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Cohort Profile: Childhood morbidity and potential nonspecific effects of the childhood vaccination programmes in the Nordic countries (NONSEnse): Register-based cohort of children born 1990-2017/2018.

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Title

Cohort Profile: Childhood morbidity and potential non-specific effects of the childhood vaccination programmes in the Nordic countries (NONSEnse): Register-based cohort of children born 1990-2017/2018.

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ABSTRACT

Purpose: The aim of the NONSEnse project is to investigate the non-specific effects of vaccines and immunisation programmes on the overall health of children by using information from the extensive nationwide registers on health and sociodemographic factors in Denmark, Finland, Norway, and Sweden.

Participants: The cohort covers 9,072,420 children aged 0-17 years, born 1990-2017/2018, and living in Denmark, Finland, Norway, or Sweden. All countries utilise a unique identification number for its permanent residents, which makes it possible to link individual-level information from different registers.

Findings to date: Data collection and harmonisation according to a Common Data Model was completed in March 2022. As a prerequisite for comparing the effects of childhood vaccinations on the overall health of children across the Nordic countries, we have identified indicators measuring similar levels of infectious disease morbidity across these settings. We have also conducted an interrupted-time series analysis of the association between the second dose of measles-mumps-rubella (MMR) vaccination and the rate of infectious disease hospitalisations due to infections not targeted by the MMR vaccine.

Future plans: We are currently performing several studies of the effects on non-targeted infectious disease morbidity across the countries following vaccination against MMR, diphtheria, tetanus, pertussis, human papilloma virus, rotavirus, and influenza. Multiple studies are planned within the next years using different study designs to facilitate triangulation of results and enhance causal inference.

Registration: No clinical trials will be conducted within the NONSEnse project.

STRENGHTS AND LIMITATIONS

Strengths:

- The cohort covers the entire Nordic child population, which minimizes selection bias.
- Real world data are collected, collated and quality-checked by national register holders.
- Data are harmonized according to a Common Data Model, which enables use of the same statistical coding and uniform data analysis across countries.
- Information on many health and sociodemographic factors facilitates comprehensive adjustment for potential confounding factors.
- The cohort covers four different countries, strengthening the generalisability of concordant results

Limitations:

- Data have been collected for administrative purposes and is therefore limited to the information available in the registers.
- Vaccines given outside the immunisation programmes e.g. travel vaccinations, are not registered in all countries.
- The data harmonisation process may entail loss of details of country-specific data e.g. due to dichotomisation of variables that have more levels in some countries but not all.
- Due to data protection regulations, datasets are stored separately in each country and pooled analyses of individual-level data from all countries have not been possible.
- Analyses of observational data entail an inherent risk of residual confounding.

INTRODUCTION

An accumulating number of epidemiological and immunological studies have found that vaccines, in addition to the disease-specific protection, may have so called non-specific effects affecting susceptibility towards other diseases than the vaccine-targeted infections (1, 2). Most previous studies on non-specific effects stem from low-income countries with a high infectious disease burden and have had overall childhood mortality as the outcome. The non-specific effects are found to vary depending on the type of vaccine being administered. Live vaccines have been associated with beneficial non-specific effects (1, 2). Non-live vaccines, although protecting against the vaccine-targeted infections, may possibly increase susceptibility to other infections (1, 2). The effects are most pronounced for the most recently administered vaccine (2).

Studies of non-specific effects from high-income countries have primarily focused on infectious disease morbidity (3) and atopic diseases (4-8). Most of these studies are observational, because it would (often) be unethical to randomise children to refrain from or delay recommended childhood vaccinations. Therefore, concerns about different types of bias in different settings and observational designs have been raised (9-12). Triangulation has been proposed as a method to strengthen causal inference in epidemiology by integrating results from several epidemiological designs and between different populations with different bias structures while using the same analysis plan across settings to enhance comparability of results (13, 14).

The "NONSEnse" project is a Nordforsk-funded collaboration between research groups in the four Northern European countries Denmark, Finland, Norway, and Sweden (henceforth referred to as the Nordic countries). The main aim of "NONSEnse" is to do careful evaluation of potential non-specific effects of childhood vaccinations in the Nordic countries. The main hypothesis underlying this evaluation is that having a live vaccine as the most recent vaccine is associated with a lower morbidity in the following time-period, compared with having a non-live vaccine as the most recent vaccine. We will analyse specific research questions using the same methodology in all countries, but also apply different analytical approaches in different studies to facilitate triangulation of the results. The main associations we will examine are associations between childhood vaccinations

and 1) infectious disease hospitalisations, 2) antibiotic use, and 3) atopic diseases (asthma, atopic dermatitis, allergic rhinoconjunctivitis).

The first step has been to examine and compare infectious disease and atopic morbidity among children in the respective countries over time and by age and sex, to inform choice of design and outcome definitions in the subsequent studies of non-specific effects of vaccines.

COHORT DESCRIPTION

Setting

The Nordic countries have many similarities including the welfare state model with universal tax-funded healthcare and a high level of social security. A detailed description of the Nordic health care systems and basic demographics has been published elsewhere (15).

National immunisation programmes

Childhood vaccinations within the national immunisation programmes (NIP) are voluntary and administered free of charge in all four countries. In Denmark, all childhood vaccines are administered by family practitioners (16). In Finland, Norway, and Sweden vaccines scheduled before school-age are administered at well-baby clinics by nurses; during school age, the vaccines are administered by school nurses (17-19). In 2018, children were offered vaccinations against 10 diseases in Denmark (16), up to 13 diseases in Finland (17), 12 diseases in Norway (19), and 10 diseases in Sweden (18). Children in specific risk groups are offered vaccines against additional diseases according to national guidelines (17-20). An overview of recommended childhood vaccinations in the four countries in 2018 is presented in Table 1 and historical changes are illustrated in Appendix 1.

Table 1: Vaccines recommended to children in Denmark, Finland, Norway, and Sweden in 2018. The vaccines are included in the childhood immunisation programmes and registered in the vaccination registers, unless otherwise specified.

Disease	Denmark	Finland	Norway	Sweden
(Vaccine)				
Tuberculosis	Not within	Before 7 years of	6 weeks of age,	After 6 months of
(BCG)	programme	age, risk groups	risk groups only ¹	age, risk groups
		only ¹		only ^{1,2}
Hepatitis A	Not within	From 1 year of	Not within	Not within
	programme	age, risk groups	programme	programme
		only ³		
Hepatitis B	From birth, risk	From birth, risk	3 doses: 3, 5, 12	Not within
	groups only4	groups only ^{4,5}	months of age	programme but
				recommended to
				all children.
				3 doses: 3, 5, 12
				months of age ⁶
Rotavirus	Not within	3 doses: 2, 3, 5	2 doses: 6	2 or 3 doses:
	programme	months of age	weeks, 3 months	6 weeks, 3 and 5
			of age	months of age ^{2, 7}
Diphtheria,	4 doses: 3, 5, 12	5 doses: 3, 5, 12	5 doses: 3, 5, 12	5 doses: 3, 5, 12
tetanus and	months, booster	months of age,	months of age,	months of age,
pertussis	at 5 years of age	booster at 4 and	Booster in 2 nd	booster at 5
(DTaP)		14 years of age	and 10 th school-	years of age and
			year	in 8 th or 9 th
				school-year
Polio (IPV)	4 doses: 3, 5, 12	4 doses: 3, 5, 12	5 doses: 3, 5, 12	4 doses: 3, 5,
	months, booster	months of age,	months of age,	and 12 months of
	at 5 years of age	booster at 4	booster in 2 nd	age, booster at 5
		years of age	and 10 th school-	years of age
			year	
Haemophilus	3 doses: 3, 5, 12	3 doses: 3, 5, 12	3 doses: 3, 5, 12	3 doses: 3, 5,
influenzae type	months of age	months of age	months	and 12 months of
В				age

Pneumococcal	13-valent; 3	10-valent; 3	13-valent; 3	10 or 13-valent;	
disease (PCV)	doses: 3, 5, 12	doses: 3, 5, 12	doses: 3, 5, 12	3 doses: 3, 5,	
	months of age	months of age	months of age	and 12 months of	
				age	
Influenza	From 6 months	Yearly, from 6	From 6 months	Yearly, from 6	
(Live- or non-	of age, risk	months to 6	of age, risk	months of age,	
live influenza	groups only8	years of age and	groups only,	risk groups	
vaccine)		for risk groups	through the	only ^{2,8}	
		after 6 years of	influenza		
		age ⁸	immunisation		
	O ₂		programme ⁸		
Measles,	2 doses: 15	2 doses: 12	2 doses: 15	2 doses: 18	
mumps and	months of age	months of age, 6	months of age,	months of age	
rubella	and 4 years of	years of age	and 6 th school-	and 1 st or 2 nd	
	age		year	school-year	
Varicella	Not	1.5-11 years of	Not	Not	
	recommended	age	recommended	recommended	
Pneumococcal	Not within	Before 5 years of	Not within	Not within	
disease (PPV)	programme	age, after PCV,	programme, but	programme, but	
		risk groups only9	recommended	recommended	
			from 2 years of	from 2 years of	
			age, to specified	age, to specified	
			risk groups ⁹	risk groups ^{2,9}	
Tick borne	Not within	From 3 years of	Not within	Not within	
encephalitis	programme	age, risk groups	programme	programme	
		only ¹⁰			
Human	2 doses: 12	2 doses: 6 th	2 doses in 7 th	2 doses in 5 th or	
papilloma virus	years of age,	school-year, girls	school-year	6 th school-year,	
	girls only	only		girls only	

Abbreviations: BCG: Bacillus Calmette-Guérin vaccine; DTaP: Diphtheria, tetanus, and acellular pertussis vaccine; IPV: Inactivated Polio Vaccine; PCV: Pneumococcal Conjugated Vaccine; PPV: Pneumococcal Polysaccharide Vaccine.

Information obtained from: The Danish health authority (16), Finnish institute for health and Welfare (17), Norwegian Institute of Public Health (19), The Public Health Agency of Sweden (18).

¹ Children with a parent from a country with a high incidence of tuberculosis. ² Not included in the vaccination registry, ³ Children of intravenous drug users. ⁴ 1) Children of mothers or another member of the household who are Hepatitis B positive, or 2) attend daycare with a child who has Hepatitis B (20, 21). ⁵ 1) children of parents from countries with high incidence of Hepatitis B, or 2) children of mothers with hepatitis C infection (21). ⁶ Only offered to children in the risk group before 2016, not included in the vaccination registry before 2016 (22). ⁶ Rotavirus vaccine was offered by some Swedish regions, as part of regional vaccination schemes. ⁶ Children with increased risk of severe influenza illness or members of households with high-risk individuals(18, 23-25). ⁶ Children with increased risk of severe pneumococcal disease e.g. children with chronic diseases (18, 26, 27). ¹ Children of families with a permanent home or holiday house in areas within Finland with high tick prevalence (28)

Nordic nationwide register data: a goldmine for epidemiological studies

All individuals residing in the Nordic countries are assigned a unique personal identification code (ID). All four countries have extensive national registers on health, demographic factors, and socio-economic factors collected for administrative purposes and linked to the individual using the personal ID (15, 29). The register information is collected automatically, which minimizes systematic reporting bias e.g. recall bias. The use of national registers limits selection bias as the entire population is included. All information in the registers are dated, which ensures that exposures and outcomes can be temporally linked and facilitates investigation of the cumulative and combined effects of multiple interventions on childhood health. Thus, the structure of the Nordic registers presents a unique opportunity to investigate the real-life effects of childhood vaccinations while incorporating multiple potential confounding factors.

Study population

We used national population registers to identify all children aged 0-17 years, who were born or permanently living in one of the Nordic countries at some point from 1990 until and including 2018 in Denmark and Norway, and 2017 in Finland and Sweden (30-33) (Figure 1). The population data obtained in Finland had incomplete information on migration history before 2014 and thus we were unable to assess the date of entering the country for children born abroad. As a result, we limited the Finnish study population to children born in the country to ensure that they were present in the country from the beginning of follow-up. After exclusions, which were primarily due to uncertain information about residency, a

total of 9,072,420 children were included across the countries (Figure 1). Children were followed from date of birth or date of immigration until the date of first emigration, 18-year birthday, death, or last date with available information, whichever came first.

Source and content of data

Using the personal ID, we linked information from the nationwide registers and obtained individual-level information on gestation and birth, hospital contacts, redeemed prescriptions, and receipt of childhood vaccines. Furthermore, each child was linked to their parents through the population registers in order to extract information on household income, family composition, and highest attained parental education (Figure 2).

Information on administered vaccines including type of vaccine and date of vaccination was obtained from The Danish Vaccination Register in Denmark (34), the Finnish vaccination register in Finland (35), the Norwegian Immunisation Registry (SYSVAK) in Norway (36), and the National vaccination register in Sweden (37). Registration of vaccinations within the NIP is mandatory in all Nordic countries (Table 1).

The Danish Vaccination Register includes information from the Danish National Health Insurance System that collects information on all vaccinations within the NIP (38). Since 2015, it has also been mandatory to report on vaccines given outside the NIP (39). In Denmark, vaccine information is linked to the individual using the personal ID, however before 1997 the information was registered on the ID of the parents only (38). Thus, in Denmark, only information on vaccines administered from 1997 and later was included. In Finland, the register includes all vaccines given in public health care since 2009, and after 2016 also private health care is obligated to register vaccinations (35). In Norway, the immunisation registry holds information since 1995 on all administered vaccines that are part of the NIP (19). Since 2011 notification to the immunisation registry is also mandatory for vaccines given outside the NIP (36). The Swedish national vaccination register has information about vaccinations given since 2013, but only those included in the NIP (37).

Information on hospital contacts was obtained from nationwide patient registers (15, 29), which reached national coverage and recorded individual-level data since 1978 in Denmark, 1994 in Finland, 2008 in Norway, and 1997 in Sweden. Since 1997, diagnoses have been coded according to the International Classification of Diseases version 10 (ICD-10) in all four countries (40).

The Danish, Norwegian, and Swedish prescription registers hold information on all redeemed prescriptions, classified using the Anatomical Therapeutic Chemical Classification System (ATC) since 1995, 2004, and mid-2005, respectively (41). The Finnish Benefits Registry holds information only for reimbursable redeemed prescriptions (41-43). In addition, the Finnish Prescription Center started gradually in 2010 and collects all redeemed prescriptions irrespective of reimbursement. By 2017, practically all prescriptions were included in the Finnish Prescription Center (44). Information on socioeconomic factors and birth characteristics was available from the beginning of the study period (1990) in all countries.

The Common Data Model: Harmonised country specific datasets

The country-specific data from the national registers may differ both across countries and within countries over time due to differences in coding practices, administration, and country-specific legislation on health and social aspects (29). We developed a Common Data Model to harmonise all information we obtained into similar datasets using the same variable names and same categories in all four countries (Figure 3). The data harmonisation focused on identifying outliers and country-specific traits that could hinder cross country comparability. Information on source of data and data preparation for each of the variables can be found in Appendix 2 "NONSense Common Data Model".

Due to national data protection legislation, country-specific data were stored and analysed in the respective countries.

Patient and Public involvement

All studies conducted within NONSEnse will be register based studies only and patients or the public will not be involved in the design or conduct of the planned studies.

Characteristics of the study population

The national study populations range from 1,637,133 children in Finlandto 3,540,560 children in Sweden (Table 2). Mean follow-up time was 11.6 years in Denmark, 12.3 years in Finland, 11.5 years in Norway, and 10.3 years in Sweden. Sweden had the highest proportion of children born abroad; 15.5% compared with 8.4 in Denmark and 11.1% in Norway. The proportion of children who were censored due to migration was lower in Finland, where we only included children born in-country: 0.7% compared with 4.4-6.2% in

the other countries. The lower emigration rate in Finland represents both underreporting due to incomplete information on migration, and a suspected lower risk of moving out of the country for children born in-country, compared with children born abroad. A higher proportion of children without a link to their mother was seen in Sweden; 5.3% compared to 0.2-1.1% in the other countries. The children without a link to their mother in Sweden were predominantly born abroad (data not presented) and may thus be affected by incomplete registration of migrant families, or children immigrating to Sweden without their mother.

Table 2: Study population – identification and follow-up

	Denmark		Finla	Finland ¹		ay	Sweden		
Study population (N)	1,979,670	1,637,133		1,915,057		3,540,560			
Years of follow-up ² per child (Mean (sd))	11.6 (6.3)		12.3 (6.0)		11.5 (6.3)		10.3 (6.9)		
Year of birth	1990-2018		1990-2017		1990-2018		1990-2017		
Sex (N (%))	1990-2010		1990-2017		1990-2010		1990-2017		
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Male	1,014,745	51.3%	836,828	51.1%	985,568	51.5%	1,827,619	51.6%	
Female	964,925	48.7%	800,305	48.9%	929,489	48.5%	1,712,941	48.4%	
Reason for entering the									
Birth	1,813,443	91.6%	1,637,133	100.0%	1,703,054	88.9%	2,993,472	84.5%	
Immigration	166,227	8.4%	0	0.0%	212,003	11.1%	547,088	15.5%	
Reason for leaving the o	cohort (N (%)))	'						
Death	8532	0.4%	761	0.0%	5422	0.3%	5614	0.2%	
Emigration	122,916	6.2%	11,789	0.7%	95,406	5.0%	154,878	4.4%	
Other ³	1917	0.1%	0	0.0%	0	0.0%	0	0.0%	
18 th birthday	704,518	35.6%	608,644	37.2%	703,164	36.7%	1,280,027	36.2%	
End of follow-up ⁴	1,141,787	57.7%	1,015,939	62.1%	1,111,065	58.0%	2,100,041	59.3%	
Linked with mother in	1,961,595	99.1%	1,634,120	99.8%	1,894,916	98.9%	3,352,706	94.7%	
registers (N (%))			1						
Linked with father in	1,920,008	97.0%	1,601,138	97,8%	1,838,444	96.0%	3,248,108	91.7%	
registers (N (%))									
Maternal age at birth		1		7					
of child (median, p25-	29 (26-33)		29 (26-33)		29 (25-33)		29 (26-33)		
p75)									
Missing information	18,075	0.9%	10,099	0.6%	20,141	1.1%	187,854	5.3%	
on maternal age (N									
(%))									
Maternal origin (N (%))		<u> </u>		I					
Born in country	1,582,885	80.0%	1,520,159	92.9%	1,432,179	74.8%	2,399,234	67.8%	
Born abroad	378,710	19.1%	111,611	6.8%	462,319	24.1%	953,467	26.9%	
Unknown	18,075	0.9%	5363	0.3%	20,559	1.1%	187,859	5.3%	

¹Finnish data only include children born in country due to incomplete information on migrations. ²Years of follow-up is calculated as first date of death, emigration, turning 18 years of age or last date with available data from the population registry minus the last date of birth, or immigration divided by 365.25. ³E.g. disappear from register without specification. ⁴Last date with data available from population registry

Exposure assessment: Vaccinations across the Nordic countries

Figure 4 depicts the coverage of diphtheria, tetanus, and acellular pertussis containing vaccines (DTaP), measles-mumps-rubella vaccine (MMR) and rota virus vaccines (rota) for children born in each country followed from birth until two years of age, date of emigration, or date of death, whichever came first (see Appendix 3, sTable 1 for the coverage at 2 years of age for each of the included birth cohorts in each country).

In Norway, the vaccine uptake rate was highest and closest to the age of recommended vaccination compared with the other countries. In Finland and Sweden, MMR uptake starts at ages earlier than scheduled according to the respective NIPs, which reflects that MMR is recommended to children from 6 and 9 months of age in Finland and Sweden respectively, before travelling abroad. Although MMR is recommended before travelling abroad in all the Nordic countries, early uptake of MMR is much less frequent in Denmark and Norway which may indicate different interpretation and roll-out of the recommendations. The greater variation in the age at MMR vaccination in Finland reflects different vaccination schedules applied to the included birth cohorts: MMR vaccination was recommended at 14-18 months of age before June 2010 and at 12-18 months (preferably 12 months of age) after June 2010. In Finland, Norway, and Sweden, the date of the next vaccination is usually scheduled during earlier well-baby check-ups or provided by post, whereas in Denmark no formal procedures are in place to ensure timely vaccination, which may explain the different variation in age at vaccination across the countries.

Human papilloma virus vaccination (HPV) for girls was introduced in the NIP in 2009 in Denmark, the end of 2013 in Finland, mid-2009 in Norway, and in 2012 in Sweden. (Appendix 1). The vaccine is recommended at age 12 years in Denmark, Finland, and Norway, and at age 11-12 years in Sweden. Figure 5 depicts the registered coverage of HPV vaccinations among girls followed from one year before the recommended age of vaccination until age 14 years, emigration, or death, whichever came first. In Norway, the uptake of the first dose of HPV vaccine follows a steep curve at 12 years of age, representing the age of recommended vaccination (Figure 5). The majority of the included birth cohorts in Norway were only able to receive the HPV vaccination free of charge during the school year it was offered, which may have contributed to the high and steep uptake rate. In Sweden, the uptake starts increasing at 11 years of age with a second

increase at 12 years of age reflecting that the vaccine may be administered in either the 5th or 6th grade. In Denmark uptake starts increasing at 12 years of age corresponding to recommended age of vaccination, but with more variation in the age of vaccination compared with the other countries. The relative low uptake combined with high age variation may be due to vaccination hesitancy following negative media attention from Danish television portraying alleged serious adverse effects of HPV vaccination (45). Confidence in the safety of the vaccine has since been restored, which is reflected in the slightly increasing vaccination coverage in the last included birth cohort (Appendix 3, sTable2). In Finland, the uptake rates follow a straight curve from 12-13 years of age followed by a small proportion of children with delayed vaccination. The vaccine uptake at 14 years of age within our cohort was highest in Norway (first dose for the birth cohort 2003: 84.8%) followed by Sweden (77.9%), Finland (69.8%) and Denmark (52.3%) (Appendix 3, sTable 2).

Health and sociodemographic characteristics

Data were available for a different set of years across the Nordic countries. For comparing the study populations in this cohort profile, we only present information from years where data are available in all countries.

Prescriptions

Information on redeemed prescriptions was included for the purpose of assessing predefined health outcomes in terms of antibiotic consumption and different atopic outcomes, and to be able to assess potential confounding factors relating to underlying health and healthcare seeking behaviour. The data legislation regulating access to information on drug utilisation differed across countries. Therefore, data were only obtained for a more narrowly defined subset of ATC-codes in Finland and Sweden, compared with Denmark and Norway (Appendix 3). Information on redeemed prescriptions was available from 2005 to 2017 in all countries. We only included information on redeemed prescriptions with ATC-codes available in all countries for the present comparison. The overall proportion of children with redeemed prescriptions ranged from 75.6% in Norway to 86.1% in Finland and varied depending on ATC-group (Table 3). The proportion of children with redeemed prescriptions in ATC-group D "dermatologicals" was 36.3% in Denmark compared with 20.6-24.7% in the other countries. Finland had the

highest proportion of children with redeemed prescriptions in ATC group J "antiinfectives for systemic use": 82.3% compared with 62.1-75.0% in the other countries. In ATC group S "eye and ear medications", the proportion was lower in Finland (7.4%) compared with the other countries (13.0-17.9%). For ATC group R "Respiratory system" and subgroup V01 "Allergens" the proportions were relatively similar across countries.



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Table 3: Health characteristics of children present in the respective countries from year 2505-2017.

	Denn	nark	Finla	nd	∮Nor	way	Sweden	
Prescriptions					10 F			
Years of follow-up	2005-2017		2005-2017		2005 2017	7	2005-2017	
Number of children with follow-up¹ (N (%))	1,904,633	100.0%	1,634,031	100.0%	1,81 231	100.0%	3,355,915	100.0%
Children with redeemed prescriptions ² (N (%))	1,592,361	83.6%	1,407,548	86.1%	1,374,180	75.6%	2,542,676	75.8%
Mean age during follow-up (mean, (sd))	8.3 (5.2)		8.3 (5.2)		8.3 (\$2)		8.2 (5.3)	
Prescriptions pr child (median, p25-p75)	4 (1-9)		5 (2-11)		3 (1-8)		3 (1-7)	
Children with prescriptions with ATC group D (N					ed fro			
(%))	691,357	36.3%	360,910	22.1%	449,226	24.7%	692,269	20.6%
Prescriptions per child with ATC group D ^{2, 3, 4}	17,				.tp://b			
(median, p25-p75)	1 (1-3)	0,	1 (1-3)		1 (1-3)		1 (1-3)	
Children with prescriptions with ATC group J (N					en.b			
(%))	1,428,652	75.0%	1,345,297	82.3%	1,129,065	62.1%	2,194,753	65.4%
Prescriptions per child with ATC group J ^{2, 3, 5}					m / o			
(median, p25-p75)	3 (2-6)		4 (2-8)	OA	2 (1-4)		3 (1-5)	
Children with prescriptions with ATC group R (N					r <u>i</u> 19			
(%))	806,105	42.3%	748,839	45.8%	841,066	46.3%	1,468,158	43.7%
Prescriptions per child with ATC group R ^{2, 3, 6}					4 by			
(median, p25-p75)	2 (1-6)		2 (1-7)		3 (1-95)		2 (1-6)	
Children with prescriptions with ATC group S (N					st. Pro			
(%))	248,522	13.0%	121,721	7.4%	326,🧗	17.9%	521,658	15.5%
Prescriptions per child with ATC group S ^{2, 3, 7}					ed by			
(median, p25-p75)	1 (1-2)		1 (1-2)		2 (1-§)		1 (1-2)	

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Children with prescriptions with ATC group V01(N					2-065			
(%))	10,384	0.5%	4662	0.3%	11,77	0.6%	5928	0.2%
Prescriptions per child with ATC group V01 ^{2, 3, 8}					on 10			
(median, p25-p75)	5 (3-9)		4 (2-7)		4 (2-8)		4 (2-8)	
Hospital contacts		1			ruary			
Years of follow-up	2008-2016		2008-2016		2008 2016		2008-2016	
Number of children with follow-up9 (N (%))	1,813,600	100.0%	1,581,854	100.0%	1,738 115	100.0%	3,177,371	100.0%
Children with hospital contacts (N (%))	1,069,628	59.0%	861,685	54.5%	982,808	56.5%	1,911,254	60.2%
Years of follow-up (mean, (sd))	5.8 (3.1)		5.9 (3.0)		5.7 (3 0)		5.5 (3.1)	
Mean age during follow-up (mean, (sd))	9.2 (5.8)		9.1 (5.9)		9.1 (\$\overline{\signifts}.8)		9.0 (5.9)	
Hospital contacts per child (main	CA				http:			
diagnosis)(median, p25-p75)	1 (0-2)		1 (0-4)		1 (0-3)		1 (0-4)	
Children with inpatient contacts (N (%))	519,945	28.7%	324,292	20.5%	420,492	24.2%	568,958	17.9%
Inpatient contacts per child (median, p25-p75)	1 (1-2)		1 (1-2)		1 (1-2)		1 (1-2)	
Children with outpatient or emergency room			1/1/		.com			
contacts (N (%))	885,243	48.8%	839,569	53.1%	911,877	52.5%	1,826,446	57.5%
Outpatient or emergency room contacts per child (1	2 (1-3)		3 (1-6)	40	2 (1-\$\bar{\bar{\bar{\bar{\bar{\bar{\bar{\bar		3 (1-6)	
per day) (median, p25-p75)					19, 2			
		2017 ² Onl		C subgrou	19, 20	05 D07 D		

¹ Number of children living in the country at any time in the period 2005-2017. ² Only including ATC subgroups: D0AF, D05, D07, D11, D01, D06, D08, J01-J07, R01, R03, R06, S01G, S03, V01 - Thus, not reflecting total use of prescription medicines. Per child with redefined prescriptions of that ATC-group. ⁴ ATC Group D: Dermatologicals. ⁵ ATC Group J: Antiinfectives for systemic use. ⁶ ATC Group R: Respiratory system. ⁷ ATC Group S: Sensory organs. ⁸ ATC

Subgroup V01: Allergens. 9 Number of children living in the country at any time in the period 2008-2016. Proportions are calculated using number of children with follow-up as the denominator.

Hospital contacts

Information on hospital contacts including inpatient and specialised outpatient care was available in all countries from 2008 to 2016. For comparison across countries, we excluded country-specific codes (e.g. codes for health characteristics of new-borns in Denmark). The proportion of children with hospital contacts was similar across countries (54.5-60.2%, Table 3). The proportion of children with inpatient contacts ranged from 17.9% in Sweden to 28.7% in Denmark. The proportion of children with outpatient contacts in the patient registers was highest in Sweden (57.5%) and lowest in Denmark (48.8%). The higher proportion of inpatient contacts in Denmark is likely explained by contributions of inpatient contacts without overnight stays, as contacts without overnight stays will predominantly be registered as outpatient contacts in the other countries (46). The higher proportion of children with outpatient contacts in Sweden may on the other hand be explained by a broader set of health care facilities (e.g. paediatric outpatient clinics) that report to the patient register in Sweden compared with the other countries (46).

Birth characteristics

Information on birth characteristics was available for birth cohorts from 1990 to 2016 in all countries (Table 4). The completeness of data was high in all countries, ranging from 97.7% to 99.9%. The birth characteristics were also very similar: the median birth weight ranged from 3500 to 3550 grams, the proportion of low-birth-weight children ranged from 3.9% to 5.0%, and the median gestational age was 40 weeks in all countries. For the variables preterm birth, delivered by caesarean section, and singleton births, the proportions only differed by 0.8-2.7 percent points across countries. The greatest difference between countries was seen for registration of maternal smoking during pregnancy, which ranged from 8.3% in Norway to 18.2% in Denmark. The proportion with unknown/missing information on maternal smoking ranged from 2.5% in Finland to 45.8% in Norway, which may be explained by the midwifes having to inform the mothers of the need for obtaining information on smoking before asking this question in Norway, thus additional effort is required, which may hamper completeness.

Table 4: Birth characteristics¹

	Denmark		Finlar	nd	Norwa	ау	Sweden		
Children born in the									
respective country									
from 1990-2016 (N)	1,728,126		1,586,526		1,591,273		2,877,753		
Children with									
information									
available from the									
birth registry	1,726,318	99.9%	1,576,797	99.4%	1,586,895	99.7%	2,811,119	97.7%	
Birth weight in						'		1	
grams (Median,									
p25-p75)	3500 (3150-3850)		3550 (3210	3550 (3210-3880)		-3900)	3540 (3200	-3890)	
Low birth weight									
(<2500g) (N (%))	86,914	5.0%	61,546	3.9%	73,437	4.6%	114,990	4.0%	
Birth weight									
missing (N (%))	23,707	1.4%	12,859	0.8%	5376	0.3%	72,892	2.5%	
Gestational age in									
weeks (Median,									
p25-p75)	40 (39-41)		40 (39-40)		40 (39-41)		40 (39-40)		
Preterm birth (N									
(%))	107,656	6.2%	85,069	5.4%	98,923	6.2%	163,168	5.7%	
Gestational age									
missing (N (%))	29,250	1.7%	16,083	1.0%	59,264	3.7%	68,973	2.4%	
Delivered by									
caesarean section									
(N (%))	305,738	17.7%	258,261	16.3%	238,013	15.0%	435,680	15.1%	
Mode of delivery									
missing (N (%))	1808	0.1%	9729	0.6%	4378	0.3%	66,634	2.3%	
Singleton (N (%))	1,660,213	96.1%	1,531,748	96.5%	1,535,556	96.5%	2,731,980	94.9%	
Child order including		-						I	
1 (firstborn)	743,923	43.0%	647,134	40.8%	658,877	41.4%	1,211,084	42.1%	
2	635,849	36.8%	532,868	33.6%	568,765	35.7%	1,023,228	35.6%	
3	243,162	14.1%	244,137	15.4%	257,294	16.2%	398,331	13.8%	
4 or more	86,090	5.0%	149,327	9.4%	101,959	6.4%	178,184	6.2%	
Missing	19,102	1.1%	13,060	0.8%	4378	0.3%	66,926	2.3%	

Maternal smoking								
during pregnancy								
(N (%))	314,174	18.2%	238,337	15.0%	132,734	8.3%	310,691	10.8%
Maternal smoking								
unknown (N (%))	134,332	7.8%	39,277	2.5%	728,038	45.8%	143,529	5.0%

¹ Information, including percentages are reported according to the number of children born in country from 1990-2016

Socioeconomic factors

Socioeconomic information is collected yearly in all countries. In the NONSEnse cohort, the information was assessed in the year of birth of each child (Table 5) and in the 10th year of life (Appendix 3, sTable 3). Information from the year of birth was available for the birth cohorts 2004-2015 in all countries. The data presented in Table 5 only include children who were born in-country and living in the country throughout their first year of life, to ensure that they were present in the country at the time of registration.

