Paediatric and Perinatal Epidemiology
Affiliated to the Society for Pediatric and Perinatal Epidemiologic Research

doi: 10.1111/ppe.12060

Review Article

Pregnancy and Birth Cohort Resources in Europe: a Large Opportunity for Aetiological Child Health Research

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Abstract

Background: During the past 25 years, many pregnancy and birth cohorts have been established. Each cohort provides unique opportunities for examining associations of early-life exposures with child development and health. However, to fully exploit the large amount of available resources and to facilitate cross-cohort collaboration, it is necessary to have accessible information on each cohort and its individual characteristics. The aim of this work was to provide an overview of European pregnancy and birth cohorts registered in a freely accessible database located at http://www.birthcohorts.net.

Methods: European pregnancy and birth cohorts initiated in 1980 or later with at least 300 mother–child pairs enrolled during pregnancy or at birth, and with postnatal data, were eligible for inclusion. Eligible cohorts were invited to provide information on the data and biological samples collected, as well as the timing of data collection.

Results: In total, 70 cohorts were identified. Of these, 56 fulfilled the inclusion criteria encompassing a total of more than 500 000 live-born European children. The cohorts represented 19 countries with the majority of cohorts located in Northern and Western Europe. Some cohorts were general with multiple aims, whilst others focused on specific health or exposure-related research questions.

Conclusion: This work demonstrates a great potential for cross-cohort collaboration addressing important aspects of child health. The web site, http://www.birthcohorts.net, proved to be a useful tool for accessing information on European pregnancy and birth cohorts and their characteristics.

Keywords: *European pregnancy birth cohort, cohort characteristics, cross-cohort collaboration.*

Introduction

Early-life exposures, such as environmental and parental lifestyle factors, may affect growth and development in fetal life and in childhood, and health across the life course.[1] Identification of key causal exposures during intrauterine and early life, as well as effective methods for preventing their adverse effects, have the potential to benefit both the individual and the society.[2] Over the last five decades, child mortality and morbidity have decreased in Europe, but considerable variation in these parameters still exists within and between countries, possibly due to variations in adverse exposures, as well as variations in disease prevention, e.g. through childhood vaccination. Also, the fact that access to health care is free of charge in some countries but not in others, likely impacts childhood morbidity and mortality. Whereas eastern European countries mainly struggle with injuries and respiratory infections, other parts of Europe are challenged by asthma, allergies, obesity and neurodevelopmental disorders.[2]

In parallel with an increased interest in the early-life developmental origins of disease, many European pregnancy and birth cohorts have been established over the last 25 years. Cohort studies offer a unique opportunity to monitor early-life factors associated with variation in growth and development. With long-term follow-up, cohorts render it possible to explore exposures – including genetic, epigenetic, socio-economic and lifestyle factors and environmental toxins – for later development of diseases. However, cohorts are expensive to maintain, and in order to fully exploit their potential in a cost-efficient way, existing cohorts and their characteristics should be made accessible to the global scientific community.

There is increasing evidence of the value of cross-cohort collaboration using pooled data from existing cohorts for determining robust genetic associations.[3] The value of pooling data from two or more cohorts to address research questions on environmental or lifestyle exposures has also been illustrated in previous studies.[4–6]

Accessible information on characteristics of existing pregnancy and birth cohorts, including basic details about enrolment, inclusion criteria and the data and biological samples collected, is essential for improving collaboration to better understand causality, e.g. through cross-cohort comparisons, and for improving statistical precision, e.g. by pooling data from different cohorts where this is appropriate. In addition, investigators of new pregnancy and birth cohorts could benefit from knowing about existing resources. Some cohort profile papers have been published in the *International Journal of Epidemiology* to improve access to and collaboration between cohorts.[7–11] However, we are aware of only a few previous publications that summarise existing cohorts across geographical regions. These publications are mostly focused on subgroups of cohorts with specific exposures or outcomes of interest, such as environmental exposures and atopic diseases.[12–14]

The main aim of this work was to provide an overview of pregnancy and birth cohorts in Europe and to summarise the characteristics of each cohort. This may facilitate greater collaboration across cohorts for the benefit of the global scientific community. Furthermore, the aim was to evaluate the potential of doing pooled analyses and to demonstrate the statistical implications of such cross-cohort collaboration.

Methods

Identification of cohorts

European pregnancy and birth cohorts were identified from multiple sources. First, we searched the web-based database located at http://www.birthcohorts.net. This database was founded in 2005 as part of the European FP5 programme research action: the ChildrenGenoNetwork. As part of the CHICOS project (http://www.chicosproject.eu) within the European FP7 programme, the database was redesigned to include detailed information on each cohort. This allows for identification of cohorts which collect information on specific exposures, outcomes or biological samples of interest. The database, http://www.birthcohorts.net, is not limited to include European cohorts only, but is open for registration of cohorts from around the world.

Second, we searched the list of cohorts that were identified by two EU funded research projects – the ENRIECO project (http://www.enrieco.org) and EUCCONET (http://www.eucconet.com). The objective of the ENRIECO project was to advance knowledge on specific causal relationships between environmental exposures and child health through the coordination of pregnancy and birth cohorts.[14] EUCCONET brings together leaders of international child cohorts in order to compare practices, exchange experience and share questionnaires and other tools.

Third, we identified published literature in PubMed using the following search terms: birth cohort, Europe, mother–child cohort, prospective cohort study. Also, we searched the reference lists of all identified papers retrieved via the earlier searches. Finally, we advertised http://www.birthcohorts.net at relevant conferences and workshops, and made contact with people whom we knew worked with pregnancy and birth cohorts in order to identify additional cohorts.

Between 1 September 2011 and 1 June 2012, we contacted all principal investigators (PIs) of the identified cohort. PIs of cohorts not already registered at http://www.birthcohorts.net were encouraged to register, and PIs of registered cohorts were encouraged to update their cohort profile through completion of a web-based questionnaire at http://www.birthcohrts.net. Each cohort was sent up to four reminders in order to be included in the present overview.

All identified European pregnancy and birth cohorts were included if they: (i) were initiated in 1980 or later; (ii) had enrolled at least 300 mother–child pairs either during pregnancy or at birth; (iii) had collected some postnatal data; and (iv) had completed the cohort profile questionnaire.

Extraction of information on cohort characteristics

The cohort profile questionnaire was divided into the following sections: (i) identification and contacts; (ii) basic cohort description including sample size, enrolment and expected follow-up of the children; (iii) birth outcomes, child development and child health; (iv) child and parental exposures; (v) parental characteristics and reproductive history; (vi) parental health; and (vii) child and parental biological samples collected. The time point was recorded for each assessment of exposure and outcome, as well as for biological samples collected. For the purpose of this overview, characteristics of each of the included cohorts were extracted directly from http://www.birthcohorts.net, as of June 2012.

Identified cohorts and their characteristics

Identified cohorts

Initially, we identified 70 potentially eligible pregnancy and birth cohorts. Of these, 56 cohorts fulfilled the inclusion criteria (Table 1). The restriction to cohorts initiated in 1980 or later guarantees that these will reflect relatively contemporary exposures and practices across Europe, whilst allowing for some cohorts to have follow-up into early adulthood already. Cohorts with a sample size of fewer than 300 were excluded because we assumed that these would be unlikely to provide robust result. However, we admit that even small cohorts can contribute importantly to a number of research questions. Also, cohorts enrolling participants after birth or without follow-up of the children, as well as cohorts, which did not respond to the cohort profile questionnaire were excluded (Figure 1). Therefore, this overview is not completely comprehensive. Moreover, other cohorts not described here may exist, but given our extensive literature search and network of pregnancy and birth cohort researchers, we find it unlikely that we have missed substantial number of cohorts in this overview that fulfil our inclusion criteria.

Characterisation of included cohorts

In total, the 56 cohorts included in this overview together encompassed around half a million live-born European children. For many of the cohorts, extensive data on maternal exposures (and some on both parents) during pregnancy, as well as data on early-life developmental periods are available. The sample size of each cohort varied considerably from fewer than 500 to more than 100 000 children. More than a third of the cohorts ($n = 22$) were general, in that they cover a broad range of exposures related to all aspects of child development, health and well-being. The remaining cohorts were established to address research questions related to one or two areas, such as environmental exposures and atopic disorders (Table 1).

Cohorts from all European regions (European regions as defined by the United Nations Statistics Division) were included, representing 19 European countries. The majority of the cohorts were, however, located in Northern and Western Europe ($n = 41$), and in high-income (Income-level as defined by The World Bank Group based on the country's gross national income per capita, in USD) countries ($n = 53$). The three largest cohorts were located in Scandinavia (Figure 2).

As of 1 June 2012, the majority of cohorts ($n = 47$) had completed enrolment of participants, three were open (or dynamic) cohorts with continuous enrolment, and six were still enrolling participants. One cohort enrolled participants before pregnancy, 34 enrolled during pregnancy and 21 enrolled at birth. Fifteen of the cohorts with enrolment at birth collected data on pregnancy exposures retrospectively (Table 1).

The oldest cohort enrolled participants during the period from 1982 to 1984,[15] and the youngest cohort had just started enrolment.[16] Most of the cohorts had completed several waves of follow-up of the children at different ages. More than half of the cohorts ($n = 32$) expected a lifelong follow-up, while the remaining only expected to follow-up the children during childhood and adolescence because child health was the focal point of these cohorts (Figure 3).

The majority of cohorts collected information on parental lifestyle exposures (e.g. diet, smoking, alcohol consumption, physical activity) during intrauterine and in the early period of life as well as information on parental occupational and environmental exposures (e.g. air pollution). Most of the cohorts collected information on maternal demographic and obstetric characteristics. Information on a wide range of pregnancy outcomes and information on child health was collected by all cohorts. Exposure and outcome data were collected from medical files or directly from participants either by questionnaires, interviews or by clinical assessments, but some cohorts also relied on information from routine

Table 1. Overview of included European pregnancy and birth cohorts and their characteristics

