D status is associated with sociodemographic factors,lifestyle and metabolic health. Eur J Nutr. 2013, Mar;52(2):513–25.
- Turunen AW, Jula A, Suominen AL, Männistö S, Marniemi J, Kiviranta H, Tiittanen P, Karanko H, Moilanen L, Nieminen MS, Kesäniemi YA, Kähönen M, Verkasalo PK. Fish consumption, omega-3 fatty acids, and environmental contaminants in relation to low-grade inflammation and early atherosclerosis. Environ Res. 2013, Jan;120:43–54.

Grey literature (Reports, PM etc):

- Project website: http://www.terveys2000.fi/indexe.html

Methodology report:

- http://www.terveys2000.fi/doc/methodologyrep.pdf

Information/feedback to participants:

- Participant were given results of the health examination and results of the basic clinical chemistry measurements.

Access to data:

- May be possible.

Comments

More biomarker analyses are being performed.

3C. DILGOM (DIetary, Lifestyle and Genetic factors on the development of Obesity and Metabolic syndrome)

Cohort name / Contact person

DILGOM studies.

Initiator/study conducted by

Institute for Health and Welfare (THL).

Funded by

THL, Ministry of Health and Social Affairs, Academy of Finland.

Study design/Duration/Population/Participation rate/Recruitment: Sampling period, year(s) of sampling

DILGOM (DIetary, Lifestyle and Genetic factors on the development of Obesity and Metabolic syndrome) studies aim to provide scientifically novel and clinically relevant information in five main areas:

1. Lifestyles: Impact of dietary factors, smoking, and physical activity on weight change, development of abdominal obesity and consequential risk factor clustering.
2. Psychosocial: Effect of psychosocial factors on changes in proximal risk factors and the moderating role of socioeconomic position on their associations with weight gain.
3. Metabolism: Predictive value of inflammatory markers, dietary glycemic load, and their interactions with diet, exercise and genetic factors on the development of obesity and metabolic syndrome.
4. Exposure to environmental pollutants: The role of chemicals with metabolic disrupting potential and their interactions with diet and lifestyle factors on the development of obesity and metabolic syndrome.
5. Genomics: The role of genetic and genomic factors and their interactions with dietary, behavioral, psychosocial and metabolic factors in the development of obesity and metabolic syndrome in a large population based sample.

The study population consists of 5,024 men and women.

Investigated biomarkers/Matrices/Analytical methods and Laboratory where analyses were performed

Table 4: DILGOM (Dietary, Lifestyle and Genetic factors on the development of Obesity and Metabolic syndrome)

Biomarker (substance/ group of substances)	Matrices	Year of sampling	Analytical method	Laboratory
Environmental contaminants (HCB, beta-HCH,oxychlordane, transnonachlor, p,p'-DDT, p,p'-DDE, PCBs118, 153, 138, 156, 180 and 170 and BDE47)	Serum	2007, subsample of 3,200 individuals	GC/MSMS triplequadrupole	THL
Environmental contaminants (PeCB, HCB, alfa-HCH, beta-HCH, gamma-HCH, oxychlordane, transnonachlor, p,p'-DDT, p,p'-DDE, PCBs74, 99, 118, 153, 138, 156, 187, 183, 180 and 170 and BDEs47, 99, 153) and also perfluorinated compounds	Serum	2014, subsample of 1,250 individuals	GC/MSMS triplequadrupole, and LC/MSMS triplequadrupole	THL

Results

[…]

Dissemination of data

Scientific publications:

- Kanerva N, Loo B-M, Eriksson JG, Leiviskä J, Kaartinen NE, Jula A, et al. Associations of the Baltic Sea diet with obesity-related markers of inflammation. Annals of Medicine. 2014 2014/03/01;46(2):90–6.

Grey literature (Reports, PM etc):

- Information/feedback to participants.

Access to data:

- […]

Comments

[…]

4. Norway study descriptions

4A. Norwegian fish and game study (Fisk- og viltundersøkelsen)

Cohort name / Contact person

The Norwegian Fish and Game Study (Fisk og viltundersøkelsen).

Contact person: Contact person

Helle Margrete Meltzer, Norwegian Institute of Public Health, Oslo, Norway (helle.margrete.meltzer@fhi.no).

Initiator/study conducted by

The Study was a collaboration between the Norwegian Food Safety Authority and the Norwegian Institute of Public Health.

Funded by

The Norwegian Food Safety Authority and the Norwegian Institute of Public Health.