Table 5: Socio-economic factors at birth

from 2004-2015 Birth cohorts included 200 Income quintile at birth First (lowest) 134 Second 137 Third 137 Fourth 137	9,294 04-2015 4,634 7,041 7,390 7,415	18.5% 18.8%	N 699,052 2004-2015 138,965	5	N 706,443 2004-201	(%) 5	N 1,314,701 2004-2015	(%)
in country at birth from 2004-2015 Birth cohorts included Income quintile at birth First (lowest) Second Third 137 Fourth 729 729 729 729 729 729 729 72	04-2015 4,634 7,041 7,390	18.5%	2004-201	5		5		
included 200 Income quintile at birth First (lowest) 134 Second 137 Third 137 Fourth 137	4,634 7,041 7,390	18.5%		5	2004-201	5	2004-2015	
First (lowest) 134 Second 137 Third 137 Fourth 137	7,041 7,390		138,965					
Second 137 Third 137 Fourth 137	7,041 7,390		138,965					
Third 137 Fourth 137	7,390	18.8%		19.9%	137,551	19.5%	247,237	18.8%
Fourth 137			138,997	19.9%	141,566	20.1%	265,557	20.2%
	7 415	18.8%	139,012	19.9%	141,962	20.1%	267,347	20.3%
Fifth 136	י ,דוט	18.9%	138,998	19.9%	141,995	20.1%	267,349	20.3%
	6,935	18.8%	138,900	19.9%	141,533	20.1%	266,528	20.3%
Unknown 45,	,531	6.2%	4180	0.6%	644	0.1%	605	0.0%
Number of children in th	e hous	ehold the ye	ear the child	d is born				
1 310	0,237	42.6%	287,312	41.1%	298,563	42.3%	574,229	43.7%
2 278	8,396	38.2%	237,291	33.9%	263,726	37.4%	487,446	37.1%
3 106	6,184	14.6%	104,278	14.9%	108,822	15.4%	176,338	13.4%
>3 32,	,106	4.4%	65,527	9.4%	33,496	4.7%	68,060	5.2%
Unknown 202	23	0.3%	4644	0.7%	644	0.1%	605	0.0%
Single parenthood in the	e years	the child is	born					
Yes 58,	,646	8.0%	55,089	7.9%	68,018	9.6%	132,243	10.1%
No 668	8,277	91.7%	639,319	91.5%	635,689	90.1%	1,181,775	89.9%
Unknown 202	23	0.3%	4644	0.7%	1544	0.2%	605	0.0%
Highest attained educati	ional le	vel1 of the r	mother on tl	he date tl	ne child is	oorn		
Low education 114	4,880	15.8%	98,608	14.1%	126,777	18.0%	149,673	11.4%
Medium 261 education	1,761	35.9%	279,687	40.0%	201,316	28.5%	431,880	32.9%
High education 336	6,536	46.2%	319,530	45.7%	350,684	49.7%	457,040	34.8%
Unknown 15,	769	2.2%	1227	0.2%	26,474	3.8%	276,030	21.0%
¹ Highest attained educa	ation wa	s categoriz	ed based c	n the Inte	ernational	Standard	Classification	າ of
Education (ISCED) 2017	1 using	the main g	roups (47).					

In Denmark, 6.2% of the study population had missing information on household income compared with 0-0.6% in the other countries. We have been unable to identify the reason for the higher proportion in Denmark. The proportion of households with 3 or more children was 9.4% in Finland compared with 4.4-5.2% in the remaining Nordic countries. The proportion living with a single parent in the year of birth ranged from 7.9% in Finland to 10.1% in Sweden. Among the remaining socioeconomic variables, the largest cross-

country difference was found for the highest attained education of the mother, where information was missing for 21.0% of the children in Sweden compared with 0.2-3.8% in the other Nordic countries. The proportion of mothers with low education ranged from 11.4% in Sweden to 18.0% in Norway. The high proportion with missing information on maternal education in Sweden is in part caused by a higher proportion of children with an unknown mother in our dataset (Table 2) but may also be caused by education not being registered for mothers born abroad. Since registration of education is often a necessity for employment in more advanced fields, it is reasonable to assume a higher accuracy for registration of high education as compared with low education.

Findings to date

The findings to date are based on data from registers, where we were able to obtain data prior to receiving the final individual-level data with linkage across all registers within each country.

We have conducted investigations of similarities and differences in rates of infectious disease hospitalisations (46), and antibiotic consumption (under review). These studies highlight trends in infectious disease morbidity across the Nordic countries and further guide the use of more consistent infectious disease outcome measures for future studies. We have furthermore investigated if changes in the recommended age at revaccination with MMR in Denmark and Sweden affected the rate of infectious disease hospitalisations using an interrupted time series analysis (48).

Future studies will include population-level investigations of natural experiments in the form of introduction of new vaccines or changes in the immunisation programmes, as well as individual-level studies comparing vaccinated and unvaccinated children with a given vaccine using multiple different study designs.

FURTHER DETAILS

Strengths and limitations

The NONSEnse project represents a unique undertaking for conducting register based epidemiological studies of the overall health effects of routine childhood vaccines.

Data are stored separately in each country, which prevents conducting analyses on the joint data, which is a limitation of the project. However, the Common Data Model enables analysis plans and statistical code to be written in one country and sent to the other countries that can then perform the same analyses and share the results (Figure 3). The use of a Common Data Model thus minimises the risk that different country-specific analytical decisions will hinder comparability of results.

The use of register data presents both strengths and weaknesses. A strength pertains to the multitude of information available for the entire study population and linked to the individual, which minimises selection bias and enables cohort studies with prospective follow-up and control for multiple confounding factors. Limitations include that not all the wished-for information are available in all countries and registration may be incomplete, which limits the possibility to e.g. adjust for hypothesised confounding factors such as day-care attendance and lifestyle factors. Also, previous studies (2) have found the non-specific effect of a vaccine to be strongest when it is the most recent vaccine administered. Therefore, it is relevant to include information on vaccines other than the ones offered through the NIP. In Denmark, Finland, and Norway vaccines outside the NIP may also be registered in the vaccination registers, but registration of these vaccines has only been mandatory in more recent years (35, 36, 39). In Sweden only vaccinations within the NIP are included in the vaccination register. The analyses are thus limited by different possibilities to assess the effect of a given vaccine as long as it is the most recent vaccine, both within and across countries.

In all the Nordic countries information on emigration relies on the individual reporting resettlement to the authorities. This is mandatory when leaving the country for more than 6 months in Denmark (49) and Norway (50), and for more than 12 months in Sweden (51) and Finland (52). Thus, incomplete information on emigrations, due to leaving the country for shorter periods of time or if parents fail to register the resettlement, may result in children being lost to follow-up without us knowing it from the registers. This may in turn result in our studies underestimating events, e.g. infectious disease hospitalisations, as these are only registered for children who are in the country.

Overall, it is clear that expert knowledge is needed before combining and using Nordic register data for research purposes (29). As such, an important strength of NONSEnse pertains to the data harmonisation process through bi-weekly analysis workshops involving

designated research groups from each of the four countries with expert knowledge on country-specific register data, the heath care systems, and immunisation programmes.

Validity of exposure and outcome measures

In all countries, the vaccines offered through the NIP are subject to mandatory registration. However, validity depends on the reporting accuracy by the health care providers that administer the vaccinations. A Danish study validated the coverage of MMR from the registers using medical records from the general practitioner in a subset of the population and found that the coverage in the register was 86% compared with 94% through inspection of the medical records (53). A similar comparison conducted in Sweden also found underreporting of MMR in the register of around 5-7 percentage units (unpublished). It is unlikely that underreporting of vaccines is associated with the outcomes investigated within the NONSEnse project, therefore, the misclassification will most likely be non-differential and would thus bias the results towards no association.

The prescription registers only contain information on drugs dispensed from filled prescriptions, whereas some drugs are also available over the counter, which are not included in the registers. This includes e.g. weak corticosteroids for topical use (ATC: D07AA) or drugs used to treat symptoms in the eye due to e.g. allergy (ATC: S01G). It is thus possible that the observed cross-country differences in the proportion of children with these prescriptions are affected by national policies or guidelines, or the behaviour of the prescriber or purchaser. Atopic outcomes will, in part, be identified using filled prescriptions for products that are also available over the counter, which may hamper cross country comparability. Antibiotics, however, are prescription drugs in all four countries and thus not affected by over-the-counter purchases.

Several differences in health care organisation, administration, and registration may hamper cross country comparability of the health outcomes included in this project. A strength of NONSEnse is the thorough investigation of the intended outcomes in independent studies which has informed and maximised comparability of the outcome measures to be used in the subsequent studies of non-specific effects of vaccines.

Methodological considerations

Evaluating the effect of implemented vaccination programmes is challenging; the high vaccine uptake rate makes comparisons between vaccinated and unvaccinated children difficult due to the individual factors that determine vaccine uptake. Healthy vaccinee bias may arise if the healthiest children are more likely to follow the vaccination recommendations than the less healthy children (54). However, due to different vaccination schedules in different countries, the children who have received MMR at e.g.15 months of age may be classified as vaccinated according to schedule, too early or too late, depending on the country. Furthermore, age is a strong predictor of both vaccination and the risk of infectious diseases (46). A strength therefore pertains to the observed delay in age at vaccination within each country, which facilitates comparison of different vaccination statuses among children of the same age. For vaccines with a steep and high uptake at the recommended age of vaccination, the children who do not receive the vaccines as scheduled are more likely a selected subgroup of the population, thus hampering comparability with the rest of the population. In contrast, larger variation in the age at vaccination increases comparability between children with different vaccination status according to age.

A strength of this study setup is the many differences in the immunisation programmes, and in changes to the immunisation programmes, the country-specific bias structures, and the possibility to integrate results from different study designs, which facilitate triangulation that can strengthen the potential for making causal deductions (13, 14). The project has already led to useful new information regarding differences and similarities in childhood morbidity between the Nordic countries. Most importantly, the project will increase our understanding of vaccines and how they may affect health in more general ways - holding potential for direct translation into more efficient immunisation programmes and improved child health.

Data sharing statement

Due to data protection rules, we are not allowed to share the individual-level data, but other researchers fulfilling the requirements could obtain similar data from the register controllers.

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Author contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

FIGURE LEGENDS

Figure 1: Flowchart of study population in Denmark, Finland, Norway, and Sweden

Figure 2: Nordic register information linked to the individual using a unique personal identification code (ID)

Figure 3: Transforming country specific datasets into NONSense datasets using a common data model

Figure 4: Vaccination coverage¹ according to age (inverse Kaplan-Meier estimates) among children² born in-country in Denmark, Finland, Norway, and Sweden

Abbreviations: DTP1: First dose of Diphtheria, Tetanus, and acellular Pertussis containing vaccine; DTP2: Second dose of Diphtheria, Tetanus, and acellular Pertussis containing vaccine; DTP3: Third dose of Diphtheria, Tetanus, and acellular Pertussis containing vaccine; MMR: Measles-Mumps-Rubella vaccine; Rota: Rota virus vaccine

¹ The coverage reflects the number of registered vaccines and may thus underestimate the actual vaccination coverage in the countries. ² Including children born in the country from birth cohorts where vaccines administered between 0-2 years of age are registered in the vaccination registers (data availability period). The included birth cohorts are 1997-2016 in Denmark; 2009-2015 in Finland; 1995-2016 for DTP and MMR vaccine and 2015-2016 for Rota in Norway; 2013-2015 in Sweden. Number of children in each birth year is presented in Appendix 3, sTable 1.

Figure 5: Human papilloma virus vaccination coverage^{1,2} according to age (inverse Kaplan-Meier estimates) among girls³ in Denmark, Finland, Norway, and Sweden

Abbreviations: HPV1: First dose of Human papilloma virus vaccine; HPV2: Second dose of Human papilloma virus vaccine

¹The coverage reflects the number of registered vaccinations and may thus underestimate the actual vaccination coverage. ²In some countries the recommended vaccination schedule changed from 3 to 2 doses during follow-up. Only the 2 first doses are reported here. ³ Including girls from birth cohorts where HPV vaccination has been offered from 1 year before age of recommended vaccination until 14 years of age and where vaccinations were registered in the vaccination registers. The included birth cohorts are 1998-2004 in Denmark, 2002-2003 in Finland, 1998-2004 in Norway, and 2003 in Sweden. Number of girls included in each birth cohort is presented in Appendix 3, sTable2.

Competing interest

AAP and HN are investigators in vaccine-related studies for which THL has received funding from GSK, Pfizer and Sanofi Pasteur. The remaining authors report no relation that could be construed as a conflict of interest.

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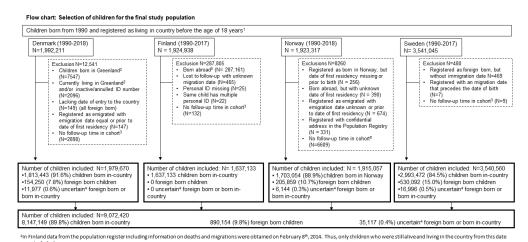
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**Children born or residing in Greenland are registered as living in Denmark. However, the Greenlandic hospitals and pharmacies do not report to the patient register or prescription register

**Children who die or migrate on the same date as they enter the cohort

**Children who die or migrate on the same date as they enter the cohort

**Children registered as born in the country but within a immigration date registered without a preceding emigration date: in these cases, it is not clear if the child is born in-country or has immigrated to the

country.
*Most immigration dates were not known, thus all children born abroad were excluded

Figure 1: Flowchart of study population in Denmark, Finland, Norway, and Sweden 855x481mm (38 x 38 DPI)

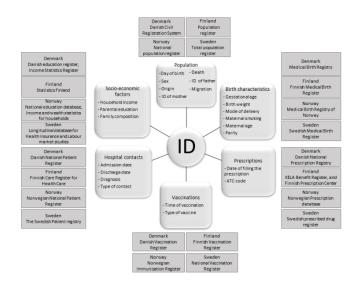


Figure 2: Nordic register information linked to the individual using a unique personal identification code (ID) 855x481mm (38 x 38 DPI)

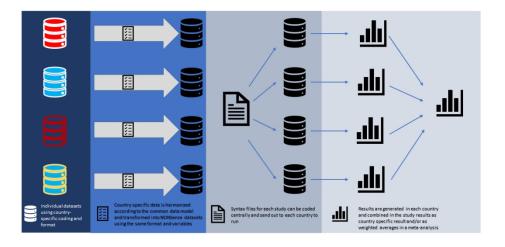
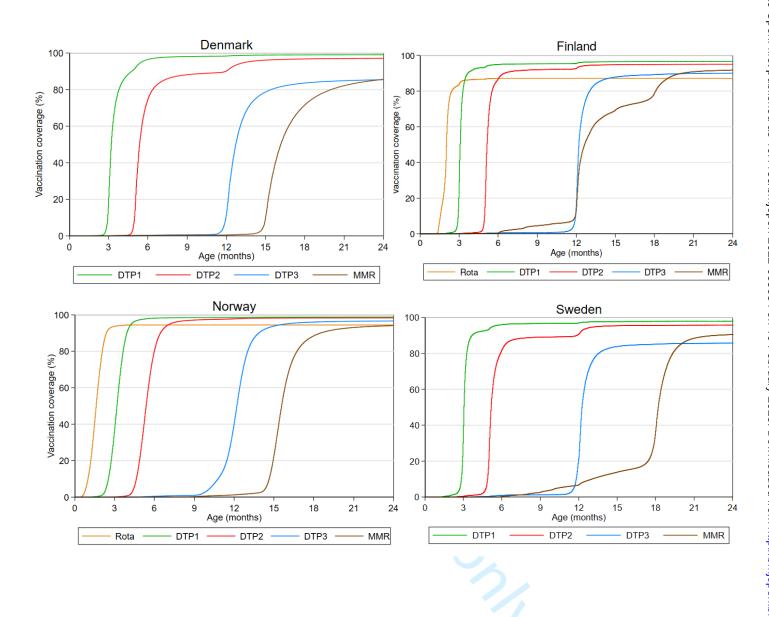
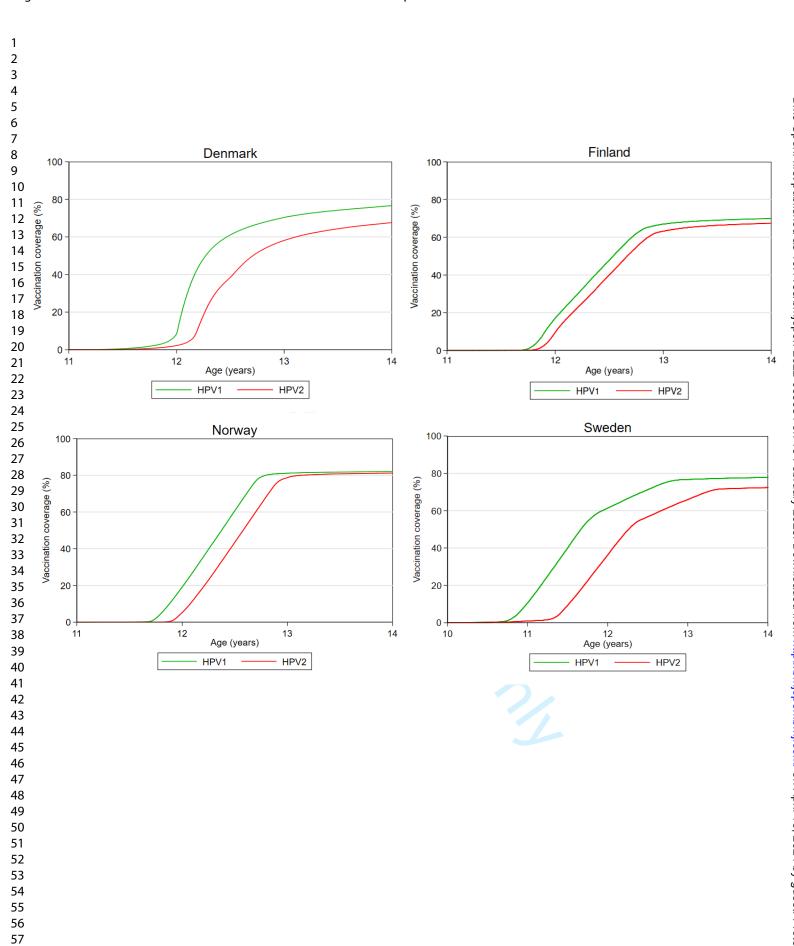
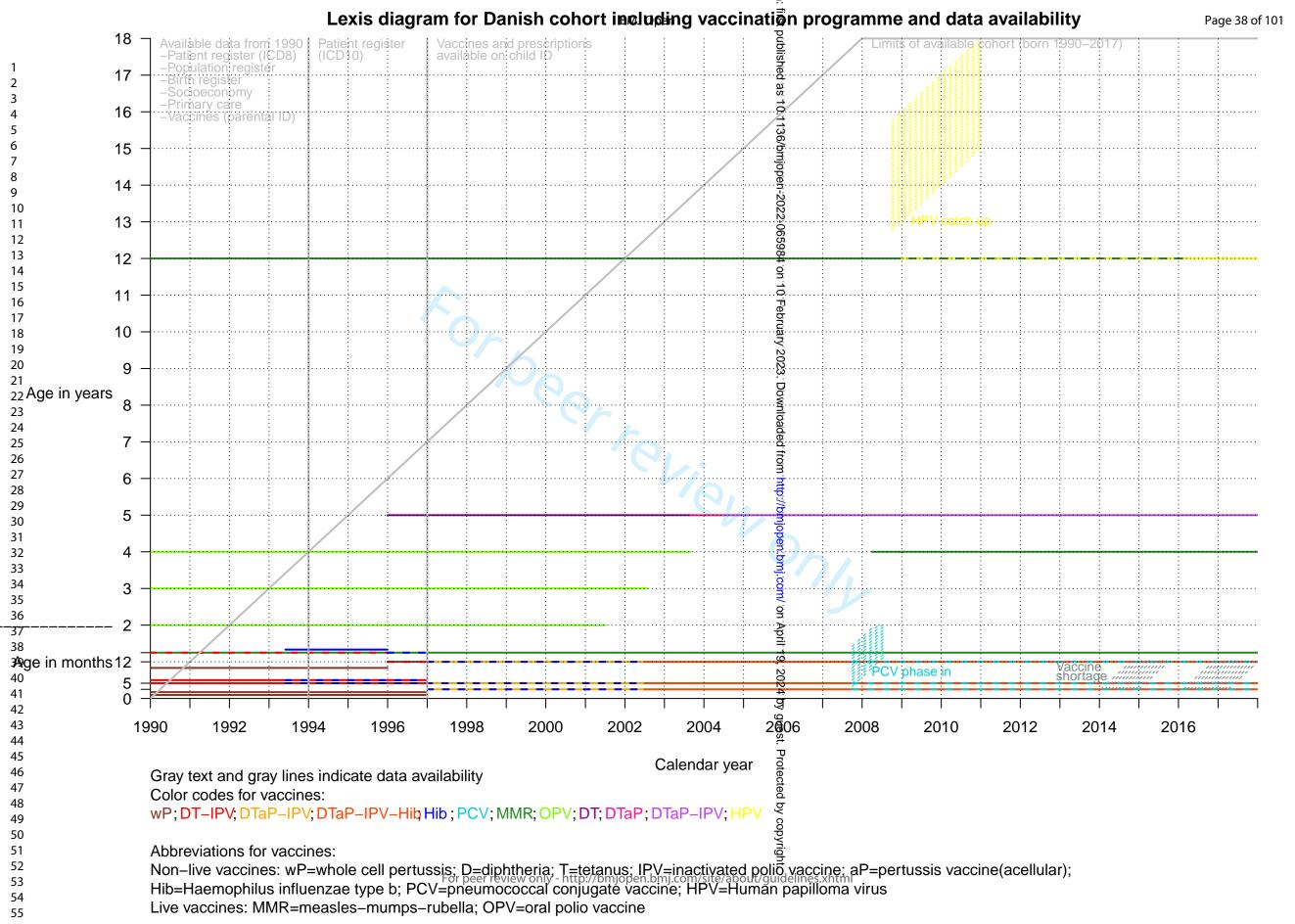


Figure 3: Transforming country specific datasets into NONSense datasets using a common data model $855 \times 481 \text{mm}$ (38 x 38 DPI)







Live vaccines: RV=Rotavirus; MMR=measles-mumps-rubella; BCG=Bacille Calmette-Guerin

Live vaccines: MMR=measles-mumps-rubella

NONSense Common Data Model

May 18th 2022

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Introduction

The Common Data Model (CDM) is a tool for documentation of data preparation and generation of uniform datasets across the Nordic countries (Denmark, Finland, Norway, and Sweden). The aim is to construct a number of uniform background datasets and event tables, which share the same name and entail the same variables, labels and values across countries. Datasets with the exact same format across Countries enables sharing of syntax-files for study analyses.

The CDM is a working document, which will be updated according to country specific data preparation, and expanded as all necessary information will be transformed into background/event tables. In the end, the background/event tables will include all necessary information to conduct all future studies (morbidity/incidence studies and vaccination studies).

The current version presents data content and preparation as per April 2022

The CDM contains 1) "Background/Event tables", and 2) "Source of data and data preparation in each country".

Background/Event tables: include information on the name of the dataset to be used by NONSEnse and format and labeling of each variable within the dataset.

Source of data in each country: includes a description of the information on the source register, and source variables, which have been used to generate the variables in the background/event tables. These tables furthermore entail information on important notes (i.e data breaks, limitations such as i.e. restricted information on redeemed prescriptions in Finland) and data preparation (how have the source variables been modified to generate the variables in the background/event tables). The tables on source of data in each country have been filled in by the individual countries following country specific data preparation.

Background/Event tables

Table: prescriptions

Description: Table of all redeemed prescriptions (included atc codes in each country is listed in

"source of data and datapreparation") among individuals in the study population.

Structure: 1 observation (line) for every redeemed pharmaceutical.

Variables:

Variable	Label	values
id	Personal id of the child	string
b_date	Birthdate of the child	Date Format (%dD_m_Y)
sex	Sex of the child as recorded in the	1="male"
	dataset	2="female"
redeemdate	Date of redeeming the	Date Format (%dD_m_Y)
	prescription	
atc	Full atc code for the redeemed	String (7 digits) use capital
+	drug	letters i.e "J01AA01"

Table: hospital_contacts

Description: Table of all diagnoses (both main diagnosis and all other diagnoses) for somatic patients including information on sex and date of birth for all children in the study population. Note that a patient can have multiple diagnoses attached to the same contact.

Structure: 1 observation (line) for each diagnosis received

Variables:

Variable	label	values
id	Personal id of the child	String
b_date	Birthdate of the child	Date Format (%dD_m_Y)
sex	Sex of the child as recorded in the	1="male"
	dataset	2="female"
adm_date	Date of admission	Date Format (%dD_m_Y)
discharge_date	Date of discharge	Date Format (%dD_m_Y)
diag	ICD diagnosis code	String (For ICD-10 codes use
		max 4 digits e.g. A063)
diagtype	Type of diagnosis	1="Main diagnosis"
		2="Other diagnosis"
type_contact	Type of hospital contact	Categorical:
		1="inpatient"
		2="emergency room patient"
		3="outpatient"
		4="outpatient or emergency
		room patient"

Table: population1

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Description: Background table including information follow-up for each child in the study population. The dataset only includes information on the child's first stay in the country (first in_date and first cens_date is recorded).

Structure: one line for each child

Variable	label	values
id	Personal id of the child	string
b_date	Birthdate of the child	Date Format (%dD_m_Y)
sex	Sex of the child as recorded in the	1="male"
	dataset	2="female"
origin	Born in the country or abroad	1="born in-country"
		2="born abroad"
		9= "Unknown"
in_date	Date of entering the cohort	Date Format (%dD_m_Y)
in_reason	Reason for entering the cohort	1="birth"
		2="immigration"
cens_date	First date of censoring	Date Format (%dD_m_Y)
cens_reason	Reason for being censored	1="death"
		2="out migration"
		3="other"
m_id	id of mother	string
f_id	id of father	string
m_age	Mothers age in years at time of delivery	Numeric (discrete)
m_origin	Maternal origin at birth	1="born in-country"
		2="born abroad"
		9= "Unknown"
p origin	Paternal origin at birth	1="born in-country"
0		2="born abroad"
	7	9= "Unknown"

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Table: birth characteristics

Structure: one line for each child in the study population

Table: Vaccines

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Table. Vaccines		T
variable	Label	values
id	Personal id of the child	string
vacdate	Date of vaccination	Date Format (%dD_m_Y)
vaccine	Type of vaccine administered	Categorical (see coding in
		appendix "vaccine
		categorization")
credibility	Credibility indication of	1=no duplicate
	vaccine information	2= duplicate same vaccine
		removed
		3=duplicate related vaccine
		removed (keep vaccine that
		aligns with vaccination
		schedule)
		4= duplicate related vaccine
		removed (none of the
		vaccines align with
		vaccination schedule)
		5= duplicate related vaccine
		removed (vaccines given
		outside the vaccination
TD and and a	Manaina wasanan dati i	schedule)
TB_endemic	Vaccine recommendations in	0=not risk group
	accordance with connections	1=risk group
	to TB endemic countries	9=not relevant
HepB_endemic	Vaccination recommendations	0=not risk group
	in accordance with	1=risk group
	connections to HepB endemic	9=not relevant
	countries	

Prioritization for duplicate selection:

- Remove same vaccines (variable name: "vaccine", see appendix "vaccine categorization") given 14 days or less after the previous vaccine for the same child (if DTP is registered on day 0, 10 and 20, only remove the vaccine registered at day 10) – keep the earliest registration
 - i. Credibility=2
- 2. Remove vaccines from the same type of vaccines (variable name: "type" see appendix "vaccine categorization") given 14 days or less after the previous vaccine of the same type. Register vaccine as given on the earliest date within the duplicate combination prioritize within combinations:
 - a. Keep vaccine that aligns with vaccination schedule according to **age** and **year of vaccination**
 - i. Credibility =3
 - b. If no vaccine aligns with vaccination schedule but type and age correspond to timing of childhood vaccinations keep the vaccine that protects against most conditions
 - i. Credibility=4
 - c. If vaccines are given outside ages for recommended vaccination according to the vaccination program keep the vaccine that protects against most conditions
 - i. Credibility=5

Table: socio economy

Assign information to all children in the study population. If a child has no registrations in the socio economic datasets variables should be coded as 9 or 99="unknown" as described in the table below.

Overall note on timing of information:

Variables ending with "_b" indicate that information is from birth of the child. Depending on the set up of the register information we will use the date or year of birth to obtain the information. If information is not available for the date or year of birth, we will use information from the year after.

Variables ending with "_10y" indicate that information is from the year/date the child turns 10 years. Depending on the set up of the register information we will use the date or year of turning 10 years to obtain the information.

variable	Label	values	Legal values	Notes
id	Personal id of the child	string		
inc_quin_b	Household income quintile at year of birth of the child	1=first (lowest) 2=second 3= third 4= fourth 5= fifth (highest) 9="unknown"		Quintiles are calculated stratified on year (i.e., calculation of quintiles are done separately for each calendar year. If several income variables are available, selection is based on this priority: 1: equated disposable household/family income; 2: disposable household/family income; 3:household/family income; 4: maternal disposable income; 5: maternal income.
inc_quin_10y	Household income quintile at the year of the child's 10 th birthday	1=first (lowest) 2=second 3= third 4= fourth 5= fifth (highest) 9="unknown"		See notes under inc_quin_b
inc_quin_m_b	Maternal income quintile at year of birth of the child	1=first (lowest) 2=second 3= third 4= fourth		See notes under inc_quin_b

		5= fifth (highest)		
inc_quin_m_10y	Maternal income quintile at the year of the child's 10 th birthday	9="unknown" 1=first (lowest) 2=second 3= third 4= fourth 5= fifth (highest) 9="unknown"		See notes under inc_quin_b
n_children_b	Number of children below 18 years in the household including the child itself at year of birth of the child	Numeric discrete 99="unknown"	>=1	
n_children_10y	Number of children below 18 years in the household including the child itself at the year of the child's 10 th birthday	Numeric discrete 99="unknown"	>=1	
single_parent_b	Single parenthood at year of birth of the child	0=No 1=Yes 9="unknown"		
single_parent_10y	Single parenthood at the year of the child's 10 th birthday	0=No 1=Yes 9="unknown"		
m_education_b	Maternal highest attained education at year of birth of the child	1=Low education (ISCED2011 level 0-2) 2=Medium education (ISCED2011 level 3-4) 3=High education (ISCED2011 level 5-8) 9="unknown"		International Standard Classification of Education (ISCED) 2011 coded into main groups. Read more in reference 1 below the table.
m_education_10y	Maternal highest attained education at	1=Low education (ISCED2011 level 0-2)		See notes under m_education_b.

the year of the child's 10th birthday	2=Medium education (ISCED2011 level 3-4) 3=High education (ISCED2011 level 5-8) 9="unknown"	
---	---	--

Reference 1 for ISCED: https://ec.europa.eu/eurostat/statistics-explained/index.php/International Standard Classification of Education (ISCED)#Implementation of ISCED 2011 .28levels of education.29

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Source of data in each country

Table: prescriptions Prescriptions Denmark

Variable	Source and description	Important notes and data preparation
id	Original name in the Danish data: "pnr". Pseudonomised unique personal identification number for linkage between registers, created by Statistics Denmark. It is linkable (by Statistics Denmark) to the original personal identification number (CPR number) assigned to all Danish residents and used when reporting to all national registers.	Renamed from "pnr"
b_date	Obtained from the Danish National Health Data Agency. Register: "CPR-Registret" Table: "t_person" Variable: "d_foddato"	Renamed from "d_foddato"
sex	Obtained from the Danish National Health Data Agency. Register: "CPR-Registret" Table: "t_person" Variable: "C_KON" Sex as recorded by personal identification number.	sex=1 "male" if C_KON is "M" sex=2 "female" if C_KON is "K"
redeemdate	Obtained from Statistics Denmark. Register: "Lægemiddeldatabasen" Variable: "EKSD" Date of redeeming the prescription	Renamed from "EKSD"
atc	Obtained from statistics Denmark. Register: "Lægemiddeldatabasen" Variable: "ATC" ATC code of purchased drug	All prescriptions with ATC group D, J, R, S and V01, including all sublevels. Renamed from "ATC"

Prescriptions Finland

Variable	Source and description	Important notes and data preparation
id	Obtained from KELA	Statistics Finland pseudonymised HETU
	Register: "KELA etuusrekisteri",	and PATIENT ID
	Table:"Lääkeostot",	_
	Variable: "HETU"	
	Register: "Kanta Reseptikeskus"	
	Table:	
	"KANTA:RESEPTI.LAAKETOIMITUKSET"	
	Variable: "PATIENT ID"	

	Г	
b_date	THL pseudonymised the original personal identification code (in these registers HETU and PATIENT_ID) to unique personal identification number for linkage between registers. THL data management can link the id back to original personal identification code. Obtained from KELA Obtained from KELA	Extracted from "HETU" before pseudonymisation was done.
	Register: "KELA etuusrekisteri", Table:"Lääkeostot", Variable: "HETU" Register: "Kanta Reseptikeskus" Table:	Extracted from "PATIENT_ID" before pseudonymisation was done.
	"KANTA:RESEPTI.LAAKETOIMITUKSET" Variable: "PATIENT ID"	
sex	Obtained from KELA Register: " KELA etuusrekisteri", Table: "Lääkeostot", Variable: "HETU"	Extracted from "HETU" and "PATIENT_ID" before pseudonymisation was done. sex=1 "male" sex=2 "female"
	Register: "Kanta Reseptikeskus" Table: "KANTA:RESEPTI.LAAKETOIMITUKSET" Variable: "PATIENT_ID"	
redeemdate	Obtained from KELA Register: " KELA etuusrekisteri", Table: "Lääkeostot", Variable: "OSTOPV"	Renamed from "OSTOPV" Renamed from "CREATION_DATE"
	Register: "Kanta Reseptikeskus" Table: "KANTA:RESEPTI.LAAKETOIMITUKSET" Variable: "CREATION_DATE" Date of redeeming the prescription	
atc	Obtained from KELA Register: " KELA etuusrekisteri" Table:" Lääkeostot" Variable: "ATC"	All prescriptions with ATC groups D07, D11AH, J, R01, R03, R06, S01G, S03 and V01, including all sublevels. V01 only from KELA data. In Korvattavat lääkkeet only reimbursable
	Register: "Kanta Reseptikeskus" Table: "KANTA:RESEPTI.LAAKETOIMITUKSET" Variable: "ATC_CODE"	products. Reimbursement of antibiotics: < 2006 no reimbursement if cheap 2006-2012: all antibiotics were reimbursed >2012: individual products not reimbursed"
	ATC code of purchased drug	Duplicates removed: if same purchase (same id, redeemdate and atc) was found from both registers only one of them was included in the data.