Cohort (Full name of cohort)	Country	Regions covered	Timing of enrolment	Prospective/retrospective collection of information on pregnancy exposures	Number of live-born children	Key scientific area
ABC ([a]Aarhus Birth Cohort[23])	Denmark	Aarhus	Pregnancy	Prospective	106 370	General with multiple aims
ABCD (Amsterdam-born Children and their development cohort[8])	Netherlands	Amsterdam	Pregnancy	Prospective	6161	General with multiple aims
ABIS (All babies in Southeast Sweden[24])	Sweden	South Eastern Sweden	[d]Birth	Retrospective	17 045	General with multiple aims
ALSPAC (Avon Longitudinal Study of Parents & Children/Children of the 90 s[7])	United Kingdom	Avon	Pregnancy	Prospective	14 062	General with multiple aims
BAMSE (Stockholm Children Allergy and Environmental Prospective Birth Cohort Study[25])	Sweden	Stockholm	[d]Birth	Retrospective	4089	Environmental exposures and asthma
BASELINE (Babies after scope: evaluating the longitudinal impact using neurological and nutritional endpoints[26])	Ireland	Cork	Pregnancy	No collection of information on pregnancy exposures	2185	Fetal growth, early life exposures, multidisciplinary outcomes
BIB (Born in Bradford[27])	United Kingdom	Bradford	Pregnancy	Prospective	13 776	General with multiple aims. A specific aim of comparing South Asian to White British populations
BILD ([a]Bern-Basel-Infant Lung Development Cohort[28])	Switzerland	Bern, Basel	Pregnancy	Prospective	488	Wheezing/asthma/allergy
CCC2000 (Copenhagen Child Cohort[29])	Denmark	Copenhagen	[d]Birth	Retrospective	6090	Developmental trajectories of psychopathology and physical health
CHEF-1 (Children's health and the environment in the Faeroes[30])	Faroe Islands	Faroe Islands	Pregnancy	Prospective	1022	Environmental exposures and neurodevelopment
CHEF-3 (Children's health and the environment in the Faeroes[30])	Faroe Islands	Faroe Islands	Pregnancy	Prospective	656	Environmental exposures and neurodevelopment
CHEF-5 (Children's health and the environment in the Faeroes[30])	Faroe Islands	Faroe Islands	[d]Birth	Retrospective	491	Environmental exposures and neurodevelopment
CHOPIN (Childhood Obesity: Early Programming by Infant Nutrition)	Germany	Munich	[d]Birth	Retrospective	1678	Nutritional exposures and obesity
Co.N.ER (Bologna Birth Cohort[31])	Italy	Bologna	[d]Birth	Retrospective	654	Environmental/nutritional exposures and wheezing/asthma/allergy
CZECH (Czech early childhood health[32])	Czech Republic	Teplice, Prachatice	Birth	No collection of information on pregnancy exposures	7577	Environmental exposures and growth

Table 1. *Continued*

Cohort (Full name of cohort)	Country	Regions covered	Timing of enrolment	Prospective/retrospective collection of information on pregnancy exposures	Number of live-born children	Key scientific area
DNBC (Danish National Birth Cohort[33])	Denmark	Denmark	Pregnancy	Prospective	94 837	General with multiple aims
EDEN (Study on the pre- and early-postnatal determinants of child health and development[34])	France	Nancy, Poitiers	Pregnancy	Prospective	1907	General with multiple aims
EHL ([b]Growing up in Wales: environments for healthy living[35])	United Kingdom	Swansea	Pregnancy	Prospective	615	General with multiple aims
ELFE (Etude Longitudinale Francaise depuis l'Enfance[36])	France	France	[d]Birth	Retrospective	18 326	General with multiple aims
FCOU (Family and children of Ukraine[37])	Ukraine	Kyiv, Dniprodzerzhynsk, Mariupol	Pregnancy	Prospective	4510	General with multiple aims
G21 (Generation XXI[38])	Portugal	Porto	[d]Birth	Retrospective	8647	General with multiple aims
GASPII (Genetic and environment: prospective study on infancy in Italy[31,39])	Italy	Rome	[d]Birth	Retrospective	708	Environmental/nutritional exposures
GECKO (Groningen Expert Center for Kids with Obesity Drenthe Cohort[40])	Netherlands	Drenthe	Pregnancy	Prospective	2997	Obesity
Generation R[41]	Netherlands	Rotterdam	Pregnancy	Prospective	9749	Environmental exposures, genetic factors and multidisciplinary outcomes
GINIplus (German Infant Study on the influence of Nutrition Intervention[42])	Germany	Munich, Wesel	Birth	No collection of information on pregnancy exposures	5991	Lifestyle exposures
GMS (Gateshead Millennium Study[43])	United Kingdom	North Eastern England	Birth	No collection of information on pregnancy exposures	1029	Lifestyle exposures
HHf2 (Healthy habits for two[44])	Denmark	Aalborg, Odense	Pregnancy	Prospective	11 144	Lifestyle exposures
HUMIS (Norwegian Human Milk Study[45])	Norway	Rogaland, Telemark, Troms, Finmark, Oppland, Akershus, Østfold	[d]Birth	Retrospective (half the cohort)	2500	Microbial/POPs/ other environmental exposures and child health outcomes
INMA (INMA-Environment and Childhood Project[46])	Spain	Ribera Ebre, Menorca, Granada, Valencia, Sabadell, Asturias, Gipuzkoa	Pregnancy	Prospective	3768	Environmental/nutritional exposures, genetic factors, and birth outcomes/ wheezing/ asthma/allergy/growth/ neurodevelopment

Table 1. *Continued*

Cohort (Full name of cohort)	Country	Regions covered	Timing of enrolment	Prospective/retrospective collection of information on pregnancy exposures	Number of live-born children	Key scientific area
[e]***INUENDO*** (Human fertility at risk from biopersistent organochlorines in the environments[47])	Sweden, Poland, Ukraine, Greenland	Sweden (east & west coast), Warsaw, Kharkiv, all regions in Greenalnd	Pregnancy	Prospective	1322	Environmental exposures semen quality and fertility
KANC (Kaunas Cohort[48])	Lithuania	Kaunas	Pregnancy	Prospective	4405	Environmental exposures, genetic factors and birth outcomes, children wheezing/asthma/allergy/growth/ neurodevelopment
KOALA (KOALA Birth Cohort Study[49])	Netherlands	Southern Netherlands	Pregnancy	Prospective	2834	Wheezing/asthma/allergy/growth/development
Kraków Cohort[50]	Poland	Kraków	Pregnancy	Prospective	505	Environmental exposures and birth outcomes/neurodevelopment
[b]***LIFE Child***	Germany	Leipzig	Pregnancy	Prospective	[c]2000	General with multiple aims
Lifeways Cross-Generation Cohort Study[51]	Ireland	Dublin, Galway	Pregnancy	Prospective	1094	General with multiple aims
LISAplus (Influence of lifestyle factors on the development of the immune system and allergies in East and West Germany[52])	Germany	Munich, Leipzig, Wesel, Bad Honnef	Birth	No collection of information on pregnancy exposures	3097	Environmental/nutritional exposures and wheezing/asthma/allergy
LRC (Leicester Respiratory Cohorts[53])	United Kingdom	Leicestershire and Rutland	Birth	No collection of information on pregnancy exposures	10 650	Wheezing/asthma/cough/ growth/allergy
LUKAS[54]	Finland	Kuopio, Jyväskylä, Joensuu, Iisalmi	Pregnancy	Prospective	442	Microbial exposure and wheezing/asthma/allergy
MAS-90 (Multizentrische Allergie Studie[55])	Germany	Berlin, Munich, Freiburg, Mainz, Düsseldorf	Birth	No collection of information on pregnancy exposures	1 314	Wheezing/asthma/allergy
Merthyr Allergy Study[15]	United Kingdom	Southern Wales	Pregnancy	Prospective	497	Environmental/nutritional exposures and wheezing/asthma/allergy
MoBa (Norwegian Mother and Child Cohort Study[56])	Norway	Norway	Pregnancy	Prospective	108 500	General with multiple aims
MUBICOS ([b]Multiple Births Cohort Study[57])	Italy	Rome, Turin, Trieste, Bologna, Pisa, Foggia, Palermo	[d]Birth	Retrospective	[c]1000	General with multiple aims
NINFEA ([a]Nascita e INFanzia: gli Effetti dell'Ambiente[58])	Italy	Italy	Pregnancy	Prospective	[c]7500	General with multiple aims
OCC ([b]Odense Child Cohort)	Denmark	Odense	Pregnancy	Prospective	2 578	General with multiple aims

Table 1. *Continued*

Cohort (Full name of cohort)	Country	Regions covered	Timing of enrolment	Prospective/retrospective collection of information on pregnancy exposures	Number of live-born children	Key scientific area
PARIS (Pollution and Asthma Risk: an Infant Study[59])	France	Paris	[d]Birth	Retrospective	3 840	Environmental exposures and wheezing/asthma/allergy
PÉLAGIE (Endocrine disruptors: longitudinal study on pathologies of pregnancy, infertility and childhood[60])	France	Brittany	Pregnancy	Prospective	4 000	Environmental exposures and
PIAMA (Prevention and incidence of asthma and mite allergy[61])	Netherlands	Netherlands	Pregnancy	Prospective	3 963	Environmental/nutritional exposures and wheezing/asthma/allergy
[b]***Piccoli+***[62]	Italy	Rome, Trieste, Firenze, Torino	[d]Birth	Retrospective	[c]2 000	General with multiple aims
PRIDE Study ([b]PRegnancy and Infant DEvelopment Study[16])	Netherlands	Netherlands	Pregnancy	Prospective	502	General with multiple aims
REPRO_PL (Polish Mother and Child Cohort Study[63])	Poland	Lodz, Lask, Legnica Wroclaw, Lublin, Szczecin, Piekary Slaskie, Katowice, Mikolow	Pregnancy	Prospective	1 647	General with multiple aims
RHEA (Mother child cohort in crete[64])	Greece	Heraklion	Pregnancy	Prospective	1 590	General with multiple aims
SEATON (Study of eczema and asthma to observe the effects of nutrition[65])	United Kingdom	Aberdeen	Pregnancy	Prospective	1 924	Nutritional exposures and wheezing/asthma/allergy
Slovak PCB Study (Early childhood development and PCB exposures in Slovakia[66])	Slovak Republic	Michalovce, Stropkov, Svidnik	[d]Birth	Retrospective	1 139	Environmental exposures
SWS (Southampton Women's Survey[67])	United Kingdom	Southampton	Pre-pregnancy	Prospective	3 159	General with multiple aims
Trieste Cohort (Trieste child development cohort)	Italy	Trieste	Pregnancy	Prospective	900	Neurodevelopment
WHISTLER (Wheezing Illnesses Study in LEidsche Rijn[68])	Netherlands	Leidsche Rijn	[d]Birth	Retrospective	2 923	Wheezing/asthma/allergy

[a]Open cohort – numbers of live-born children as of June 2012.
[b]Enrolment not completed.
[c]Expected number of children that will be enrolled in the cohort. The actual numbers may be slightly lower.
[d]Birth cohorts that collect inormation on pregnancy exposures retrospectively.
[e]The INUENDO represents Greenland that is however not a part of the European continent geographically, but it is an autonomous country within the kingdom of Denmark and is therefore associated with Europe politically.