Study design/Duration/Population/Participation rate/Recruitment: Sampling period, year(s) of sampling

Materials and Methods: Part A of the Norwegian Fish and Game Study (F&G) was conducted in 1999 with the aim to estimate the consumption of foods that may contain considerable amounts of environmental pollutants, in a representative sample of the Norwegian population. The main focus was on foods that contribute to exposure of mercury, cadmium and PCBs/dioxins. Ten thousand adults between 18 and 79 years of age, drawn at random from the total population database, were invited to participate through a letter which also included a two-page semi-quantitative food frequency questionnaire (FFQ), and 60% (n = 6,015) returned the FFQ. The FFQ was without portion sizes. The FFQ consisted of 38 food questions, where 27 related to fish and fish products and 8 related to the consumption of game.

Part B of the study was conducted in 2000 with the specific aim to be able to capture high-end consumers of foods with potentially high levels of heavy metals and POPs. We assumed that easy access to such foods would increase the likelihood of finding the consumers we were looking for. Fish is predominantly eaten in coastal areas, while many inland communities have ready access to game, either because people hunt themselves, or hunters sell surplus meat to locals. We used official statistics on quotas of game shot every autumn to identify 13 inland municipalities with high quotas for moose, the most commonly hunted large game in Norway. Fourteen coastal municipalities were similarly chosen, but this time the criteria were easy access to shellfish (crabs and shrimps) or longstanding tradition for high consumption of fish. Two of the coastal municipalities were chosen because of the historical tradition to eat seagull eggs. Municipalities which included contaminated fiords were dietary advice had been given to avoid certain types of seafood, were not considered. Again our national population database was used to draw participants between the age of 18 and 79, but this time only drawings from the 27 municipalities were included. As in part A, 10,000 people were invited to participate in our study. This time the response rate was 55% (n = 5,400). The FFQ was slightly enlarged, including the same questions as in part A of the study, but also asking about how they had obtained their foods, i.e. bought in a shop, bought from local people, hunted or fished themselves or given as a gift.

Part C of the study was conducted in 2003. Based on concentrations of different contaminants in the actual foods, a rough estimate of the individual intake of mercury, cadmium and PCBs for the participants in study B was established. Based on these estimates, 700 people among the participants of study B were invited to participate in this in-depth study. 433 were specially selected because of their high consumption of particular foods or high estimated intake of the above contaminants, while 267 were randomly drawn, to serve as a reference group. 199 persons gave informed consent and answered a 12-page semi-quantitative food frequency questionnaire covering the whole diet the previous year. In addition, blood, serum and urine samples were collected.

Investigated biomarkers/Matrices/Analytical methods and Laboratory where analyses were performed

Table 5: Norwegian fish and game study

Biomarker (substance/ group of substances)	Matrices	Year of sampling	Analytical method	Laboratory
PCBs and dioxins	Serum	2003	GC-MS	NIPH, Oslo
Hg	Blood	2003	ICP-MS	STAMI, Oslo
Cd	Blood	2003	ICP-MS	STAMI, Oslo
Pb	Blood	2003	ICP-MS	STAMI, Oslo
Se	Blood	2003	ICP-MS	STAMI, Oslo
As	Urine	2003	ICP-MS	STAMI, Oslo
Brominated flame retarants	Serum	2003	GC-MS	NIPH, Oslo
Phthalates	Urine	2003	LC-MS	NIPH, Oslo
Perfluorinated compounds	Serum	2003	LC-MS	NIPH, Oslo
Vitamins A and D	Serum	2003	LC-MS	Fürsts Medical Laboratory, Oslo

Results

Please see the articles referred to below.

Dissemination of data

Scientific publications:

1. Knutsen HK, Kvalem HE, Thomsen C, Frøshaug M, Haugen M, Becher G, Alexander J and Meltzer HM. Dietary exposure to brominated flame retardants correlate with male blood levels in a selected group of Norwegians with a wide range of seafood consumption. Molecular Nutrition & Food Research. 2008; 52:217–27.
2. Kvalem HE, Knutsen HK, Thomsen C, Haugen M, Stigum H, BrantsæterAL, Frøshaug M, Lohmann N, Päpke O, Becher G, Alexander J and Meltzer HM. Role of dietary patterns for dioxin and PCB exposure. Molecular Nutrition & Food Research. 2009; 53:1438–51.
3. Haug LS, Thomsen C, Brantsæter AL, Kvalem HE, Haugen M, Becher G, Alexander J, Meltzer HM, Knutsen HK. Diet and particularly seafood are major sources of perfluorinated compounds in humans. Environ Int. 2010, Oct;36(7):772–8.