Prescriptions Norway

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Prescriptions	Notway	
Variable	Source and description	Important notes and data preparation
id	Obtained from Register: "The Norwegian Prescription Database" (NorPD) Pseudonomised unique personal identification number for linkage between registers	Renamed from "pasient_lopenr_pdb2471"
b_date	Obtained from The National Population Register	We have received information on month and year of birth, but not day. For each individual, we have therefore generated a random integer between 1 and length of their month of birth. Using this random integer as day of birth, everyone is assigned an exact birth date.
sex	Obtained from The National Population Register.	Renamed from "kjonn"
redeemdate	Obtained from Register: "NorPD" Variable: "UtleveringsDato" Date of redeeming the prescription	Renamed from "UtleveringsDato"
atc	Obtained from Register: "NorPD" Variable: "ATCKode" ATC code of purchased drug	All prescriptions with ATC group D, J, R, S and V01, including all sublevels Renamed from "ATCKode"

Prescriptions Sweden

Variable	Source and description	Important notes and data preparation
id	Created by Statistics Sweden	Renamed from lopnr
	Pseudonomised unique personal	
	identification number for linkage	
	between registers	
b_date	Obtained from Statistics Sweden	Renamed from fodddatum
	Register: "Register över	
	totalbefolkningen, RTB"	
	Variable: "fodddatum"	D 16 (1)
sex	Obtained from Statistics Sweden	Renamed from "kon"
	Register: "RTB"	
	Variable: "kon"	D 16 " 1 1 "
redeemdate	Obtained from Socialstyrelsen	Renamed from "edatum".
	Register: "Läkemedelsregisteret"	(Date of redeeming the prescription)
	Variable: "edatum"	
atc	Obtained from Socialstyrelsen	ATC code of purchased drug. The data from
	Register: "Läkemedelsregisteret" Variable: "atc"	Sweden included all prescriptions within ATC

	groups D, J, R, S and V01, including all sublevels

Table: hospital_contacts Hospital contacts Denmark

Variable	Source and Description	Important notes and data preparation
id	Original name in the Danish data: "pnr". Pseudonomised unique personal identification number for linkage between registers, created by Statistics Denmark. It is linkable (by Statistics Denmark) to the original personal identification number (CPR number) assigned to all Danish residents and used when reporting to all national registers.	Renamed from "pnr"
b_date	Obtained from the Danish National Health Data Agency. Register: "CPR-Registret" Table: "t_person" Variable: "d_foddato"	Renamed from "d_foddato"
sex	Obtained from the Danish National Health Data Agency. Register: "CPR-Registret" Table: "t_person" Variable: "C_KON" Sex as recorded by personal identification number.	sex=1 "male" if C_KON is "M" sex=2 "female" if C_KON is "K"
adm_date	Obtained from the Danish National Health Data Agency. Register: Danish national patient registry Table: T_ADM Variable: D_INDDTO	Renamed from "D_INDDTO" For outpatient contacts with multiple visits adm_date is recoded according to the date of visit ("D_AMBDTO" from the table "t_bes")
discharge_date	Obtained from the Danish National Health Data Agency. Register: Danish national patient registry Table: T_ADM Variable: D_UDDTO	Renamed from "D_UDDTO" For contacts without a discharge date (N=1080) the discharge date is set as the last observed discharge date in the dataset+1day (11May2018) For outpatient contacts, discharge date is recoded to be the same date as "adm_date".
diag	Obtained from the Danish National Health Data Agency.	Renamed from "C_DIAG"

Register: Danish national patient registry

Table: T_DIAG
Variable: C_DIAG

Diagnosis coded as ICD 8 until December 31 1994, hereafter coded using ICD 10.

Danish specification letters to the ICD-10 codes removed and the administrative letter "D" in front of all codes removed: Values changed to string4 format (i.e

DA011a→A011)

Diagnoses other than the main or other diagnoses are excluded.
Diagnoses with modifications indicating that the diagnosis cannot be validated are excluded (c diagmod==1 | 2).

diagtype

Obtained from the Danish National
Health Data Agency.
Register: Danish national patient

registry Table: T DIAG

Variable: C_DIAGTYPE

Renamed from variable "C_DIAGTYPE" Recoded: C_DIAGTYPE: "A"= "main diagnosis" C_DIAGTYPE: "B"= "other diagnosis"

Renamed variable "C PATTYPE"

A patient can have multiple other diagnoses for the same contact.

Excluding diagnoses other than main or other (i.e temporary diagnoses or additional diagnosis ("tillægsdiagnose").

type_contact Obtained from the Danish National Health Data Agency.

Register: Danish national patient

registry

D AMBDTO

Table: T_DIAG and t_bes Variables: C_PATTYPE, Recoded:

type_contact=1 "inpatient" if C_PATTYPE is "0" (inpatient) or "1" (Before year 2002 some patients were coded as "1= deldøgnspatienter" (~part day patient)

type_contact=2 "emergency room contact" if C_PATTYPE is 3 "emergency room contact". Outpatient contacts (C_PATTYPE=2) admitted after year 2014 with "C_INDM"= "Acute" are coded as type_contact=2 "emergency room patient"

type_contact=3 "outpatient contact" if C_PATTYPE=2 before year 2014 or C_PATTYPE=2 and c_indm is not 1 from and including year 2014

In Denmark we have some long outpatient contacts with multiple visit dates (D_AMBDTO) during the contact. Each visit date is coded as an independent outpatient contact. All diagnoses within the original outpatient contact is recorded for each visit.

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Hospital contacts Finland

Variable	Source and Description	Important notes and data preparation
id	Obtained from THL Register: "the Finnish National Patient Register THL=Hilmo" Table: "Perustiedot/Asiakas, potilas" Variable: "HT" THL pseudonymised the original personal identification code (in this register HT) to unique personal identification number for linkage between registers. THL data management can link the id back to original personal identification code.	Statistics Finland pseudonymised HT with their own id for the remote user system.
b_date	Obtained from THL Register: "Hilmo" Table: "" Variable: "SYNTAIKA"	Renamed from "SYNTAIKA"
sex	Obtained from THL Register: "Hilmo" Table: "Perustiedot/Asiakas, potilas" Variable: "SP"	Renamed from "SP"
adm_date	Obtained from THL Register: "Hilmo" Table: "Tulotiedot" Variable: ""TUPVA"	Extracted from "TUPVA" which contain the date and time of arrival
discharge_date	Obtained from THL Register: "Hilmo" Table: "Poistumistiedot" Variable: "LPVM"	Extracted from "LPVM" which contain the date and time of discharge
diag	Obtained from THL Register: "Hilmo" Table: "Hoitotiedot" Variable: "PDGO, PDGE, SDGO, SDGE"	Renamed from PDGO, PDGE, SDGO, SDGE ICD-codes ICD-codes V01-Y98 not available, codes O00-O99 were not analysed
diagtype	Obtained from THL Register: "Hilmo" Table: "Hoitotiedot" Variable: "PDGO, PDGE, SDGO, SDGE"	1=main diagnosis: PDGO and PDGE 2=add diagnosis: SDGO and SDGE
type_contact	Obtained from THL Register: "Hilmo" Table: "Perustiedot/Hoitojakso tai avohoitokäynti" Variable: "PALA" and "EA"	All visits with EA = 98 were omitted (EA= special branches of medicine, 98=general practice) - type_contact = 1, if PALA = 1 or PALA = 6 (inpatient) - type_contact = 2, if PALA = 91 (emergency) - type_contact = 3, if PALA is not 1, 6 or 91 (outpatient, not emergency)

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PALA: 1 = inpatient ward, 6 = rehabilitation
ward 91 = emergency room visit

Hospital contacts Norway

Variable	Source and description	Important notes and data preparation
id	Obtained from the Norwegian	Renamed from " pasientlopenr pdb2471"
	National Patient Register	' -
b_date	Obtained from The National	We have received information on month and
_	Population Register	year of birth, but not day. For each individual,
		we have therefore generated a random
		integer between 1 and length of their month
		of birth. Using this random integer as day of
		birth, everyone is assigned an exact birth
		date.
sex	Obtained from The National	Renamed from "kjonn"
	Population Register	
	Variable: "kjonn"	
adm_date	Obtained from	Renamed from "innDato"
	Register: Norwegian National	
	Patient Register	
	Variable: "innDato"	
discharge_date	Obtained from	Renamed from "utDato". The data set only
	Register: "Norwegian National	includes admissions that have ended, i.e.
	Patient Register"	utDato before Dec 31, 2018.
	Variable: "utDato"	75 contacts had missing utDate. These were
		75 contacts had missing utData. These were
		either outpatient contacts (n=69) or daycare procedures (n=6). utDato was defined
		innDato in these cases
diag	Obtained from	Original dataset has one record for each
diag	Register: "Norwegian National	hospital contact with variables
	Patient Register"	hovedtilstand_1, hovedtilstand_2,
	T different regions.	bitilstand_1,, bitilstand_19 that contain ICD
		10 diagnosis codes.
		The variables were renamed diag1, diag2,
		diag3, where diag1 and diag2 correspond
		to the 2 primary diagnoses. The dataset was
		reshaped to long format containing one
		observation per diagnosis with variables diag
		containing the ICD-10 codes and diag_ind =
		1, 2, 3,
diagtype		diagtype = 1 if diag_ind = 1 or diag_ind = 2
		diagtype = 2 if diag_ind > 2
type_contact	Obtained from	Based on the variables Behandlingsniva3
	Register: "Norwegian National	and Aktivitetskategori3:
	Patient Register"	For contacts with utDato in 2008-2014:
	Variable: ""	 IF Behanglingsniva3 = 1 OR
		Behandlingsniva3 = 2 THEN
		type_contact = 1
		• ELSE IF Behandlingsniva3 = 3 THEN
		type contact = 4

	 For contacts with utDato in 2015-2018: IF Aktivitetsjkategori3 = 1 OR Aktivitetskategori3 = 2 THEN type_contact = 1 ELSE IF Aktivitetskategori3 = 3 THEN type_contact = 4
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Hospital contacts Sweden

In the original Swedish register data, each admission date is a separate line with all diagnoses and other information included in one line. The dataset has been reshaped to long format with one line for each diagnosis

Variable	Source and Description	Restrictions Modifications
id	Created by Statistics Sweden Pseudonomised unique personal identification number for linkage between registers	Renamed from "lopnr"
b_date	Obtained from Statistics Sweden Register: "RTB" Variable: "fodddatum"	Renamed from "fodddatum"
sex	Obtained from Statistics Sweden Register: "RTB" Variable: "kon"	Renamed from "kon" Note: There were some discrepancies regarding sex in the two registries (RTB and Patientregistret), circa 1100 cases regarding inpatients and circa 2900 regarding outpatients. We used the information from Statistics Sweden.
adm_date	Obtained from Socialstyrelsen Register: "Patientregisteret" Variable: "INDATUM"	Renamed from "INDATUM". Inpatient visits: - Date missing (n=6); left unchanged. - Date registered as earlier than birth (n=103); dropped observations if both date of admission and discharge came before birth (n=8), replaced date of admission with date of birth if less than 15 days apart (n=68), replaced month or year, to align with date of discharge (n=29). - Date registered as later than discharge but not missing (n=11); adm_date and discharge_date were shifted. Outpatient visits: - Date missing (n=1,253); left unchanged

discharge_date diag	Obtained from Socialstyrelsen Register: "Patientregisteret" Variable: ""UTDATUM"	For inpatient visits, the variable was renamed from "UTDATUM". For outpatient visits, there was no corresponding variable, and the discharge date was therefore created to be equal to the admission date. The variable "DIAGNOS1 30" can contain up
alag	Register: "Patientregisteret" Variables: "HDIA" and "DIAGNOS1_30"	to 30 different diagnoses. It was therefore split to create separate variables for each sequential diagnosis. Duplicate codes within each observation and the code _atc were removed.
diagtype	Obtained from socialstyrelsen Register: "Patientregisteret" Variables: "HDIA" and "DIAGNOS1_30"	Diagtype was coded as 1="Main diagnosis" if indicated in variable "HDIA". If no main diagnosis was listed in variable HDIA, the first diagnosis within variable "DIAGNOS1_30" was chosen as the main diagnosis. Other diagnoses listed within DIAGNOS1_30 were coded as 2="Other diagnosis".
type_contact	Obtained from Socialstyrelsen Register: "Patientregisteret"	Variable coded based on which source file the data came from: in- or outpatient data. All data in the outpatient-file was coded = 4, as emergency room visits could not be distinguished. (A variable for emergency room visits [VERKS_AKUT] was only included in the patient registry in 2016 and therefore not part of our data request.).
		2

Table: population1

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Population 1 Denmark

Variable	Source and Description	Important notes and data preparation
id	Original name in the Danish data: "pnr". Pseudonomised unique personal identification number for linkage between registers, created by Statistics Denmark. It is linkable (by Statistics Denmark) to the original personal identification number (CPR number) assigned to all Danish residents and used when reporting to all national registers.	Renamed from "pnr"
b_date	Obtained from the Danish National Health Data Agency. Register: "CPR-Registret" Table: "t_person" Variable: "d_foddato"	Renamed from "d_foddato"
sex	Obtained from the Danish National Health Data Agency. Register: "CPR-Registret" Table: "t_person" Variable: "C_KON" Sex as recorded by personal identification number.	sex=1 "male" if C_KON is "M" sex=2 "female" if C_KON is "K"
origin	Obtained from the Danish National Health Data Agency. Register: "CPR-Registeret" Table: "T_FODESTED" Variables: "fodested_kode", "fodested_tekst" Variables from table: population1; in_date, cens_date are used to define if there is uncertain origin	Children are categorised as: 1="born in-country" if fodested_kode=000 or 208 (Denmark), 2= "foreign born" if fodested_kode is not 000 or 208 9="unknown" if fodested_kode=000 or 208 (Denmark) and if there is date of inmigration not preceded by an outmigration (In this case we cannot be certain that the child is born in Denmark as it appears to have migrated to Denmark after the date of birth)
in_date	Obtained from the Danish National Health Data Agency. Register: "CPR-Registeret" Table: "T_FODESTED" Variables: "D_FODDATO" Table: " T_ADRESSE_UDLAND_HIST " Variables: "C_ANNKOR", "D_INDREJSE_DATO"	in_date is defined as date of birth "D_FODDATO" if "origin" is 1="born in- country" . in_date is defined as the first date of in-migration "D_INDREJSE_DATO" if origin is not 1="born in-country".

in_reason	Table: " T_ARKIV_ADRESSE_UDLAND_HI ST" Variables: "C_ANNKOR", "D_INDREJSE_DATO" Obtained from NONSense CDM Table: Population1 Variable: "origin", "cens_date" Obtained from the Danish National Health Data Agency. Register: "CPR-Registeret" Table: "T_FODESTED" Variables: "D_FODDATO" Table: " T_ADRESSE_UDLAND_HIST " Variables: "C_ANNKOR", "D_INDREJSE_DATO" Table: " T_ARKIV_ADRESSE_UDLAND_HI ST" Variables: "C_ANNKOR", "D_INDREJSE_DATO" Obtained from NONSense CDM Table: Population1 Variable:"in_date"	in_reason is categorised as: 1="birth" if in_date is obtained from "D_FODDATO" 2="immigration" if in_date is obtained from D_INDREJSE_DATO
cens_date	Obtained from the Danish National Health Data Agency. Register: "CPR-Registret" Table: "t_person" Variables: "D_STATUS_HEN_START", "C_STATUS" Table: " T_ADRESSE_UDLAND_HIST" Variables: "C_ANNKOR", "D_UDREJSE_DATO" Table: "T_FORSVIND_HIST" Variables: "C_ANNKOR", "D_FORSVIND_DATO"	Cens_date is defined as the first date of either 1) "D_STATUS_HEN_START" if "C_STATUS" is "90"=death, "20"=CPR number for tax purposes, "70"=disappearing, "80"=out-migration or 2) D_UDREJSE_DATO or 3) D_FORSVIND_DATO.
cens_reason	Obtained from the Danish National Health Data Agency. Register: "CPR-Registret"	Cens_reason is categorized as: 1= "death" if cens_date is obtained from C_STATUS="90" (death)

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Table: "t person" 2="out-migration" if cens date is obtained from C STATUS="80" (outmigration) or from Variables: "D STATUS HEN START", D UDREJSE DATO 3="other" if cens date is obtained from "C STATUS" C STATUS="20" (CPR for tax purposes" | Table: " "70" (disappearing) or from D_FORSVIND DATO. T ADRESSE_UDLAND_HIST " Variables: "C ANNKOR", "D UDREJSE DATO" If more than one cens reason is registered for the first cens date preference is given to Table: "T FORSVIND HIST" 1="death" Variables: "C ANNKOR", "D FORSVIND DATO" Obtained from the Danish National m id Renamed from Health Data Agency. "V MOR PNR ENCRYPTED" Register: "CPR-Registret" Table: "t person" Variable: "V MOR PNR ENCRYPTED" Obtained from the Danish National Renamed from "V FAR PNR ENCRYPTED" f id Health Data Agency. Register: "CPR-Registret" Table: "t_person" Variable: "V FAR PNR ENCRYPTED" Obtained from the Danish National Id of the mother is obtained from the dataset m age Health Data Agency. "population1" (originally obtained from the Register: "MFR" linked with-CPR register). Using information on maternal Register: "CPR-Registeret" birthday (d foddato) and birthday of the child, Table: "t_person" Maternal age in years is calculated as age in Variable: "d foddato" whole years at time of delivery of the child. ld of the mother is obtained from the dataset m origin Obtained from the Danish National "population1" and linked with information from Health Data Agency. the CPR register Register MFR Register: "CPR-Registeret" 1="born in-country" if fodested kode=000 or Table: "T FODESTED" 208 (Denmark), Variables: "fodested kode", 2= "born abroad" if fodested kode is not 000 "fodested tekst" 9="unknown" if information is missing Variables from table: population1; in date, cens date are used to define if there is uncertain origin Obtained from the Danish National Id of the father is obtained from the dataset p origin Health Data Agency. "population1" and linked with information from Register MFR the CPR register Register: "CPR-Registeret" 1="born in-country" if fodested kode=000 or Table: "T FODESTED" 208 (Denmark), Variables: "fodested kode", 2= "born abroad" if fodested kode is not 000 "fodested tekst" or 208

	9="unknown" if the information is missing
Variables from table: population1; in_date, cens_date are used to define if there is uncertain origin	

Population 1 Finland

Variable	Source and Description	Important notes and data preparation
id	Obtained from: Register: Population register Table: VTJ.HENKILO	Person included only if hetu_voimassa (=id is valid) is checked.
	Variable: hetu Table: VTJ.HENKILO_HETU Variable: hetu voimassa	Statistics Finland pseudonymised "hetu" with their own id for the remote user system.
	THL pseudonymised the original personal identification code (in this register "hetu") to unique personal identification number for linkage between registers. THL data management can link the id back to original personal identification code.	
b_date	Obtained from: Register: Population register Table:VTJ.HENKILO Variable: syntymapaiva	Renamed from syntymapaiva
sex	Obtained from: Register: Population register Table: VTJ.HENKILO Variable: sukupuoli	sex=1 "male" if lapsen sukupuoli is "mies" sex=2 "female" if lapsen sukupuoli is "nainen"
origin	Obtained from: Register: Population register Table:VTJ.HENKILO Variable: "syntymakunta"	1 = born in country, if the code of syntymakunta (birth municipality is not 200 or NA (not available) 2 = born abroad, if syntymakunta is 200 3 = uncertain foreign or in-country, if syntymakunta is NA, 198,199 or 000 (children born abroad were excluded as only minority of them had immigration dates available in the THL's population register copy, in which the follow-up begin in 2014, also children with uncertain origin were excluded)

in_date	Obtained from: Register: Population register Table:VTJ.HENKILO Variable: "syntymapaiva" and	If born in country (origin=1), equal to the date of birth = syntymapaiva
in_reason	Obtained from: Register: Population register Table:VTJ.HENKILO Variable: "syntymapaiva"	1 = Birth, if born in the country (origin=1)
cens_date	Obtained from: Register: Population register Table: VTJ.HENKILO Variable: "KUOLINPVM" and Register: Statistic Finland Table:	Equal to date of emigration, if such has occurred, otherwise equal to date of death. Emigration from Population register (select min (kunta_muuttopvm) from vtj.henkilo_kotikuntahistoria and kunta='200')
	Variable: "kuolinpäivä" Variable: ensimmäinen maastamuuttopäivä Table: VTJ.HENKILO Table: KOTIKUNTAHISTORIA: Variable: "kotikunta" and "kunta	Ensimmäinen maastamuuttopäivä=first emigration date available only in remote user system Fiona
cens_reason	muuttopaiva" Obtained from: Register: Population register Table: VTJ.HENKILO	1 = Death If subject died 2 = Emigration
m_id	Variable:kuolinpvm, muuttopvm Obtained from: Birth register Table: Äidin henkilötiedot Variable: aiti_hetunnus THL pseudonymised the original personal identification code (in this register "aiti_hetunnus") to unique personal identification number for linkage between registers. THL data management can link the id back to original personal identification code.	Renamed from "aiti_hetunnus" and pseudonymised by Statistics Finland for data lingage.
f_id	Obtained from: Statistics Finland	Not available for THL. Pseudonymised id for data linkage in Statistics Finland
m_age	Obtained from Register: Birth register Table: Äidin henkilötiedot Variable: aiti_ika	Renamed from aiti_ika
m_origin	Obtained from Register: Statistics Finland Table: Variable: svaltio_aiti	Available only in the Fiona remote user system. svaltio_aiti = 246 -> 1 = "born in-country" svaltio_aiti != 246 (ts joku muu kuin Suomi) -> 2 = "born abroad"

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		svaltio_aiti = NA (ts puuttuu) -> 9 = "Unknown"
p_origin	Obtained from Register: Statistics Finland Table: Variable: svaltio_isa	Available only in the Fiona remote user system. svaltio_isa = 246 -> 1 = "born in-country" svaltio_isa != 246 (ts joku muu kuin Suomi) -> 2 = "born abroad" svaltio_isa = NA (ts puuttuu) -> 9 = "Unknown"

Population 1 Norway

Variable	Source and Description	Important notes and data preparation
Variable	Source and Description	Important notes and data preparation
id	Obtained from: SSB (Statistics Norway) Register: "National Population Register"	Renamed from pasientlopenr_pdb2471
b_date	Obtained from: SSB (Statistics Norway) Register: "National Population Register"	For all individuals in population1 as well as their parents, we have received information on month and year of birth, but not day. For each individual, we have therefore generated a random integer between 1 and length of their month of birth. Using this random integer as day of birth, everyone is assigned an exact birth date.
sex	Obtained from: SSB (Statistics Norway) Register: "National Population Register"	Renamed from kjonn
origin	Obtained from: SSB (Statistics Norway) Register: "National Population Register"	Based on the variables in_date (see below) and "fodeland". Origin is coded as 1 if country of birth is Norway (fodeland = 0) and in_date is equal to date of birth. Origin is coded as 2 if country of birth is any other country. Origin is coded as 9 if country of birth is Norway and in_date is later than date of birth.
in_date	Obtained from: SSB (Statistics Norway) Register: "National Population Register"	Based on the variables "regstatus", "regstatusdato", "forstdato" and "fodeland". Indate is defined as forstdato if invkat = B (immigrants). "forstdato" is the date of first registration in the Population Registry. The variable is only defined for persons with invkat = B (immigrants). Otherwise (invkat = A, C, E, F or G), indate is defined as a person's earliest regstatusdato with regstatus = 1 (Bosatt). In general, individuals who have been residents in Norway since birth, will be registered with

		regstatus = 1 and corresponding
		regstatusdato = date of birth. However, regstatus is only available as of January 1 each year. If a person's regstatus has
		changed more than once during a calendar year, we only have information about the
		most recent change. Therefore, in_date was set to date of birth for individuals with country
		of birth Norway who died or emigrated in their year of birth even if they do not have a record with regstatus = 1 and regstatusdato = date of birth.
		Note: cross-checked with the Birth Registry,
		and > 98% of children with country of birth Norway who died or emigrated in their year of
		birth have a record in the Birth Registry.
		Thus, it is a reasonable assumption that these children have been residents of
		Norway since birth.
in_reason	Obtained from: SSB (Statistics Norway)	in_reason is coded as 1 if origin = 1. in_reason is coded as 2 if origin = 2 or origin
	Register: "National Population RegisterBefolkning	= 9.
cens_date	Obtained from: SSB (Statistics Norway)	Based on the variables "regstatus", "regstatusdato", and "dodsdato". Date of
	Register: "National Population	emigration was defined as a person's earliest
	RegisterBefolkning	regstatusdato with regstatus = 3 (emigration). Date of death was defined as dodsdato. We only have information on month and year of death. Exact date of date was assigned as a
		random integrer within the month of death. cens_date was set to date of emigration if emigration occurred before date of 18th
		birthday or January 1, 2019. cens_date was set to date of death if death occurred before
		date of 18th birthday or January 1, 2019,
		unless date of death was preceded by date of emigration (N = 40).
cens_reason	Obtained from: SSB (Statistics Norway)	cens_reason was coded as 1 if cens_date = date of death. cens_reason is coded as 2 if
	Register: "National Population RegisterBefolkning	cens_date = date of emigration.
m_id	Obtained from: SSB (Statistics Norway)	Renamed from lopenr_mor_pdb2471
	Register: "National Population Register"	
f id	Variable: Løpenummer mor Obtained from: SSB (Statistics	Renamed from lopenr far pdb2471
1_IU	Norway) Register: "National Population	Tenamed nom lopelii_lai_pub247 1
	, , , , , , , , , , , , , , , , , , ,	

	Variable: Løpenummer far	
m_age	Obtained from: SSB (Statistics Norway) Register: "National Population RegisterBefolkning	Mother's age in whole years at time of birth of child. Based on the mother's assigned exact date of birth (b_date).
m_origin	Obtained from: SSB (Statistics Norway) Register: "National Population RegisterBefolkning	Based on the variable "fodeland". m origin = 1 if mother's country of birth is Norway (fodeland = 0), m_origin = 2 if mother's country of birth is any other country, and m_origin = 9 if mother's country of birth is missing (n = 20,559).



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Population 1 Sweden

Variable	Source and Description	Important notes and data preparation
id	Created by Statistics Sweden Register: Registret över totalbefolkningen (RTB) Variable: lopnr	Pseudonomised unique personal identification number for linkage between registers Renamed from "lopnr".
b_date	Obtained from Statistics Sweden Register: Registret över totalbefolkningen (RTB) Variable: fodddatum	Renamed from "fodddatum"
sex	Obtained from Statistics Sweden Register: Registret över totalbefolkningen (RTB) Variable: kon	Renamed from "kon"
origin	Obtained from Statistics Sweden Register: Registret över totalbefolkningen (RTB) Variable: UtlSvBakg Combined with data from the National Board of Health and Welfare Register: Medical Birth Registry	Recoded from: "UtlSvBakg" where 11 = Born abroad 12 = Born in the country with two foreign-born parents 21 = Born in the country with one native and one foreign born parent 22 = Born in the country with two native born parents. Individuals were coded 1 = "born in-country", if UtlSvBakg = 12, 21 or 22, and 2 = "born abroad", if UtlSvBakg = 11. Individuals were coded 9 = "Unknown" if registered as born in country (UtlSvBakg = 12, 21 or 22) but also had a registered immigration date not preceded by an emigration date. (In this case we cannot be certain that the child was born in the country as it appeared that they have immigrated after the date of birth.) If the individual was initially coded as 9 "Unknown", but was registered in the medical birth registry, they were recoded as 1 = "born in-country".
in_date	Variable created based on information from Statistics Sweden Register: Registret över totalbefolkningen (RTB) Variables: fodddatum and datum [migration], posttyp [migration]	If born in country (origin=1), equal to the date of birth = fodddatum If born outside the country (origin=2), equal to first date of immigration If unknown origin (=9), equal to first date of immigration
in_reason	Variable created based on information from Statistics Sweden	1 = Birth, if born in the country (origin=1) 2 = Immigration,

		Tarana and a same and
	Register: Registret över	if born abroad (origin=2) or unknown origin
	totalbefolkningen (RTB)	(origin=9)
	Variables: foddatum, datum,	
	posttyp	
cens_date	Variable created based on	Equal to date of emigration, if such an event
	information from Statistics Sweden	had been registered, otherwise equal to date
	Register: Registret över	of death.
	totalbefolkningen (RTB)	
	Variables: Doddatum, datum	
	[migration], posttyp [migration]	
cens reason	Variable created based on	1 = Death, if there was a date of death
_	information from Statistics Sweden	registered in variable Doddatum.
	Register: Registret över	2 = Out migration, if there was a registered
	totalbefolkningen (RTB)	migration out of the country
	Variables: Doddatum, datum	Ingraner care and country
	[migration], posttyp [migration]	
m id	Obtained from Statistics Sweden	Renamed from "LopNrMor"
	Register: Flergenerationsregistret	Tremames nem zeprimer
f id	Obtained from Statistics Sweden	Renamed from "LopNrFar"
	Register: Flergenerationsregistret	Tronamou nom Zopran an
m_age	Obtained from Statistics Sweden	Calculated as mother's date of birth minus
_ 3	Register: RTB	the child's date of birth, divided by 365, and
	Variable: datum fodd	rounded down to yield age in years.
m origin	Obtained from Statistics Sweden	Recoded from variable "UtlSvBakg" as
_ 3	Register: RTB	described above for variable Origin in table
	Variable: UtlSvBakg	Population 1.
p_origin	Obtained from Statistics Sweden	Recoded from variable "UtlSvBakg" as
P_0g	Register: RTB	described above for variable Origin in table
	Variable: UtlSvBakg	Population 1.
	variable. Glievbang	T operation 1.