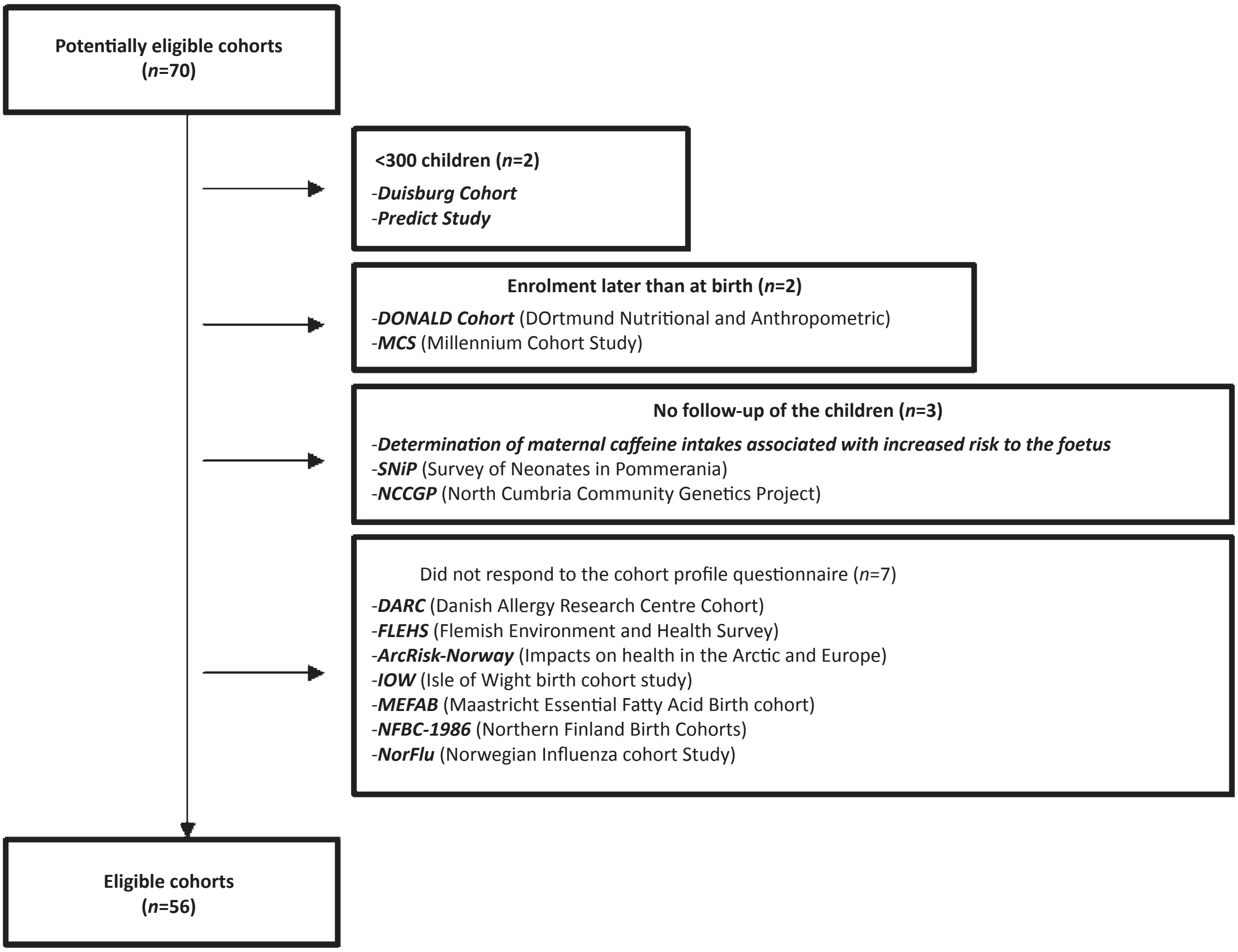


Figure 1. Overview of excluded pregnancy and birth cohorts.

health registers. Many of the cohorts collected biological samples, such as DNA from mother and/or child, although not all cohorts yet have DNA available for, say, genome-wide association studies and epigenome-wide association studies (Table 2). Also, several cohorts have analysed biological samples for biomarkers of environmental exposures, such as water contamination, metals, persistent organic pollutions (POPs) and smoking.[17] It has, however, not been possible to determine the number or which of the included cohorts that have assessed environmental as well as nutrient exposures by means of biomonitoring.

From Figure 3, the data collection waves for each of the cohort appear. It should be noticed that not all exposure and outcome information, as well as biological samples have been collected at each follow-up of the children. What has been collected by the cohorts at different ages of the children can be found at http://www.birthcohorts.net.

Why collaborate across cohorts?

The aetiology of some rare conditions, such as congenital heart defects and childhood epilepsy, could be, and has been explored using large cohorts built from existing disease and related registers which can be linked.[18–20] For some research questions these registers are however unlikely to have data on relevant exposures. For example, biological samples as well as detailed questionnaire and physical examination data are rarely available in registers, which can assess exposures such as diet, physical activity, smoking, alcohol and body composition with reasonable accuracy. However, there are also other major reasons for using data from existing cohorts on a collaborative

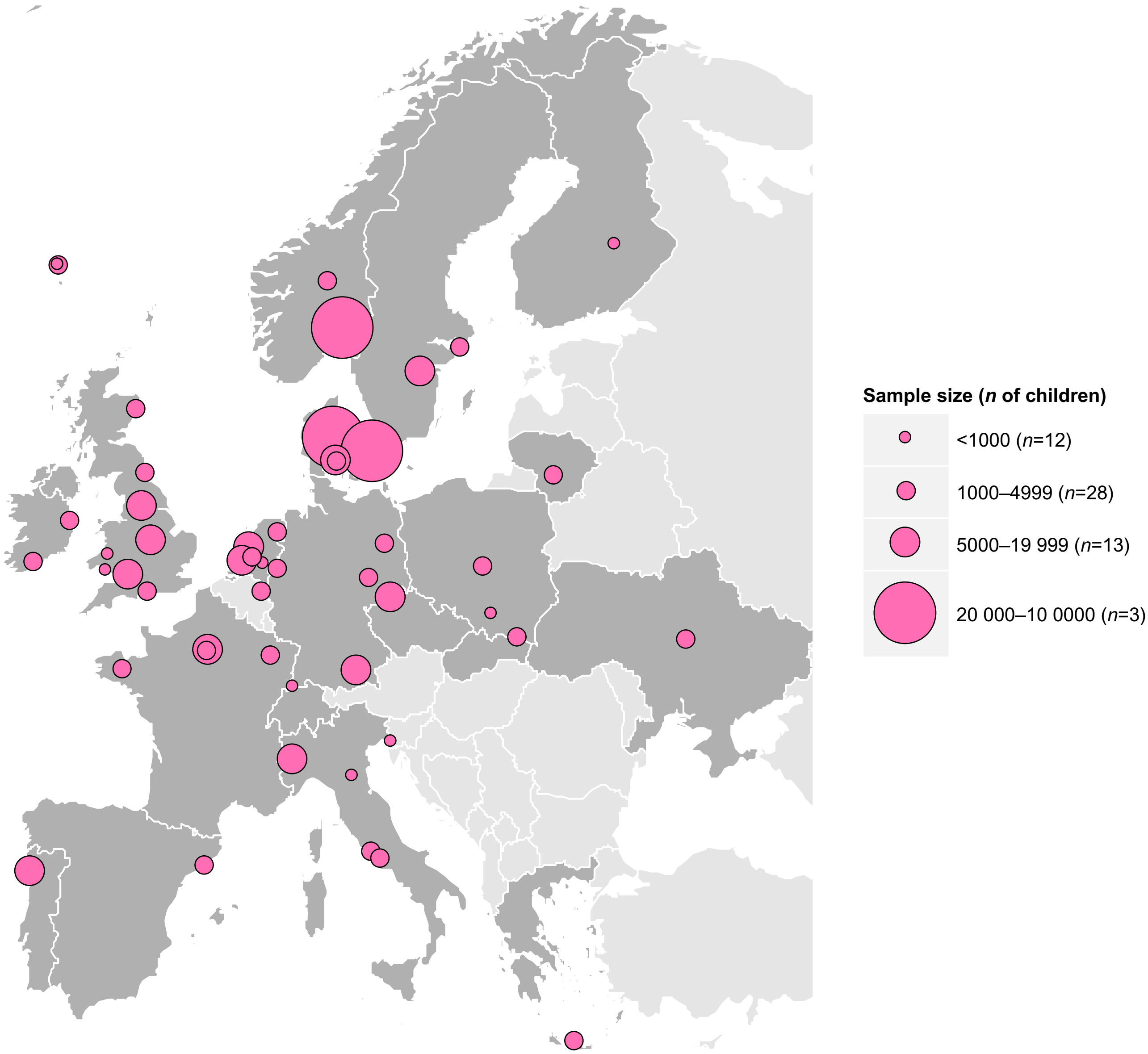


Figure 2. Location and sample size (No. of children) of included European pregnancy and birth cohorts.

basis: (i) the variation in geography and time periods make it likely that confounding structures would differ between cohorts, and thus cross-cohort comparisons could strengthen causal inference;[4] (ii) many cohorts have collected biological samples with DNA and could explore genetic associations with rare phenotypes in collaboration, as well as biological samples for biomonitoring of environmental and nutrient exposures; (iii) replication of findings is increasingly recognised as important, and the European pregnancy and birth cohorts provide ample opportunity for doing this; (iv) the cohorts provide the opportunity for doing pooled analyses in order to increase statistical precision, which is likely to be particularly valuable for exploring associations with rare outcomes; and finally (v) funding for single cohorts, encompassing very large samples, is rarely feasible.

Statistical precision

We have performed a number of power calculations under different assumptions in order to demonstrate the statistical implications of pooling data across cohorts. Figure 4 illustrates that a study of 200 000 mother–child pairs would have a statistical power of