4. Knutsen HK, Kvalem HE, Haugen M, Meltzer HM, Brantsæter AL, Alexander J, Päpke O, Liane VH, Becher G and Thomsen C. Sex, BMI and age in addition to dietary intakes influence blood concentrations and congener profiles of dioxins and PCBs. Mol Nutr Food Res. 2011, 55:772–82.
5. Birgisdottir BE, Brantsæter AL, Kvalem HE, Knutsen HK, Haugen M, Alexander J, Hetland RH, Aksnes L, Meltzer HM. Fish liver and seagull eggs, vitamin-D rich foods with a shadow: Results from the Norwegian Fish and Game Study. Mol Nutr Food Res. 2012, 56: 388–98.
6. Kvalem HE, Brantsaeter AL, Meltzer HM, Stigum H, Thomsen C, Haugen M, Alexander J, Knutsen HK. Development and validation of prediction models for blood concentrations of dioxins and PCBs using dietary intakes. Environ Int. 2012, Dec 1;50:15–21.
7. Jenssen MT, Brantsæter AL, Haugen M, Meltzer HM, Larssen T, Kvalem HE, Birgisdottir BE, Thomassen Y, Ellingsen D, Alexander J, Knutsen HK. Dietary mercury exposure in a population with a wide range of fish consumption, Self-capture of fish and regional differences are important determinants of mercury in blood. Sci Total Environ. 2012, Nov 15;439:220-9. Epub 2012 Oct 13.
8. Birgisdottir BE, Knutsen HK, Haugen M, Gjelstad IM, Jenssen MT, Ellingsen DG, Thomassen Y, Alexander J, Meltzer HM, Brantsæter AL. Essential and toxic element concentrations in blood and urine and their associations with diet: Results from a Norwegian population study including high-consumers of seafood and game. Sci Total Environ. 2013, Jul 15;463-464C:836–844.

Grey literature (Reports, PM etc) (Proceedings):

1. Knutsen HK, Bergsten C, Thomsen C, Sletta A, Becher G, Alexander J, Meltzer HM. Preliminary assessment of PBDE exposure from food in Norway. Organohalogen Compounds. 2005; 67;1624-7.
2. Kvalem HE, Knutsen HK, Thomsen C, Haugen M, Bergsten C, Sletta A, Trygg KU, Alexander J, Becher G, Meltzer HM. Dietary dioxin and PCB exposure in a selected group of Norwegians. Organohalogen Compounds. 2005;67;1741-4.

3. Kvalem HE, Knutsen HK, Thomsen C, Haugen M, Stigum H, Alexander J, Becher G, Meltzer HM. The predictive value of dietary intake estimations on serum levels of some non-dioxin like PCBs. Organohalogen Compounds. 2006, 68:1517-20.
4. Knutsen HK, Kvalem HE, Thomsen C; Froshaug M, Haugen M, Becher G, Alexander J, Meltzer HM. Dietary exposure to polybrominated diphenyl ethers correlate with male blood levels in a selected group of Norwegians with a wide range of seafood consumption. Tox Letters. 2007, 172: 105–105.
5. Knutsen HK; Kvalem HE; Meltzer HM; Alexander J. TWI for dioxins and dl-PCB, calculated with 1998 and 2005 TEFs, protects against toxic effects of non-dioxin like PCB in Norwegian foods. Organohalogen Compounds. 2008, Volume 70. 1399–1401.
6. Kvalem HE; Knutsen HK; Thomsen C, Haugen M; Stigum H; Brantsæter AL; Alexander J; Meltzer HM. Can non-dl-PCB concentrations in serum be predicted by dietary intake? A validated prediction model. Organohalogen Compounds. 2008, Volume 70. 570–573.

Reports:

- *Part A of the Study*:Meltzer HM, Bergsten C, Stigum H. Fisk- og viltundersøkelsen. Konsum av matvarer som kan ha betydning for inntaket av kvikksølv, kadmium og PCB/dioksin i norsk kosthold. Rapport 6-2002, SNT.
- *Part B of the Study*: Christina Bergsten. FISH- AND GAME STUDY, PART B. The consumption of foods that may be important when assessing the dietary intake of mercury, cadmium and PCB/dioxins, with a focus on population groups living on the coast and in the inland of Norway. The Norwegian Food Safety Authority. 2007.

Information/feedback to participants:

- […]

Access to data:

- […]

Comments

[…]

4B. The Norwegian lead and game study

Cohort name / Contact person

The Norwegian lead and game study (Hjortevilt og blyrisikoundersøkelsen).

Contact person: Helle Margrete Meltzer, Norwegian Institute of Public Health, Oslo, Norway (helle.margrete.meltzer@fhi.no).

Initiator/study conducted by

The Study was collaboration between the Norwegian Scientific Committee for Foor Safety and the Norwegian Institute of Public Health.

Funded by

The Norwegian Scientific Committee for Food Safety and the Norwegian Institute of Public Health.