Link to *Contents*

Table: birth_charcteristics birth_characteristics Denmark

Variable	Source and Description	Important notes and data preparation
id	Original name in the Danish data:	Renamed from "pnr"
	"pnr". Pseudonomised unique	
	personal identification number for	
	linkage between registers, created	
	by Statistics Denmark. It is linkable	
	(by Statistics Denmark) to the	
	original personal identification	
	number (CPR number) assigned to	
	all Danish residents and used	
	when reporting to all national	
	registers.	
b_weight	Obtained from the Danish National	Renamed from "vaegt_barn" and " V_VAGT"
	Health Data Agency.	Registrations of birthweight less than 100g or
	Register: "MFR" from 1997 and	higher than 9990g are categorized as missing
	onwards, "Fødselsregisteret"	
	before 1997	
	Table: "MFR"(from MFR),	
	"levendefødt" (From	
	fødselsregisteret)	
	Variable: "vaegt_barn" (MFR),	
	V_VAGT (fødselsregisteret)	
ga	Obtained from the Danish National	Derived from "Gestationsalder_dage" (ga in
	Health Data Agency.	days) rounded down to whole weeks of
	Register: "MFR" from 1997 and	gestation: ga=floor(gestationsalder_dage/7)
	onwards, "Fødselsregisteret"	
	before 1997	Renamed from V_SVLANGDE
	Table: "MFR"(from MFR),	
	"levendefødt" (From	
	fødselsregisteret)	
	Variable: "Gestationsalder_dage"	
	(MFR), "V SVLANGDE"	
	(fødselsregisteret)	
sectio	Obtained from the Danish National	From MFR:
	Health Data Agency.	0="not delivered by caesarean section" if they
	Register: "MFR" from 1997 and	do not have any diagnosis code indicating
	onwards, "Fødselsregisteret"	caesarean section
	before 1997	("Markoer kejsersnit"=missing)
	Table: "MFR"(from MFR),	
	"levendefødt" (From	1="delivered by caesarean section" if they
	fødselsregisteret)	have a diagnosis code indicating caesarean
		section in the variable "Markoer kejsersnit"
	Variables: "Markoer kejsersnit"	
	(MFR), B_I11, B_SECTIOF,	Fødselsregisteret
	B SECTIOU (fødselsregisteret)	sectio=1 if B I11=1 B SECTIOU=1
	(!_ddoi:10giotorot)	B SECTIOF=1
		5_5251161

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smoke	Obtained from the Danish National Health Data Agency. Register: "CPR-Registeret" Register: "MFR" from 1997 and onwards, "Fødselsregisteret" before 1997 Table: "MFR" (from MFR), "levendefødt" (From fødselsregisteret) Variable: "rygerstatus_moder" (MFR), B_RYGER (fødselsregisteret) Obtained from the Danish National Health Data Agency. Register: Danish national patient registry Table: "T_ADM", "T_DIAG" Variables: pnr, recnum, D_INDDTO, D_UDDTO, C_ADIAG, C_TILDIAG,	Information from MFR, variable "RYGERSTATUS_MODER" Smoke=0 if rygerstatus_moder=0 Smoke=1 if rygerstaus moder >0 and <99 (indicating any smoking during pregnancy regardless of magnitude) Smoke=9 if rygerstatus_moder=99(unknown) or missing. From fødselsregisteret: smoke=0 if B_RYGER=0 smoke=1 if B_RYGER=1 smoke=9 if B_RYGER=. For some pregnancies especially in 1997 and partially in 1998, smoke information is not available in MFR, but we are able to subtract the information from the patient registry using the additional diagnosis "DUT00-DUT99". Information about smoke is inserted from the patient registry if: a) the information is not present in MFR/fødselsregisteret; b) if the patient registry indicates smoking while MFR/fødselsregisteret indicates no smoking
singleton	Obtained from the Danish National Health Data Agency. Register: "CPR-Registeret" Register: "MFR" from 1997 and onwards, "Fødselsregisteret" before 1997 Table: "MFR" (from MFR), "levendefødt" (From fødselsregisteret) Variable: "Flerfoldsgraviditet" (MFR), C_PLAC (fødselsregisteret)	MFR Children are categorized as: 0="no" if there is an indication of multiple child delivery (diagnosis code) or there is registered another child born by the same mother within 1 day from the child's birthday 1="yes" if there is no indication of multiple child delivery ("Flerfoldsgraviditet"=missing) Fødselsregisteret Children are categorized as: 0="no" if C_PLAC>0 or there is registered another child born by the same mother within 1 day from the child's birthday 1="yes" if C_PLAC=0 and no child born by the same mother within 1 day from the child's birthday
child_order	Obtained from the Danish National Health Data Agency. Register: "CPR-Registeret"	The variable from MFR contains information on number of fulfilled pragnancies including stillbirths. Before 1997 the variables

Register: "MFR" from 1997 ar onwards, "Fødselsregisteret" before 1997 Table: "MFR"(from MFR),	births)+V_TIDLDOD (previous still births) has been added plus 1(current delivery), to simulate the information from MFR.
"levendefødt" (From fødselsregisteret) Variable: "paritet" (MFR), V_TIDLLEV, V_TIDLDOD (fødselsregisteret)	Second, a counting method is applied using the registered parity indication for the first registered child and counting onwards for following liveborn children. Preparation is done in 3 steps: 1) parity of the first registered child is
	determined: a) missing information on the first registered child by a mother but with information on the second registered child are recoded with parity of the second child minus 1. b) children with missing information on the first registered child are recoded with parity=1 if the second child is registered as parity=1.
	2) child order of following children is determined using a counting method from the parity of the first registered child plus 1 for each following child 3) multiple delivered children are identified, and child order is recoded to the lowest value i.e., twins with 1 older sibling will both be coded with parity=2
birth_characteristics Finland	

birth_characteristics Finland

Variable	Source and Description	Important notes and data preparation
id	Obtained from	Statistics Finland pseudonymised
	Register: Birth Register	lapsi_hetunnus with their own id for the
	Table:	remote user system.
	Variable: lapsi_hetunnus	
	THL pseudonymised the original	
	personal identification code	
	(lapsi_hetunnus) to unique	
	personal identification number for	
	linkage between registers. THL	
	data management can link the id	
	back to original personal	
	identification code.	
b_weight	Obtained from	Registrations of birthweight less than 100g or
	Register: Birth Register	higher than 9990g are categorized as missing
	Table:	
	Variable: syntymapaino	
ga	Obtained from	kestovkpv, ga will be notified as weeks, the
	Register: Birth Register	days are not noted.
	Table:	
	Variable: kestovkpv	Ga <20 or >45 are coded as missing

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sectio	Obtained from Register: Birth Register Table: Variable: synnytystapatunnus	Children are categorised as: 0="not delivered by caesarean section" if synnytystapatunnus is 1-4 1="delivered by caesarean section" if synnytystapatunnus is 5-8 9="unknown" if synnytystapatunnus=9 or missing
smoke	Obtained from Register: Birth Register Table: Variable: tupakointitunnus	Smoke=0 if tupakointitunnus=1 Smoke=1 if tupakointitunnus =2-4 Smoke=9 if tupakointitunnus=9 (unknown) or missing.
singleton	Obtained from Register: Birth Register Table: Variable: sikioita	Children are categorized as: 0="no" if sikioita=2 or more 1="yes" if sikioita=1
Child_order	Obtained from Register: Birth Register Table: Variable: aiemmatsynnytykset Variable: kuolleenasynt	Number of the child ="Aiemmatsynnytykset" (previous births) minus "kuolleenasynt" (=stillbirths) plus 1 multiple delivered children are identified, and parity is recoded to the lowest value i.e., twins with 1 older sibling will both be coded with child order=2

birth characteristics Norway

		•
Variable	Source and Description	Important notes and data preparation
id		Renamed from "pasientlopenr_pdb2471"
b_weight	Obtained from	Registrations of birthweight less than 100g or
	Register: Medical Birth Registry of	higher than 9990g are defined as missing
	Norway	
	Variable: vekt	
ga	Obtained from	ga is calculated as floor(svlen/7), where svlen
	Register: Medical Birth Registry of	is the length of gestation in days based on
	Norway	ultrasound estimation. If ultrasound is not
	Variable: svlen	available, the gestational length is calculated
acatio	Ohtain ad frans	from the last menstrual period.
sectio	Obtained from	Information on delivery with c-section is obtained from the variable ksnitt. Possible
	Register: Medical Birth Registry of Norway	values of ksnitt are
	Norway	1 = Planned C-section
	Variable: ksnitt	2 = Emergency C-section
	Variable: Nerma	9 = Unspecified C-section
		If ksnitt is missing, sectio is coded as 0.
		Otherwise, sectio is coded as 1.
smoke	Obtained from	Information on smoking at start and end of
	Register: Medical Birth Registry of	pregnancy is obtained from royk_beg and
	Norway	royk_avsl, respectively. Both variables are
	Variable: royk_beg and royk_avsl	coded as

		-
		1 = No 2 = Sometimes 3 = Daily If royk_beg = 1 AND royk_avsl = 1, smoke is coded as 0 If royk_beg = 2 OR royk_beg = 3 OR royk_avsl = 2 OR royk_avsl = 3, smoke is coded as 1 Otherwise smoke = 9. Mothers can opt out of having information on smoking recorded. Thus, royk_beg and royk_avsl is missing for a high proportion of births. The proportion with smoke = 9 is 43%.
singleton	Obtained from Register: Medical Birth Registry of Norway Variable: flerfodsel	singleton is coded as 0 if flerfodsel = 1 or if another child is born to the same mother in the same month (N = 13). Otherwise, singleton is coded as 1.
child_order	Obtained from Register: Medical Birth Registry of Norway Variable: paritet	parity is defined as paritet + 1. The variable paritet is defined by MBRN as the highest value of the variables paritet_mor and paritet_mfr, where paritet_mor is number of previous deliveries as stated by mother and paritet_mor is number of previous deliveries registered by MBRN. Stillbirths are included in paritet. Pairs of twins should have the same value of parity and will therefore be assigned the same value of parity (lowest within the set).

Birth characteristics Sweden

Variable	Source and Description	Important notes and data preparation
id	Created by Statistics Sweden	Renamed from lopnr
	Pseudonomised unique personal	
	identification number for linkage	
	between registers	
b_weight	Obtained from Socialstyrelsen	Registrations of birthweight less than 100g or
	Register: Medicinska	higher than 9990g were categorized as
	födelseregistret	missing.
	Variable: bvikt	
ga	Obtained from Socialstyrelsen	Socialstyrelsen recommends using this
	Register: Medicinska	variable (for the best estimated gestational
	födelseregistret	age), over the variable grvfv (which is based
	Variable: grvbs	on medical records).
sectio	Obtained from Socialstyrelsen	Variable renamed from secmark; coding
	Register: Medicinska	unaltered: 0 = no, 1 =yes.
	födelseregistret	
	Variable: secmark	

smoke	Obtained from Socialstyrelsen Register: Medicinska födelseregistret Variable: rok1	The variable rok1 pertains to smoking habits at registration with maternal health (usually at 8-12 weeks of pregnancy).
		If the woman was smoking >=1 cigarette/day at registration (rok1 coded 2 or 3), the variable smoke was coded = 1. If the woman was not smoking (rok1 coded 1) the variable smoke was coded = 0. If data was missing the variable smoke was coded = 9 (missing).
		(There is another variable, rok2, which pertains to smoking habits at pregnancy week circa 30-32. This was not included due to very poor data quality 1990-1999, and poor completeness thereafter (Source publication: Graviditeter, förlossningar och nyfödda barn (socialstyrelsen.se), Statistikdatabaser - Förlossningsstatistik - Val (socialstyrelsen.se))
singleton	Obtained from Socialstyrelsen Register: Medicinska födelseregistret Variable: bordf2	1="Enkelbörd" was left unaltered (=1 "Yes"). 2="Flerbörd" was recoded to 0 "No".
child_order	Obtained from Socialstyrelsen Register: Medicinska födelseregistret Variable: paritet	The child's order, based on the number of children previously born by the mother, including this birth. Twins were given the same number, the lowest within the set.
		Towest within the set.

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Table: Vaccines Vaccines Denmark

Variable	Source and Description	Important notes and data preparation
id	Original name in the Danish data: "pnr". Pseudonomised unique personal identification number for linkage between registers, created by Statistics Denmark. It is linkable (by Statistics Denmark) to the original personal identification number (CPR number) assigned to all Danish residents and used when reporting to all national registers.	string
vacdate	Obtained from the state serum institue. Register: "vaccinationsregisteret" Variable: "EffectuationDate"	Date Format (%dD_m_Y)
vaccine	Obtained from the state serum institue. Register: "vaccinationsregisteret" Variable: "ATCCode"	Categorical (see coding in appendix "vaccine categorization") Duplicates were handled as follows, so that only one entry was kept: - same ATCCode: duplicate removed same group of vaccines (see appendix vaccine categorization) within 14 days: the entry most likely to have been administered according to the national vaccination schedule at the time was keptHib-vaccine given within 14 days of a multivalent Hib-containing vaccine: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed
credibility	Variable generated based on data preparation	1=no duplicate 2= duplicate same vaccine removed 3=duplicate related vaccine removed (keep vaccine that aligns with vaccination schedule 4= duplicate related vaccine removed (none of the vaccines align with vaccination schedule) 5= duplicate related vaccine removed (vaccines given outside usual vaccination ages within the national immunisation programme)
TB endemic		9= not relevant
HepB endemic		9=not relevant

Link to *Contents*

Vaccines Finland

Variable	Source and Description	Important notes and data preparation
id	Obtained from Register: Vaccination Register Table: Variable: hetu THL pseudonymised the original personal identification code (hetu) to unique personal identification number for linkage between registers. THL data management can link the id back to original	Statistics Finland pseudonymised "hetu" with their own id for the remote user system.
vacdate	personal identification code. Obtained from Register: Vaccination Register Table: Variable: Recorddate	Date Format (%dD_m_Y)
vaccine	Obtained from Register: Vaccination Register Table: Variable: atc_code	Categorical (see coding in appendix "vaccine categorization") Duplicates were handled as follows, so that only one entry was kept: - same ATCCode: duplicate removed same group of vaccines (see appendix vaccine categorization) within 14 days: the entry most likely to have been administered according to the national vaccination schedule at the time was keptHib-vaccine given within 14 days of a multivalent Hib-containing vaccine: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed
credibility	Variable generated based on data preparation	1=no duplicate 2= duplicate same vaccine removed 3=duplicate related vaccine removed (keep vaccine that aligns with vaccination schedule) 4= duplicate related vaccine removed (none of the vaccines align with vaccination schedule) 5= duplicate related vaccine removed (vaccines given outside usual vaccination ages within the national immunisation programme)
TB endemic		9= not relevant

Vaccines Norway

Variable	Source and Description	Important notes and data preparation
id	Obtained from Register: Norwegian Immunisation Registry (SYSVAK)	string
vacdate	Obtained from Register: Norwegian Immunisation Registry (SYSVAK) Variable: konsultasjonsdato	Renamed from konsultasjonsdato Date Format (%dD_m_Y)
vaccine	Obtained from Register: Norwegian Immunisation Registry (SYSVAK) Variable: vaksinekode	Categorical (see coding in appendix "vaccine categorization") Duplicates by same ATCCode are removed. Duplicates by same group of vaccines (see appendix vaccine categorization) within 14 days are cleaned based on information on which vaccine is most likely to have been administered according to the national vaccination schedule and historical changes. Hib given within 14 days of Hib containing vaccines are removed IPV given within 14 days of IPV containing vaccines are removed
credibility	Variable generated based on data preparation	1=no duplicate 2= duplicate same vaccine removed 3=duplicate related vaccine removed (keep vaccine that aligns with vaccination schedule) 4= duplicate related vaccine removed (none of the vaccines align with vaccination schedule) 5= duplicate related vaccine removed (vaccines given outside usual vaccination ages within the national immunisation programme)
TB_endemic		9=not relevant
HepB_endemic		9=not relevant

Vaccines Sweden

Variable	Source and Description	Important notes and data preparation
id	Created by Statistics Sweden Pseudonomised unique personal identification number for linkage between registers	String

vacdate	Obtained from The Public Health Agency of Sweden (PHAS) Register: The National Vaccination Registry (NVR) Variable: vaccination date	Date Format (%dD_m_Y)
vaccine	Obtained from: PHAS Register: NVR Variable: atc, product_name	Categorical (see coding in appendix "vaccine categorization") Duplicates were handled as follows, so that only one entry was kept: - same ATCCode: duplicate removed same group of vaccines (see appendix vaccine categorization) within 14 days: the entry most likely to have been administered according to the national vaccination schedule at the time was keptHib-vaccine given within 14 days of a multivalent Hib-containing vaccine: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed
credibility	Variable generated based on data preparation	1=no duplicate 2= duplicate same vaccine removed 3=duplicate related vaccine removed (keep vaccine that aligns with vaccination schedule) 4= duplicate related vaccine removed (none of the vaccines align with vaccination schedule) 5= duplicate related vaccine removed (vaccines given outside usual vaccination ages within the national immunisation programme)
TB_endemic	Obtained from Statistics Sweden Register: RTB Variable: fodelselandnamn	If the child, mother OR father was born in a country with high or very high incidence of tuberculosis ie. >25 cases per 100,000 inhabitants (as listed in WHO:s Global TB report 2018, link), the child was coded 1=risk group, as this corresponds to eligibility for BCG-vaccination. All other children were coded = 0.
HepB_endemic	Obtained from Statistics Sweden Register: Table: Variable: fodelselandnamn	If the child, mother OR father was born in a country with an intermediary or high prevalence of hepatitis B in the population (> 2 percent HbsAg-positive), the child was coded 1=risk group. *

If the child and both parents came from low prevalence countries, the child was coded = 0. (This included all native-born children.)
If the child came from a country with an unknown prevalence, it was coded as missing.

^{*} Source: Schweitzer A, Horn J, Mikolajczyk RT, Krause G, Ott JJ. Estimations of worldwide prevalence of chronic hepatitis B virus infection: a systematic review of data published between 1965 and 2013. The Lancet. 2015;386(10003):1546-55. DOI:https://doi.org/10.1016/S0140-TO TORREST ONLY 6736(15)61412-X.

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Table: socio_economy Socio economy Denmark

Variable	Source and Description	Important notes and data preparation
id	Original name in the Danish data: "pnr". Pseudonomised unique personal identification number for linkage between registers, created by Statistics Denmark. It is linkable (by Statistics Denmark) to the original personal identification number (CPR number) assigned to all Danish residents and used when reporting to all national registers.	Renamed from "pnr"
inc_quin_b	Obtained from Statistics Denmark. Table: "FAIK" (tables for each year) Variable: "FAMAEKVIVADISP_13" (Equated disposable family income) Link between each child and family is obtained from Statistics Denmark: Table: BEF (tables for each year) Link variable: FAMILIE_ID (combined with calendar year)	Birth year 2016 and higher do not have information on family income at birth. No children have information from the year they are born, because the statistics are made on the first of January each year. Include information from the year after birth. If no info from that year, the child is coded with unknown (9). Note: quintiles made separately for each calendar year for the children born the year before.
inc_quin_10y	Obtained from Statistics Denmark. Table: "FAIK" (tables for each year) Variable: "FAMAEKVIVADISP_13" (Equated disposable family income) Link between each child and family is obtained from Statistics Denmark: Table: BEF(tables for each year) Link variable: FAMILIE_ID (combined with calendar year)	Birth year 2007 and higher do not have info on family income at ten years. If no info from the year the child turn 10 years the variable is coded with unknown (9). Note: quintiles made separately for each calendar year for the children turning 10 years that year.
n_children_b	Obtained from Statistics Denmark. Table: "FAM" (tables for each year) Variables: Sumarized from the variables ANTB00-ANTB17 (number of children in the family age 0, 1, 2,17) Link between each child and family is obtained from Statistics Denmark: Table: BEF(tables for each year) Link variable: FAMILIE_ID (combined with calendar year)	Birth year 2018 do not have info on number of children at birth. No children have information from the year they are born, because the statistics made on the first of January each year. Include information from the year after birth. If no info from that year the child is code with unknown (99). Some children end-up with a count of 0 children, as this is not a legal value they are recoded to 99. Based on the values on family_type, it is judged that the children with a count of 0, are children who are registered as the main person in a family and therefore are not counted as a child although they are children.
n_children_10y	Obtained from Statistics Denmark. Table: "FAM" (tables for each year)	Birth year 2009 and higher do not have info on number of children at 10 years.

Variables: Sumarized from the variables ANTB00-ANTB17 (number of children in the family age 0, 1, 2...,17 years)

If no info from the year the child turn 10 years the variable is coded with unknown (99).

Link between each child and family is obtained from Statistics Denmark: Table: BEF(tables for each year) Link variable: FAMILIE_ID (combined with calendar year)

Some children end-up with a count of 0 children, as this is not a legal value they are recoded to 99. Based on the values on family_type, it is judged that the children with a count of 0, are children who are registered as the main person in a family and therefore are not counted as a child although they are children.

Single_parent_b

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Obtained from Statistics Denmark. Table: "FAM" (tables for each year) Variable: FAMILIE TYPE Birth year 2018 do not have info on single parenthood at birth.

Link between each child and family is obtained from Statistics Denmark: Table: BEF(tables for each year) Link variable: FAMILIE_ID (combined with calendar year)

No children have information from the year they are born, because the statistics made on the first of January each year. Include information from the year after birth. If no info from that year the child is code with unknown (9).

I also set children who originally were coded with 0 children on n_children_b as unknown (9) because it is judgded that these are children registered as the main person in the family (no adults in the family?).

Single_parent_1 0y

Obtained from Statistics Denmark.

Table: "FAM" (tables for each year)

Variable: FAMILIE TYPE

Birth year 2018 do not have info on single parenthood at birth.

Link between each child and family is obtained from Statistics Denmark: Table: BEF(tables for each year) Link variable: FAMILIE_ID (combined with calendar year)

If no info from the year the child turn 10 years the variable is coded with unknown (9).

set children who originally were coded with 0 children on n_children_10y as unknown (9) because it is judged that these are children registered as the main person in the family (no adults in the family?).

m_education_b

Obtained from Statistics Denmark.
Table: "UDDF"
Variable: "hfaudd"
"hfaudd" i linked with format from statistics Denmark grouping the
Danish education classification into ISCED 2011, based on which maternal education is grouped.

Use the highest obtained education for the mother on the date of birth of the child. There is no information on this for children born 2017 or later. Statistics Denmark had a format available for transforming national Danish education codes into ISCED.

Link to mother is available from the dataset "population1" (originally obtained from the CPR register).

Use the highest obtained education for the mother on the date of the child turns 10 years.

m_education_1 0y

Obtained from Statistics Denmark.
Table: "UDDF"
Variable: "hfaudd"
"hfaudd" i linked with format from
Satistics Denmark grouping the

There is no information on this for children born 2007 or later.

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Danish education classification into ISCED 2011, based on which maternal education is grouped.	
Link to mother is available from the dataset "population1" (originally obtained from the CPR register).	

Socio economy Finland

Variable	Source and Description	Important notes and data preparation
id	Obtained from	Statistics Finland pseudonymised "hetu"
	Register: Population register	with their own id for the remote user system.
	Table:	
	Variable: hetu	
	THL pseudonymised the original	
	personal identification code	
	(lapsi_hetunnus) to unique personal	
	identification number for linkage	
	between registers. THL data	
	management can link the id back to original personal identification code.	
inc_quin_b	Obtained from	Only available in Fiona remote user system.
inc_quii_b	Register: Statistics Finland	Renamed from "kturaha ak lapsi" at the
	Table:	year when child was born.
	Variable: kturaha ak lapsi	Calculation of quintiles are done separately
		for each calendar year. E.g. calculating
		income quintiles for 2008 include all children
		who use income information from 2008 to
		assess the income quintile at birth
		kturaha_ak_lapsi = NA, coded as 9 =
		"Unknown"
inc_quin_10y	Obtained from	Only available in Fiona remote user system.
	Register: Statistics Finland	Renamed from "kturaha_ak_lapsi" at the
	Table	year when child was 10 years old.
	Table:	Calculation of quintiles are done separately
	Variable: kturaha_ak_lapsi	for each calendar year. E.g. calculating income quintiles for 2008 include all children
		who use income information from 2008 to
		assess the income quintile at birth
		kturaha_ak_lapsi = NA, coded as 9 =
		"Unknown"
n children b	Obtained from	Only available in Fiona remote user system.
	Register: Statistics Finland	Renamed from "lkm lapsi" at the year when
		child was born.
	Table:	
	Variable: lkm_lapsi	
n_children_10y	Obtained from	Only available in Fiona remote user system.
	Register: Statistics Finland	Renamed from "lkm_lapsi" at the year when
		child was 10 years old.
	Table:	

Link to <u>Contents</u>

	Veriable: Ilm Janei	
Cinala warrat !	Variable: lkm_lapsi	Only evallable in Figure remarks were surely
Single_parent_b	Obtained from	Only available in Fiona remote user system.
	Register: Statistics Finland	Calculated from "pety_lapsi" at the year
	Table	when child was born.
	Table:	If pety_lapsi is 2 (married couple and
	Variable: pety_lapsi	children) or 5-6 (couple with children) ->
		single parent =0 (no)
		If pety_lapsi is 3 or 4 (mother or father with
		children) -> single parent = 1 (yes).
0: 1 1		If pety_lapsi is unknown -> single parent = 9
Single_parent_1	Obtained from	Only available in Fiona remote user system.
0y	Register: Statistics Finland	Calculated from "pety_lapsi" at the year
		when child was 10 years old.
	Table:	If pety_lapsi is 2 (married couple and
	Variable: pety_lapsi	children) or 5-6 (couple with children) ->
		single parent =0 (no)
		If pety_lapsi is 3 or 4 (mother or father with
		children) -> single parent = 1 (yes).
		If pety_lapsi is empty -> single parent = 9
		(unknown)
m_education_b	Obtained from	Education is classified by ISCED-11,
	Register: Statistics Finland	although the classes 0-2 are not available
		for us. In Finland, we have compulsory
	Table:	education during which the ISCED level 2 is
	Variable:ututku_aiti and	achieved and thus we classified education:
	koulutusaste_taso_1 and birthday of	NA= 1 low education level
	child obtained from population1	3-4 = 2 medium education level
		5-8 = 3 high education level
		9 = no information of the mother's
		Education at child's birth year.
m_education_1	Obtained from	Education is classified by ISCED-11.
0y	Register: Statistics Finland	although the classes 0-2 are not available
		for us. In Finland, we have compulsory
	Table:	education during which the ISCED level 2 is
	Variable: ututku_aiti and	achieved and thus we classified education:
	koulutusaste_taso_1 and birthday of	NA= 1 low education level
	child obtained from population1	3-4 = 2 medium education level
		5-8 = 3 high education level
		9 = no information of the mother's
		Education when child is 10 years old.
		If education was lower than m_education_b
		it was coded to be the same as at birth, also
		if education was unknown when child was
		ten, but it was known when child was born,
		the m_education_b was used as
		m education 10y
		9 = no information of the mother's Education when child is 10 years old. If education was lower than m_education_ it was coded to be the same as at birth, al if education was unknown when child was ten, but it was known when child was born the m_education_b was used as

Socio_economy Norway

Variable	Source and Description	Important notes and data preparation
id		Renamed from "pasientlopenr_pdb2471"

inc_quin_b	Obtained from Statistics Norway Variable: ies_eu	Based on the variable "ies_eu", defined as total after-tax income for the household per consumption unit calculated according to the EU scale. Total after-tax income is calculated as the sum of the household's wages and salaries, income from self-employment, property income and transfers received minus total assessed taxes and negative transfers. Each income year includes all persons residing in Norway and resident in a private household as of 31st December of the income year. Household income in year of birth is used to define inc_quin_b. Income quintiles are made separately for each birth cohort. Available for children born 2004–2018.
inc_quin_10y	Obtained from Statistics Norway Variable: ies_eu	Based on the variable "ies_eu", see definition above. Household income in the year of the child's 10th birthday is used to define inc_quin_10y. Income quintiles are made separately for each birth cohort. Available for children born 1994–2008.
inc_quin_m_b	Obtained from Statistics Norway Variable: wies	Based on the variable "wies", defined as a person's after-tax income. After-tax income is calculated as the sum of wages and salaries, income from self-employment, property income and transfers received minus total assessed taxes and negative transfers. The mother's income in the child's year of birth is used to define inc_quin_m_b. Income quintiles are made separately for each birth cohort. Available for children born 1993–2018.
inc_quin_m_10y	Obtained from Statistics Norway Variable: wies	Based on the variable "wies", see definition above. The mother's income in the year of the child's 10th birthday is used to define inc_quin_m_10y. Income quintiles are made separately for each birth cohort. Available for children born 1990–2008.
n_children_b	Obtained from Statistics Norway Variable: barn_i_regstat_famnr	Based on variable "barn_i_regstat_famnr", number of children in the family. Persons are considered children if they are below 18 years and registered as resident in the family of at least one parent. A family is defined as persons resident in the same dwelling and related to each other as spouse, registered partner, cohabitant, and/or parent and child (regardless of the child's age). At most, a family may consist of two subsequent generations and one couple only. The variable includes residents of Norway as of January 1 each year. We

		have the surface and second as the contract of
		have therefore used number of children in the year after the child's year of birth. Individuals registered with 0 number of children in their family have been recoded to 1. Available for children born 2004–2018.
n_children_10y	Obtained from Statistics Norway Variable: barn_i_regstat_famnr	Based on variable "barn_i_regstat_famnr", see above. The variable includes residents of Norway as of January 1 each year. We have therefore used number of children in the year after the year of the child's 10th birthday. Individuals registered with 0 number of children in their family have been recoded to 1. Available for children born
0: 1		1994–2009.
Single_parent_b	Obtained from Statistics Norway Variable: regstat_famtyp	Based on the variable "regstat_famtyp", a detailed classification of family type, where family is defined as described above. The variable includes residents of Norway as of January 1 each year. We have therefore used the value of family type in the year after a child's year of birth to define single_parent_b. If the registered family type is either "married couple with small children (youngest child aged 0-5 years)" or "cohabitants with small children (youngest child aged 0-5 years)", single_parent_b is coded as 0. If the registered family type is either "mother with small children (youngest child aged 0-5 years)" or "father with small children (youngest child aged 0-5 years)", single_parent_b is coded as 1. Otherwise (family type is any other category or missing), single_parent_b is coded as 9. Available for children born 2004–2018.
Single_parent_1 0y	Obtained from Statistics Norway Variable: regstat_famtyp	Based on the variable "regstat_famtyp", see above. The variable includes residents of Norway as of January 1 each year. We have therefore used the value of family type in the year after the year of a child's 10th birthday to define single_parent_10y. If the registered family type is either "married couple with small children (youngest child aged 0-5 years)", "married couple with older children (youngest child aged 6-17 years) "cohabitants with small children (youngest child aged 6-17 years)", or "cohabitants with older children (youngest child aged 6-17 years)", single_parent_10y is coded as 0. If the registered family type is either "mother with small children (youngest child aged 0-5 years)", "mother with older children (youngest child aged 6-17 years)", "father

with small children (youngest child aged 0-5 years)", or "father with older children (youngest child aged 6-17 years)", single_parent_10y is coded as 1. Otherwise (family type is any other category or missing), single parent 10y is coded as 9. Available for children born 1994–2009. m education b Obtained from Statistics Norway Based on the variables "bu niva YYYY". Variable: bu niva YYYY The variables contain information on highest level of education as of October 1 of the year YYYY. Mother's level of education from the child's year of birth was used to define m education b. Education is classified according to The Norwegian Standard Classification of Education (NUS). If the NUS-level is 0 (corresponding to ISCED2011 levels 01, 02), 1 or 2 (corresponding to ISCED2011 level 1 and 2, respectively), m education is coded as 1. If the NUS level is 3 or 4 (corresponding to ISCED2011 = 3), m education is coded as 2. If the NUS-level is 6. 7 or 8 (corresponding to ISCED2011 level 6, 7, and 8, respectively), m education is coded as 3 (https://www.ssb.no/utdanning/artiklerpublikasjoner/ attachment/240569? ts=150 ebb996e0, page 25). NUS-level = 5 is defined as tertiary vocational educational level not approved as higher education. Tertiary education with duration less than 2 years corresponds to ISCED2011 level 4. In this case, m educaion b should be coded as 2. Tertiary education with duration of 2 years corresponds to ISCED2011 level 5, and m education b should be coded as 3. However, we do not have information on type or duration of the tertiary education. In 2016, 83.6% of women graduating from tertiary vocational education, had finished an education with duration of 2 years, while only 16.4% had finished an education with duration less than 2 years(https://www.ssb.no/en/statbank/table/ 11635). Therefore, m education b was coded as 2 if the NUS-level was 5. Available for children born 1990-2018. m education 1 Obtained from Statistics Norway Mother's highest level of education as of

October 1 in the year of child's 10-year

For definitions and coding, see above.

Available for children born 1990–2009.

birthday was used to define m education b.

0y

60

Variable: bu niva YYYY

0 .

Link to **Contents**

Socio economy Sweden

Variable	Source and Description	Important notes and data preparation
id	Created by Statistics Sweden Pseudonomised unique personal identification number for linkage between registers Variable: lopnr	Renamed from lopnr
inc_quin_b	Obtained from Statistics Sweden Register: Longitudinell integrationsdatabas för Sjukförsäkrings- och Arbetsmarknadsstudier (LISA) Variable: DisplnkFam	In Sweden, disposable income is defined as the sum of all household members' all forms of income (including wages, capital gains, and different forms of financial support/social assistance) minus taxes and other negative transfers (Statistikskolan: Att jämföra inkomster för hushåll (scb.se)). The information primarily came from the information registered for the household of the mother in the year of birth of the child. If this was missing, the information was instead taken from the father. Thus, the child was primarily assumed to be part of the mother's household, and secondly of the father's. Income quintiles was then calculated based on all children in each birth cohort.
inc_quin_10y	As above.	As above, but from the year the child turned 10 years old.
inc_quin_m_b	Obtained from Statistics Sweden Register: Longitudinell integrationsdatabas för Sjukförsäkrings- och Arbetsmarknadsstudier (LISA) Variable: Displnk	Information about disposable income of the mother in the year of birth of the child. Income quintiles was then calculated based on all children in each birth cohort. See also above.
inc_quin_m_10y	As above.	As above, but from the year the child turned 10 years old.
n_children_b	Obtained from Statistics Sweden Register: LISA Variable: Barn0_3, Barn4_6, Barn7_10, Barn11_15, Barn16_17	Created as the sum of children in variables Barn0_3, Barn4_6, Barn7_10, Barn11_15 and Barn16_17. The sum denotes the number of children living in the household on 31 Dec in the year of birth of the child. The child itself is part of the count. The information <i>primarily</i> came from the information registered for the mother in the year of birth of the child. If this was missing, the information was instead taken from the father.