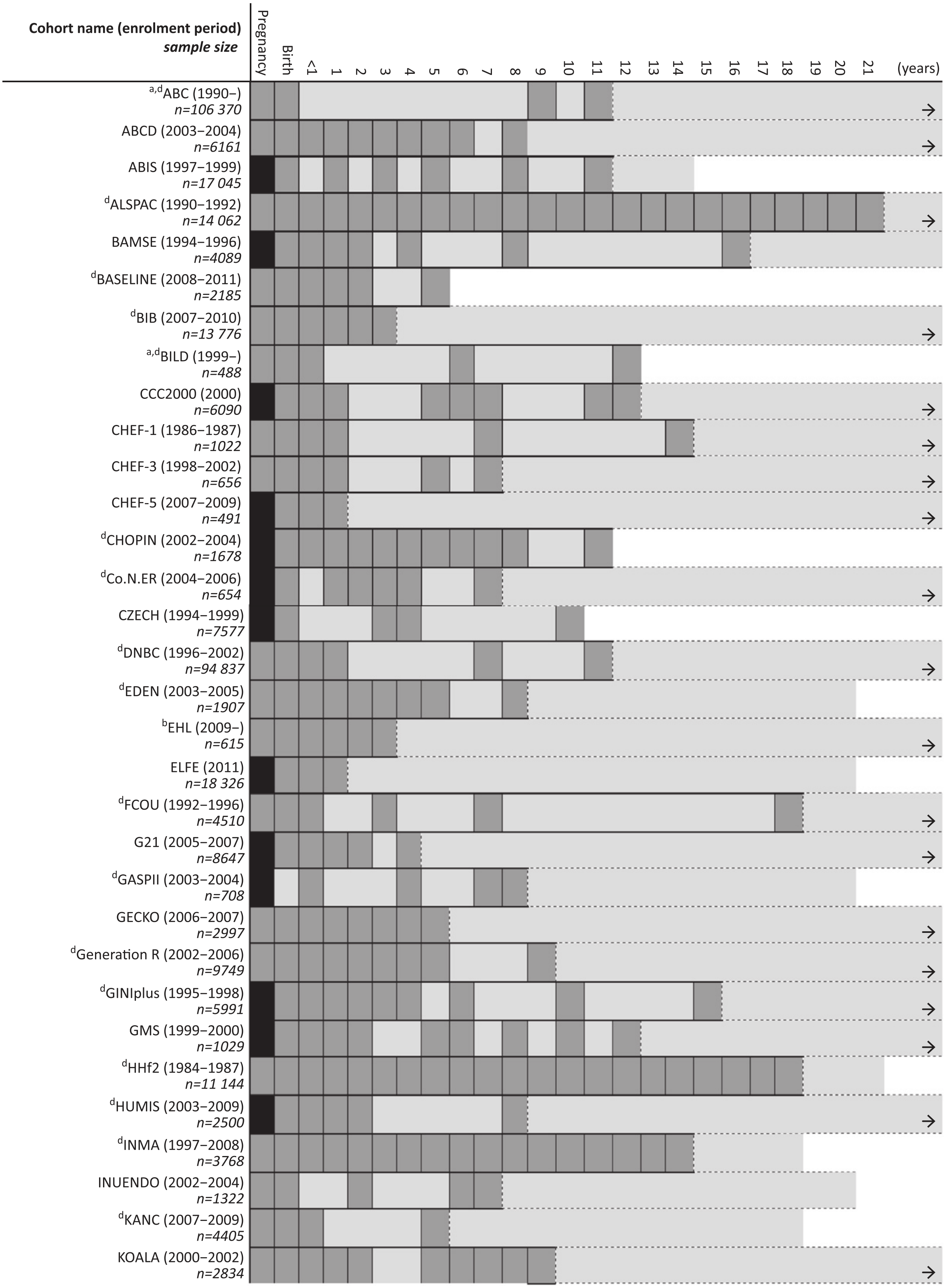


Figure 3. Enrolment and follow-up of the children in the included European pregnancy and birth cohorts.

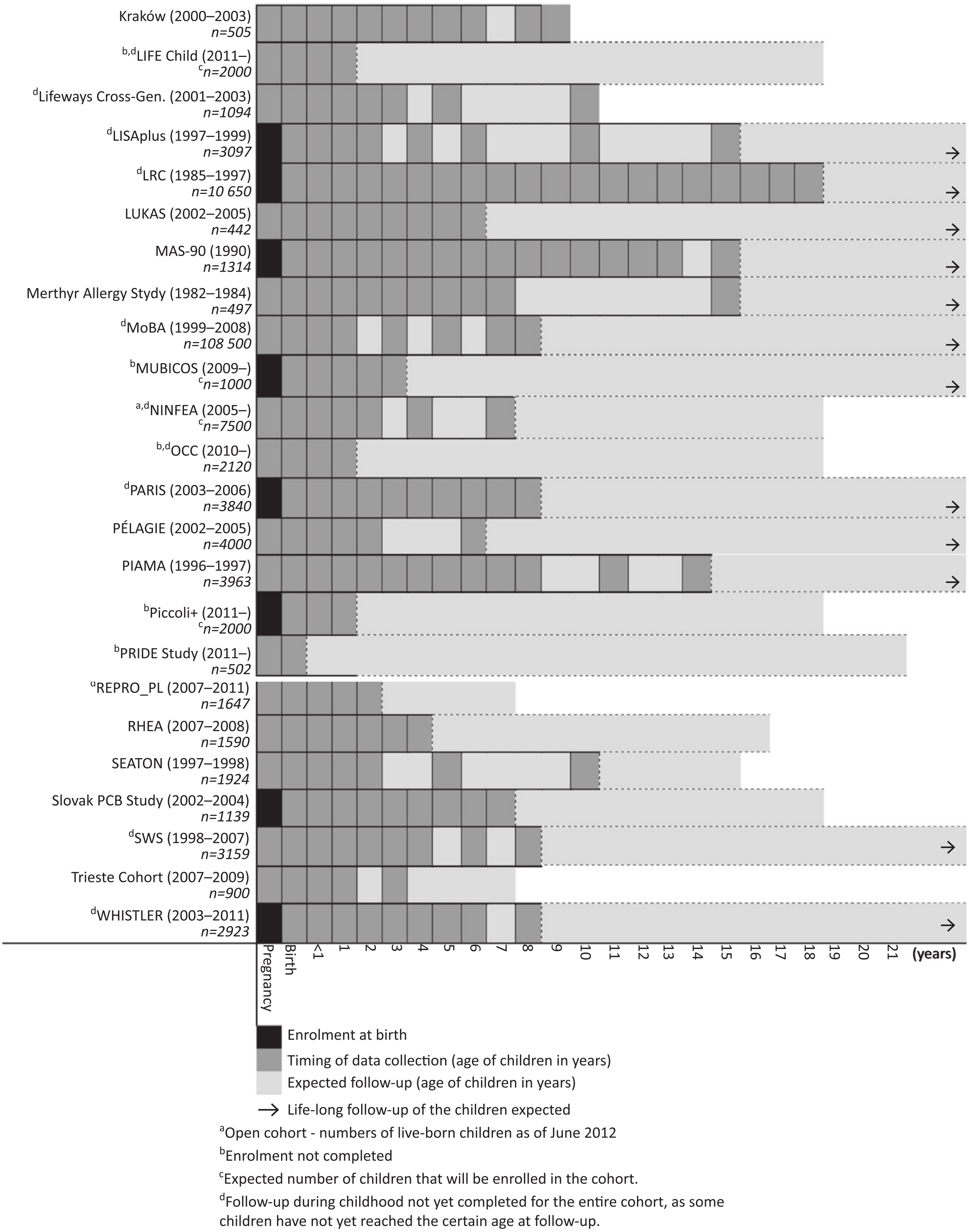


Figure 3. *Continued*

Table 2. Selected exposure and outcome data and biological samples collected by the included European pregnancy and birth cohorts

Maternal demographic characteristics	Name/acronym	No. of cohorts
Age at birth	ABC, ABCD, ABIS, ALSPAC, BAMSE, BASELINE, BIB, BILD, CCC2000, CHEF-3, CHEF-5, CHOPIN, Co.N.ER, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GINIpuls, GMS, HHf2, HUMIS, INMA, INUENDO, KANC, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LISAplus, LRC, LUKAS, Merthyr Allergy Study, MoBa, MUBICOS, NINFEA, OCC, PARIS, PIAMA, PRIDE Study, Piccoli+, PÉLAGIE, REPRO_PL, RHEA, SEATON, Slovak PCB Study, SWS, Trieste Cohort, WHISTLER	54
Ethnicity	ABC, ABCD, ABIS, ALSPAC, BAMSE, BASELINE, BIB, BILD, CCC2000, CHEF-1, CHEF-3, CHEF-5, CHOPIN, CZECH, EHL, FCOU, GASPII, GECKO, Generation R, GMS, HUMIS, INMA, INUENDO, KANC, KOALA, LIFE Child, LRC, LUKAS, MUBICOS, OCC, PARIS, PÉLAGIE, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, Slovak PCB Study, SWS, Trieste Cohort, WHISTLER	41
Education	ABC, ABCD, ABIS, ALSPAC, BAMSE, BASELINE, BIB, BILD, CCC2000, CHEF-3, CHEF-5, CHOPIN, Co.N.ER, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GMS, HHf2, HUMIS, INMA, INUENDO, KANC, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LRC, LUKAS, MoBa, MUBICOS, NINFEA, OCC, PARIS, PÉLAGIE, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SEATON, Slovak PCB Study, SWS, Trieste Cohort, WHISTLER	51
Occupation	ABC, ABCD, ABIS, ALSPAC, BAMSE, BASELINE, BIB, BILD, CCC2000, CHEF-3, CHEF-5, CHOPIN, Co.N.ER, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GMS, HHf2, HUMIS, INMA, INUENDO, KANC, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LRC, LUKAS, Merthyr Allergy Study, MoBa, MUBICOS, NINFEA, OCC, PARIS, PÉLAGIE, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SEATON, Slovak PCB Study, SWS, Trieste Cohort, WHISTLER	48
Income	ABC, ABCD, ABIS, ALSPAC, BASELINE, BIB, CCC2000, EDEN, EHL, ELFE, G21, GECKO, Generation R, HUMIS, LIFE Child, Lifeways Cross-Gen., LRC, MoBa, PÉLAGIE, PRIDE Study, Slovak PCB Study, WHISTLER	21

Maternal obstetric characteristics	Name/acronym	No. of cohorts
Fertility treatment	ABC, ABCD, ALSPAC, CHEF-5, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, HHf2, HUMIS, INMA, MoBa, MUBICOS, NINFEA, OCC, PELAGIE, Piccoli+, PRIDE Study, RHEA	24
Parity	ABC, ABCD, ABIS, ALSPAC, BAMSE, BIB, BILD, CCC2000, CHEF-1,CHEF-3, CHEF-5, CHOPIN, Co.N.ER, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GINIplus, HHf2, HUMIS, INMA, INUENDO, KANC, KOALA, LIFE Child, Lifeways Cross-Gen., LRC, LUKAS, Merthyr Allergy Study, MoBa, MUBICOS, NINFEA, OCC, PARIS, PÉLAGIE, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SEATON, Slovak PCB Cohort, SWS, Trieste Cohort	49
Waiting time to pregnancy	ABC, ABCD, ALSPAC, CHEF-5, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GECKO, Generation R, HHf2, HUMIS, INMA, INUENDO, KOALA, LIFE Child, MoBa, NINFEA, OCC, PÉLAGIE, Piccoli+, PRIDE Study, RHEA,	25
Mode of delivery	ABC, ABCD, ABIS, ALSPAC, BAMSE, BASELINE, BIB, BILD, CCC2000, CHEF-1, CHEF-3, CHEF-5, CHOPIN, Co.N.ER, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GINIplus, GMS, HHf2, HUMIS, INMA, KOALA, Kraków Cohort, Lifeways Cross-Gen., LISAplus, LRC, LUKAS, Merthyr Allergy Study, Moba, MUBICOS, NINFEA, OCC, PARIS, PÉLAGIE, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SEATON, Slovak PCB Study, SWS, Trieste Cohort, WHISTLER	52
Prenatal diagnostics	ABCD, ALSPAC, BIB, CCC2000, CHEF-3, CHEF-5, Co.N.ER, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GECKO, Generation R, HHf2, Life Child, Lifeways Cross-Gen., MUBICOS, MoBa, NINFEA, OCC, Piccoli+, PRIDE Study, PÉLAGIE, REPRO_PL, RHEA, WHISTLER	29

Maternal lifestyle characteristics	Name/acronym	No. of cohorts
Weight and height	ABC, ABCD, ABIS, ALSPAC, BAMSE, BASELINE, BIB, CHEF-3, CHEF-5, CHOPIN, Co.N.ER, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GMS, HHf2, HUMIS, INMA, INUENDO, KANC, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LRC, LUKAS, MoBa, MUBICOS, NINFEA, OCC, PÉLAGIE, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SEATON, Slovak PCB Study, SWS, Trieste Cohort, WHISTLER	47