Study design/Duration/Population/Participation rate/Recruitment: Sampling period, year(s) of sampling

Cross-sectional study, recruitment from primo April till mid October 2012, invitation to hunters and their families + non-consumers of cervid meat. Informed consent and blood samples from 195 persons. In the final statistics there were 147 participants, i.e. the number when counting complete questionnaires and blood analyses. 103 of these were recruited through the hunting team leaders and 44 were in house participants.

Investigated biomarkers/Matrices/Analytical methods and Laboratory where analyses were performed

Table 6: The Norwegian lead and game study

Biomarker (substance/ group of substances)	Matrices	Year of sampling	Analytical method	Laboratory
Pb	Blood	2012	ICP-MS	Fürsts medical baboratory, Oslo

Results

Median (5 and 95 percentile) blood concentration of lead was 16.6 µg/L (7.5 and 39 µg/L). An optimal multivariate linear regression model for log-transformed blood lead indicated that cervid game meat consumption once a month or more was associated with approximately 31% increase in blood lead concentrations. The increase seemed to be mostly associated with consumption of minced cervid meat, particularly purchased minced meat. However, many participants with high and long-lasting game meat intake had low blood lead concentrations. Cervid meat together with number of bullet shots per year, years with game consumption, self-assembly of bullets, wine consumption and smoking jointly accounted for approximately 25% of the variation in blood lead concentrations, while age and sex accounted for 27% of the variance. Blood lead concentrations increased approximately 18% per decade of age, and men had on average 30% higher blood lead concentrations than women. Hunters who assembled their own ammunition had 52% higher blood lead concentrations than persons not making ammunition. In conjunction with minced cervid meat, wine intake was significantly associated with increased blood lead.

Dissemination of data

Scientific publications:

- Meltzer HM, Dahl H, Brantsæter AL, Birgisdottir BE, Knutsen HK, Bernhoft A, Oftedahl B, Lande US, Alexander J, Haugen M, Ydersbond TA. Consumption of lead-shot cervid meat and blood lead concentrations in a group of adult Norwegians. Environmental Research. 2013, Nov;127:29–39.

Grey literature (Reports, PM etc):

- Risk assessment of lead exposure from cervid meat in Norwegian consumers and in hunting dogs. Oslo: Norwegian Scientific Committee for Food Safety. 2013, Contract No.: 11–505.
- Opinion of the Panel on Contaminants of the Norwegian Scientific Committee for Food Safety. Risk assessment of lead exposure from cervid meat in Norwegian consumers and in hunting dogs. ISBN: 978-82-8259-096-9, Oslo. 2013, Can be downloaded from http://www.vkm.no/dav/cbfe3b0544.pdf

Information/feedback to participants:

- Yes, a letter with the general results. For individual results they contacted their local physician.

Access to data:

- […]

Comments

[…]

5. Swedish study descriptions

5A. POPUP (Persistent Organic Pollutants in Uppsala Primiparas)

Cohort name

POPUP (Persistent Organic Pollutants in Uppsala Primiparas).

Initiator/study conducted by

The Swedish National Food Agency (NFA).

Funded by

NFA and the Swedish Environmental Protection Agency.

Study design/Duration/Population/Recruitment: Sampling period, year(s) of sampling

The POPUP study was started to improve basic data for risk assessments of POPs in food. It is a cohort of first-time mothers recruited in Uppsala County from 1996 and onwards. The study is still ongoing.

During the first part of the study (1996–1999), pregnant women were recruited among controls in a case-control study of risk factors for early miscarriages. A total of 325 women donated blood samples in early and late pregnancy and 211 women donated breast milk and hair after delivery. In addition, blood samples were taken from 160 infants at 3 weeks and 138 infants at 3 months after delivery.

During the second part of the study (2000–) 30 first-time mothers have been randomly recruited (after delivery) every 1–2 years among first-time mothers who had a normal delivery at Uppsala University Hospital and were Swedish by birth. These mothers donate breast milk, blood and hair 3 weeks after delivery. In addition, urine has been sampled since year 2009. A total of 330 women have been recruited in 2000–2014.

Life-style information and dietary data (consumption of fish and other foods of animal origin) from all participants has been gathered by in-person interviews and self-administered questionnaires.

In 2009–2010, a dust sample was collected from the homes of the participating mothers (N = 60). When the children to these mothers were about 11 months old, the mothers were re-contacted and asked to participate in a follow-up study. For those who agreed, blood samples from the mothers (n = 24), blood (n = 24) and feces samples (n = 22) from their toddlers and house dust samples from each home (n = 27) were collected.

From 2008 the cohort has been expanded with a follow-up of the mothers and children (blood sample and questionnaire) at the age of 4, 8 and 12 years.