Link to <u>Contents</u>

n_children_10y	As above.	As above, but from the year the child turned
		10 years old.
Single_parent_b	Obtained from Statistics Sweden	The information came from the information
	Register: LISA	registered for the mother in the year of birth
	Variable: FamTypF	of the child.
		Codes FamTypF=41, 42 classifies the
		mother as a single parent, and 50 denotes
		Other singles. These codes were included
		when coding single_parent_b=1 (yes).
		If FamTypF was missing, single_parent_b
		was coded as 9 (missing).
		All other FamTypF-codes were recoded as
		0 (no).
Single parent 1	As above.	As above, but from the year the child turned
0y		10 years old.
m_education_b	Obtained from Statistics Sweden	The variable denotes the highest level of
	Register: LISA	education achieved during the spring
	Variable: Sun2000niva	semester in the year the child was born.
		That means, that if the mother achieved a
		higher level of education mid-year, it will
		only be visible in the register for the
		following year.
		Level of education was recoded from
		Sun2000 to ISCED by a translational key
		available from Statistics Sweden:
		Svensk utbildningsnomenklatur (SUN)
		(scb.se) (retrieved 2021-08-20).
m education 1	As above.	As above, but from the year the child turned
0y		10 years old.
		/

Appendix: Vaccine categorization: presentation of ATC codes for vaccines identified in the vaccination registries in each of the Nordic countries and categorisation hereof into common vaccine categories "vaccine". The vaccines are further grouped by "type" i.e. vaccines against a similar set of diseases. NB in Sweden only vaccines that are included in the national immunisation programme is registered in the vaccination register.

		DENMARK	Finland	Norway	Sweden
Vaccine	Туре		ATC		103 103
1= "DTaP-IPV-Hib"		J07CA06	J07CA06	J07CA06	5 SJ07CA06
2= "DTaP-IPV-Hib-HepB"		J07CA09		J07CA09	2 J07CA09
3= "DTaP-IPV"		J07CA02 J07CA02	J07CA02 J07CA02	J07CA02 J07CA02	J07CA02
4= "DT-Pol"		J07CA01	J07CA02	J07CA01	ttp://
5= "DT-HepB"		J07CA07			/bmi
6= "DTwP-HepB"		J07CA05			oper
7= "DTwP-Hib-HepB"	1	J07CA11			bmi
8= "DTaP-IPV-HepB"		J07CA12			J07CA12
10= "DTaP"		J07AJ52	J07AJ52	J07AJ52	SJ07AJ52
11= "DTwP"		J07AJ51		J07AJ51	Apri
12= "DT"		J07AM51	J07AM51	J07AM51 J07AM52	🕯07AM51
13= "D"		J07AF01		J07AF01	₹J07AF01
15= "T"		J07AM01		J07AM01	្គ ភ្លួJ07AM01
20= "PCV"	2	J07AL02	J07AL02		ปู07AL52 อีป07AL02
21="PPV"		J07AL01	J07AL01	J07AL01	^B J07AL01

					122
25="HepA"		J07BC02	J07BC02	J07BC02	22-065
26= "HepAB"	3	J07BC20	J07BC20	J07BC20	984
27= "HepB"] 3	J07BC01	J07BC01	J07BC01	on 1
28= "HepA-Thyphoid"		J07CA10		J07CA10) Fe
30= "HPV4"		J07BM01		J07BM01	្ឌីJ07BM01
31="HPV2"	4	J07BM02	J07BM02	J07BM02	ე ე07BM02
32="HPV9"		J07BM03	J07BM03	J07BM03	²³ J07BM03
35= "Hib"		J07AG01	J07AG01	J07AG01	€J07AG01
36= "Hib-MenC"		J07AG53			nload
37= "Hib-Pol"	5			J07CA04	led from
38= "Hib-HepB"		J07CA08			http
40- "Influence (near live)"		J07BB01		J07BB01	//bm
40= "Influenza (non-live)"	6	J07BB02	J07BB02	J07BB02	ji ope
41= "Influenza (live)"		J07BB03	J07BB03	J07BB03	n bo
45= "wP"	7	J07AJ01		J07AJ01	<u>s.</u> 8
46= "aP"	,	J07AJ02		J07AJ02	b/ o
50= "MMR"		J07BD52	J07BD52	J07BD52	€J07BD52
51= "MMR-Varicella"		J07BD54	J07BD54		il 19
52= "Measles"	8	J07BD01		J07BD01	203
53= "Measles-Mumps"		J07BD51		J07BD51	⁷ 4 b)
54= "Measles-Rubella"		J07BD53		J07BD53	QUIE.
55= "Rubella"		J07BJ01		J07BJ01	St
56= "Mumps"		J07BE01		J07BE01	rote
60= "OPV"	9	J07BF01		J07BF04 J07BF01	ted by copy

ĺ	Link to <u>Content</u>
	61= "IPV"
	65= "Rota"
	67= "BCG"

	J07BF02		J07BF02	2- <u>06</u> -
61= "IPV"	J07BF03	J07BF03	J07BF03	207BF03
65= "Rota"	J07BH01		J07BH01	on 1
65= ROta	J07BH02	J07BH02	J07BH02	0 E
67= "BCG"	J07AN01	J07AN01	J07AN01	brus
			J07BK03)C /u
70="Varicella"	J07BK01		J07BK02	123
	J07BK02	J07BK01	J07BK01	Doy
71= "yellow fever"	J07BL01	J07BL01	J07BL01	nloz
72= "Japanease Encephalitis"	J07BA02	J07BA02	J07BA02	ded
73= "Tick borne Encephalitis"	J07BA01	J07BA01	J07BA01	from
	J07AE51			άπα
74 = "Cholera"	J07AE02			.//bn
	J07AE01	J07AE01	J07AE01	pi jo
			J07AH07	ıd ne
	J07AH08	J07AH08	J07AH08	pj.
	J07AH09	J07AH09	J07AH09) /mc
75= "Meningococcal	J07AH03		J07AH03	A ac
vaccine"	J07AH04		J07AH04	pril :
	J07AH06		J07AH06	119.2
	J07AH05			2024
	J07AH02			ا الم
	J07AH01		J07AH01	y gues
	J07AP01	J07AP01	J07AP01	t Pr
76= "Typhus"			J07AP02	otec
	J07AP10			Protected by cop
			J07AP	₩

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	J07AP03		J07AP03	2-065
77= "Rabies"	J07BG01		J07BG01	984
78= "Smallpox"			J07B01	on 1
76- Smanpox	J07BX01			0 Fi
79="Anthrax"			J07AC01	brua
80="covid-19 vaccine"		J07BX03	J07BX03	V 2
99="other vaccines"	ATC code missing	ATC code missing	ATC code missing	ATC code missing
	ATC code missing			Downloaded from http://bmjopen.bmj.com/ on April 19, 2024 by guest. Protecte

Online supplementary files

sTable 1: Vaccination coverage¹ at 2 years of age according to year of birth among children born in the respective countries

sTable2: Human papilloma virus vaccination coverage¹ before 14 years of age of vaccination among girls² born in the respective countries

sTable 3: Socio-economic factors at 10 years of age

Appendix 3: ATC codes obtained for the study population in each country within NONSEnse

sTable 1: Vaccination coverage¹ at 2 years of age according to year of birth among children born in the respective countries

Denmark	(
Year of	Eligible ²	DTP1 %	DTP2 %	DTP3 %	MMR1 %	
birth	Children	(95% CI)	(95% CI)	(95% CI)	(95% CI)	
1997	66,406	98.9	96.0	82.2	81.5	
1998	64,936	99.0	97.0	85.0	83.6	
1999	64,996	99.0	97.0	84.9	84.5	
2000	65,811	99.0	97.3	86.2	85.9	
2001	64,207	99.1	97.4	86.4	85.5	
2002	62,948	99.1	97.0	84.1	84.9	
2003	63,462	98.9	96.6	82.5	85.2	
2004	63,339	98.9	96.5	82.7	86.8	
2005	62,912	98.9	96.0	80.1	84.8	
2006	63,769	99.0	95.8	78.7	84.4	
2007	63,006	99.0	96.4	80.9	82.6	
2008	63,892	99.2	97.2	83.9	83.7	
2009	61,676	99.3	97.6	86.6	86.2	
2010	62,200	99.2	97.9	88.8	87.3	
2011	57,892	99.2	98.0	89.7	86.7	
2012	56,842	99.2	98.0	90.0	86.4	
2013	54,881	98.9	97.6	88.5	88.3	
2014	55,753	98.8	97.5	87.6	88.4	
2015	57,100	98.9	98.0	93.2	90.3	
2016	23,103	99.0	98.3	94.7	90.7	
Finland						
Year of	Eligible ²	DTP1 %	DTP2 %	DTP3 %	MMR1 %	Rota virus
birth	Children	(95% CI)	(95% CI)	(95% CI)	(95% CI)	vaccine %
						(95% CI)
2009	59,934	94.0	92.7	89.4	87.8	63.8
2010	60,560	96.7	94.2	90.8	91.6	90.7
2011	59,645	97.0	95.1	90.4	92.3	90.8
2012	59,309	95.7	94.5	90.3	91.9	91.2
2013	58,249	97.5	95.7	91.8	93.3	90.4

2014	57,693	97.6	96.5	89.3	92.6	91.6
2015	55,569	98.0	96.6	88.1	93.4	92.1
Norway						
Year of	Eligible ²	DTP1 %	DTP2 %	DTP3 %	MMR1 %	Rota virus
birth	Children	(95% CI)	(95% CI)	(95% CI)	(95% CI)	vaccine %
						(95% CI)
1995	59964	98.5	97.9	95.8	94.7	
1996	60652	98.2	97.4	95.4	94.3	
1997	59431	98.5	98.0	96.2	94.4	
1998	57999	98.7	98.2	96.4	94.1	
1999	58975	98.8	98.3	96.4	94.1	
2000	58907	98.6	98.0	96.1	89.2	
2001	56405	98.7	98.3	96.1	89.3	
2002	55232	98.8	98.5	96.7	92.7	
2003	56301	99.0	98.6	96.8	94.2	
2004	56734	99.1	98.8	97.5	94.7	
2005	56531	99.2	99.0	97.6	94.4	
2006	58316	99.1	98.8	97.3	94.2	
2007	58199	99.0	98.6	96.7	94.0	
2008	60284	99.0	98.5	96.6	93.8	
2009	61465	98.9	98.6	97.4	94.4	
2010	61080	98.9	98.5	97.3	95.0	
2011	59855	98.8	98.4	97.2	94.8	
2012	59937	98.6	98.2	96.6	95.0	
2013	58745	98.6	98.0	96.5	95.5	
2014	58839	98.7	98.3	96.6	95.9	
2015	58954	98.6	98.1	96.6	95.7	94.1
2016	58975	98.5	97.8	96.3	95.9	94.8
Sweden				•		
Year of	Eligible ²	DTP1 N (%)	DTP2 N (%)	DTP3 N (%)	MMR1 (%)	
birth	Children					
2013	113,457	97.6	95.1	83.3	89.1	
2014	114,639	98.0	95.9	86.1	90.7	
2015	114,542	98.1	96.3	87.8	91.8	

Abbreviations: DTP1: First dose of Diphtheria, Tetanus, and acellular Pertussis containing vaccine; DTP2: Second dose of Diphtheria, Tetanus, and acellular Pertussis containing vaccine; DTP3: Third dose of Diphtheria, Tetanus, and acellular Pertussis containing vaccine; MMR: Measles-Mumps-Rubella vaccine; Rota: Rota virus vaccine.

¹The coverage reflects the number of registered vaccines and may thus underestimate the actual vaccination coverage in the countries. ² Including children born in the country from birth cohorts where vaccines administered between 0-2 years of age are registered in the vaccination registers (data availability period).



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STable 2: Human papilloma virus vaccination coverage¹ before 14 years of age of vaccination among girls² born in the respective countries

	Denmar	·k		Finland			Norway		10	Sweder	<u> </u>	
	Delilliai	K		i iiiiaiia			Norway		0 1	Sweder	•	
Year	Eligible	HPV1	HPV2	Eligible ³	HPV1	HPV2	Eligible	HPV1	HPV2 율	Eligible	HPV1	HPV2
of	3	vaccinated	vaccinated	children	vaccinated	vaccinated	3	vaccinated	vaccinated	3	vaccinated	vaccinated
birth	children	N (%)	N (%)		N (%)	N (%)	children	N (%)	N (%) 2023.	children	N (%)	N (%)
1998	34,392	85.7	81.2				30,914	76.5 (76.0,	75.8			
				0				77.0)	vnloa			
1999	34,484	86.8	82.4		0		31,391	78.5	77.7			
2000	34,881	86.5	82.3				31,490	80.2	79.5 (79. §),			
					- C	<i>/</i> -			79.9)			
2001	34,030	81.4	74.5				30,546	82.7	82.0			
2002	33,241	73.6	57.6	4053	71.1	69.3	30,213	84.5	83.7			
2003	33,762	52.3	36.1	27,310	69.8	67.2	30,925	84.8	84.0	53,623	77.9	72.4
2004	13,184	58.4	43.0				31,208	86.8	85.8			

Abbreviations: HPV1: First dose of Human papilloma virus vaccine; HPV2: Second dose of Human papilloma virus vaccine

¹The coverage reflects the number of registered vaccines and may thus underestimate the actual vaccination coverage. ² Including girls from birth cohorts where HPV vaccination has been offered from 1 year before age of recommended vaccination until 14 years of age and where vaccinations were registered in the vaccination registers. The years with available data is defined based on introduction of HPV vaccinations into the National immunization programme or introduction of vaccination register which have comes last until last date with available data from both the population register and vaccination register.

sTable 3: Socio-economic factors at 10 years of age

	Denmark		Finland		Norway		Sweden	
	N	(%)	N	(%)	N	(%)	N	(%)
Children present in country at birth from 2004-2015	793,471		687,721		726,257		1,205,112	
Birth cohorts included	1994-200)5	1994-200)5	1994-200)5	1994-200	5
Income quintile at 10 y	ears of ag	е						
First (lowest)	147,098	18.5%	135,946	19.8%	141,762	19.5%	219,673	18.2%
Second	149,579	18.9%	136,334	19.8%	146,247	20.1%	241,503	20.0%
Third	149,865	18.9%	136,384	19.8%	146,604	20.2%	245,097	20.3%
Fourth	149,310	18.8%	136,259	19.8%	146,471	20.2%	245,138	20.3%
Fifth	146,712	18.5%	135,464	19.7%	144,939	20.0%	241,452	20.0%
Unknown	50,907	6.4%	7334	1.1%	234	0.0%	12,249	1.0%
Number of children in	the housel	nold the ye	ear the chil	d turns 1	0 years of	age		
1	103,585	13.1%	96,861	14.1%	119,295	16.4%	162,968	13.5%
2	405,367	51.1%	293,068	42.6%	336,480	46.3%	587,332	48.7%
3	213,413	26.9%	184,925	26.9%	208,045	28.6%	292,516	24.3%
>3	61,674	7.8%	103,561	15.1%	62,203	8.6%	105,595	8.8%
Unknown	9432	1.2%	9306	1.4%	234	0.0%	12,249	1.0%
Single parenthood in t	he years th	ne child tui	ns 10 yea	rs of age				
Yes	151,471	19.1%	124,986	18.2%	131,761	18.1%	268,484	22.3%
No	632,568	79.7%	553,429	80.5%	587,793	80.9%	924,379	76.7%
Unknown	9432	1.2%	9306	1.4%	6703	0.9%	12,249	1.0%
Highest attained educ	ational leve	el ¹ of the n	nother on t	he date t	he child tu	rns 10 ye	ears of age	
Low education	135,466	17.1%	75,462	11.0%	138,351	19.0%	193,551	16.1%
Medium education	340,574	42.9%	281,479	40.9%	270,114	37.2%	515,407	42.8%
High education	303,384	38.2%	329,885	48.0%	305,368	42.0%	394,220	32.7%
Unknown	14,047	1.8%	895	0.1%	12,424	1.7%	101,934	8.5%

¹ Highest attained education was categorized based on the International Standard Classification of Education (ISCED) 2011 using the main groups (1).

Appendix 3: ATC codes obtained for the study population in each country within NONSEnse

ATC-Group	Denmark	Finland	Norway	Sweden
D	D	D07, D11AH	D	D02AF, D05
				D07, D11
				D01, D06, D08
J	J	J	J	J01-J06
				J07
R	R	R01, R03, R06	R	R01, R03, R06
S	S	S01G, S03	S	S01-S03
V	V01	V01 ¹	V01	V01

¹Data on redeemed prescriptions with ATC=V01 is only available from the Finnish Benefits Registry, which holds information only for reimbursable redeemed prescriptions.

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1. UNESCO Institute for Statistics. International standard classification of education: ISCED 2011. 2012.

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Cohort Profile: Childhood morbidity and potential nonspecific effects of the childhood vaccination programmes in the Nordic countries (NONSEnse): Register-based cohort of children born 1990-2017/2018.

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Title

Cohort Profile: Childhood morbidity and potential non-specific effects of the childhood vaccination programmes in the Nordic countries (NONSEnse): Register-based cohort of children born 1990-2017/2018.

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ABSTRACT

Purpose: The aim of the NONSEnse project is to investigate the non-specific effects of vaccines and immunisation programmes on the overall health of children by using information from the extensive nationwide registers on health and sociodemographic factors in Denmark, Finland, Norway, and Sweden.

Participants: The cohort covers 9,072,420 children aged 0-17 years, born 1990-2017/2018, and living in Denmark, Finland, Norway, or Sweden. All countries utilise a unique identification number for its permanent residents, which makes it possible to link individual-level information from different registers.

Findings to date: Data collection and harmonisation according to a Common Data Model was completed in March 2022. As a prerequisite for comparing the effects of childhood vaccinations on the overall health of children across the Nordic countries, we have identified indicators measuring similar levels of infectious disease morbidity across these settings. So far studies pertaining to non-specific effects of vaccines are limited to investigations that could be undertaken using aggregated datasets that were available before the NONSEnse cohort with individual level information was completely setup.

Future plans: We are currently performing several studies of the effects on non-targeted infectious disease morbidity across the countries following vaccination against measles, mumps, rubella, diphtheria, tetanus, pertussis, human papilloma virus, rotavirus, and influenza. Multiple studies are planned within the next years using different study designs to facilitate triangulation of results and enhance causal inference.

Registration: No clinical trials will be conducted within the NONSEnse project.

STRENGHTS AND LIMITATIONS

Strengths:

- Complete population cohort minimizes selection bias.
- Real world data which has been collected, collated and quality checked.
- A Common Data Model enables uniform data analysis across countries.

Limitations:

- lacking information on some potential confounding factors.
- The data harmonisation process may entail loss of details of country-specific data.



INTRODUCTION

An accumulating number of epidemiological and immunological studies have found that vaccines, in addition to the disease-specific protection, may have so called non-specific effects affecting susceptibility towards other diseases than the vaccine-targeted infections (1, 2). Most previous studies on non-specific effects stem from low-income countries with a high infectious disease burden and have had overall childhood mortality as the outcome. The non-specific effects are found to vary depending on the type of vaccine being administered. Live vaccines have been associated with beneficial non-specific effects (1, 2). Non-live vaccines, although protecting against the vaccine-targeted infections, may possibly increase susceptibility to other infections (1, 2). The effects are most pronounced for the most recently administered vaccine (2).

Studies of non-specific effects from high-income countries have primarily focused on infectious disease morbidity (3) and atopic diseases (4-8). Most of these studies are observational, because it would (often) be unethical to randomise children to refrain from or delay recommended childhood vaccinations. Therefore, concerns about different types of bias in different settings and observational designs have been raised (9-12). Triangulation has been proposed as a method to strengthen causal inference in epidemiology by integrating results from several epidemiological designs and between different populations with different bias structures while using the same analysis plan across settings to enhance comparability of results (13, 14).

The "NONSEnse" project is a Nordforsk-funded collaboration between research groups in the four Northern European countries Denmark, Finland, Norway, and Sweden (henceforth referred to as the Nordic countries. The main aim of NONSEnse is to evaluate if childhood vaccinations influence other health outcomes than those targeted by the vaccine in the Nordic countries. The main hypothesis underlying this evaluation is that having a live vaccine as the most recent vaccine is associated with beneficial non-specific effects and thus a lower morbidity in the following time-period, compared with having a non-live vaccine as the most recent vaccine. The individual studies will be undertaken using the same methodology and statistical coding across countries. Furthermore, we will examine the same research question in multiple studies using different analytical approaches to facilitate triangulation of the results. The main associations we will examine are

associations between childhood vaccinations and 1) infectious disease hospitalisations, 2) antibiotic use, and 3) atopic diseases (asthma, atopic dermatitis, allergic rhinoconjunctivitis).

The first step has been to examine and compare infectious disease and atopic morbidity among children in the respective countries over time and by age and sex, to inform choice of design and outcome definitions in the subsequent studies of non-specific effects of vaccines.

The aim of the present cohort profile is to describe the content and quality of the data included in the registry-based NONSEnse cohort and present characteristics of the cohort, thereby demonstrating the research potential of the NONSEnse cohort. The insights presented can be used to guide future epidemiological research projects using registry data from the Nordic countries.

COHORT DESCRIPTION

Setting

The Nordic countries have many similarities including the welfare state model with universal tax-funded healthcare and a high level of social security. A detailed description of the Nordic health care systems and basic demographics has been published elsewhere (15).

National immunisation programmes

Childhood vaccinations within the national immunisation programmes (NIP) are voluntary and administered free of charge in all four countries. In Denmark, all childhood vaccines are administered by family practitioners (16). In Finland, Norway, and Sweden vaccines scheduled before school-age are administered at well-baby clinics by nurses; during school age, the vaccines are administered by school nurses (17-19). In 2018, children were offered vaccinations against 10 diseases in Denmark (16), up to 13 diseases in Finland (17), 12 diseases in Norway (19), and 10 diseases in Sweden (18). Children in specific risk groups are offered vaccines against additional diseases according to national guidelines (17-20). An overview of recommended childhood vaccinations in the four

countries in 2018 is presented in Table 1 and historical changes are illustrated in Appendix 1.

Table 1: Vaccines recommended to children in Denmark, Finland, Norway, and Sweden in 2018. The vaccines are included in the childhood immunisation programmes and registered in the vaccination registers, unless otherwise specified.

Disease	Denmark	Finland	Norway	Sweden
(Vaccine)				
Tuberculosis	Not within	Before 7 years of	6 weeks of age,	After 6 months of
(BCG)	programme	age, risk groups	risk groups only ¹	age, risk groups
		only ¹		only ^{1,2}
Hepatitis A	Not within	From 1 year of	Not within	Not within
	programme	age, risk groups	programme	programme
		only ³		
Hepatitis B	From birth, risk	From birth, risk	3 doses: 3, 5, 12	Not within
	groups only ⁴	groups only ^{4,5}	months of age	programme but
				recommended to
				all children.
		6.		3 doses: 3, 5, 12
				months of age ⁶
Rotavirus	Not within	3 doses: 2, 3, 5	2 doses: 6	2 or 3 doses:
	programme	months of age	weeks, 3 months	6 weeks, 3 and 5
			of age	months of age ^{2, 7}
Diphtheria,	4 doses: 3, 5, 12	5 doses: 3, 5, 12	5 doses: 3, 5, 12	5 doses: 3, 5, 12
tetanus and	months, booster	months of age,	months of age,	months of age,
pertussis	at 5 years of age	booster at 4 and	Booster in 2 nd	booster at 5
(DTaP)		14 years of age	and 10 th school-	years of age and
			year	in 8 th or 9 th
				school-year
Polio (IPV)	4 doses: 3, 5, 12	4 doses: 3, 5, 12	5 doses: 3, 5, 12	4 doses: 3, 5,
	months, booster	months of age,	months of age,	and 12 months of
	at 5 years of age	booster at 4	booster in 2 nd	age, booster at 5
		years of age	and 10 th school-	years of age
			year	

Haemophilus	3 doses: 3, 5, 12	3 doses: 3, 5, 12	3 doses: 3, 5, 12	3 doses: 3, 5,	
influenzae type	months of age	months of age	months	and 12 months of	
В				age	
Pneumococcal	13-valent; 3	10-valent; 3	13-valent; 3	10 or 13-valent;	
disease (PCV)	doses: 3, 5, 12	doses: 3, 5, 12	doses: 3, 5, 12	3 doses: 3, 5,	
	months of age	months of age	months of age	and 12 months of	
				age	
Influenza	From 6 months	Yearly, from 6	From 6 months	Yearly, from 6	
(Live- or non-	of age, risk	months to 6	of age, risk	months of age,	
live influenza	groups only8	years of age and	groups only,	risk groups	
vaccine)		for risk groups	through the	only ^{2,8}	
		after 6 years of	influenza		
		age ⁸	immunisation		
			programme ⁸		
Measles,	2 doses: 15	2 doses: 12	2 doses: 15	2 doses: 18	
mumps and	months of age	months of age, 6	months of age,	months of age	
rubella	and 4 years of	years of age	and 6 th school-	and 1st or 2nd	
	age		year	school-year	
Varicella	Not	1.5-11 years of	Not	Not	
	recommended	age	recommended	recommended	
Pneumococcal	Not within	Before 5 years of	Not within	Not within	
disease (PPV)	programme	age, after PCV,	programme, but	programme, but	
		risk groups only9	recommended	recommended	
			from 2 years of	from 2 years of	
			age, to specified	age, to specified	
			risk groups ⁹	risk groups ^{2,9}	
Tick borne	Not within	From 3 years of	Not within	Not within	
encephalitis	programme	age, risk groups	programme	programme	
		only ¹⁰			
Human	2 doses: 12	2 doses: 6 th	2 doses in 7 th	2 doses in 5 th or	
papilloma virus	years of age,	school-year, girls	school-year	6 th school-year,	
	girls only	only		girls only	
Abbrevietiene DCC	Pacillus Calmotto Cu		Nicelatha suita. Antanassa and	al a a a III. I a u ua a utu ua a l'a	

Abbreviations: BCG: Bacillus Calmette-Guérin vaccine; DTaP: Diphtheria, tetanus, and acellular pertussis vaccine; IPV: Inactivated Polio Vaccine; PCV: Pneumococcal Conjugated Vaccine; PPV: Pneumococcal Polysaccharide Vaccine.

Information obtained from: The Danish health authority (16), Finnish institute for health and Welfare (17), Norwegian Institute of Public Health (19), The Public Health Agency of Sweden (18).

¹ Children with a parent from a country with a high incidence of tuberculosis. ² Not included in the vaccination registry, ³ Children of intravenous drug users. ⁴ 1) Children of mothers or another member of the household who are Hepatitis B positive, or 2) attend daycare with a child who has Hepatitis B (20, 21). ⁵ 1) children of parents from countries with high incidence of Hepatitis B, or 2) children of mothers with hepatitis C infection (21). ⁶ Only offered to children in the risk group before 2016, not included in the vaccination registry before 2016 (22). ⁷ Rotavirus vaccine was offered by some Swedish regions, as part of regional vaccination schemes. ⁶ Children with increased risk of severe influenza illness or members of households with high-risk individuals(18, 23-25). ⁶ Children with increased risk of severe pneumococcal disease e.g. children with chronic diseases (18, 26, 27). ¹ Children of families with a permanent home or

Nordic nationwide register data: a goldmine for epidemiological studies

holiday house in areas within Finland with high tick prevalence (28)

All individuals residing in the Nordic countries are assigned a unique personal identification code (ID). All four countries have extensive national registers on health, demographic factors, and socio-economic factors collected for administrative purposes and linked to the individual using the personal ID (15, 29). The register information is collected automatically, which minimizes systematic reporting bias e.g. recall bias. The use of national registers limits selection bias as the entire population is included. All information in the registers are dated, which ensures that exposures and outcomes can be temporally linked and facilitates investigation of the cumulative and combined effects of multiple interventions on childhood health. Thus, the structure of the Nordic registers presents a unique opportunity to investigate the real-life effects of childhood vaccinations while incorporating multiple potential confounding factors.

Study population

We used national population registers to identify all children aged 0-17 years, who were born or became permanent residents after migrating to one of the Nordic countries at some point from 1990 until and including 2018 in Denmark and Norway, and 2017 in Finland and Sweden (30-33) (Figure 1). End of follow-up in each country reflects when the data application process was final. The individual registries included in this cohort were established in the respective countries at different time points. We have included the birth cohorts from 1990 in all countries to ensure that we have full information on follow-up from

birth also for the children who will be included at older ages for e.g., the studies of HPV vaccination given to teenagers. The population data obtained in Finland had incomplete information on migration history before 2014 and thus we were unable to assess the date of entering the country for children born abroad. As a result, we limited the Finnish study population to children born in the country to ensure that they were present in the country from the beginning of follow-up. After exclusions, which were primarily due to uncertain information about residency, a total of 9,072,420 children were included across the countries (Figure 1). Children were followed from date of birth or date of immigration until the date of first emigration, 18-year birthday, death, or last date with available information, whichever came first.

Source and content of data

Using the personal ID, we linked information from the nationwide registers and obtained individual-level information on gestation and birth, hospital contacts, redeemed prescriptions, and receipt of childhood vaccines. Furthermore, each child was linked to their parents through the population registers in order to extract information on household income, family composition, and highest attained parental education (Figure 2). The included data reflects necessary information to identify the vaccination status of the child, relevant outcomes, potential confounding factors, and information to be included as negative control outcomes.

Information on administered vaccines including type of vaccine and date of vaccination was obtained from The Danish Vaccination Register in Denmark (34), the Finnish vaccination register in Finland (35), the Norwegian Immunisation Registry (SYSVAK) in Norway (36), and the National vaccination register in Sweden (37). Registration of vaccinations within the NIP is mandatory in all Nordic countries (Table 1).

The Danish Vaccination Register includes information from the Danish National Health Insurance System that collects information on all vaccinations within the NIP (38). Since 2015, it has also been mandatory to report on vaccines given outside the NIP (39). In Denmark, vaccine information is linked to the individual using the personal ID, however before 1997 the information was registered on the ID of the parents only (38). Thus, in Denmark, only information on vaccines administered from 1997 and later was included. In Finland, the register includes all vaccines given in public health care since 2009, and after 2016 also private health care is obligated to register vaccinations (35). In Norway, the

immunisation registry holds information since 1995 on all administered vaccines that are part of the NIP (19). Since 2011 notification to the immunisation registry is also mandatory for vaccines given outside the NIP (36). The Swedish national vaccination register has information about vaccinations given since 2013, but only those included in the NIP (37).

Information on hospital contacts was obtained from The Danish National patient register, Finnish Care Register for Health Care, Norwegian National Patient Register, and The Swedish Patient Registry (15, 29). The registries reached national coverage and recorded individual-level data since 1978 in Denmark, 1994 in Finland, 2008 in Norway, and 1997 in Sweden. Since 1997, diagnoses have been coded according to the International Classification of Diseases version 10 (ICD-10) in all four countries (40).

The Danish, Norwegian, and Swedish prescription registers hold information on all redeemed prescriptions, classified using the Anatomical Therapeutic Chemical Classification System (ATC) since 1995, 2004, and mid-2005, respectively (41). The Finnish Benefits Registry holds information only for reimbursable redeemed prescriptions (41-43). In addition, the Finnish Prescription Center started gradually in 2010 and collects all redeemed prescriptions irrespective of reimbursement. By 2017, practically all prescriptions were included in the Finnish Prescription Center (44). We combined the information from the Finnish Prescription Center and the Finnish Benefits Registry to obtain the most complete information on redeemed prescriptions (see Appendix 2 for details on source of data).

Information on socioeconomic factors and birth characteristics was available from the beginning of the study period (1990) in all countries.

The Common Data Model: Harmonised country specific datasets

The country-specific data from the national registers may differ both across countries and within countries over time due to differences in coding practices, administration, and country-specific legislation on health and social aspects (29). We developed a Common Data Model to harmonise all information we obtained into similar datasets using the same variable names and same categories in all four countries (Figure 3). The data harmonisation focused on identifying outliers and country-specific traits that could hinder cross country comparability. Information on source of data and data preparation for each of the variables can be found in Appendix 2 "NONSense Common Data Model".

Due to national data protection legislation, country-specific data was stored and analysed in the respective countries using platforms that adhere to country specific regulations to ensure safe storing and handling of data. Country specific data was pseudonymized by the registry holders before being transferred to the research team in each country. The common data model allows for the exchange of aggregated or summary data between countries, thus precluding the need to set up separate platforms to exchange data.

Patient and Public involvement

All studies conducted within NONSEnse will be register based studies only and patients or the public will not be involved in the design or conduct of the planned studies.