Table 2. *Continued*

Maternal lifestyle characteristics	Name/acronym	No. of cohorts
Smoking	ABC, ABCD, ABIS, ALSPAC, BAMSE, BASELINE, BIB, BILD, CCC2000, CHEF-1, CHEF-3, CHEF-5, CHOPIN, Co.N.ER, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GMS, HHf2, HUMIS, INMA, INUENDO, KANC, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LRC, LUKAS, Merthyr Allergy Study, MoBa, MUBICOS, NINFEA, OCC, PARIS, PÉLAGIE, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SEATON, Slovak PCB Study, SWS, Trieste Cohort, WHISTLER	53
Alcohol consumption	ABC, ABCD, ABIS, ALSPAC, BASELINE, BIB, BILD, CHEF-1, CHEF-3, CHEF-5, CHOPIN, Co.N.ER, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GMS, HHf2, HUMIS, INMA, INUENDO, KANC, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., MoBa, MUBICOS, NINFEA, OCC, PÉLAGIE, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SEATON, Slovak PCB Study, SWS, Trieste Cohort, WHISTLER	44
Diet	ABC, ABCD, ABIS, ALSPAC, BASELINE,BILD, CHEF-1, CHEF-3, CHEF-5, Co.N.ER, DNBC, EDEN, EHL, ELFE, FCOU, GASPII, Generation R, GMS, HHf2, HUMIS, INMA, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LUKAS, MoBa, NINFEA, OCC, PÉLAGIE, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SEATON, Slovak PCB Study, SWS, Trieste Cohort	39
Physical activity	ABC, ABCD, ALSPAC, BASELINE, BIB, CHOPIN, DNBC, EDEN, EHL, ELFE, FCOU, GECKO, Generation R, GMS, HHf2, HUMIS, INMA, KOALA, Lifeways Cross-Gen., MoBa, MUBICOS, NINFEA, OCC, PÉLAGIE, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SWS,WHISTLER	30
Medication	ABC, ABCD, ABIS, ALSPAC, BASELINE, BIB, BILD,CHEF-1, CHEF-3, CHEF-5, CHOPIN, Co.N.ER, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, HHf2, HUMIS, INMA, INUENDO,KANC, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LUKAS, MoBa, MUBICOS, NINFEA, OCC, PARIS, PÉLAGIE, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, Slovak PCB Study, SWS, Trieste Cohort, WHISTLER	47
Maternal environmental exposures	**Name/acronym**	**No. of cohorts**
Occupational hazards	ABC, ABCD, ALSPAC, BIB, Co.N.ER, CZECH, DNBC, EDEN, ELFE, FCOU, GASPII, Generation R, HUMIS, INMA, INUENDO, KANC, Kraków Cohort, MoBa, MUBICOS, NINFEA, PÉLAGIE, Piccoli+, PRIDE Study, REPRO_PL, RHEA, Trieste Cohort, WHISTLER	27
Outdoor air pollution	ABCD, BIB BILD, CZECH, DNBC, EDEN, GASPII, Generation R, INMA, KANC, Kraków Cohort, Lifeways Cross-Gen., NINFEA, PIAMA, Piccoli+, REPRO_PL, RHEA, Trieste Cohort, WHISTLER	19
Indoor air pollution	ABCD, BILD, Co.N.ER, DNBC, EDEN, ELFE, FCOU, GASPII, Generation R, INMA, KOALA, Kraków Cohort, LUKAS, NINFEA, OCC, PIAMA, Piccoli+, REPRO_PL RHEA, Trieste Cohort, WHISTLER	21
Infant and child exposures	**Name/acronym**	**No. of cohorts**
Childcare attendance	ABCD, ABIS, ALSPAC, BAMSE, BASELINE, BIB, BILD, CCC2000, CHEF-3, CHEF-5, Co.N.ER, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GINIplus, HHf2, INMA, INUENDO, KOALA, LIFE child, Lifeways Cross-Gen., LISAplus, LRC, LUKAS, MoBa, MUBICOS, NINFEA, PARIS, PÉLAGIE, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, WHISTLER	42
Passive smoking	ABCD, ABIS, ALSPAC,BAMSE, BASELINE, BILD, CCC2000, CHEF-1, CHOPIN, DNBC, EDEN, ELFE, FCOU, GASPII, Generation R, GINIplus, GMS, HHf2, INMA,KANC, KOALA, LIFE Child, LISAplus, LRC, LUKAS, Merthyr Allergy Study, MoBa, NINFEA, PARIS, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, SEATON, Slovak PCB Study, SWS	36
Breast feeding	ABCD, ABIS, ALSPAC, BAMSE, BASELINE, BIB, BILD, CCC2000, CHEF-1, CHEF-3, CHEF-5, CHOPIN, Co.N.ER, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GINIplus, GMS, HHf2, HUMIS, INMA, INUENDO,KANC, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LISAplus, LRC, LUKAS, Merthyr Allergy Study, MoBa, MUBICOS, NINFEA, OCC, PARIS, PÉLAGIE, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SEATON, Slovak PCB Study, SWS, Trieste Cohort, WHISTLER	55

Table 2. *Continued*

Infant and child exposures	Name/acronym	No. of cohorts
Diet	ABCD, ABIS, ALSPAC, BAMSE, BASELINE, BIB, BILD, CCC2000, CHEF-1, CHEF-3, CHOPIN, Co.N.ER, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GINIplus, GMS, HHf2, HUMIS,INMA, INUENDO,KANC, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LISAplus, LRC, LUKAS, Merthyr Allergy Study, MoBa, MUBICOS, NINFEA, OCC, PARIS, PÉLAGIE, PIAMA, Piccoli+, REPRO_PL, RHEA, SEATON, Slovak PCB Study, SWS, Trieste Cohort, WHISTLER	51
Physical activity	ABCD, ABIS, BAMSE, BIB, BILD, CCC2000, CHEF-1, CHOPIN, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GINIplus, GMS, HHf2, INMA, INUENDO,KANC, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LISAplus, LRC, LUKAS, MoBa, MUBICOS, OCC, PARIS, PÉLAGIE, PIAMA, RHEA, SEATON, SWS, WHISTLER	40
Medication	ABCD, ABIS, ALSPAC, BAMSE, BASELINE, BIB, BILD, CHEF-1, CHEF-3, CHEF-5, CHOPIN, Co.N.ER, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GMS, HHf2, HUMIS, INUENDO, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LRC, LUKAS, MoBa, MUBICOS, NINFEA, OCC, PARIS, PÉLAGIE, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SEATON, SWS, WHISTLER	46
Vaccination	ABIS, ALSPAC, BAMSE, BASELINE, BIB, BILD, CHEF-1, CHEF-3, CHEF-5, Co.N.ER, DNBC, EDEN, ELFE, FCOU,GASPII, Generation R, HHf2, INUENDO, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LRC, LUKAS, MoBa, MUBICOS, NINFEA, OCC, PARIS, PÉLAGIE, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, Slovak PCB Study, SWS, WHISTLER	38

Prenatal and perinatal outcomes	Name/acronym	No. of cohorts
Birth weight and gestational age	ABC, ABCD, ABIS, ALSPAC, BAMSE, BASELINE, BIB, BILD, CCC2000, CHEF-1, CHEF-3, CHEF-5, CHOPIN, Co.N.ER, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GINIplus, GMS, HHf2, HUMIS, INMA, INUENDO, KANC, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LISAplus, LRC, LUKAS, MAS-90, Merthyr Allergy Study, MoBa, MUBICOS, NINFEA, OCC, PARIS, PÉLAGIE, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SEATON, Slovak PCB Study, SWS, Trieste Cohort, WHISTLER	56
Congenital malformation	ABC, ABCD, ABIS, ALSPAC,BASELINE, BIB, CCC2000, CHEF-1, CHEF-3, CHEF-5, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, HHf2, HUMIS, INMA, KANC, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., Merthyr Allergy Study, MoBa, MUBICOS, NINFEA, OCC, PÉLAGIE, Piccoli+, PRIDE Study, REPRO_PL, SWS, Trieste Cohort, WHISTLER	39
Miscarriage (<20 or <22 weeks)	ABC, ABCD, ALSPAC, Co.N.ER, DNBC, EDEN, ELFE, FCOU, GASPII, GECKO, Generation R, HHf2, INMA, INUENDO, KANC, LIFE Child, MUBICOS, OCC, PRIDE Study, REPRO_PL, RHEA	21
Stillbirth	ABC, ABCD, ALSPAC, BIB, CCC2000, Co.N.ER, DNBC, EDEN, FCOU, GECKO, Generation R, INMA, Lifeways Cross-Gen., LRC, MoBa, OCC, PÉLAGIE, PRIDE Study, RHEA, SEATON, SWS	22

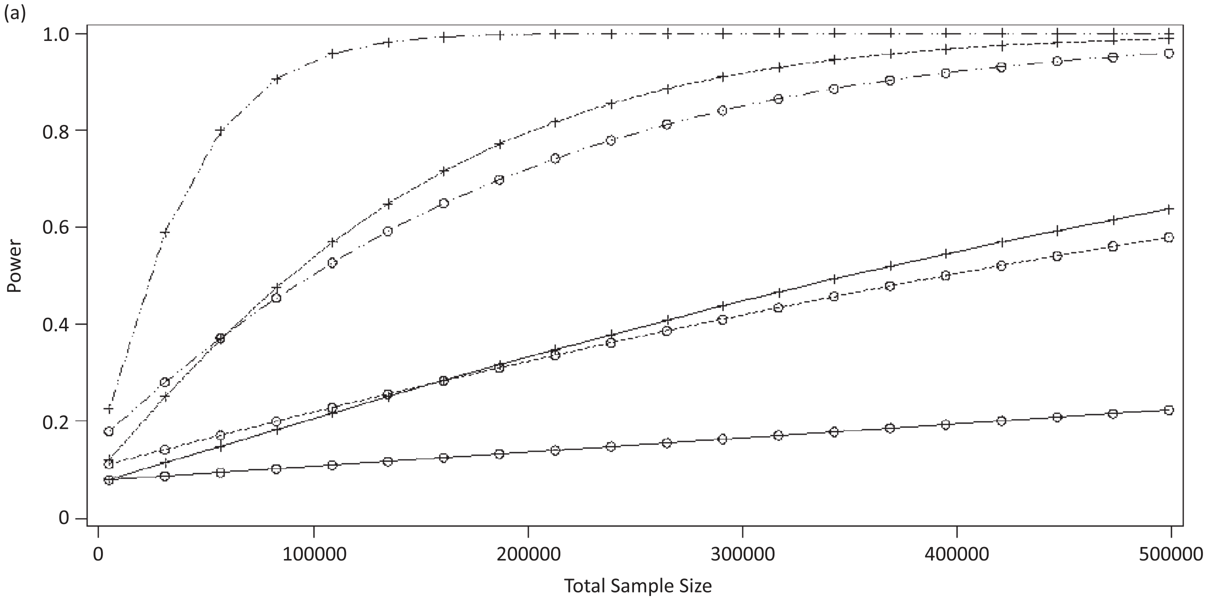
Development and child health outcomes	Name/acronym	No. of cohorts
Asthma/allergy	ABCD, ABIS, BAMSE, BASELINE, BIB, BILD, CCC2000,CHEF-1, CHEF-3, CHEF-5, CHOPIN, Co.N.ER, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GINIplus, GMS, HHf2, HUMIS, INMA, INUENDO, KANC, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LISAplus, LRC, LUKAS, Merthyr Allergy study, MoBa, MUBICOS, NINFEA, OCC, PARIS, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SEATON, Slovak PCB Study, SWS, WHISTLER	51
Weight and height	ABCD, ABIS, BAMSE, BASELINE, BIB, BILD, CCC2000, CHEF-1, CHEF-3, CHEF-5, CHOPIN, Co.N.ER, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, GECKO, Generation R, GMS, HHf2, HUMIS, INMA, INUENDO, KANC, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LRC, LUKAS, MoBa, MUBICOS, NINFEA, OCC, PARIS, PÉLAGIE, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SEATON, Slovak PCB Study, SWS, WHISTLER	48
Sexual maturation	ALSPAC, BAMSE, CCC2000, CHEF-1, CHEF-3, CHOPIN, DNBC, EDEN, FCOU, GINIplus, GMS, HHf2, INMA, KOALA, LIFE Child, LISAplus, LRC, LUKAS, PIAMA	19
Mental health	ABCD, ABIS, BIB, CCC2000, CHEF-1, CHEF-5, CHOPIN, DNBC, EDEN, ELFE, FCOU, Generation R, HHf2, HUMIS, KANC, KOALA, LIFE Child, MoBa, Trieste Cohort	20