Investigated biomarkers/Matrices/ Analytical methods and Laboratory where analyses were performed

Table 7: POPUP (Persistent Organic Pollutants in Uppsala Primiparas)

Biomarker (substance/ group of substances)	Matrices	Years of analysis	Analytical method	Laboratory
Brominated flame retardants	Breast milk	1996–2012	See publications	See publications
Dioxins				
Furans				
PCBs				
Chlorinated pesticides				
Metals: Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cs, Cu, Fe, Hg, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Rb, S, Sb, Se, Sn, Sr, Tl, W, U, V, Zn		2000–2002 + 2009		
Musk compounds		1996–2003		
Chlorinated paraffins		1996–2010		
Fatty acids		2009–2012		
Nutrients: I, Se		1996–1999		
Brominated flame retardants	Blood serum	1996–2012		
Phenolic substances		1996–2011		
Perfluorinated and polyfluorinated compounds		1996–2013		
Markers of the immune system		1996–1999		
Thyroid hormones		1996–1999		
Metals; Hg	Hair	planned		
Nutrients; I	Urine	planned		

Results

- Declining rates of chlorinated POPs (PCB, dioxins, chlorinated pesticides) over time (Lignell et al 2009).
- Trends for BFRs and perfluorinated compounds depend on congener/substance studied (Lignell et al 2009, Glynn et al 2012).

Dissemination of data

Scientific publications:

- Wicklund Glynn A, Atuma S, Aune M, Darnerud PO, Cnattingius S. PCB congeners as marker substances for concentrations of toxic equivalents of polychlorinated dibenzo-p-dioxin, dibenzo-furans, and biphenyls in breast milk. Environ Res Section A. 2001, 86, 217–228.
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Grey literature (Reports, PM etc):

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- Reports from the study to the Swedish Environmental Protection Agency. Available at: (http://ki.se/imm/alla-rapporter). The latest reports are also presented on the project web page (http://www.livsmedelsverket.se/modersmjolk)

Information/feedback to participants:

- Information to participants on the NFA web page: http://www.livsmedelsverket.se/modersmjolk

Access to data:

- Possible if the projects are research collaborations.

Comments:

No additional comments.

5B. Riksmaten vuxna 2010–11

Cohort name

Riksmaten vuxna 2010–11.

Initiator/study conducted by

The National Food Agency (NFA).

Funded by

The National Food Agency (NFA). Biomonitoring also funded by the Swedish Environmental Protection Agency.

Study design/Duration/Population/Recruitment: Sampling period, year(s) of sampling

Cross-sectional study, data collection between May 2010 and July 2011. Representative sample of 5,000 men and women between 18–80 years were invited to take part. A sub sample of 1,008 individuals were also invited for blood and urine sampling. In total 1,797 women and men participated in the diet part of the survey (36%) and 300 men and women provided blood and urine samples (30%). Recruitment was done via letter followed by a telephone call. The blood and urine was sampled at Occupational and Environmental Medicine Centres in Sweden.

Investigated biomarkers/Matrices/Volumes/Analytical methods and Laboratory where analyses were performed

Tabel 8: Riksmaten vuxna, nutrients

Biomarker	Matrice	Analytical method	Laboratory
Vitamin D	serum	25(OH)D3 25(OH)D2 HPLC atmospheric pressure chemical ionization mass spectrometry	Vitas Analytical Services, Oslo, Norway
Fatty acids in phospholipids	serum	Gas chromatography[1]	Lipid laboratory at Clinical Nutrition and Metabolism unit, University Hospital Uppsala
Folate	plasma	Chemiluminescence immunoassay method (total analytical imprecision of plasma folate measurements was 12 and 7 CV % at 4 and 35 nmol/L, respectively. Cutoff level was 8 nmol/L)	Clinical Chemistry and Pharmacology Department, Uppsala University Hospital, Sweden
Folate (erythrocytes)	whole blood	Chemiluminescence immunoassay (range 45–1,407 nmol/L, intraassay CV 3%	Karolinska University Hospital, Sweden
Sodium	spot urine	Flame atomic absorption spectrophotometry (Perkin–Elmer model 5000; Norwalk, CT, USA)	Sahlgrenska University Hospital, Gothenburg, Sweden
Iodine	spot urine	Modified Sandell–Kolthoff method, inter-assay CV 3.9% at 61 mg/L.	Dept of Internal Medicine and Clinical Nutrition, Sahlgrenska akademi at University of Gothenburg, Sweden
Ferritin	plasma	Chemiluminescant microparticle immunoassay	Department of Clinical Chemistry at Uppsala University Hospital, Sweden
CRP (for evalauation iron deficiency)	plasma	Clincal routine analyses	Department of Clinical Chemistry at Uppsala University Hospital, Sweden

Note: [1]Berglund M et al. Fatty acid proportions in plasma cholesterol esters and phospholipids correlate strongly in Swedish men and women. J Nutr, 2017 in press.