Characteristics of the study population

The national study populations range from 1,637,133 children in Finland to 3,540,560 children in Sweden (Table 2). Median follow-up time was 13.1 years in Denmark, 14.2 years in Finland, 12.6 years in Norway, and 10.8 years in Sweden. Sweden had the highest proportion of children born abroad; 15.5% compared with 8.4 in Denmark and 11.1% in Norway. The proportion of children who were censored due to migration was lower in Finland, where we only included children born in-country: 0.7% compared with 4.4-6.2% in the other countries. The lower emigration rate in Finland represents both underreporting due to incomplete information on migration, and a suspected lower risk of moving out of the country for children born in-country, compared with children born abroad. A higher proportion of children without a link to their mother was seen in Sweden; 5.3% compared to 0.2-1.1% in the other countries. The children without a link to their mother in Sweden were predominantly born abroad (data not presented) and may thus be affected by incomplete registration of migrant families, or children immigrating to Sweden without their mother.

Table 2: Study population – identification and follow-up

	Denmark	Finland ¹	Norway	Sweden	
Study population (N)	1,979,670	1,637,133	1,915,057	3,540,560	
Years of follow-up ² per					
child (Median (p25-	13.1 (5.9-18.0)	14.2 (7.2-18.0)	12.6 (5.7-18.0)	10.8 (4.2-18.0)	
p75))					
Year of birth	1990-2018	1990-2017	1990-2018	1990-2017	

Sex (N (%))								
Male	1,014,745	51.3%	836,828	51.1%	985,568	51.5%	1,827,619	51.6%
Female	964,925	48.7%	800,305	48.9%	929,489	48.5%	1,712,941	48.4%
Reason for entering the	cohort (N (%	6))	I	ı			1	l
Birth	1,813,443	91.6%	1,637,133	100.0%	1,703,054	88.9%	2,993,472	84.5%
Immigration	166,227	8.4%	0	0.0%	212,003	11.1%	547,088	15.5%
Reason for leaving the	cohort (N (%))	I	ı			ı	l
Death	8532	0.4%	761	0.0%	5422	0.3%	5614	0.2%
Emigration	122,916	6.2%	11,789	0.7%	95,406	5.0%	154,878	4.4%
Other ³	1917	0.1%	0	0.0%	0	0.0%	0	0.0%
18 th birthday	704,518	35.6%	608,644	37.2%	703,164	36.7%	1,280,027	36.2%
End of follow-up ⁴	1,141,787	57.7%	1,015,939	62.1%	1,111,065	58.0%	2,100,041	59.3%
Linked with mother in	1,961,595	99.1%	1,634,120	99.8%	1,894,916	98.9%	3,352,706	94.7%
registers (N (%))								
Linked with father in	1,920,008	97.0%	1,601,138	97,8%	1,838,444	96.0%	3,248,108	91.7%
registers (N (%))	,							
Maternal age at birth				ı				I
of child (median, p25-	29 (26-33)		29 (26-33)		29 (25-33)		29 (26-33)	
p75)								
Missing information	18,075	0.9%	10,099	0.6%	20,141	1.1%	187,854	5.3%
on maternal age (N								
(%))								
Maternal origin (N (%))		1		4	1	'		
Born in country	1,582,885	80.0%	1,520,159	92.9%	1,432,179	74.8%	2,399,234	67.8%
Born abroad	378,710	19.1%	111,611	6.8%	462,319	24.1%	953,467	26.9%
Unknown	18,075	0.9%	5363	0.3%	20,559	1.1%	187,859	5.3%

¹Finnish data only include children born in country due to incomplete information on migrations. ²Years of follow-up is calculated as first date of death, emigration, turning 18 years of age or last date with available data from the population registry minus the last date of birth, or immigration divided by 365.25. ³E.g. disappear from register without specification. ⁴Last date with data available from population registry

Exposure assessment: Vaccinations across the Nordic countries

Figure 4 depicts the coverage of diphtheria, tetanus, and acellular pertussis containing vaccines (DTaP), measles-mumps-rubella vaccine (MMR) and rota virus vaccines (rota) for children born in each country followed from birth until two years of age, date of

emigration, or date of death, whichever came first (see Appendix 3, sTable 1 for the coverage at 2 years of age for each of the included birth cohorts in each country).

In Norway, the vaccine uptake rate was highest and closest to the age of recommended vaccination compared with the other countries. In Finland and Sweden, MMR uptake starts at ages earlier than scheduled according to the respective NIPs, which reflects that MMR is recommended to children from 6 and 9 months of age in Finland and Sweden respectively, before travelling abroad. Although MMR is recommended before travelling abroad in all the Nordic countries, early uptake of MMR is much less frequent in Denmark and Norway which may indicate different interpretation and roll-out of the recommendations. The greater variation in the age at MMR vaccination in Finland reflects different vaccination schedules applied to the included birth cohorts: MMR vaccination was recommended at 14-18 months of age before June 2010 and at 12-18 months (preferably 12 months of age) after June 2010. In Finland, Norway, and Sweden, the date of the next vaccination is usually scheduled during earlier well-baby check-ups or provided by post, whereas in Denmark no formal procedures are in place to ensure timely vaccination, which may explain the different variation in age at vaccination across the countries.

Human papilloma virus vaccination (HPV) for girls was introduced in the NIP in 2009 in Denmark, the end of 2013 in Finland, mid-2009 in Norway, and in 2012 in Sweden. (Appendix 1). The vaccine is recommended at age 12 years in Denmark, Finland, and Norway, and at age 11-12 years in Sweden. Figure 5 depicts the registered coverage of HPV vaccinations among girls followed from one year before the recommended age of vaccination until age 14 years, emigration, or death, whichever came first. In Norway, the uptake of the first dose of HPV vaccine follows a steep curve at 12 years of age, representing the age of recommended vaccination (Figure 5). The majority of the included birth cohorts in Norway were only able to receive the HPV vaccination free of charge during the school year it was offered, which may have contributed to the high and steep uptake rate. In Sweden, the uptake starts increasing at 11 years of age with a second increase at 12 years of age reflecting that the vaccine may be administered in either the 5th or 6th grade. In Denmark uptake starts increasing at 12 years of age corresponding to recommended age of vaccination, but with more variation in the age of vaccination compared with the other countries. The relative low uptake combined with high age variation may be due to vaccination hesitancy following negative media attention from

Danish television portraying alleged serious adverse effects of HPV vaccination (45). Confidence in the safety of the vaccine has since been restored, which is reflected in the slightly increasing vaccination coverage in the last included birth cohort (Appendix 3, sTable2). In Finland, the uptake rates follow a straight curve from 12-13 years of age followed by a small proportion of children with delayed vaccination. The vaccine uptake at 14 years of age within our cohort was highest in Norway (first dose for the birth cohort 2003: 84.8%) followed by Sweden (77.9%), Finland (69.8%) and Denmark (52.3%) (Appendix 3, sTable 2).

Health and sociodemographic characteristics

Data were available for a different set of years across the Nordic countries. For comparing the study populations in this cohort profile, we only present information from years where data are available in all countries.

Prescriptions

Information on redeemed prescriptions was included for the purpose of assessing predefined health outcomes in terms of antibiotic consumption and different atopic outcomes, and to be able to assess potential confounding factors relating to underlying health and healthcare seeking behaviour. The data legislation regulating access to information on drug utilisation differed across countries. Therefore, data were only obtained for a more narrowly defined subset of ATC-codes in Finland and Sweden. compared with Denmark and Norway (Appendix 3). Information from the prescription registries was available from 2005 to 2017 in all countries. We only included information on redeemed prescriptions with ATC-codes available in all countries for the present comparison. The overall proportion of children with redeemed prescriptions ranged from 75.6% in Norway to 86.1% in Finland and varied depending on ATC-group (Table 3). The proportion of children with redeemed prescriptions in ATC-group D "dermatologicals" was 36.3% in Denmark compared with 20.6-24.7% in the other countries. Finland had the highest proportion of children with redeemed prescriptions in ATC group J "antiinfectives for systemic use": 82.3% compared with 62.1-75.0% in the other countries. In ATC group S "eye and ear medications", the proportion was lower in Finland (7.4%) compared with the other countries (13.0-17.9%). For ATC group R "Respiratory system" and subgroup V01 "Allergens" the proportions were relatively similar across countries.

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Table 3: Health characteristics of children present in the respective countries from year 2505-2017.

	Denmark		Finland		Norway		Sweden			
Prescriptions On One										
Years of follow-up	2005-2017		2005-2017		2005 2017		2005-2017			
Number of children with follow-up¹ (N (%))	1,904,633	100.0%	1,634,031	100.0%	1,81 231	100.0%	3,355,915	100.0%		
Children with redeemed prescriptions ² (N (%))	1,592,361	83.6%	1,407,548	86.1%	1,374,180	75.6%	2,542,676	75.8%		
Mean age during follow-up (mean, (sd))	8.3 (5.2)		8.3 (5.2)		8.3 (\$\varepsilon 2.2)		8.2 (5.3)			
Prescriptions pr child (median, p25-p75)	4 (1-9)		5 (2-11)		3 (1-8)		3 (1-7)			
Children with prescriptions with ATC group D (N					ed fro					
(%))	691,357	36.3%	360,910	22.1%	449,226	24.7%	692,269	20.6%		
Prescriptions per child with ATC group D ^{2, 3, 4}					tp://b					
(median, p25-p75)	1 (1-3)		1 (1-3)		1 (1-3)		1 (1-3)			
Children with prescriptions with ATC group J (N					en.b					
(%))	1,428,652	75.0%	1,345,297	82.3%	1,129,065	62.1%	2,194,753	65.4%		
Prescriptions per child with ATC group J ^{2, 3, 5}					m/ o					
(median, p25-p75)	3 (2-6)		4 (2-8)	0 _A	2 (1-4 2)		3 (1-5)			
Children with prescriptions with ATC group R (N				1//	19					
(%))	806,105	42.3%	748,839	45.8%	841,266	46.3%	1,468,158	43.7%		
Prescriptions per child with ATC group R ^{2, 3, 6}					4 by					
(median, p25-p75)	2 (1-6)		2 (1-7)		3 (1-9g)		2 (1-6)			
Children with prescriptions with ATC group S (N					Pro					
(%))	248,522	13.0%	121,721	7.4%	326,🕎7	17.9%	521,658	15.5%		

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				.065			
1 (1-2)		1 (1-2)		2 (1-32)		1 (1-2)	
				on 10			
10,384	0.5%	4662	0.3%	11,770	0.6%	5928	0.2%
				ruary			
5 (3-9)		4 (2-7)		4 (2-8)		4 (2-8)	
	I		I	3. D	I		
2008-2016		2008-2016		2008 2016		2008-2016	
1,813,600	100.0%	1,581,854	100.0%	1,738 115	100.0%	3,177,371	100.0%
1,069,628	59.0%	861,685	54.5%	982,808	56.5%	1,911,254	60.2%
5.8 (3.1)		5.9 (3.0)		5.7 (30)		5.5 (3.1)	
9.2 (5.8)		9.1 (5.9)		9.1 (\$ 8)		9.0 (5.9)	
	9/	•		joper			
1 (0-2)		1 (0-4)		1 (0-3)		1 (0-4)	
519,945	28.7%	324,292	20.5%	420,492	24.2%	568,958	17.9%
1 (1-2)		1 (1-2)	0.	1 (1-2)		1 (1-2)	
			4/)	April			
885,243	48.8%	839,569	53.1%	911,	52.5%	1,826,446	57.5%
2 (1-3)		3 (1-6)		2 (1-\$)		3 (1-6)	
				оу дс			
	10,384 5 (3-9) 2008-2016 1,813,600 1,069,628 5.8 (3.1) 9.2 (5.8) 1 (0-2) 519,945 1 (1-2) 885,243	10,384 0.5% 5 (3-9) 2008-2016 1,813,600 100.0% 1,069,628 59.0% 5.8 (3.1) 9.2 (5.8) 1 (0-2) 519,945 28.7% 1 (1-2) 885,243 48.8%	10,384 0.5% 4662 5 (3-9) 4 (2-7) 2008-2016 2008-2016 1,813,600 100.0% 1,581,854 1,069,628 59.0% 861,685 5.8 (3.1) 5.9 (3.0) 9.2 (5.8) 9.1 (5.9) 1 (0-2) 1 (0-4) 519,945 28.7% 324,292 1 (1-2) 1 (1-2) 885,243 48.8% 839,569	10,384 0.5% 4662 0.3% 5 (3-9) 4 (2-7) 2008-2016 2008-2016 1,813,600 100.0% 1,581,854 100.0% 1,069,628 59.0% 861,685 54.5% 5.8 (3.1) 5.9 (3.0) 9.2 (5.8) 9.1 (5.9) 1 (0-2) 1 (0-4) 519,945 28.7% 324,292 20.5% 1 (1-2) 1 (1-2) 885,243 48.8% 839,569 53.1%	10,384 0.5% 4662 0.3% 11,7 (1) 1,7 (2) 4 (2-8) 2008-2016 2008-2016 2008-2016 1,813,600 100.0% 1,581,854 100.0% 1,73 (1) 15 1,069,628 59.0% 861,685 54.5% 982, (3) 5.8 (3.1) 5.9 (3.0) 5.7 (3,0) 9.2 (5.8) 9.1 (5.9) 9.1 (5.8) 1 (0-2) 1 (0-4) 1 (0-3) 519,945 28.7% 324,292 20.5% 420,492 1 (1-2) 1 (1-2) 1 (1-2) 885,243 48.8% 839,569 53.1% 911,877	10,384 0.5% 4662 0.3% 11,770 0.6% 5 (3-9) 4 (2-7) 4 (2-8) 0.6% 2008-2016 2008-2016 2008-2016 1,738-115 100.0% 1,813,600 100.0% 1,581,854 100.0% 1,738-115 100.0% 1,069,628 59.0% 861,685 54.5% 982,808 56.5% 5.8 (3.1) 5.9 (3.0) 5.7 (3.0) 9.1 (3.8) 1 (0-2) 1 (0-4) 1 (0-3) 9.1 (3.8) 1 (0-2) 1 (0-4) 1 (0-3) 24.2% 1 (1-2) 1 (1-2) 1 (1-2) 52.5% 885,243 48.8% 839,569 53.1% 911,877 52.5%	10,384 0.5% 4662 0.3% 11,760 0.6% 5928 5 (3-9) 4 (2-7) 4 (2-8) 4 (2-8) 4 (2-8) 2008-2016 2008-2016 2008-2016 2008-2016 1,813,600 100.0% 1,581,854 100.0% 1,73&15 100.0% 3,177,371 1,069,628 59.0% 861,685 54.5% 982,808 56.5% 1,911,254 5.8 (3.1) 5.9 (3.0) 5.7 (3.0) 5.5 (3.1) 9.2 (5.8) 9.1 (5.9) 9.1 (3.8) 9.0 (5.9) 1 (0-2) 1 (0-4) 1 (0-3) 1 (0-4) 519,945 28.7% 324,292 20.5% 420,492 24.2% 568,958 1 (1-2) 1 (1-2) 1 (1-2) 1 (1-2) 1 (1-2) 885,243 48.8% 839,569 53.1% 911,877 52.5% 1,826,446

¹ Number of children living in the country at any time in the period 2005-2017. ² Only including ATC subgroups: D02AF, D05, D07, D11, D01, D06, D08, J01-J07, R01, R03, R06, S01G, S03, V01 - Thus, not reflecting total use of prescription medicines. Per child with redefined prescriptions of that ATC-group. ⁴ATC Group D: Dermatologicals. ⁵ATC Group J: Antiinfectives for systemic use. ⁶ATC Group R: Respiratory system 7ATC Group S: Sensory organs. ⁸ATC Subgroup V01: Allergens. 9 Number of children living in the country at any time in the period 2008-2016. Proportion are calculated using number of children with follow-up as the denominator. copyright.

Hospital contacts

Information on hospital contacts including inpatient and specialised outpatient care was available in all countries from 2008 to 2016. For comparison across countries, we excluded country-specific codes (e.g. codes for health characteristics of new-borns in Denmark). The proportion of children with hospital contacts was similar across countries (54.5-60.2%, Table 3). The proportion of children with inpatient contacts ranged from 17.9% in Sweden to 28.7% in Denmark. The proportion of children with outpatient contacts in the patient registers was highest in Sweden (57.5%) and lowest in Denmark (48.8%). The higher proportion of inpatient contacts in Denmark is likely explained by contributions of inpatient contacts without overnight stays, as contacts without overnight stays will predominantly be registered as outpatient contacts in the other countries (46). The higher proportion of children with outpatient contacts in Sweden may on the other hand be explained by a broader set of health care facilities (e.g. paediatric outpatient clinics) that report to the patient register in Sweden compared with the other countries (46).

Birth characteristics

Information on birth characteristics was available for birth cohorts from 1990 to 2016 in all countries (Table 4). The completeness of data was high in all countries, ranging from 97.7% to 99.9%. The birth characteristics were also very similar: the median birth weight ranged from 3500 to 3550 grams, the proportion of low-birthweight (below 2500 g) children ranged from 3.9% to 5.0%, and the median gestational age was 40 weeks in all countries. For the variables preterm birth, delivered by caesarean section, and singleton births, the proportions only differed by 0.8-2.7 percent points across countries. The greatest difference between countries was seen for registration of maternal smoking during pregnancy, which ranged from 8.3% in Norway to 18.2% in Denmark. The proportion with unknown/missing information on maternal smoking ranged from 2.5% in Finland to 45.8% in Norway, which may be explained by the midwifes having to inform the mothers of the need for obtaining information on smoking before asking this question in Norway, thus additional effort is required, which may hamper completeness. However, the greater proportion with missing information on maternal smoking in Norway could partly explain the lower proportion with registered maternal smoking during pregnancy, if missing information is more prevalent among smoking mothers.

Table 4: Birth characteristics¹

	Denmark		Finland		Norway		Sweden	
Children born in the								
respective country								
from 1990-2016 (N)	1,728,126		1,586,526		1,591,273		2,877,753	
Children with								
information								
available from the								
birth registry	1,726,318	99.9%	1,576,797	99.4%	1,586,895	99.7%	2,811,119	97.7%
Birth weight in						'		1
grams (Median,								
p25-p75)	3500 (3150	-3850)	3550 (3210)-3880)	3550 (3200-	-3900)	3540 (3200	-3890)
Low birth weight								
(<2500g) (N (%))	86,914	5.0%	61,546	3.9%	73,437	4.6%	114,990	4.0%
Birth weight								
missing (N (%))	23,707	1.4%	12,859	0.8%	5376	0.3%	72,892	2.5%
Gestational age in								
weeks (Median,								
p25-p75)	40 (39-41)		40 (39-40)		40 (39-41)		40 (39-40)	
Preterm birth (N								
(%))	107,656	6.2%	85,069	5.4%	98,923	6.2%	163,168	5.7%
Gestational age								
missing (N (%))	29,250	1.7%	16,083	1.0%	59,264	3.7%	68,973	2.4%
Delivered by								
caesarean section								
(N (%))	305,738	17.7%	258,261	16.3%	238,013	15.0%	435,680	15.1%
Mode of delivery								
missing (N (%))	1808	0.1%	9729	0.6%	4378	0.3%	66,634	2.3%
Singleton (N (%))	1,660,213	96.1%	1,531,748	96.5%	1,535,556	96.5%	2,731,980	94.9%
Child order including		-						I
1 (firstborn)	743,923	43.0%	647,134	40.8%	658,877	41.4%	1,211,084	42.1%
2	635,849	36.8%	532,868	33.6%	568,765	35.7%	1,023,228	35.6%
3	243,162	14.1%	244,137	15.4%	257,294	16.2%	398,331	13.8%
4 or more	86,090	5.0%	149,327	9.4%	101,959	6.4%	178,184	6.2%
Missing	19,102	1.1%	13,060	0.8%	4378	0.3%	66,926	2.3%

Maternal smoking								
during pregnancy								
(N (%))	314,174	18.2%	238,337	15.0%	132,734	8.3%	310,691	10.8%
Maternal smoking								
unknown (N (%))	134,332	7.8%	39,277	2.5%	728,038	45.8%	143,529	5.0%

¹ Information, including percentages are reported according to the number of children born in country from 1990-2016

Socioeconomic factors

Socioeconomic information is collected yearly in all countries. In the NONSEnse cohort, the information was assessed in the year of birth of each child (Table 5) and in the 10th year of life (Appendix 3, sTable 3). Information from the year of birth was available for the birth cohorts 2004-2015 in all countries. The data presented in Table 5 only include children who were born in-country and living in the country throughout their first year of life, to ensure that they were present in the country at the time of registration.

Table 5: Socio-economic factors at birth

	Denmark		Finland	Finland		Norway		Sweden	
	N	(%)	N	(%)	N	(%)	N	(%)	
Children present in country at birth from 2004-2015	729,294		699,052	699,052		706,443			
Birth cohorts included	2004-201	5	2004-201	5	2004-201	5	2004-2015		
Income quintile at b	oirth								
First (lowest)	134,634	18.5%	138,965	19.9%	137,551	19.5%	247,237	18.8%	
Second	137,041	18.8%	138,997	19.9%	141,566	20.1%	265,557	20.2%	
Third	137,390	18.8%	139,012	19.9%	141,962	20.1%	267,347	20.3%	
Fourth	137,415	18.9%	138,998	19.9%	141,995	20.1%	267,349	20.3%	
Fifth	136,935	18.8%	138,900	19.9%	141,533	20.1%	266,528	20.3%	
Unknown	45,531	6.2%	4180	0.6%	644	0.1%	605	0.0%	
Number of children	in the hous	ehold the y	ear the chil	d is born					
1	310,237	42.6%	287,312	41.1%	298,563	42.3%	574,229	43.7%	
2	278,396	38.2%	237,291	33.9%	263,726	37.4%	487,446	37.1%	
3	106,184	14.6%	104,278	14.9%	108,822	15.4%	176,338	13.4%	
>3	32,106	4.4%	65,527	9.4%	33,496	4.7%	68,060	5.2%	
Unknown	2023	0.3%	4644	0.7%	644	0.1%	605	0.0%	
Single parenthood	in the years	the child is	born						
Yes	58,646	8.0%	55,089	7.9%	68,018	9.6%	132,243	10.1%	
No	668,277	91.7%	639,319	91.5%	635,689	90.1%	1,181,775	89.9%	
Unknown	2023	0.3%	4644	0.7%	1544	0.2%	605	0.0%	
Highest attained ed	ducational le	vel ¹ of the	mother on t	he date t	he child is	born		•	
Low education	114,880	15.8%	98,608	14.1%	126,777	18.0%	149,673	11.4%	
Medium education	261,761	35.9%	279,687	40.0%	201,316	28.5%	431,880	32.9%	
High education	336,536	46.2%	319,530	45.7%	350,684	49.7%	457,040	34.8%	
Unknown	15,769	2.2%	1227	0.2%	26,474	3.8%	276,030	21.0%	
¹ Highest attained e	education wa	as categoriz	zed based o	on the Int	ernational	Standard	Classification	n of	
Education (ISCED)	2011 using	the main g	roups (47).						

In Denmark, 6.2% of the study population had missing information on household income compared with 0-0.6% in the other countries. We have been unable to identify the reason for the higher proportion in Denmark. The proportion of households with 3 or more children was 9.4% in Finland compared with 4.4-5.2% in the remaining Nordic countries. The proportion living with a single parent in the year of birth ranged from 7.9% in Finland to 10.1% in Sweden. Among the remaining socioeconomic variables, the largest cross-

country difference was found for the highest attained education of the mother, where information was missing for 21.0% of the children in Sweden compared with 0.2-3.8% in the other Nordic countries. The proportion of mothers with low education ranged from 11.4% in Sweden to 18.0% in Norway. The high proportion with missing information on maternal education in Sweden is in part caused by a higher proportion of children with an unknown mother in our dataset (Table 2) but may also be caused by education not being registered for mothers born abroad. Since registration of education is often a necessity for employment in more advanced fields, it is reasonable to assume a higher accuracy for registration of high education as compared with low education.

Findings to date

The data collection process was completed in March 2022. The findings to date pertain to investigations of similarities and differences in rates of infectious disease hospitalisations (46), and antibiotic consumption (48). These studies highlight trends in infectious disease morbidity across the Nordic countries and further guide the use of more consistent infectious disease outcome measures for future studies.

The results regarding the non-specific effects of vaccines are at the moment limited to an interrupted timeseries analysis, which could be undertaken using aggregated data that was ready before all the individual based data was obtained in all countries (49). Future studies will include population-level investigations of natural experiments in the form of introduction of new vaccines or changes in the immunisation programmes, as well as individual-level studies comparing vaccinated and unvaccinated children with a given vaccine using multiple different study designs.

FURTHER DETAILS

Strengths and limitations

The NONSEnse project represents a unique undertaking for conducting register based epidemiological studies of the overall health effects of routine childhood vaccines.

Data are stored separately in each country, which prevents conducting analyses on the joint data, which is a limitation of the project. However, the Common Data Model enables analysis plans and statistical code to be written in one country and sent to the other

countries that can then perform the same analyses and share the results (Figure 3). The use of a Common Data Model thus minimises the risk that different country-specific analytical decisions will hinder comparability of results.

The use of register data presents both strengths and weaknesses. A strength pertains to the multitude of information available for the entire study population and linked to the individual, which minimises selection bias and enables cohort studies with prospective follow-up and control for multiple confounding factors. The generalisability of the Finnish cohort is limited to children born in-country. However, for most of studies to be undertaken within this project, this will have limited implications since we will often restrict the study population to children born in-country for the studies of childhood vaccinations to ensure complete information on vaccinations given from birth. Limitations include that not all the wished-for information are available in all countries and registration may be incomplete, which limits the possibility to e.g., adjust for hypothesised confounding factors such as day-care attendance and lifestyle factors. Also, previous studies (2) have found the nonspecific effect of a vaccine to be strongest when it is the most recent vaccine administered. Therefore, it is relevant to include information on vaccines other than the ones offered through the NIP. In Denmark, Finland, and Norway vaccines outside the NIP may also be registered in the vaccination registers, but registration of these vaccines has only been mandatory in more recent years (35, 36, 39). In Sweden only vaccinations within the NIP are included in the vaccination register. The analyses are thus limited by different possibilities to assess the effect of a given vaccine as long as it is the most recent vaccine, both within and across countries.

In all the Nordic countries information on emigration relies on the individual reporting resettlement to the authorities. This is mandatory when leaving the country for more than 6 months in Denmark (50) and Norway (51), and for more than 12 months in Sweden (52) and Finland (53). Thus, incomplete information on emigrations, due to leaving the country for shorter periods of time or if parents fail to register the resettlement, may result in children being lost to follow-up without us knowing it from the registers. This may in turn result in our studies underestimating events, e.g. infectious disease hospitalisations, as these are only registered for children who are in the country.

Overall, it is clear that expert knowledge is needed before combining and using Nordic register data for research purposes (29). As such, an important strength of NONSEnse

pertains to the data harmonisation process through bi-weekly analysis workshops involving designated research groups from each of the four countries with expert knowledge on country-specific register data, the heath care systems, and immunisation programmes.

Validity of exposure and outcome measures

In all countries, the vaccines offered through the NIP are subject to mandatory registration. However, validity depends on the reporting accuracy by the health care providers that administer the vaccinations. A Danish study validated the coverage of MMR from the registers using medical records from the general practitioner in a subset of the population and found that the coverage in the register was 86% compared with 94% through inspection of the medical records (54). A similar comparison conducted in Sweden also found underreporting of MMR in the register of around 5-7 percentage units (unpublished). It is unlikely that underreporting of vaccines is associated with the outcomes investigated within the NONSEnse project, therefore, the misclassification will most likely be non-differential and would thus bias the results towards no association.

The prescription registers only contain information on drugs dispensed from filled prescriptions, whereas some drugs are also available over the counter, which are not included in the registers. This includes e.g. weak corticosteroids for topical use (ATC: D07AA) or drugs used to treat symptoms in the eye due to e.g. allergy (ATC: S01G). It is thus possible that the observed cross-country differences in the proportion of children with these prescriptions are affected by national policies or guidelines, or the behaviour of the prescriber or purchaser. Atopic outcomes will, in part, be identified using filled prescriptions for products that are also available over the counter, which may hamper cross country comparability. Antibiotics, however, are prescription drugs in all four countries and thus not affected by over-the-counter purchases.

Several differences in health care organisation, administration, and registration may hamper cross country comparability of the health outcomes included in this project. A strength of NONSEnse is the thorough investigation of the intended outcomes in independent studies which has informed and maximised comparability of the outcome measures to be used in the subsequent studies of non-specific effects of vaccines.

Methodological considerations

Evaluating the effect of implemented vaccination programmes is challenging; the high vaccine uptake rate makes comparisons between vaccinated and unvaccinated children difficult due to the individual factors that determine vaccine uptake. Healthy vaccinee bias may arise if the healthiest children are more likely to follow the vaccination recommendations than the less healthy children (55). However, due to different vaccination schedules in different countries, the children who have received MMR at e.g.15 months of age may be classified as vaccinated according to schedule, too early or too late, depending on the country. Furthermore, age is a strong predictor of both vaccination and the risk of infectious diseases (46). A strength therefore pertains to the observed delay in age at vaccination within each country, which facilitates comparison of different vaccination statuses among children of the same age. For vaccines with a steep and high uptake at the recommended age of vaccination, the children who do not receive the vaccines as scheduled are more likely a selected subgroup of the population, thus hampering comparability with the rest of the population. In contrast, larger variation in the age at vaccination increases comparability between children with different vaccination status according to age.

A strength of this study setup is the many differences in the immunisation programmes, and in changes to the immunisation programmes, the country-specific bias structures, and the possibility to integrate results from different study designs, which facilitate triangulation that can strengthen the potential for making causal deductions (13, 14). The project has already led to useful new information regarding differences and similarities in childhood morbidity between the Nordic countries. Most importantly, the project will increase our understanding of vaccines and how they may affect health in more general ways - holding potential for direct translation into more efficient immunisation programmes and improved child health.

Data sharing statement

Due to data protection rules and ethical permissions, we are not allowed to share the individual-level data. However, the insights presented in this cohort profile, including the common data model, can serve to guide the construction of similar Nordic databases by other researchers fulfilling the requirements to obtain Nordic registry data. The possibility

to generate Nordic population-based cohorts could for example be used to study health interventions and outcomes related to the SARS-CoV-2 pandemic across the Nordic countries

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Author contributions

LG, IL, HE, HN, BF, ML, AP, LT, CSB, and SS conceptualized the Manuscript. LG, IL, HE, HN, and SS designed the methodology used to present the included data. LG, IL, HE, and ML managed data curation, undertook the country specific coding, and produced the aggregated data presented. LG, IL, HE, HN, BF, ML, AP, LT, CSB, and SS investigated and validated the aggregated data produced. LG and IL did the formal analysis of data. LG, IL, HE, BF, LT, HN, AP, and SS obtained the data to be included in this cohort. LG drafted the first version of the manuscript. IL, HE, HN, BF, ML, AP, LT, CSB, and SS critically revised the draft. LG and IL produced the visualizations. CSB and SS supervised the project. LG, IL, HN, BF, ML, AP, LT, CSB, and SS obtained the funding for the present project.

Ethics

Ethical approval is not required for registry-based studies in Denmark and Finland. However, the study was approved by the Danish Data Protection Agency and by the Institutional Review Board of the Finnish Institute for Health and Welfare. In Norway, study approval was obtained from the Regional Ethics Committee, South-East. In Sweden, study approval was obtained from the Regional Ethical Review Board, Stockholm, Sweden.

Competing interest

AAP, HN and ML are investigators in vaccine-related studies for which THL has received funding from GSK, Pfizer and Sanofi Pasteur. The remaining authors report no relation that could be construed as a conflict of interest.

FIGURE LEGENDS

Figure 1: Flowchart of study population in Denmark, Finland, Norway, and Sweden

Figure 2: Nordic register information linked to the individual using a unique personal identification code (ID)

Figure 3: Transforming country specific datasets into NONSense datasets using a common data model

Figure 4: Vaccination coverage¹ according to age (inverse Kaplan-Meier estimates) among children² born in-country in Denmark, Finland, Norway, and Sweden

Abbreviations: DTP1: First dose of Diphtheria, Tetanus, and acellular Pertussis containing vaccine; DTP2: Second dose of Diphtheria, Tetanus, and acellular Pertussis containing vaccine; DTP3: Third dose of Diphtheria, Tetanus, and acellular Pertussis containing vaccine; MMR: Measles-Mumps-Rubella vaccine; Rota: Rota virus vaccine

¹ The coverage reflects the number of registered vaccines and may thus underestimate the actual vaccination coverage in the countries. ² Including children born in the country from birth cohorts where vaccines administered between 0-2 years of age are registered in the vaccination registers (data availability period). The included birth cohorts are 1997-2016 in Denmark; 2009-2015 in Finland; 1995-2016 for DTP and MMR vaccine and 2015-2016 for Rota in Norway; 2013-2015 in Sweden. Number of children in each birth year is presented in Appendix 3, sTable 1.