Table 2. *Continued*

Development and child health outcomes	Name/acronym	No. of cohorts
Neuro-development	ABCD, BASELINE, BIB, CCC2000, CHEF-1, CHEF-3 CHEF-5, CHOPIN, Co.N.ER, DNBC, EDEN, ELFE, FCOU, GASPII, Generation R, HHf2, HUMIS, INMA, KANC, KOALA, LIFE Child, MoBa, MUBICOS, NINFEA, PÉLAGIE, Piccoli+, PRIDE Study, REPRO_PL, RHEA, Slovak PCB Study, SWS, Trieste Cohort	31
Infectious disease	ABCD, ABIS, BAMSE, BASELINE, BIB, BILD, CHEF-3, CHEF-5, Co.N.ER, CZECH, DNBC, EDEN, EHL, ELFE, FCOU, G21, GASPII, Generation R, GINIplus, HHf2, HUMIS, INMA, INUENDO, KOALA, Kraków Cohort, LIFE Child, Lifeways Cross-Gen., LISAplus, LUKAS, MoBa, MUBICOS, NINFEA, OCC, PARIS, PÉLAGIE, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, WHISTLER	41
Biological samples	**Name/acronym**	**No. of cohorts**
Maternal whole blood	ABC, ALSPAC, BIB, CZECH, CHEF-1, CHEF-3, CHEF-5, DNBC, EDEN, ELFE, G21, Generation R, HUMIS, INMA, INUENDO, KANC, KOALA, Kraków Cohort, MoBa, PIAMA, PRIDE Study, REPRO_PL, RHEA, SWS	24
Maternal serum/plasma	ABC, ABCD, ABIS, ALSPAC, BIB, CHEF-3, CHEF-5, Co.N.ER, DNBC, EDEN, ELFE, G21, GASPII, Generation R, INMA, INUENDO, KOALA, LIFE Child, LUKAS, MoBa, OCC, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SEATON, Slovak PCB Study, SWS, Trieste Cohort	29
Maternal DNA	ABC, ALSPAC, Co.N.ER, CZECH, DNBC, EDEN, GASPII, Generation R, GSM, INMA, INUENDO, KANC, KOALA, LIFE Child, LUKAS, MoBa, MUBICOS, NINFEA, OCC, PIAMA, Piccoli+, PRIDE Study, REPRO_PL, RHEA, SWS	25
Breast milk	ABIS, CHEF-1, CHEF-3, CHEF-5, EDEN, ELFE, FCOU, HUMIS, INMA, KOALA, LIFE Child, LUKAS, OCC, PIAMA, REPRO_PL, Slovak PCB Study, Trieste Cohort	17
Child whole blood	ABC, ABCD, ABIS, ALSPAC, BAMSE, BASELINE, BIB, BILD, CHEF-1, CHEF-3, CHEF-5, CHOPIN, DNBC, EDEN, FCOU, GECKO, Generation R, GINIplus, GMS, INMA, KANC, KOALA, Kraków Cohort, Lifeways Cross-Gen., LISAplus, LRC, LUKAS, MoBa, PARIS, PIAMA, RHEA, Slovak PCB Study	32
Child serum/plasma	ABC, ABIS, ALSPAC, BAMSE, BASELINE, BIB, BILD, CHEF-1, CHEF-3, CHEF-5, CHOPIN, Co.N.ER, DNBC, EDEN, FCOU, G21, GASPII, GECKO, Generation R, GINIplus, INMA, KOALA, LIFE Child, Lifeways Cross-Gen., LISAplus, LRC, LUKAS, MoBa, OCC, PARIS, Piccoli+, RHEA, SEATON, Slovak PCB Study	34
Child DNA	ABC, ABIS, ALSPAC, BAMSE, BASELINE, BILD, CHOPIN, Co.N.ER, CZECH, DNBC, EDEN, GASPII, GECKO, Generation R, GINIplus, GSM, INMA, INUENDO, KANC, KOALA, LIFE Child, Lifeways Cross-Gen., LISAplus, LRC, LUKAS, MoBa, MUBICOS, NINFEA,OCC, PARIS, PIAMA, Piccoli+, SWS	33
Umbilical cord blood	ABC, ABIS, ALSPAC, BASELINE, BIB, BILD, CHEF-1, CHEF-3, CHEF-5, CZECH, DNBC, EDEN, ELFE, G21, GASPII, GECKO, Generation R, HUMIS, INMA, KANC, Kraków Cohort, LIFE Child, LUKAS, MoBa, OCC, PÉLAGIE, Piccoli+, REPRO_PL, RHEA, SEATON, Slovak PCB Study, SWS, Trieste Cohort	33
Paternal DNA	BIB, EDEN, Generation R, INUENDO, KOALA, LIFE Child, MoBa, MUBICOS, OCC, PIAMA, RHEA, SWS	12

80% to detect a relative risk of 1.5 for a rare outcome (0.2%), given an exposure prevalence of 10%, at a 5% significance level. For an exposure prevalence of 2%, and an outcome prevalence of 0.2%, a sample size of around 300.000 would render it possible to detect a relative risk of 2.0 with a statistical power of 80%, at a 5% significance level. To illustrate the opportunities provided, a total of 39 cohorts, which collected information on congenital malformation can be identified at http://www.birthcohorts.net, varying from small ($n = 491$ children) to large ($n = 108\,500$ children) cohorts, encompassing a total of 473 152 children. This provides a unique opportunity for exploring early-life determinants of rare anomalies. It is, however, far from likely that information on specific anomalies are available in all 39 cohorts, and since http://www.birthcohorts.net can only indicate broad categories of collected data, the details may reveal that some cohorts that are seemingly eligible for a specific study may not be. Hence, direct contact with PIs to obtain exact information about individual characteristics of each cohort is needed, also to discuss the possibilities

(a)

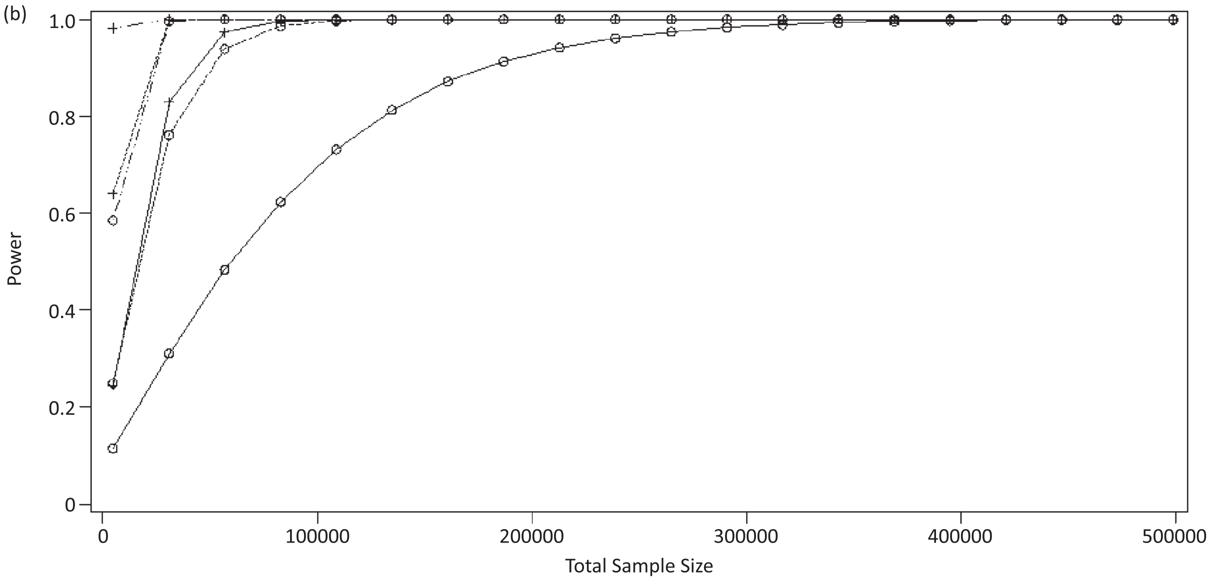


Relative risk
— 1.25
--- 1.50
··— 2.00

Exposure prevalence
o 2%
\+ 10%

X-axis: Total sample sizes referring to the number of mother/child-pairs or number of children needed
Y-axis: Power stated in proportions

(b)



Relative risk
— 1.25
--- 1.50
··— 2.00

Exposure prevalence
o 2%
\+ 10%

X-axis: Total sample sizes referring to the number of mother/child-pairs or number of children needed
Y-axis: Power stated in proportions

Figure 4. Statistical implications of combining of data across cohorts. (a) Assumptions: outcome prevalence 0.2%, significance level 5%. (b) Assumptions: outcome prevalence 5%, significance level 5%.

of data sharing, since registration at http://www.birthcohrts.net not necessarily implies easy or open access to data. However, the above calculations importantly illustrate the value of efforts to work collaboratively across cohorts.

Data collection methods – a great challenge

The wide range of data collection methods that have been used poses a great challenge when pooling data from different cohorts. Therefore, there is a need to develop methods that are suitable to support the use of currently collected data for pooled analyses in epidemiology, and also for considering which exposures and outcomes should be collected by similar items/procedures in future cohorts. Difficulties or challenges in trying to harmonise measures across all or most upcoming cohorts can be that: (i) some cohorts have obtained funding to use the most up to date and most expensive tool for a given exposure, while others only have funds for a much cheaper possibly proxy measure; and (ii) the available resources for different cohorts may reflect the true priorities in different populations in terms of how important different exposures and outcomes are, which will not be the same across Europe. On the other hand, a variety of different measurement methods can be useful for exploring how response and reliability differs between them, and how robust associations are despite differences in methods.