Tabel 9: Riksmaten vuxna toxicological biomarkers

Biomarker	Matrice	Analytical method[1]	Laboratory[1]
Cd	spot urine		
Cd, Pb, Hg	Whole blood		
PCBs (PCB28, PCB52,PCB118, PCB138, PCB153, PCB156, PCB170, PCB180)	serum		
Fungicider (HCB)	serum		
Insecticides and metabolites (β-HCH, Oxyklordan, Trans-nonaklor, p,p'-DDT, p,p'-DDE)	serum		
PFAA (PFHpA PFHxS PFOA PFNA PFOS PFDA PFUnDA PFDoDA)	serum		
PBDE (PBDE28 PBDE47 PBDE66 PBDE99 PBDE100 PBDE138, PBDE153, PBDE154, PBDE183, PBDE209 HBCD	serum		
Bisfenols and phtalate metabolites	spot urine		
DON	spot urine	Single mycotoxin method. LC-MS	Division of Epidemiology, Leeds institute for Genetics, Health and Therapeutics, UK
DON, NIV, FB1, FB2, ZEA, OTA and metabolites AFM1, DOM-1, a-ZOL and b-ZOL	spot urine	Multi mycotoxin method. UPLC-MS/MS	Institute of Sciencesof Food Production (ISPA), Bari, Italy

Note: [1] For more information on methods and laboratories for contaminants see report "Rapport till Naturvårdsverket. Miljöföroreningar i blod och urin och kopplingar till rapporterat matintag i Riksmaten 2010–11 – resultatsammanställning". Naturvårdsverket 2013.diva2:710439.

Results/Interpretations

The blood and urine collected in 2010—11 have been used for analyses of toxic compounds and markers of nutrition and nutritional status.

The toxic compounds analysed in the Riksmaten adults HBM project were chosen based on their potential for health effects, possibility to have a dietary exposure route and the presence/absence of earlier data. Thus, a number of environmental contaminants and mycotoxins with known presence in food, were measured in human samples (blood and urine) in order to achieve new insights of whether and to what extent these compounds are taken up in humans and what are their (biologically relevant) levels in the body. The resulting data have become very valuable from a risk assessment point of view, as few national surveys with this focus have earlier been performed. Moreover, as the results from the chemical analyses can be combined with data on dietary and life style factors, food and behavioral patterns and their association to the chemical body burden could be studied.

The nutritional biomarkers have been used to analyze status of folate, vitamin D, iodine and iron as well as a relative validation of dietary fat intake using plasma phospholipid fatty acid composition.

Results from the human biomonitoring part of the Riksmaten 2010–11 survey have been published in reports and scientific journals and are used as a bases for the ongoing work on recommendations and other issues at NFA.

Dissemination of data

Grey literature (Reports, PM etc):

- Amcoff E, Edberg A, Enghardt Barbieri H, Lindroos AK, Nälsén C, Pearson M, et al. Riksmaten – vuxna 2010–11. Livsmedels- och näringsintag bland vuxna i Sverige.
- Riksmaten adults 2010–11. Food and nutrient intakes in adults in Sweden. Uppsala: Livsmedelsverket,2012.
- Bjermo H, Ax E, Cantillana T, Glynn A, Darnerud PO, Lindroos AK. Rapport till Naturvårdsverket. Miljöföroreningar i blod och urin och kopplingar till rapporterat matintag i Riksmaten 2010–11 – resultatsammanställning. Naturvårdsverket 2013. diva2:710439.

Scientific literature:

- Ax E, Warensjö Lemming E, Becker W, Andersson A, Lindroos AK, Cederholm T, et al. Dietary patterns in Swedish adults; results from a national dietary survey. British Journal of Nutrition. 2016;115(1):95–104.

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- Bjermo H, Darnerud PO, Lignell S, Pearson M, Rantakokko P, Nälsén C, Enghardt Barbieri H, Kiviranta H, Lindroos AK, Glynn A. Fish intake and breastfeeding time are associated with serum concentrations of organochlorines in a Swedish population. Environment International. 2013, 51:88–96.
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- Lundberg-Hallén N, Öhrvik V. Key foods in Sweden: Identifying high priority foods for future food composition analysis. Journal of Food Composition and Analysis. 2015, 37:51-7.
- Turner PC, Gost A, Gambacorta L , Olsen M, Olsen, Wallin S, Kotova N. Comparison of Data from a Single and a Multi-analyte Method for Determination of Urinary Total Deoxynivalenol in Human Samples. J. Agric. Food Chem http://pubs.acs.org/doi/10.1021/acs.jafc.6b04755. Publication Date (Web): 16 Nov 2016.
- Wallin S, Gambacorta L, Kotova N, Warensjö Lemming E, Nälsén C, Solfrizzo M, Olsen M. Biomonitoring of concurrent mycotoxin exposure among adults in Sweden through urinary multi-biomarker analysis. Food and Chemical Toxicology. 2015, 83, 133–139.