Figure 5: Human papilloma virus vaccination coverage^{1,2} according to age (inverse Kaplan-Meier estimates) among girls³ in Denmark, Finland, Norway, and Sweden

Abbreviations: HPV1: First dose of Human papilloma virus vaccine; HPV2: Second dose of Human papilloma virus vaccine

¹The coverage reflects the number of registered vaccinations and may thus underestimate the actual vaccination coverage. ²In some countries the recommended vaccination schedule changed from 3 to 2 doses during follow-up. Only the 2 first doses are reported here. ³ Including girls from birth cohorts where HPV vaccination has been offered from 1 year before age of recommended vaccination until 14 years of age and where vaccinations were registered in the vaccination registers. The included birth cohorts are 1998-2004 in Denmark, 2002-2003 in Finland, 1998-2004 in Norway, and 2003 in Sweden. Number of girls included in each birth cohort is presented in Appendix 3, sTable2.

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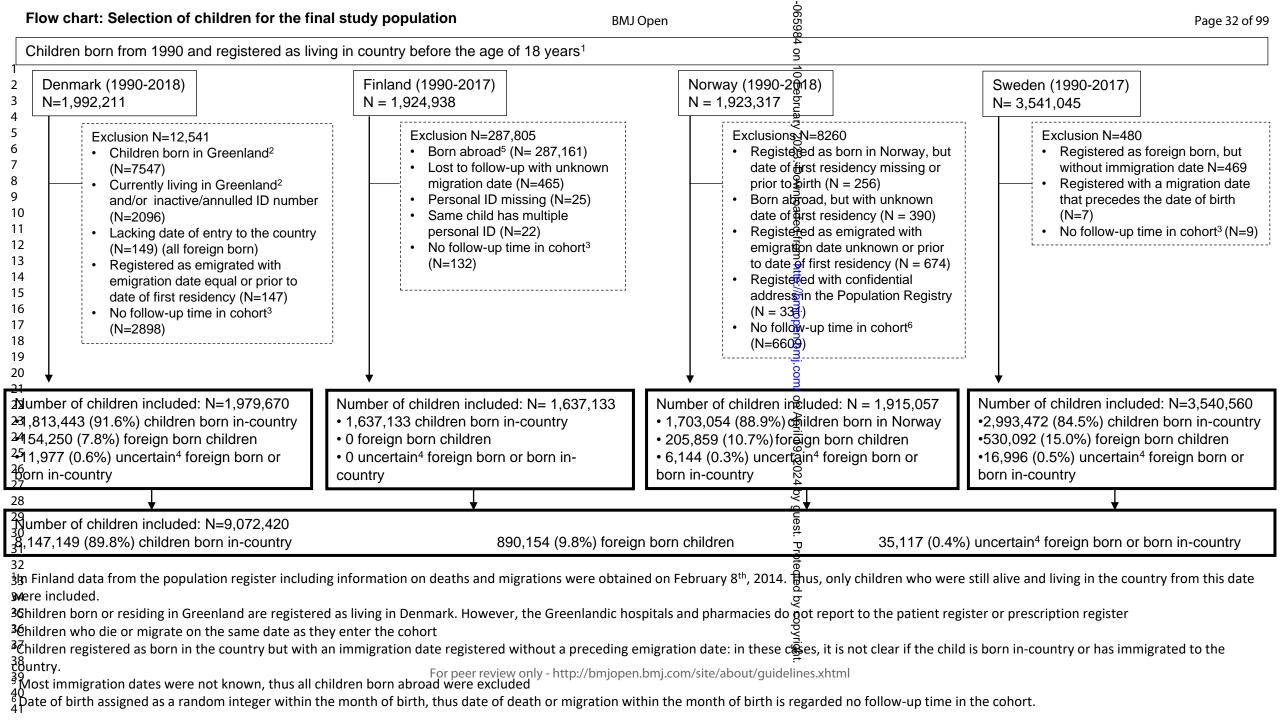
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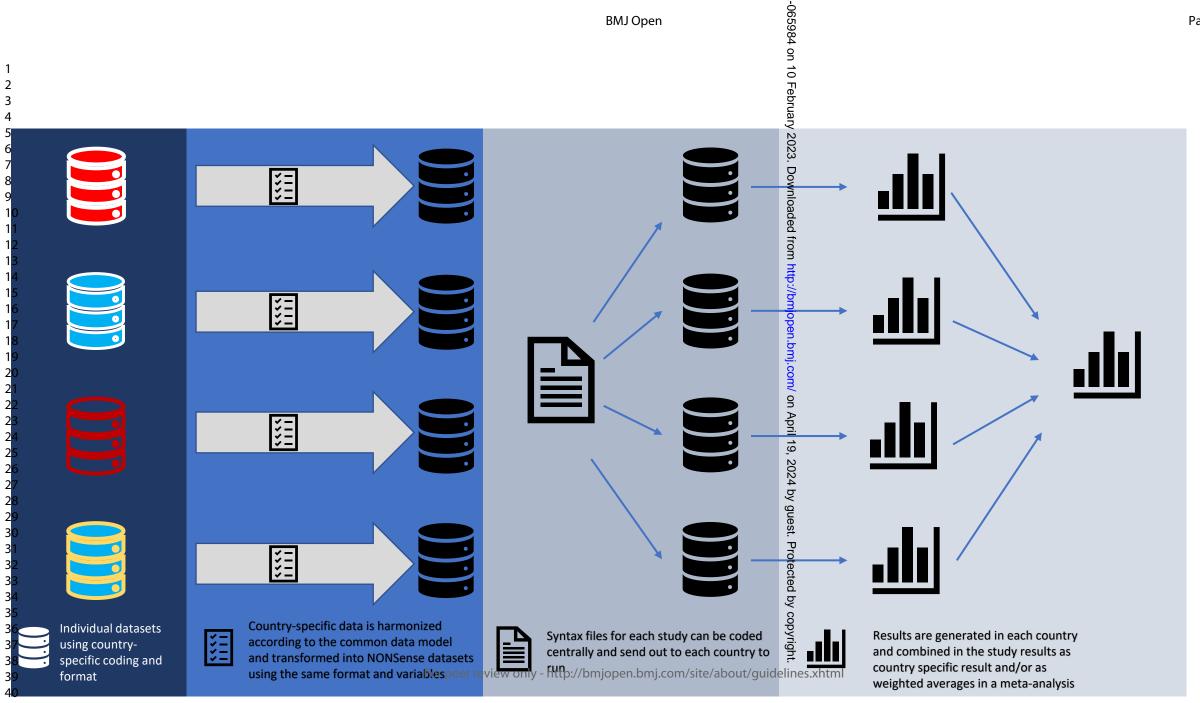
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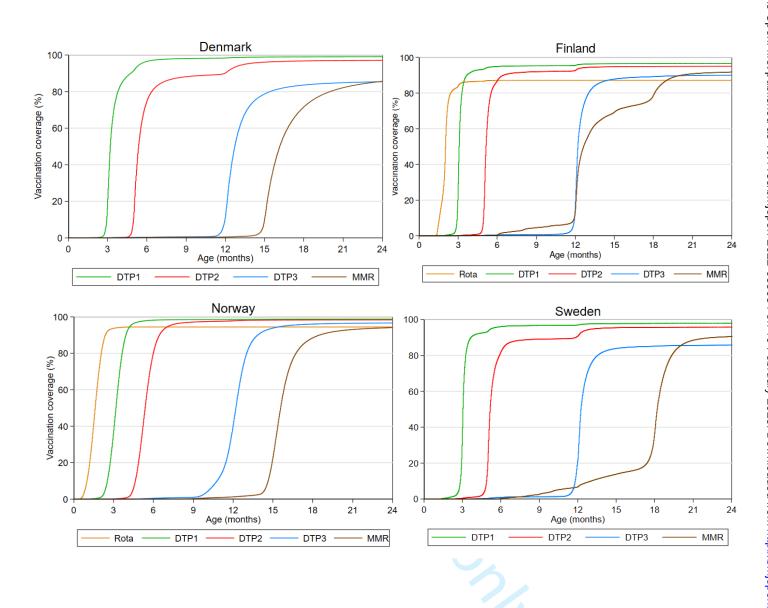
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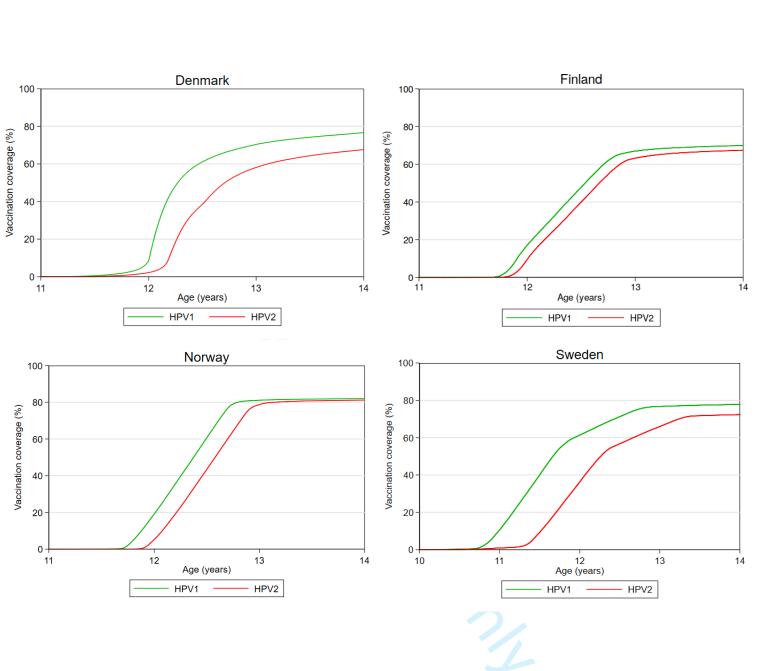
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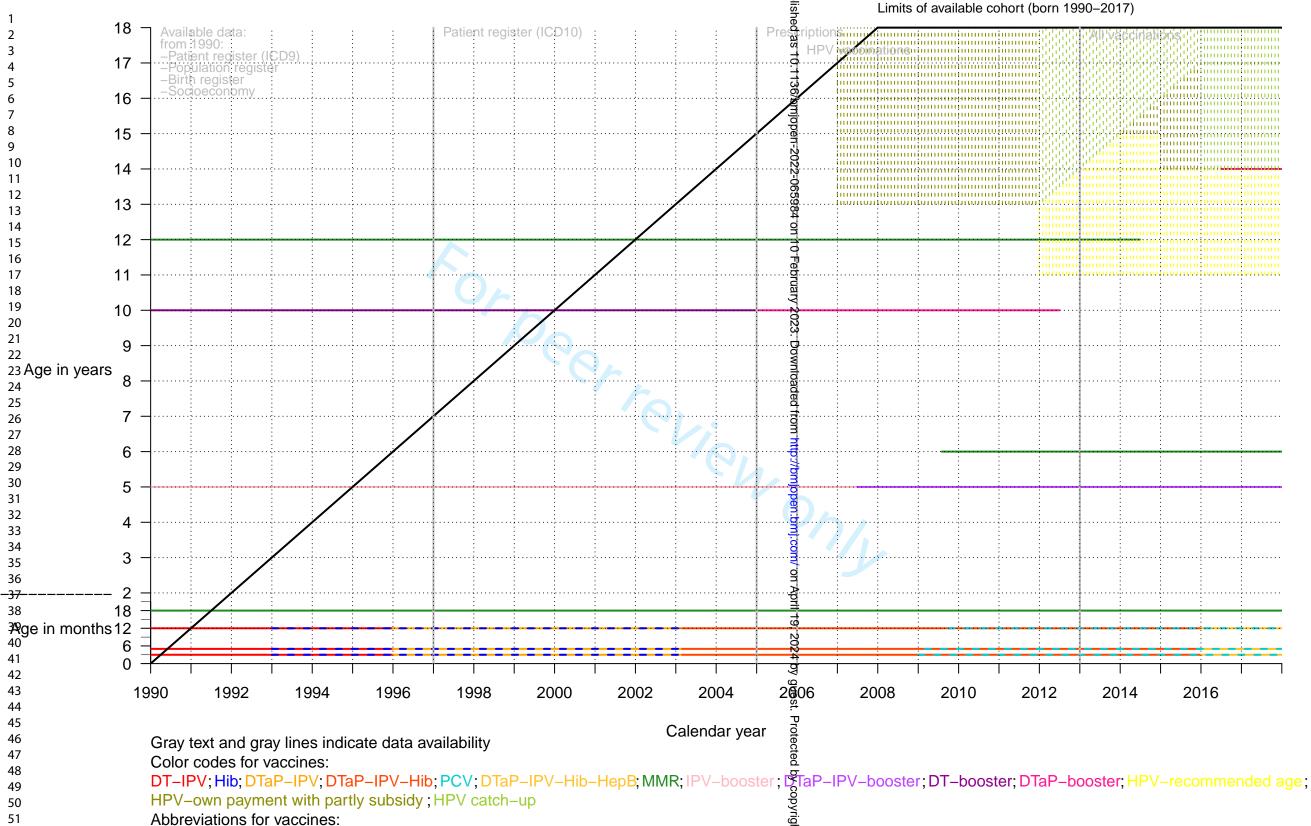






Non-live vaccines: D=diphtheria; T=tetanus; aP=pertussis vaccine(acellular); IPV=inactivated polio vaccine; Hib=Haemophilus influenzae type b; PCV=pneumococcal conjugate vaccine; TIV=trivalent influenza vaccine; HPV=Human papilloma virus
Live vaccines: BCG=Bacille Calmette-Guerin; RV=Rotavirus; MMR=measles-mumps-rubella; V=varicella; LAIV=live attenuated influenza vaccine

Non-live vaccines: D=diphtheria; T=tetanus; wP=whole-cell pertussis vaccine; Hib=Haemophilus influenzae type b;aP=pertussis vaccine(acellula IPV=inactivated polio vaccine; PCV=pneumococcal conjugate vaccine; HepB=Hepatitis B; HPV=Human papilloma virus Live vaccines: RV=Rotavirus; MMR=measles-mumps-rubella; BCG=Bacille Calmette-Guerin



Non-live vaccines: D=diphtheria; T=tetanus; aP=pertussis vaccine(acellular); IPV=inactivated polio vaccine; Hib=Haemophilus influenzae type b;

PCV=pneumococcal conjugate vaccine; HepB=Hepatitis B; HPV=Human papilloma virus

Live vaccines: MMR=measles-mumps-rubella

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NONSense Common Data Model

Nov 28th 2022

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Introduction

The Common Data Model (CDM) is a tool for documentation of data preparation and generation of uniform datasets across the Nordic countries (Denmark, Finland, Norway, and Sweden). The aim is to construct a number of uniform background datasets and event tables, which share the same name and entail the same variables, labels and values across countries. Datasets with the exact same format across Countries enables sharing of syntax-files for study analyses.

The CDM is a working document, which will be updated according to country specific data preparation, and expanded as all necessary information will be transformed into background/event tables. In the end, the background/event tables will include all necessary information to conduct all future studies (morbidity/incidence studies and vaccination studies).

The current version presents data content and preparation as per April 2022

The CDM contains 1) "Background/Event tables", and 2) "Source of data and data preparation in each country".

Background/Event tables: include information on the name of the dataset to be used by NONSEnse and format and labeling of each variable within the dataset.

Source of data in each country: includes a description of the information on the source register, and source variables, which have been used to generate the variables in the background/event tables. These tables furthermore entail information on important notes (i.e data breaks, limitations such as i.e. restricted information on redeemed prescriptions in Finland) and data preparation (how have the source variables been modified to generate the variables in the background/event tables). The tables on source of data in each country have been filled in by the individual countries following country specific data preparation.

Background/Event tables

Table: prescriptions

Description: Table of all redeemed prescriptions (included atc codes in each country is listed in

"source of data and datapreparation") among individuals in the study population.

Structure: 1 observation (line) for every redeemed pharmaceutical.

Variables:

Variable	Label	values
id	Personal id of the child	string
b_date	Birthdate of the child	Date Format (%dD_m_Y)
sex	Sex of the child as recorded in the	1="male"
	dataset	2="female"
redeemdate	Date of redeeming the	Date Format (%dD_m_Y)
	prescription	
atc	Full atc code for the redeemed	String (7 digits) use capital
+	drug	letters i.e "J01AA01"

Table: hospital_contacts

Description: Table of all diagnoses (both main diagnosis and all other diagnoses) for somatic patients including information on sex and date of birth for all children in the study population. Note that a patient can have multiple diagnoses attached to the same contact.

Structure: 1 observation (line) for each diagnosis received

Variables:

Variable	label	values
id	Personal id of the child	String
b_date	Birthdate of the child	Date Format (%dD_m_Y)
sex	Sex of the child as recorded in the	1="male"
	dataset	2="female"
adm_date	Date of admission	Date Format (%dD_m_Y)
discharge_date	Date of discharge	Date Format (%dD_m_Y)
diag	ICD diagnosis code	String (For ICD-10 codes use
		max 4 digits e.g. A063)
diagtype	Type of diagnosis	1="Main diagnosis"
		2="Other diagnosis"
type_contact	Type of hospital contact	Categorical:
		1="inpatient"
		2="emergency room patient"
		3="outpatient"
		4="outpatient or emergency
		room patient"

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Table: population1

Description: Background table including information follow-up for each child in the study population. The dataset only includes information on the child's first stay in the country (first in_date and first cens_date is recorded).

Structure: one line for each child

Variable	label	values
id	Personal id of the child	string
b_date	Birthdate of the child	Date Format (%dD_m_Y)
sex	Sex of the child as recorded in the	1="male"
	dataset	2="female"
origin	Born in the country or abroad	1="born in-country"
•		2="born abroad"
		9= "Unknown"
in_date	Date of entering the cohort	Date Format (%dD_m_Y)
in_reason	Reason for entering the cohort	1="birth"
		2="immigration"
cens_date	First date of censoring	Date Format (%dD_m_Y)
cens_reason	Reason for being censored	1="death"
		2="out migration"
	· O	3="other"
m_id	id of mother	string
f_id	id of father	string
m_age	Mothers age in years at time of delivery	Numeric (discrete)
m_origin	Maternal origin at birth	1="born in-country"
		2="born abroad"
	<u>_</u> .	9= "Unknown"
p origin	Paternal origin at birth	1="born in-country"
-		2="born abroad"
	7	9= "Unknown"

Table: birth characteristics

Structure: one line for each child in the study population

Personal id of the child Birthweight of child (gram) Gestational age (full weeks) Delivered by caesarean section	string Numeric Numeric (discrete) 0="not delivered by caesarean section" 1="delivered by	Legal values 100-9990
(gram) Gestational age (full weeks) Delivered by caesarean	Numeric (discrete) 0="not delivered by caesarean section" 1="delivered by	100-9990
weeks) Delivered by caesarean	0="not delivered by caesarean section" 1="delivered by	
	caesarean section" 1="delivered by	
	caesarean section" 9=" unknown"	
Maternal smoking or snuff at any point during pregnancy	0= "no" 1= "smoking (or snuff) during pregnancy" 9= "unknown"	
singleton	0="no" 1="yes" 9=" unknown"	
Child order (including the child itself)	Numeric (discrete)	
	snuff at any point during pregnancy singleton Child order (including	snuff at any point during pregnancy singleton Child order (including) 1= "smoking (or snuff) during pregnancy" 9= "unknown" 1="yes" 9=" unknown" Numeric (discrete)

Table: Vaccines

Link to Contents

Table. Vaccines		1
variable	Label	values
id	Personal id of the child	string
vacdate	Date of vaccination	Date Format (%dD_m_Y)
vaccine	Type of vaccine administered	Categorical (see coding in appendix "vaccine categorization")
credibility	Credibility indication of vaccine information	1=no duplicate 2= duplicate same vaccine removed 3=duplicate related vaccine removed (keep vaccine that aligns with vaccination schedule) 4= duplicate related vaccine removed (none of the vaccines align with vaccination schedule) 5= duplicate related vaccine removed (vaccines given outside the vaccination schedule)
TB_endemic	Vaccine recommendations in accordance with connections to TB endemic countries	0=not risk group 1=risk group 9=not relevant
HepB_endemic	Vaccination recommendations in accordance with connections to HepB endemic countries	0=not risk group 1=risk group 9=not relevant

Prioritization for duplicate selection:

- Remove same vaccines (variable name: "vaccine", see appendix "vaccine categorization") given 14 days or less after the previous vaccine for the same child (if DTP is registered on day 0, 10 and 20, only remove the vaccine registered at day 10) – keep the earliest registration
 - i. Credibility=2
- 2. Remove vaccines from the same type of vaccines (variable name: "type" see appendix "vaccine categorization") given 14 days or less after the previous vaccine of the same type. Register vaccine as given on the earliest date within the duplicate combination prioritize within combinations:
 - a. Keep vaccine that aligns with vaccination schedule according to **age** and **year of vaccination**
 - i. Credibility =3
 - b. If no vaccine aligns with vaccination schedule but type and age correspond to timing of childhood vaccinations keep the vaccine that protects against most conditions
 - i. Credibility=4
 - c. If vaccines are given outside ages for recommended vaccination according to the vaccination program keep the vaccine that protects against most conditions
 - i. Credibility=5

Table: socio economy

Assign information to all children in the study population. If a child has no registrations in the socio economic datasets variables should be coded as 9 or 99="unknown" as described in the table below.

Overall note on timing of information:

Variables ending with "_b" indicate that information is from birth of the child. Depending on the set up of the register information we will use the date or year of birth to obtain the information. If information is not available for the date or year of birth, we will use information from the year after.

Variables ending with "_10y" indicate that information is from the year/date the child turns 10 years. Depending on the set up of the register information we will use the date or year of turning 10 years to obtain the information.

variable	Label	values	Legal values	Notes
id	Personal id of the child	string		
inc_quin_b	Household income quintile at year of birth of the child	1=first (lowest) 2=second 3= third 4= fourth 5= fifth (highest) 9="unknown"		Quintiles are calculated stratified on year (i.e., calculation of quintiles are done separately for each calendar year. If several income variables are available, selection is based on this priority: 1: equated disposable household/family income; 2: disposable household/family income; 3:household/family income; 4: maternal disposable income; 5: maternal income.
inc_quin_10y	Household income quintile at the year of the child's 10 th birthday	1=first (lowest) 2=second 3= third 4= fourth 5= fifth (highest) 9="unknown"		See notes under inc_quin_b
inc_quin_m_b	Maternal income quintile at year of birth of the child	1=first (lowest) 2=second 3= third 4= fourth		See notes under inc_quin_b

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		5= fifth (highest) 9="unknown"		
inc_quin_m_10y	Maternal income quintile at the year of the child's 10 th birthday	1=first (lowest) 2=second 3= third 4= fourth 5= fifth (highest) 9="unknown"		See notes under inc_quin_b
n_children_b	Number of children below 18 years in the household including the child itself at year of birth of the child	Numeric discrete 99="unknown"	>=1	
n_children_10y	Number of children below 18 years in the household including the child itself at the year of the child's 10 th birthday	Numeric discrete 99="unknown"	>=1	
single_parent_b	Single parenthood at year of birth of the child	0=No 1=Yes 9="unknown"		
single_parent_10y	Single parenthood at the year of the child's 10 th birthday	0=No 1=Yes 9="unknown"		
m_education_b	Maternal highest attained education at year of birth of the child	1=Low education (ISCED2011 level 0-2) 2=Medium education (ISCED2011 level 3-4) 3=High education (ISCED2011 level 5-8) 9="unknown"		International Standard Classification of Education (ISCED) 2011 coded into main groups. Read more in reference 1 below the table.
m_education_10y	Maternal highest attained education at	1=Low education (ISCED2011 level 0-2)		See notes under m_education_b.

Reference 1 for ISCED: https://ec.europa.eu/eurostat/statistics-explained/index.php/International Standard Classification of Education (ISCED)#Implementation of ISCED 2011 .28levels of education.29

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Source of data in each country

Table: prescriptions

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	Denmark		Finland		Norway	bruar	Sweden	
Variable	Source and description	Important notes and data preparation	Source and description	Important notes and data preparation	Source and description	Important notes and data of preparation	Source and description	Important notes and data preparation
Ď	Original name in the Danish data: "pnr". Pseudonomised unique personal identification number for linkage between registers, created by Statistics Denmark. It is linkable (by Statistics Denmark) to the original personal identification number (CPR number) assigned to all Danish residents and used when reporting to all national registers.	Renamed from "pnr"	Obtained from KELA Register: "KELA etuusrekisteri", Table: "Lääkeostot", Variable: "HETU" Register: "Kanta Reseptikeskus" Table: "KANTA:RESEPTI.LA AKETOIMITUKSET" Variable: "PATIENT_ID" THL pseudonymised the original personal identification code (in these registers HETU and PATIENT_ID) to unique personal identification number for linkage between registers. THL data management can link the id back to original personal identification code.	Statistics Finland pseudonymised HETU and PATIENT_ID	Obtained from Register: "The Norwegian Prescription Database" (NorPD) Pseudonomised unique personal identification number for linkage between registers	Renamed bom "pasient_lopenr_l db2471" db2471" db2471" adb2471" db2471"	Created by Statistics Sweden Pseudonomise d unique personal identification number for linkage between registers	Renamed from lopnr

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			E	BMJ Open		omjopen-2022		Page 5
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b_date	Obtained from the Danish National Health Data Agency. Register: "CPR- Registret" Table: "t_person" Variable: "d_foddato"	Renamed from "d_foddato"	Obtained from KELA Obtained from KELA Register: "KELA etuusrekisteri", Table:"Lääkeostot", Variable: "HETU" Register: "Kanta Reseptikeskus" Table: "KANTA:RESEPTI.LA AKETOIMITUKSET" Variable: "PATIENT_ID"	Extracted from "HETU" before pseudonymisatio n was done. Extracted from "PATIENT_ID" before pseudonymisatio n was done.	Obtained from The National Population Register	We have received information on month and year of birth, but not day. For each individual, be have therefore generated and length of their month of both. Using this wandom integer as day of birth, ever one is assigned an exact	Obtained from Statistics Sweden Register: "Register över totalbefolkning en, RTB" Variable: "fodddatum"	Renamed from fodddatum
×es	Obtained from the Danish National Health Data Agency. Register: "CPR- Registret" Table: "t_person" Variable: "C_KON" Sex as recorded by personal identification number.	sex=1 "male" if C_KON is "M" sex=2 "female" if C_KON is "K"	Obtained from KELA Register: "KELA etuusrekisteri", Table: "Lääkeostot", Variable: "HETU" Register: "Kanta Reseptikeskus" Table: "KANTA:RESEPTI.LA AKETOIMITUKSET" Variable: "PATIENT ID"	Extracted from "HETU" and "PATIENT_ID" before pseudonymisatio n was done. sex=1 "male" sex=2 "female"	Obtained from The National Population Register.	Birth date. On Renamed from http://bmjopen.bmj.c	Obtained from Statistics Sweden Register: "RTB" Variable: "kon"	Renamed from "kon"
redeemdate	Obtained from Statistics Denmark. Register: "Lægemiddeldatabasen" Variable: "EKSD" Date of redeeming the prescription	Renamed from "EKSD"	Obtained from KELA Register: "KELA etuusrekisteri", Table:"Lääkeostot", Variable: "OSTOPV" Register: "Kanta Reseptikeskus" Table: "KANTA:RESEPTI.LA AKETOIMITUKSET" Variable: "CREATION_DATE" Date of redeeming the prescription	Renamed from "OSTOPV" Renamed from "CREATION_DA TE"	Obtained from Register: "NorPD" Variable: "UtleveringsDato" Date of redeeming the prescription	Renamed from "Utleverings Dato" April 19, 2024 by guest. Pro	Obtained from Socialstyrelse n Register: "Läkemedelsre gisteret" Variable: "edatum"	Renamed from "edatum". (Date of redeeming the prescription)
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All prescriptions

D07, D11AH, J,

R01, R03, R06,

with ATC groups

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	Obtained from statistics
	Denmark.
	Register:
	"Lægemiddeldatabasen"
	Variable: "ATC"

ATC code of purchased

drug

All prescriptions with ATC group D,
J, R, S and V01,
including all sublevels.
Renamed from "ATC"
AIC

Obtained from KELA Register: "KELA etuusrekisteri" Table:" Lääkeostot" Variable: "ATC"

Register: "Kanta Reseptikeskus" Table: "KANTA:RESEPTI.LA AKETOIMITUKSET" Variable: "ATC CODE"

S01G, S03 and V01, including all sublevels. V01 only from KELA data. In Korvattavat lääkkeet only reimbursable products. Reimbursement Variable: "ATCKode" ATC code of purchased drug

Obtained from

Register: "NorPD"

All prescri∰ons with ATC group D, J, R, S and V01, including all sublevels ⊃ Renamed #pm "ATCKode"

Obtained from ATC code of purchased Socialstyrelse Register: "Läkemedelsre gisteret" Variable: "atc"

drug. The data from Sweden included all prescriptions within ATC groups D, J, R, S and V01, including all sublevels

atc

ATC code of purchased drug

of antibiotics: < 2006 no reimbursement if cheap 2006-2012: all antibiotics were reimbursed >2012: individual

> reimbursed" **Duplicates** removed: if same purchase (same id, redeemdate and atc) was found from both registers only

one of them was

included in the

data.

products not

ebruary 2023. Downloaded from http://bmjopen.bmj.com/ on April 19,

2024 by guest. Protected by copyright

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Table: hospital_contacts

	Denmark		Finland		Norway	5984	Sweden	
Variable	Source and Description	Important notes and data preparation	Source and Description	Important notes and data preparation	Source and Description	Important notes and data preparation	Source and Description	Important notes and data preparation
						February 202	In the original Swe admission date is diagnoses and oth one line. The data	edish register data, each a separate line with all her information included in set has been reshaped to he line for each diagnosis
Þį	Original name in the Danish data: "pnr". Pseudonomised unique personal identification number for linkage between registers, created by Statistics Denmark. It is linkable (by Statistics Denmark) to the original personal identification number (CPR number) assigned to all Danish residents and used when reporting to all national registers.	Renamed from "pnr"	Obtained from THL Register: "the Finnish National Patient Register THL=Hilmo" Table: "Perustiedot/Asiak as, potilas" Variable: "HT" THL pseudonymised the original personal identification code (in this register HT) to unique personal identification number for linkage between registers. THL data management can link the id back to original personal identification code.	Statistics Finland pseudonymised HT with their own id for the remote user system.	Obtained from the Norwegian National Patient Register	19, 2024	Created by Statistics Sweden Pseudonomised unique personal identification number for linkage between registers	Renamed from "lopnr"
						oy guest. Protec		
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b_date	Obtained from the Danish National Health Data Agency. Register: "CPR-Registret" Table: "t_person" Variable: "d_foddato"	Renamed from "d_foddato"	Obtained from THL Register: "Hilmo" Table: "" Variable: "SYNTAIKA"	Renamed from "SYNTAIKA"	Obtained from The National Population Register	We have recipived information on month and year of lighth, but not day. For each individual, we have therefore generated a random integer as day of birth. Using this random integer as day of birth, everyone is signed an exact birthedate.	Obtained from Statistics Sweden Register: "RTB" Variable: "fodddatum"	Renamed from "fodddatum"
sex	Obtained from the Danish National Health Data Agency. Register: "CPR-Registret" Table: "t_person" Variable: "C_KON" Sex as recorded by personal identification number.	sex=1 "male" if C_KON is "M" sex=2 "female" if C_KON is "K"	Obtained from THL Register: "Hilmo" Table: "Perustiedot/Asiak as, potilas" Variable: "SP"	Renamed from "SP"	Obtained from The National Population Register Variable: "kjonn"	Renamed freeownloaded from http://bmjoper	Obtained from Statistics Sweden Register: "RTB" Variable: "kon"	Renamed from "kon" Note: There were some discrepancies regarding sex in the two registries (RTB and Patientregistret), circa 1100 cases regarding inpatients and circa 2900 regarding outpatients. We used the information from Statistics Sweden.

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adm_date ot all a superior of the superior of	Obtained from the Danish National Health Data Agency. Register: Danish national patient registry Table: T_ADM Variable: D_INDDTO	Renamed from "D_INDDTO" For outpatient contacts with multiple visits adm_date is recoded according to the date of visit ("D_AMBDTO" from the table "t_bes")	Obtained from THL Register: "Hilmo" Table: "Tulotiedot" Variable: ""TUPVA"	Extracted from "TUPVA" which contain the date and time of arrival Extracted from "LPVM" which contain the date	Obtained from Register: Norwegian National Patient Register Variable: "innDato"	(022-655984 on 10 February 2023. Downloaded from http://bmjopen.bmj.com/ on A Renandation of the state of the	Obtained from Socialstyrelsen Register: "Patientregistere t" Variable: "INDATUM"	Renamed from "INDATUM". Inpatient visits: - Date missing (n=6); left unchanged. - Date registered as earlier than birth (n=103); dropped observations if both date of admission and discharge came before birth (n=8), replaced date of admission with date of birth if less than 15 days apart (n=68), replaced month or year, to align with date of discharge (n=29). - Date registered as later than discharge but not missing (n=11); adm_date and discharge_date were shifted. Outpatient visits: - Date missing (n=1,253); left unchanged
discharge_date	Obtained from the Danish National Health Data Agency. Register: Danish national patient registry Table: T_ADM Variable: D_UDDTO	Renamed from "D_UDDTO" For contacts without a discharge date (N=1080) the discharge date is set as the last observed discharge date in the dataset+1day (11May2018) For outpatient contacts, discharge date is recoded to be the same date as "adm_date".	Obtained from THL Register: "Hilmo" Table: "Poistumistiedot" Variable: "LPVM"	Extracted from "LPVM" which contain the date and time of discharge	Obtained from Register: "Norwegian National Patient Register" Variable: "utDato"	Renamed frem "utDato". The data set only includes admissions that have ended, i.e. utDato before Dec 3, 2018. 75 contacts ad missing utD 2. These were either outpatient contacts (n=6) or daycare produres (n=6). utDate was defined inn at these cases	Obtained from Socialstyrelsen Register: "Patientregistere t" Variable: ""UTDATUM"	For inpatient visits, the variable was renamed from "UTDATUM". For outpatient visits, there was no corresponding variable, and the discharge date was therefore created to be equal to the admission date.