Experiences from ongoing cross-cohort studies

Currently, information from http://www.birthcohorts.net has been used for the identification of cohorts for a number of ongoing collaborative studies in Europe, e.g. a pooled analysis of associations between moderate maternal alcohol consumption and fetal effects in low-risk pregnancies, a comparative study of socio-economic gradients in preterm birth, and a study of occupational hazards and adverse reproductive outcomes. Experiences from these studies have demonstrated remarkable willingness to share data and to do collaborative studies across European cohorts. However, these studies have also highlighted a number of discrepancies between the information about cohort sample sizes at http://www.birthcohorts.net and the actual number of whom data are available. For example, not surprisingly, the number of available participants estimated, based on information at http://www.birthcohorts.net, will commonly reflect the total number of pregnancies/births at the time of enrolment or the expected number of children who will be enrolled, whereas less data for any specific variable will often be available. Furthermore, information on attrition in every single follow-up of the children does not appear anywhere. Since attrition is a major drawback of cohort studies, future updates of the http://www.birthcohorts.net should include this important information.

Another major experience of the difficulties in post-harmonisation of data was that otherwise eligible cohorts had to be excluded from the studies using pooled data, because it was impossible to harmonise data. For example, the study on fetal effects of maternal alcohol consumption included only eight cohorts ($n \approx 270\,000$), as data on maternal alcohol consumption particularly proved impossible to harmonise. The methods used to collect data on alcohol consumption during pregnancy, were different in almost all of the existing cohorts, since some cohorts asked for type and some for total intake, some used open response categories, while others had predefined response categories that moreover differed between the cohorts, and finally the data were collected at different time points during pregnancy. In order to facilitate data harmonisation, the PhenX project has provided the scientific community with a core set of 21 research domains, such as anthropometrics, environmental exposures, nutrition, reproductive health etc., each of which includes up to 16 measures. The PhenX toolkit is freely accessible and for efficient use of data, it could be suggested to apply standard measures as provided by PhenX when planning future cohort studies.[21] However, the measures in the PhenX toolkit have been developed for adults (and parents), and there is a need for additional measures developed specifically for children. On the other hand, many cohorts are at various stages, as in some cohorts the offspring are young adults, while other cohorts have recently started enrolment, and most cohorts would probably use tools corresponding to those used at earlier stages. In these respects, data from existing cohorts have to be post-harmonised in the best possible way. Moreover, a broad coverage of different context-specific exposures may also be highly relevant in the long run.

Another efficient approach of using existing data sources and handling difficulties of data harmonising could be to pool aggregated data obtained separately in different cohorts. However, this arise the risk of aggregation bias that may not reflect the association existing at the individual level. Also, it may be problematic to estimate biologic effects due to heterogeneity in exposure level or level of covariates across cohorts, but this could partly be taken into account if using internal or external information.

Finally, when pooling data from both general cohorts and cohorts that address specific exposures or outcomes, it should be considered that cohorts with specific aims presumable relate to selected groups. For example, some cohorts have excluded ethnic minority groups, while other cohorts include different ethnic groups. This is an issue of major concern for the validity of cross-cohort studies doing pooled analyses, and this need to be carefully considered when interpreting the results.

Conclusions

In conclusion, we have summarised the characteristics of existing pregnancy and birth cohorts in Europe. The database, http://www.birthcohorts.net, proved to be a useful tool for identification of cohorts, but it cannot replace direct contact with PIs to obtain detailed information about individual characteristics of each cohort. Previous publications have similarly summarised characteristics of cohorts that are located in low and middle-income countries and of cohorts which address specific exposures and outcomes.[12–14] The value of these overviews is that they illustrate the potential to address key research questions which require or would greatly benefit from collaboration across cohorts. Whilst we have emphasised the potential added-value of cross-cohort collaboration, we recognise that there are hindrances to such collaborative work. It is simplistic to assume that just because data are available, such collaborative research is available to the scientific community. Clearly, there are costs associated with preparing data sets and completing pooled analyses, and it is important for funders to recognise these requirements. Where key research questions can be addressed by collaboration across existing data sources, it is clearly more cost-effective to support this than to undertake a new European mega-cohort. Other issues, such as whether ethical and governance issues permit data sharing, difficulties in harmonisation of data across cohorts, as well as incomplete recognition of important collaborators to be included may impede high quality collaborative research. Both in the genetic and non-genetic field, an increasing number of examples exist on how these issues can be overcome.[22] Thus, we envisage useful collaborations being realised between European pregnancy and birth cohorts, and we encourage publications of similar overviews from other geographical regions, so that cohorts from all over the globe are ultimately documented. Furthermore, http://www.birthcohorts.net is still open for registration of new cohorts as well as for cohorts registered elsewhere, so that it may serve as a global platform for collaboration. A global overview of the possibilities offered by existing cohorts in life-course research would be of great value, and this would support the vision of active cross-cohort collaboration in order to improve statistical precision, to replicate findings, to share knowledge and to develop strong scientific networks across cohorts.

Acknowledgement

This work was supported by CHICOS ('Developing a Child Cohort Strategy for Europe') a project conducted within the European Community's Seventh Framework Programme (FP7/2009–2013) under grant agreement number 241604.

References

1 Lynch J, Smith GD. A life course approach to chronic disease epidemiology. *Annual Review of Public Health* 2005; 26:1–35.

2 World Health Organization. The European health report 2005: public health action for healthier children and populations. 2005.

3 Paternoster L, Standl M, Chen CM, Ramasamy A, Bonnelykke K, Duijts L, *et al*. Meta-analysis of genome-wide association studies identifies three new risk loci for atopic dermatitis. *Nature Genetics* 2012; 44:187–192.

4 Brion MJ, Zeegers M, Jaddoe V, Verhulst F, Tiemeier H, Lawlor DA, *et al*. Intrauterine effects of maternal prepregnancy overweight on child cognition and behavior in 2 cohorts. *Pediatrics* 2011; 127:e202–e211.

5 Brion MJ, Lawlor DA, Matijasevich A, Horta B, Anselmi L, Araujo CL, *et al*. What are the causal effects of breastfeeding on IQ, obesity and blood pressure? Evidence from comparing high-income with middle-income cohorts. *International Journal of Epidemiology* 2011; 40:670–680.

6 Govarts E, Nieuwenhuijsen M, Schoeters G, Ballester F, Bloemen K, de Boer M, *et al*. Birth weight and prenatal exposure to polychlorinated biphenyls (PCBs) and dichlorodiphenyldichloroethylene (DDE): a meta-analysis within 12 European Birth Cohorts. *Environmental Health Perspectives* 2012; 120:162–170.

7 Boyd A, Golding J, Macleod J, Lawlor DA, Fraser A, Henderson J, *et al*. Cohort Profile: the 'children of the 90s' – the index offspring of the Avon Longitudinal Study of Parents and Children. *International Journal of Epidemiology* 2013; 42:111–127.
8 van Eijsden M, Vrijkotte T, Gemke R, van der Wal M. Cohort profile: the Amsterdam Born Children and their Development (ABCD) study. *International Journal of Epidemiology* 2011; 40:1176–1186.
9 Fuchs O, Latzin P, Kuehni CE, Frey U. Cohort profile: the Bern infant lung development cohort. *International Journal of Epidemiology* 2012; 41:366–376.
10 Li J, Vestergaard M, Obel C, Cnattingus S, Gissler M, Olsen J. Cohort profile: the Nordic Perinatal Bereavement Cohort. *International Journal of Epidemiology* 2011; 40:1161–1167.
11 Santos IS, Barros AJ, Matijasevich A, Domingues MR, Barros FC, Victora CG. Cohort profile: the 2004 Pelotas (Brazil) birth cohort study. *International Journal of Epidemiology* 2011; 40:1461–1468.
12 Batty GD, Alves JG, Correia J, Lawlor DA. Examining life-course influences on chronic disease: the importance of birth cohort studies from low- and middle- income countries. An overview. *Brazilian Journal of Medical Biological Research* 2007; 40:1277–1286.
13 Keil T, Kulig M, Simpson A, Custovic A, Wickman M, Kull I, *et al*. European birth cohort studies on asthma and atopic diseases: I. Comparison of study designs – a GALEN initiative. *Allergy* 2006; 61:221–228.
14 Vrijheid M, Casas M, Bergstrom A, Carmichael A, Cordier S, Eggesbo M, *et al*. European birth cohorts for environmental health research. *Environmental Health Perspectives* 2012; 120:29–37.
15 Burr ML, Merrett TG, Dunstan FD, Maguire MJ. The development of allergy in high-risk children. *Clinical & Experimental Allergy* 1997; 27:1247–1253.
16 van Gelder MM, Bretveld RW, Roukema J, Steenhoek M, van Drongelen J, Spaanderman ME, *et al*. Rationale and design of the PRegnancy and Infant DEvelopment (PRIDE) Study. *Paediatric and Perinatal Epidemiology* 2013; 27:34–43.
17 Gehring U, Casas M, Brunekreef B, Bergstrom A, Bonde JP, Botton J, *et al*. Environmental exposure assessment in European birth cohorts: results from the ENRIECO project. *Environmental Health* 2013; 12:8.
18 Strandberg-Larsen K, Skov-Ettrup LS, Gronbaek M, Andersen AM, Olsen J, Tolstrup J. Maternal alcohol drinking pattern during pregnancy and the risk for an offspring with an isolated congenital heart defect and in particular a ventricular septal defect or an atrial septal defect. *Birth Defects Research Part A: Clinical and Molecular Teratology* 2011; 91:616–622.
19 Sun Y, Vestergaard M, Christensen J, Nahmias AJ, Olsen J. Prenatal exposure to maternal infections and epilepsy in childhood: a population-based cohort study. *Pediatrics* 2008; 121:e1100–e1107.
20 Lynge E, Sandegaard JL, Rebolj M. The Danish National Patient Register. *Scandinavian Journal of Public Health* 2011; 39:30–33.
21 Hamilton CM, Strader LC, Pratt JG, Maiese D, Hendershot T, Kwok RK, *et al*. The PhenX Toolkit: get the most from your measures. *American Journal of Epidemiology* 2011; 174:253–260.
22 Wills AK, Lawlor DA, Matthews FE, Sayer AA, Bakra E, Ben-Shlomo Y, *et al*. Life course trajectories of systolic blood pressure using longitudinal data from eight UK cohorts. *PLoS Medicine* 2011; 8:e1000440.
23 Wisborg K, Kesmodel U, Henriksen TB, Olsen SF, Secher NJ. Exposure to tobacco smoke in utero and the risk of stillbirth and death in the first year of life. *American Journal of Epidemiology* 2001; 154:322–327.
24 Ludvigsson J, Ludvigsson M, Sepa A. Screening for prediabetes in the general child population: maternal attitude to participation. *Pediatric Diabetes* 2001; 2:170–174.
25 Wickman M, Kull I, Pershagen G, Nordvall SL. The BAMSE project: presentation of a prospective longitudinal birth cohort study. *Pediatric Allergy and Immunology* 2002; 13 (Suppl 15):11–13.
26 Hawkes CP, Hourihane JO, Kenny LC, Irvine AD, Kiely M, Murray DM. Gender- and gestational age-specific nody fat percentage at birth. *Pediatrics* 2011; 128:e645–e651.
27 Raynor P. Born in Bradford, a cohort study of babies born in Bradford, and their parents: protocol for the recruitment phase. *BMC Public Health* 2008; 8:327.
28 Fuchs O, Latzin P, Kuehni CE, Frey U. Cohort profile: the Bern infant lung development cohort. *International Journal of Epidemiology* 2012; 41:366–376.
29 Skovgaard AM, Olsen EM, Houmann T, Christiansen E, Samberg V, Lichtenberg A, *et al*. The Copenhagen County child cohort: design of a longitudinal study of child mental health. *Scandinavian Journal of Public Health* 2005; 33:197–202.
30 Grandjean P, Weihe P, Jorgensen PJ, Clarkson T, Cernichiari E, Videro T. Impact of maternal seafood diet on fetal exposure to mercury, selenium, and lead. *Archives of Environmental Health* 1992; 47:185–195.
31 Porta D, Fantini MP. Prospective cohort studies of newborns in Italy to evaluate the role of environmental and genetic characteristics on common childhood disorders. *Italian Journal of Pediatrics* 2006; 32:350–357.
32 Dejmek J, Solansky I, Benes I, Lenicek J, Sram RJ. The impact of polycyclic aromatic hydrocarbons and fine particles on pregnancy outcome. *Environmental Health Perspectives.* 2000; 108:1159–1164.
33 Olsen J, Melbye M, Olsen SF, Sorensen TI, Aaby P, Andersen AM, *et al*. The Danish National Birth Cohort – its background, structure and aim. *Scandinavian Journal of Public Health* 2001; 29:300–307.
34 Drouillet P, Forhan A, De Lauzon-Guillain B, Thiebaugeorges O, Goua V, Magnin G, *et al*. Maternal fatty acid intake and fetal growth: evidence for an association in overweight women. The 'EDEN mother-child' cohort (study of pre- and early postnatal determinants of the child's development and health). *British Journal of Nutrition* 2009; 101:583–591.
35 Hill RA, Brophy S, Brunt H, Storey M, Thomas NE, Thornton CA, *et al*. Protocol of the baseline assessment for