- Warensjö Lemming E, Nälsén C, Becker W, Ridefelt P, Mattisson I, Lindroos AK. Relative validation of the dietary intake of fatty acids among adults in the Swedish National Dietary Survey using plasma phospholipid fatty acid composition.. J Nutr Sci. 2015, Jun 26;4:e25.
- Öhrvik V, Lemming EW, Nalsen C, Becker W, Ridefelt P, Lindroos, AK. Dietary intake and biomarker status of folate in Swedish adults. Eur J Nutr, 2016.

Information/feedback to participants:

- Study information and main results published on www.livsmedelsverket.se

Access to data:

- The data is available to researchers on request to the National Food Agency.

Comments

No additional comments.

5C. School children study (MSB Skolbarn)

Cohort name

School children study (MSB skolbarn).

Initiator/study conducted by

The National Food Agency (NFA).

Funded by

The Swedish Civil Contingencies Agency (MSB).

Study design/Duration/Population/Recruitment/Participation rate: Sampling period, year(s) of sampling

Children 11–12 years in grade 5. Recruited in Swedish schools from the six different regions (Linköping, Lund, Stockholm, Umeå, Uppsala, Örebro) during February–May 2014. Blood and urine are available from 234 children, participation rate 50%. Food and drinks recorded for 4 days via a web application (The Riksmaten method). The children also completed a questionnaire on lifestyle, living conditions and frequencies of irregularly consumed key foods.

Investigated biomarkers/Matrices/Analytical methods and Laboratory where analyses were performed

Table 10: School children study (MSB skolbarn)

Biomarker	Matrices	Year of analysis	Analytical method	Name of laboratory
Al, As, Cd	Urine	All 2014		ALS, Luleå
Creatinine, density				AMM, Lund and GU
Iodine			Modified Sandell-Kolthoff method	GU
Sodium				GU
PFAA (15 different)	Serum		LC-MS/MS	AMM, Lund
25-OH-vit D			LC-MS/MS	AMM, Lund
Al			ICP-MS	AMM, Lund
TSH, T3, T4				AS
Ferritin	Plasma			AS
Folate				AS
B12				AS
CRP				AS
Phosphate				AS
Cd, Pb, Hg	Blood		ICP-MS	AMM, Lund
B-folat	Blood			Unilabs, Gothenburg

Results/Interpretations

Data from the study has not been published yet.

Dissemination of data

Scientific publications:

- […]

Grey literature (Reports, PM etc):

- […]

Information/feedback to participants:

- A simple report describing the main results from the diet survey has been sent to schools.

Access to data:

- May be possible, if terms are agreed on.

Comments

More chemical and statistical analyses will be carried out.

5D. The hunter study (Jägarstudien)

Cohort name

The Hunter study (Jägarstudien).

Initiator/study conducted by

A collaboration between The Swedish National Food Agency (NFA), Svenska Jägareförbundet (Swedish) and Swedish National Veterinary Institute.

Funded by

NFA and partially financed by the Swedish Civil Contingencies Agency.

Study design/Duration/Population/Recruitment: Sampling period, year(s) of sampling

The recruitment was via an advertisement in the journal "Svensk jakt". Families from five different cities in Sweden, during spring 2013, were invited to participate in the study. The selection criterias were: a) Only families with children between 3–17 years old were asked to voluntarily participate. B) The age of the participants had to be between 18–65 years. C) At least one of the family members used to eat game meat at least two times a week. D) Only families where at least one of the participants was an active hunter could participate. E) BMI between 19–29. At the same time as the participants delivered blood and urine samples they had to fill in questionnaires about their eating habits. The study participants answered questions regarding e.g. alcohol, vegetable, and fruit intake in order to determine possible exposure sources. In addition, the consumption of game meat was, by the participants, in detail described.

In total 213 persons from 74 families were included in the study. The mean age of the adults was 43 years and the mean age of the children was 11 years. A group of 273 persons, where blood and urine samples were collected in Riksmaten adults 2010–11 some years before the hunting study, constituted the control group.