the Environments for Healthy Living (EHL) Wales cohort study. *BMC Public Health* 2010; 10:150.
36 Vandentorren S, Bois C, Pirus C, Sarter H, Salines G, Leridon H. Rationales, design and recruitment for the Elfe longitudinal study. *BMC Pediatrics* 2009; 9:58.
37 Hryhorczuk DO, Monaghan S, Lukyanova E, Truchly L, Shkyryak-Nyzhnyk Z, Oliynyk I, *et al*. Collaborative research and research training through the 'Family and Children of Ukraine' research program. *International Journal of Occupational and Environmental Health* 1999; 5:213–218.
38 Alves E, Lunet N, Correia S, Morais V, Azevedo A, Barros H. Medical record review to recover missing data in a Portuguese birth cohort: agreement with self-reported data collected by questionnaire and inter-rater variability. *Gaceta Sanitaria* 2011; 25:211–219.
39 Porta D, Forastiere F, Di LD, Perucci CA. [Enrolment and follow-up of a birth cohort in Rome]. *Epidemiologia E Prevenzione* 2007; 31:303–308.
40 L'Abee C, Sauer PJ, Damen M, Rake JP, Cats H, Stolk RP. Cohort Profile: the GECKO Drenthe study, overweight programming during early childhood. *International Journal of Epidemiology* 2008; 37:486–489.
41 Jaddoe VW, van Duijn CM, Franco OH, van der Heijden AJ, van Iizendoorn MH, de Jongste JC, *et al*. The Generation R Study: design and cohort update 2012. *European Journal of Epidemiology* 2012; 27:739–756.
42 von BA, Koletzko S, Grubl A, Filipiak-Pittroff B, Wichmann HE, Bauer CP, *et al*. The effect of hydrolyzed cow's milk formula for allergy prevention in the first year of life: the German Infant Nutritional Intervention Study, a randomized double-blind trial. *Journal of Allergy and Clinical Immunology* 2003; 111:533–540.
43 Parkinson KN, Pearce MS, Dale A, Reilly JJ, Drewett RF, Wright CM, *et al*. Cohort profile: the Gateshead Millennium Study. *International Journal of Epidemiology* 2011; 40:308–317.
44 Olsen J, Frische G, Poulsen AO, Kirchheiner H. Changing smoking, drinking, and eating behaviour among pregnant women in Denmark. Evaluation of a health campaign in a local region. *Scandinavian Journal of Social Medicine* 1989; 17:277–280.
45 Eggesbo M, Stigum H, Longnecker MP, Polder A, Aldrin M, Basso O, *et al*. Levels of hexachlorobenzene (HCB) in breast milk in relation to birth weight in a Norwegian cohort. *Environmental Research* 2009; 109:559–566.
46 Guxens M, Ballester F, Espada M, Fernandez MF, Grimalt JO, Ibarluzea J, *et al*. Cohort Profile: The INMA – INfancia y Medio Ambiente – (Environment and Childhood) Project. *International Journal of Epidemiology* 2012; 41:930–940.
47 Toft G, Axmon A, Giwercman A, Thulstrup AM, Rignell-Hydbom A, Pedersen HS, *et al*. Fertility in four regions spanning large contrasts in serum levels of widespread persistent organochlorines: a cross-sectional study. *Environmental Health* 2005; 4:26.
48 Grazuleviciene R, Danileviciute A, Nadisauskiene R, Vencloviene J. Maternal smoking, GSTM1 and GSTT1 polymorphism and susceptibility to adverse pregnancy outcomes. *International Journal of Environmental Research and Public Health* 2009; 6:1282–1297.
49 Kummeling I, Thijs C, Penders J, Snijders BE, Stelma F, Reimerink J, *et al*. Etiology of atopy in infancy: the KOALA Birth Cohort Study. *Pediatric Allergy and Immunology* 2005; 16:679–684.
50 Jedrychowski W, Whyatt RM, Camann DE, Bawle UV, Peki K, Spengler JD, *et al*. Effect of prenatal PAH exposure on birth outcomes and neurocognitive development in a cohort of newborns in Poland. Study design and preliminary ambient data. *International Journal of Occupational Medicine & Environmental Health* 2003; 16:21–29.
51 O'Mahony D, Fallon UB, Hannon F, Kloeckner K, Avalos G, Murphy AW, *et al*. The Lifeways Cross-Generation Study: design, recruitment and data management considerations. *Irish Medical Journal* 2007; 100:suppl 3–6.
52 Heinrich J, Bolte G, Holscher B, Douwes J, Lehmann I, Fahlbusch B, *et al*. Allergens and endotoxin on mothers' mattresses and total immunoglobulin E in cord blood of neonates. *European Respiratory Journal* 2002; 20:617–623.
53 Kuehni CE, Brooke AM, Strippoli MP, Spycher BD, Davis A, Silverman M. Cohort profile: the Leicester respiratory cohorts. *International Journal of Epidemiology* 2007; 36:977–985.
54 Karvonen AM, Hyvarinen A, Roponen M, Hoffmann M, Korppi M, Remes S, *et al*. Confirmed moisture damage at home, respiratory symptoms and atopy in early life: a birth-cohort study. *Pediatrics* 2009; 124:e329–e338.
55 Bergmann RL, Bergmann KE, Lau-Schadensdorf S, Luck W, Dannemann A, Bauer CP, *et al*. Atopic diseases in infancy. The German multicenter atopy study (MAS-90). *Pediatric Allergy and Immunology* 1994; 5:19–25.
56 Magnus P, Irgens LM, Haug K, Nystad W, Skjaerven R, Stoltenberg C. Cohort profile: the Norwegian Mother and Child Cohort Study (MoBa). *International Journal of Epidemiology* 2006; 35:1146–1150.
57 Brescianini S, Cotichini R, Serino L, Medda E. Studio longitudinale su una coorte di neonati gemelli. 2010; 3 – Rapporti ISTISAN.
58 Richiardi L, Baussano I, Vizzini L, Douwes J, Pearce N, Merletti F. Feasibility of recruiting a birth cohort through the Internet: the experience of the NINFEA cohort. *European Journal of Epidemiology* 2007; 22:831–837.
59 Clarisse B, Nikasinovic L, Poinsard R, Just J, Momas I. The Paris prospective birth cohort study: which design and who participates? *European Journal of Epidemiology* 2007; 22:203–210.
60 Guldner L, Monfort C, Rouget F, Garlantezec R, Cordier S. Maternal fish and shellfish intake and pregnancy outcomes: a prospective cohort study in Brittany, France. *Environmental Health* 2007; 6:33.
61 Brunekreef B, Smit J, de Jongste J, Neijens H, Gerritsen J, Postma D, *et al*. The prevention and incidence of asthma and mite allergy (PIAMA) birth cohort study: design and first results. *Pediatric Allergy and Immunology* 2002; 13 (Suppl 15):55–60.
62 Di Lallo D. Studio Piccoli+. Arruolmento e sorvegilanza epidemiologica de una coorte nazionale de nati. Progetti applicativi al programma CCM 2010. *LAZIOSANITÁ – Agenzia di Sanitá Pubblica della Regione Lazio.* 2011.

63 Polanska K, Hanke W, Gromadzinska J, Ligocka D, Gulczynska E, Sobala W, *et al*. Polish mother and child cohort study – defining the problem, the aim of the study and methodological assumption. *International Journal of Occupational Medicine & Environmental Health* 2009; 22:383–391.
64 Chatzi L, Plana E, Daraki V, Karakosta P, Alegkakis D, Tsatsanis C, *et al*. Metabolic syndrome in early pregnancy and risk of preterm birth. *American Journal of Epidemiology* 2009; 170:829–836.
65 Martindale S, McNeill G, Devereux G, Campbell D, Russell G, Seaton A. Antioxidant intake in pregnancy in relation to wheeze and eczema in the first two years of life. *American Journal of Respiratory and Critical Care Medicine* 2005; 171:121–128.
66 Hertz-Picciotto I, Trnovec T, Kocan A, Charles MJ, Ciznar P, Langer P, *et al*. PCBs and early childhood development in Slovakia: study design and background. *Fresenius Environmental Bulletin* 2003; 12:208–214.
67 Inskip HM, Godfrey KM, Robinson SM, Law CM, Barker DJ, Cooper C. Cohort profile: The Southampton Women's Survey. *International Journal of Epidemiology* 2006; 35:42–48.
68 Katier N, Uiterwaal CS, de Jong BM, Kimpen JL, Verheij TJ, Grobbee DE, *et al*. The Wheezing Illnesses Study Leidsche Rijn (WHISTLER): rationale and design. *European Journal of Epidemiology* 2004; 19:895–903.