Investigated biomarkers/Matrices/Analytical methods and Laboratory where analyses were performed

Table 11: The hunter study (Jägarstudien)

Biomarker (substance/ group of substances)	Matrices	Year of sampling	Analytical method	Name of laboratory
Pb	Blood Urine	2013 2013	ICP-MS not analysed	AMM, Skåne

Results

Among the adults there was a correlation between high intake of game meat and the lead level in blood. However this correlation was not strictly dose related. The participating children did not have any higher Pb-level in blood than a corresponding control group.

Dissemination of data

Scientific publications:

- So far, no peer reviewed publications.

Grey literature (Reports, PM etc):

- NFA report: Rapport 18-2014, Bly i viltkött (Swedish).

Information/feedback to participants:

- NFA web page: http://www.livsmedelsverket.se/om-oss/samarbeten/projekt/matningar-av-halter-av-kemikalier-i-manniska/

Access to data:

- Available on request.

Comments

No additional comments.

5E. Riksmaten adolescents (Riksmaten ungdom)

Cohort name

Riksmaten adolescents (Riksmaten ungdom).

Initiator/study conducted by

The National Food Agency (NFA).

Funded by

The National Food Agency (NFA). We will also apply for external funding.

Study design/Duration/Population/Recruitment: Sampling period, year(s) of sampling

Recruitment will take place in schools selected to provide a nationally representative sample of 3,000 adolescents, evenly divided by age group (grade 5, 11–12 years old; grade 8, 14–15 years old and second year at gymnasium 17–18 years old) and sex. A sub-sample of 1,200 adolescents will be asked to donate blood (not fasting blood samples) and spot urine. Height and weight will be measured. Diet will be recorded in the newly developed web-based 24 h recall application *RiksmatenFlex* on the examination day and one day 1–2 weeks later. In addition the adolescents will be asked to complete an on-line questionnaire on demographics, health, dietary supplements and frequencies of foods that may not be captured in the 24 h web-recall.

The study will be carried out over one school year in 2016 and 2017. A pilot study was carried out in the autumn of 2015.

Investigated biomarkers/Matrices/Volumes/Analytical methods and Laboratory where analyses were performed

Tabel 12: Riksmaten adolescents (Riksmaten ungdom) The final list is not decided yet as it depends on the funding. The following markers have been suggested

Biomarkers	Matrices
Metals	
As, F, Cd, Pb	urine
Cd, Hg, Pb	blood
Al	serum
POPs	
PCBs	serum
Chlorpesticides (DDT/DDE)	serum
PFAS	serum
PBDE, HBCD	serum
New flame retardants	serum
Phenolic substances	
Bisphenol (A) etc.	urine
Pentachloride phenol	serum
Miscellaneous	
Phthalates (incl. metabolites)	urine
DON, OTA and other mycotoxins	urine
"Modern pesticides" (2,4-DMCPA, HMPA ,2,4,5-T, 3-PBA, 4-F, DCCA,TCP, 2,4,6-T ,OH-T, MQ, CCC, ETU, Vinclozelin, Iprodion, Procymidon etc). Dikofol, Trifluralin	
Nutritional markers	
Vitamin D	serum
Fatty acid in phospholipids	serum
Folate	plasma
Sodium	urine
Iodine	urine
Potassium	urine
Carotenoids	plasma
Alkylresorcinol	plasma
Ferritin	plasma
Metabolomics	urine and serum
Selenium?	serum
General health markers	
LDL and HDL-cholesterol	serum
T_3, T_4, TSH	serum
CRP (inflammatory marker)	plasma

Results/Interpretations

Not applicable.

Dissemination of data

Grey literature (Reports, PM etc):

- Results will be published in NFA reports.

Scientific literature:

- Results will be published in scientific peer reviewed journals.

Information/feedback to participants:

- Study information and main results will be published on http://www.livsmedelsverket.se/matvanor-halsa--miljo/kostrad-och-matvanor/matvanor---undersokningar/riksmaten-ungdom/

Access to data:

- The data will be available on request after the completion of the study.

Comments

- No additional comments.

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Human biomonitoring at food authorities

Human biomonitoring (HBM) can be defined as the systematic standardized measurement of a concentration of a substance or its metabolites in human tissues and is an important tool in evaluating exposure to chemicals. This report maps HBM studies performed at or initiated by food safety authorities in the Nordic countries and discuss problems and options for further work. The report shows that only few studies have been performed and it differs among the countries. Reasons for this could be that sampling blood and urine is demanding, there are ethical and privacy issues and analytical costs are high. More cooperation with researchers and between countries is needed. Food safety authorities have special responsibilities in cases of emergencies and disasters. In these cases HBM provides a good tool for exposure measurement but cooperation and infrastructure should be established beforehand.

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