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diag	Obtained from the Danish National Health Data Agency. Register: Danish national patient registry Table: T_DIAG Variable: C_DIAG	Renamed from "C_DIAG" Diagnosis coded as ICD 8 until December 31 1994, hereafter coded using ICD 10. Danish specification letters to the ICD-10 codes removed and the administrative letter "D" in front of all codes removed: Values changed to string4 format (i.e DA011a→A011) Diagnoses other than the main or other diagnoses are excluded. Diagnoses with modifications indicating that the diagnosis cannot be validated are excluded (c_diagmod==1 2). Renamed from variable	Obtained from THL Register: "Hilmo" Table: "Hoitotiedot" Variable: "PDGO, PDGE, SDGO, SDGE"	Renamed from PDGO, PDGE, SDGO, SDGE ICD-codes ICD-codes V01-Y98 not available, codes O00-O99 were not analysed	Obtained from Register: "Norwegian National Patient Register"	Original dataset has one record for each hospital consect with variables hovedtilstand 1, hovedtilstand 2, bitilstand 199 hat contain ICD 20 diagnosis codes. The variables were renamed diagnosis with the 2 primary diagnoses. The dataset was beshaped to long formation one observation per diagnosis with variables diagnosis with variables diagnosis with variables diagnosis diagnosis and d	Obtained from Socialstyrelsen Register: "Patientregistere t" Variables: "HDIA" and "DIAGNOS1_30"	The variable "DIAGNOS1_30" can contain up to 30 different diagnoses. It was therefore split to create separate variables for each sequential diagnosis. Duplicate codes within each observation and the code _atc were removed.
diagtype	the Danish National Health Data Agency. Register: Danish national patient registry Table: T_DIAG Variable: C_DIAGTYPE	"C_DIAGTYPE" Recoded: C_DIAGTYPE: "A"= "main diagnosis" C_DIAGTYPE: "B"= "other diagnosis" A patient can have multiple other diagnoses for the same contact. Excluding diagnoses other than main or other (i.e temporary diagnoses or additional diagnosis ("tillægsdiagnose").	THL Register: "Hilmo" Table: "Hoitotiedot" Variable: "PDGO, PDGE, SDGO, SDGE"	PDGO and PDGE 2=add diagnosis: SDGO and SDGE	40,	diag_ind = 13pr diag_ind = 20 diagtype = 29f diag_ind > 20 April 19, 2024 by gu	socialstyrelsen Register: "Patientregistere t" Variables: "HDIA" and "DIAGNOS1_30"	Jagnybe was coded as 1="Main diagnosis" if indicated in variable "HDIA". If no main diagnosis was listed in variable HDIA, the first diagnosis within variable "DIAGNOS1_30" was chosen as the main diagnosis. Other diagnoses listed within DIAGNOS1_30 were coded as 2="Other diagnosis".
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Obtained from the Danish National Health Data Agency. Register: Danish national patient registry Table: T_DIAG and t_bes Variables: C_PATTYPE, D_AMBDTO	Renamed variable "C_PATTYPE" Recoded: type_contact=1 "inpatient" if C_PATTYPE is "0" (inpatient) or "1" (Before year 2002 some patients were coded as "1= deldøgnspatienter" (*part day patient) type_contact=2 "emergency room contact" if C_PATTYPE is 3 "emergency room contact". Outpatient contacts (C_PATTYPE=2) admitted after year 2014 with "C_INDM"= "Acute" are coded as type_contact=2 "emergency room patient" type_contact=2 "emergency room contact" if C_PATTYPE=2 before year 2014 or C_PATTYPE=2 before year 2014 or C_PATTYPE=2 and c_indm is not 1 from and including year 2014 In Denmark we have some long outpatient contacts with multiple visit dates (D_AMBDTO) during the contact. Each visit date is coded as an independent outpatient contact. All diagnoses within the original outpatient contact is recorded for each visit.	Obtained from THL Register: "Hilmo" Table: "Perustiedot/Hoitoj akso tai avohoitokäynti" Variable: "PALA" and "EA"	All visits with EA = 98 were omitted (EA= special branches of medicine, 98=general practice) - type_contact = 1, if PALA = 1 or PALA = 6 (inpatient) - type_contact = 2, if PALA = 91 (emergency) - type_contact = 3, if PALA is not 1, 6 or 91 (outpatient, not emergency) PALA: 1 = inpatient ward, 6 = rehabilitation ward 91 = emergency room visit	Obtained from Register: "Norwegian National Patient Register" Variable: ""	Based on the variables on Behandlings ava3 and Aktivitetskategori3: For contacts with utDato in 2063-2014: IF Behanglings iva3 = 1 OR	Obtained from Socialstyrelsen Register: "Patientregistere t"	Variable coded based on which source file the data came from: in- or outpatient data. All data in the outpatient-file was coded = 4, as emergency room visits could not be distinguished. (A variable for emergency room visits [VERKS_AKUT] was only included in the patient registry in 2016 and therefore not part of our data request.).

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able: ¡	population1					·065		
	Denmark		Finland		Norway	984	Sweden	
Variable	Source and Description Original name in the Danish data: "pnr". Pseudonomised unique personal identification number for	Important notes and data preparation Renamed from "pnr"	Source and Description Obtained from: Register: Population register Table: VTJ.HENKILO Variable: hetu	Important notes and data preparation Person included only if hetu_voimassa (=id is valid) is checked. Statistics Finland pseudonymised "hetu" with their own id for the	Source and Description Obtained from: SSB (Statistics Norway) Register: "National Population Register"	Important notes and data preparation. Renamed from pasientlopenr dbb247	Sweden Register: Registret över totalbefolkning en (RTB)	Important notes and data preparation Pseudonomised unique personal identification number for linkage between registers Renamed from "lopnr".
Þ	linkage between registers, created by Statistics Denmark. It is linkable (by Statistics Denmark) to the original personal identification number (CPR number) assigned to all Danish residents and used when reporting to all national registers.		Table: VTJ.HENKILO_HE TU Variable: hetu_voimassa THL pseudonymised the original personal identification code (in this register "hetu") to unique personal identification number for linkage between registers. THL data management can link the id back to original personal identification code.	remote user system.	40	uary 2023. Downloaded from http://bmjopen.bmj.com/ on Apr	Variable: lopnr	
b_date	Obtained from the Danish National Health Data Agency. Register: "CPR- Registret" Table: "t_person" Variable: "d_foddato"	Renamed from "d_foddato"	Obtained from: Register: Population register Table:VTJ.HENKI LO Variable: syntymapaiva	Renamed from syntymapaiva	Obtained from: SSB (Statistics Norway) Register: "National Population Register"	For all individuals in population 1 as well as their parents, we have received information or month and year of birth but not day. For each individual, we have therefore generated a random integer between 1 and length of their month of birth. Using this random integer as day of birth, everyone assigned an exact birth	Registret över totalbefolkning en (RTB) Variable: fodddatum	Renamed from "fodddatum"
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sex	Obtained from the Danish National Health Data Agency. Register: "CPR-Registret" Table: "t_person" Variable: "C_KON" Sex as recorded by personal identification number.	sex=1 "male" if C_KON is "M" sex=2 "female" if C_KON is "K"	Obtained from: Register: Population register Table: VTJ.HENKILO Variable: sukupuoli	sex=1 "male" if lapsen sukupuoli is "mies" sex=2 "female" if lapsen sukupuoli is "nainen"	"National Population Register"	Renamed from 10 February 2023.	Obtained from Statistics Sweden Register: Registret över totalbefolkning en (RTB) Variable: kon	Renamed from "kon"
	TIMILIDES.		TO CC	1000		Downloaded from http://bmjopen.bmj.com/ on April 19, 2024 by gue		
						gue		

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	Obtained from	Children are categorised	Obtained from:	1 = born in country,	Obtained from:	Based on the Rigidal Prize	Obtained from	Recoded from:
	the Danish	as:	Register:	if the code of	SSB (Statistics	in date (see below) and	Statistics	"UtlSvBakg" where
	National Health	1="born in-country" if	Population register	syntymakunta (birth	Norway)	"fodeland". Ori gi n is	Sweden	11 = Born abroad
	Data Agency.	fodested kode=000 or	Table:VTJ.HENKI	municipality is not 200 or	Register:	coded as 1 if country of	Register:	12 = Born in the country
	Register: "CPR-	208 (Denmark),	LO	NA (not available)	"National	birth is Norway⊅	Registret över	with two foreign-born
	Registeret"	2= "foreign born" if	Variable:	2 = born abroad,	Population	(fodeland = 0) and	totalbefolkning	parents
	Table:	fodested_kode is not	"syntymakunta"	if syntymakunta is 200	Register"	in date is equa l lto date	en (RTB)	21 = Born in the country
	"T FODESTED"	000 or 208		3 = uncertain foreign or	3	of birth. Origin∯s coded	Variable:	with one native and one
	Variables:	9="unknown" if		in-country, if		as 2 if country a f birth is	UtlSvBakg	foreign born parent
	"fodested kode",	fodested kode=000 or		syntymakunta is NA,		any other cour ₩ ry. Origin	· ·	22 = Born in the country
	"fodested tekst"	208 (Denmark) and if		198,199 or 000		is coded as 9 if country	Combined with	with two native born
	_	there is date of		(children born abroad		of birth is Norveay and	data from the	parents.
		inmigration not preceded		were excluded as only		in_date is lateruthan date	National Board	
	Variables from	by an outmigration (In		minority of them had		of birth.	of Health and	Individuals were coded
	table:	this case we cannot be		immigration dates		O _W	Welfare	1 = "born in-country", if
	population1;	certain that the child is		available in the THL's		<u>p</u>	Register:	UtlSvBakg = 12, 21 or 22,
	in_date,	born in Denmark as it		population register copy,		oa oa	Medical Birth	and 2 = "born abroad", if
	cens_date are	appears to have		in which the follow-up		l d e	Registry	UtlSvBakg = 11.
\Box	used to define if	migrated to Denmark		begin in 2014, also		<u>a</u>		
igi	there is	after the date of birth)		children with uncertain		Ō		Individuals were coded 9 =
origin	uncertain origin			origin were excluded)		3		"Unknown" if registered as
				/		h #		born in country (UtlSvBakg
						Ď.		= 12, 21 or 22) but also
						/b		had a registered
				10.		<u>.</u>		immigration date not
						용		preceded by an emigration date. (In this case we
						en		cannot be certain that the
						<u>.</u>		child was born in the
						ļ 후.		country as it appeared that
						8		they have immigrated after
				tevie		Ď		the date of birth.)
						0		the date of birth.)
						7,		If the individual was
						Į į		initially coded as 9
						Downloaded from http://bmjopen.bmj.com/ on April 19,		"Unknown", but was
						9,		registered in the medical
						20		birth registry, they were
						2024		recoded as 1 = "born in-
						4 5		country".
								Country .

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Obtained from the Danish National Health Data Agency. Register: "CPR-Registeret" Table: "T_FODESTED" Variables: "D_FODDATO" Table: "T_ADRESSE_U DLAND_HIST" Variables: "C_ANNKOR", "D_INDREJSE_DATO" Table: "T_ARKIV_ADRE SSE_UDLAND_HIST" Variables: "C_ANNKOR", "D_INDREJSE_DATO" Obtained from NONSense CDM Table: Population1 Variable: "origin", "cens_date"	in_date is defined as date of birth "D_FODDATO" if "origin" is 1="born in-country" . in_date is defined as the first date of in-migration "D_INDREJSE_DATO" if origin is not 1="born in-country".	Obtained from: Register: Population register Table:VTJ.HENKI LO Variable: "syntymapaiva" and	If born in country (origin=1), equal to the date of birth = syntymapaiva	Obtained from: SSB (Statistics Norway) Register: "National Population Register"	Based on the Griables "regstatus", "O" "regstatusdato" and "forstdato" and "fodeland". Indate is defined as forst date of first registration in the Population Red stry. The variable is only defined for persons with invitate is defined as a person's earliest regstatus of the Rosatt). In general, individuals who have been residented in Norway since birth, will be registered with regstatus of birth. However registratus is only available as on an analy 1 each year. It is person's regstatus as changed more than once during a galendar year, we only have information about the most recent change. Therefore, in Gate was set to date of both for individuals with country of birth Norway who died or emigrated in their year of birth each year. It is person's regstatus is only available as of both for individuals with country of birth Norway who died or emigrated in their year of birth each if they do not have a geoord with regstatus and regstatusdato of birth. Norway who died or emigrated in their year of birth each if they do not have a geoord with regstatus and regstatusdato of birth. Norway who died or emigrated in their year of birth each if they do not have a geoord with regstatus and registry, and > 98% of children with country of birth with country of birth with country of birth with country of birth country of bi	Variable created based on information from Statistics Sweden Register: Registret över totalbefolkning en (RTB) Variables: fodddatum and datum [migration], posttyp [migration]	If born in country (origin=1), equal to the date of birth = fodddatum If born outside the country (origin=2), equal to first date of immigration If unknown origin (=9), equal to first date of immigration
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						Norway who ded or emigrated in the irrepresentation of birth have accord in the Birth Registry. Thus, it is a reasonable assumption that these children have been residents of Neway since birth.		
in_reason	Obtained from the Danish National Health Data Agency. Register: "CPR-Registeret" Table: "T_FODESTED" Variables: "D_FODDATO" Table: "T_ADRESSE_U DLAND_HIST" Variables: "C_ANNKOR", "D_INDREJSE_DATO" Table: "T_ARKIV_ADRE SSE_UDLAND_HIST" Variables: "C_ANNKOR", "D_INDREJSE_DATO" Obtained from NONSense CDM Table: Population1 Variable: "in_dat e"	in_reason is categorised as: 1="birth" if in_date is obtained from "D_FODDATO" 2="immigration" if in_date is obtained from D_INDREJSE_DATO	Obtained from: Register: Population register Table:VTJ.HENKI LO Variable: "syntymapaiva"	1 = Birth, if born in the country (origin=1)	Obtained from: SSB (Statistics Norway) Register: "National Population RegisterBefolk ning	in_reason is coded as 1 if origin = 1. in season is coded as 2 if coorigin = 2 or origin = 9.	Variable created based on information from Statistics Sweden Register: Registret över totalbefolkning en (RTB) Variables: foddatum, datum, posttyp	1 = Birth, if born in the country (origin=1) 2 = Immigration, if born abroad (origin=2) or unknown origin (origin=9)
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	Obtained from	Cens_date is defined as	Obtained from:	Equal to date of	Obtained from:	Based on the 🛱 riables	Variable	Equal to date of
	the Danish	the first date of either	Register:	emigration, if such has	SSB (Statistics	"regstatus", ເວ	created based	emigration, if such an
	National Health	1)"D_STATUS_HEN_ST	Population register	occurred, otherwise	Norway)	"regstatusdatoర్హ్ and	on information	event had been registered,
	Data Agency.	ART" if "C_STATUS" is	Table:	equal to date of death.	Register:	"dodsdato". Dਕ੍ਰੀe of	from Statistics	otherwise equal to date of
	Register: "CPR-	"90"=death, "20"=CPR	VTJ.HENKILO		"National	emigration waജdefined	Sweden	death.
	Registret"	number for tax	Variable:	Emigration from	Population	as a person's earliest	Register:	
	Table:	purposes,	"KUOLINPVM"	Population register	RegisterBefolk	regstatusdato w ith	Registret över	
	"t_person"	"70"=disappearing,	and	(select min	ning	regstatus = 3 ₾	totalbefolkning	
	Variables:	"80"=out-migration or 2)	Register: Statistic	(kunta_muuttopvm) from		(emigration). Date of	en (RTB)	
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	N_START",	3)	Table:	oria and kunta='200')		dodsdato. We only have	Doddatum,	
	"C_STATUS"	D_FORSVIND_DATO.	Variable:	·		information on∰nonth	datum	
Φ.			"kuolinpäivä"	Ensimmäinen		and year of death. Exact	[migration],	
date	Table: "		Variable:	maastamuuttopäivä=first		date of date w as	posttyp	
ام	T_ADRESSE_U		ensimmäinen	emigration date		assigned as a g andom	[migration]	
တ္ဆ'	DLAND_HIST "		maastamuuttopäiv	available only in remote		integrer within <u>∄</u> he month		
cens	Variables:		ä	user system Fiona		of death.		
Ö	"C_ANNKOR",					cens_date wa § set to		
	"D_UDREJSE_		Table:			date of emigra∰on if		
	DATO"		VTJ.HENKILO			emigration occarred		
			Table:			before date of ∄8th		
	Table: "		KOTIKUNTAHIST	1		birthday or Janwary 1,		
	T_FORSVIND_		ORIA: Variable:			2019. cens_date was		
	HIST"		"kotikunta" and			set to date of death if		
	Variables:		"kunta			death occurred before		
	"C_ANNKOR",		muuttopaiva"			date of 18th bidhday or		
	"D_FORSVIND_					January 1, 2016, unless		
	DATO"					date of death was		
						preceded by date of		
						emigration (N = 40).		
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				13		
Obtained from the Danish National Health Data Agency. Register: "CPR-Registret" Table: "t_person" Variables: "D_STATUS_HE N_START", "C_STATUS" Table: "T_ADRESSE_U DLAND_HIST" Variables: "C_ANNKOR", "D_UDREJSE_DATO" Table: "T_FORSVIND_HIST" Variables: "C_ANNKOR", "D_UDREJSE_DATO" Table: "T_FORSVIND_HIST" Variables: "C_ANNKOR", "D_FORSVIND_HIST" Variables: "C_ANNKOR", "D_FORSVIND_DATO" Obtained from categorized as: 1= "death" if cer is obtained from C_STATUS="20" (outmigration) of D_UDREJSE_DATO" (outmigration) of D_UDREJSE_DATO" (outmigration) of D_UDREJSE_DATO" (outmigration) of D_UDREJSE_DATO" (outmigration) of C_STATUS="20" (Register: Population register Table: VTJ.HENKILO Variable:kuolinpv m, muuttopvm T from DATO or from DATO. The first perence is	1 = Death If subject died 2 = Emigration If subject emigrated	Obtained from: SSB (Statistics Norway) Register: "National Population RegisterBefolk ning	cens_reason was coded as 1 if cens_date = date of death. cens_date = date of death. cens_date = date of emigration. Tebruary 2023. Downloaded from http://bmjopen.bm	Variable created based on information from Statistics Sweden Register: Registret över totalbefolkning en (RTB) Variables: Doddatum, datum [migration], posttyp [migration]	1 = Death, if there was a date of death registered in variable Doddatum. 2 = Out migration, if there was a registered migration out of the country

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<u>tents</u>					-2022		
Obtained from he Danish National Health Data Agency. Register: "CPR-Registret" Fable: t_person" V_MOR_PNR_ENCRYPTED"	Renamed from "V_MOR_PNR_ENCRY PTED"	Obtained from: Birth register Table: Äidin henkilötiedot Variable: aiti_hetunnus THL pseudonymised the original personal identification code (in this register "aiti_hetunnus") to unique personal identification number for linkage between registers. THL data management can link the id back to original personal identification code.	Renamed from "aiti_hetunnus" and pseudonymised by Statistics Finland for data lingage.	Obtained from: SSB (Statistics Norway) Register: "National Population Register" Variable: Løpenummer mor	Renamed from 00 lopenr_mor_peb2471	Obtained from Statistics Sweden Register: Flergeneration sregistret	Renamed from "LopNrMor"
Obtained from he Danish National Health Data Agency. Register: "CPR-Registret" Fable: t_person" / Ariable: V_FAR_PNR_E NCRYPTED"	Renamed from "V_FAR_PNR_ENCRYP TED"	Obtained from: Statistics Finland	Not available for THL. Pseudonymised id for data linkage in Statistics Finland	Obtained from: SSB (Statistics Norway) Register: "National Population Register" Variable: Løpenummer far	Renamed from 100 lopenr_far_pdb2471 lopenr_far_pdb2471 lopen.bmj.com/ on	Obtained from Statistics Sweden Register: Flergeneration sregistret	Renamed from "LopNrFar"
Dobtained from he Danish National Health Data Agency. Register: "MFR" inked with- Register: "CPR- Registeret" Fable: t_person" /ariable: d_foddato"	Id of the mother is obtained from the dataset "population1" (originally obtained from the CPR register). Using information on maternal birthday (d_foddato) and birthday of the child, Maternal age in years is calculated as age in whole years at time of delivery of the child.	Obtained from Register: Birth register Table: Äidin henkilötiedot Variable: aiti_ika	Renamed from aiti_ika	Obtained from: SSB (Statistics Norway) Register: "National Population RegisterBefolk ning	Mother's age is whole years at time of birth of child. Based of the mother's assigned exact date of birth (by date).	Obtained from Statistics Sweden Register: RTB Variable: datum_fodd	Calculated as mother's date of birth minus the child's date of birth, divided by 365, and rounded down to yield age in years.
こ かくこそ で けんべ ミ	Obtained from ne Danish lational Health lata Agency. legister: "CPR- legister: "CPR- legisters" lable: "	Detained from the Danish lational Health that Agency. Register: "CPR-Register: "MFR" that Agency. Register: "MFR" that Agency. Register: "MFR" the Danish lational Health that Agency. Register: "MFR" the Register: "CPR-Register: "MFR" the Register: "CPR-Register: "CPR-Register: "CPR-Register: "MFR" that Agency. Register: "CPR-Register:	Debtained from the Danish lational Health lata Agency. Legister: "CPR-lational Health lata Agency. Legister: "MRP" obtained from the Danish lational Health lata Agency. Legister: "MRP" obtained from the CPR register). Using lational Health lata Agency. Legister: "MRP" obtained from the CPR register). Using lational Health lata Agency. Legister: "CPR-lational Health lata Agency. Legister: "MRP" obtained from the CPR register). Using lational Health lata Agency. Legister: "CPR-lational Health lata Agency. Legister: "GPR-lational Health lational Health lata Agency. Legister: "GPR-lational Health lational Health lata Agency. Legister: "GPR-lational Health lational Health lata Agency. Legister: "GPR-lational Health lational H	Distained from ne Danish latin Agency. tegister: "CPR-tegisters" able:person" ariable: ariable: ariable: person" ariable: ariable: person" ariable: ariable: ariable: person" ariable:	Dobtained from to Danish lated Agency. Legister: "CPR-Legister "CPR-Legister "Dobtained from "V_FAR_PNR_ENCRY" able: "Alting her personal identification code (in this register "aitit_hetunnus") to unique personal identification code (in this register "aitit_hetunnus") to unique personal identification code (in this register "aitit_hetunnus") to unique personal identification code (in this register "aitit_hetunnus") to unique personal identification code (in this register "aitit_hetunnus") to unique personal identification code (in this register "aitit_hetunnus") to unique personal identification code. **PRAPNE_CORPED** **Dobtained from to Danish lational Health late Agency. Legister: "OPR-Legister: "OPR-Legister: "OPR-Legister: "OPR-Legister: "OPR-Legister: "National Population from the Danish lational Health late Agency. Legister: "Formation on material between the Danish lational Health late Agency. Legister: "OPR-Legister: "Oprelation on the Danish lational Health late Agency. Legister: "OPR-Legister: "Operation on material between the Danish lational Health late Agency. Legister: "Topulation on material between the Danish lational Health late Agency. Legister: "Topulation on material between the Danish lational Health late and birthday of the child, Maternal age in years is calculated as age in whole years at time of whole years	Dibtained from be Danish altonal Health label: JUMOR_PNR_ENCRY PTED' And Agency. register: "OPR-Egister" CPR-Egister" JUMOR_PNR_ENCRY PTED' And In the company of the child, distingtion ode (in this register) attended from: altitude of the configural personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from: altitude personal identification ode (in this register) attended from the correct personal identi	Detained from to Danish Renamed from No. PRR. ENCRY PTED" Detained from No. PRE. Detained from No.

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m_origin	Obtained from the Danish National Health Data Agency. Register MFR Register: "CPR-Registeret" Table: "T_FODESTED" Variables: "fodested_kode", "fodested_tekst" Variables from table: population1; in_date, cens_date are used to define if there is uncertain origin	Id of the mother is obtained from the dataset "population1" and linked with information from the CPR register 1="born in-country" if fodested_kode=000 or 208 (Denmark), 2= "born abroad" if fodested_kode is not 000 or 208 9="unknown" if information is missing	Obtained from Register: Statistics Finland Table: Variable: svaltio_aiti	Available only in the Fiona remote user system. svaltio_aiti = 246 -> 1 = "born in-country" svaltio_aiti != 246 (ts joku muu kuin Suomi) -> 2 = "born abroad" svaltio_aiti = NA (ts puuttuu) -> 9 = "Unknown"	Obtained from: SSB (Statistics Norway) Register: "National Population RegisterBefolk ning	Based on the Griable "fodeland". m origin = 1 if mother's country of birth is Norway (fodeland = 0), m_origin = 2 if mother's country of birth is any other country, and morigin = 9 if mother's country of birth is missing (n = 20,559). 2023. Downloaded from http	Obtained from Statistics Sweden Register: RTB Variable: UtlSvBakg	Recoded from variable "UtlSvBakg" as described above for variable Origin in table Population 1.
p_origin	Obtained from the Danish National Health Data Agency. Register MFR Register: "CPR-Registeret" Table: "T_FODESTED" Variables: "fodested_kode", "fodested_tekst" Variables from table: population1; in_date, cens_date are used to define if there is uncertain origin	Id of the father is obtained from the dataset "population1" and linked with information from the CPR register 1="born in-country" if fodested_kode=000 or 208 (Denmark), 2= "born abroad" if fodested_kode is not 000 or 208 9="unknown" if the information is missing	Obtained from Register: Statistics Finland Table: Variable: svaltio_isa	Available only in the Fiona remote user system. svaltio_isa = 246 -> 1 = "born in-country" svaltio_isa!= 246 (ts joku muu kuin Suomi) -> 2 = "born abroad" svaltio_isa = NA (ts puuttuu) -> 9 = "Unknown"	40	//bmjopen.bmj.com/ on April 19, 2024 by guest. Protecte	Obtained from Statistics Sweden Register: RTB Variable: UtlSvBakg	Recoded from variable "UtlSvBakg" as described above for variable Origin in table Population 1.

Table: birth_charcteristics

	Denmark		Finland		Norway	,	Sweden	
Variable	Source and Description	Important notes and data preparation	Source and Description	Important notes and data preparation	Source and Description	Important botes and data preparation	Source and Description	Important notes and data preparation
Þi	Original name in the Danish data: "pnr". Pseudonomise d unique personal identification number for linkage between registers, created by Statistics Denmark. It is linkable (by Statistics Denmark) to the original personal identification number (CPR number) assigned to all Danish residents and used when reporting to all national registers.	Renamed from "pnr"	Obtained from Register: Birth Register Table: Variable: lapsi_hetunnus THL pseudonymised the original personal identification code (lapsi_hetunnus) to unique personal identification number for linkage between registers. THL data management can link the id back to original personal identification code.	Statistics Finland pseudonymised lapsi_hetunnus with their own id for the remote user system.	40	Renamed mpasientlopenr_pdb2471 per "pasientlopen "pasientlopen bruary 2023. Downloaded from http://bmjopen.bmj.com/ on A	Created by Statistics Sweden Pseudonomise d unique personal identification number for linkage between registers	Renamed from lopnr

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Link to g	Obtained from the Danish National Health Data Agency.	Renamed from "vaegt_barn" and " V_VAGT" Registrations of birthweight less than 100g	Obtained from Register: Birth Register Table: Variable:	Registrations of birthweight less than 100g or higher than 9990g are categorized as missing	Obtained from Register: Medical Birth Registry of Norway Variable: vekt	Registrations of birthweightyless than 100g or higher than 9990g are defined as missing	Obtained from Socialstyrelse n Register: Medicinska	Registrations of birthweight less than 100g or higher than 9990g were categorized as
weight	Register: "MFR" from 1997 and onwards, "Fødselsregist eret" before 1997 Table: "MFR"(from	or higher than 9990g are categorized as missing	syntymapaino			10 February 2023. Do	födelseregistre t Variable: bvikt	missing.
α΄	MFR), "levendefødt" (From fødselsregister et) Variable: "vaegt_barn" (MFR), V_VAGT	· O,	Pee			Downloaded from http://br		
	(fødselsregiste ret)					//bmjc		

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Obtained from the Danish National Health Data Agency. Register: "MFR" from 1997 and onwards, "Fødselsregist eret" before 1997 Table: "MFR" (from MFR), "levendefødt" (From fødselsregister et) Variable: "Gestationsald er_dage" (MFR), "V_SVLANGD E" (fødselsregiste ret)	Derived from "Gestationsalder_dage" (ga in days) rounded down to whole weeks of gestation: ga=floor(gestationsalder_d age/7) Renamed from V_SVLANGDE	Obtained from Register: Birth Register Table: Variable: kestovkpv	kestovkpv, ga will be notified as weeks, the days are not noted. Ga <20 or >45 are coded as missing	Obtained from Register: Medical Birth Registry of Norway Variable: svlen	ga is calculated as floor(svlengt), where svlen is the ength of gestation in days based on ultrasound estimation of ultrasound is not available, the gestational ength is calculated from the last menstrual geriod. 20 23 Downloaded from http://bmjope	Obtained from Socialstyrelse n Register: Medicinska födelseregistre t Variable: grvbs	Socialstyrelsen recommends using this variable (for the best estimated gestational age), over the variable grvfv (which is based on medical records).
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sectio	Obtained from the Danish National Health Data Agency. Register: "MFR" from 1997 and onwards, "Fødselsregist eret" before 1997 Table: "MFR" (from MFR), "levendefødt" (From fødselsregister et) Variables: "Markoer_kejse rsnit" (MFR), B_I11, B_SECTIOF, B_SECTIOU (fødselsregister et)	From MFR: 0="not delivered by caesarean section" if they do not have any diagnosis code indicating caesarean section ("Markoer_kejsersnit"=mis sing) 1="delivered by caesarean section" if they have a diagnosis code indicating caesarean section in the variable "Markoer_kejsersnit" Fødselsregisteret sectio=1 if B_I11=1 B_SECTIOU=1 B_SECTIOF=1 Otherwise sectio=0	Obtained from Register: Birth Register Table: Variable: synnytystapatunnu s	Children are categorised as: 0="not delivered by caesarean section" if synnytystapatunnus is 1-4 1="delivered by caesarean section" if synnytystapatunnus is 5-8 9="unknown" if synnytystapatunnus=9 or missing	Obtained from Register: Medical Birth Registry of Norway Variable: ksnitt	Information on delivery with c-section is obtained from the variable kshitt. Possible values of kshitt are 1 = Planned C-section 2 = Emergency C-section 9 = Unspecified C-section If ksnitt is Rissing, sectio is coded as 0. Otherwise sectio is coded as 10 ownloaded from http://bmjopen.bmj.com	Obtained from Socialstyrelse n Register: Medicinska födelseregistre t Variable: secmark	Variable renamed from secmark; coding unaltered: 0 = no, 1 =yes.
Link to <u>C</u>	<u>ontents</u>			://bmjopen.bmj.com/site		n/ on April 19, 2024 by guest. Protected by copyright.		31

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smoke	Obtained from the Danish National Health Data Agency. Register: "CPR-Registeret" Register: "MFR" from 1997 and onwards, "Fødselsregist eret" before 1997 Table: "MFR" (from MFR), "levendefødt" (From fødselsregister et) Variable: "rygerstatus_moder" (MFR), B_RYGER (fødselsregister et) Obtained from the Danish National Health Data Agency. Register: Danish national patient registry Table: "T_ADM", "T_DIAG" Variables: pnr, recnum, D_INDDTO, C_ADIAG, C_TILDIAG,	Information from MFR, variable "RYGERSTATUS_MODE R" Smoke=0 if rygerstatus_moder=0 Smoke=1 if rygerstaus moder >0 and <99 (indicating any smoking during pregnancy regardless of magnitude) Smoke=9 if rygerstatus_moder=99(un known) or missing. From fødselsregisteret: smoke=0 if B_RYGER=0 smoke=1 if B_RYGER=1 smoke=9 if B_RYGER=1 smoke=9 if B_RYGER=1 smoke=9 if B_RYGER=1 smoke=0 if B_RY	Obtained from Register: Birth Register Table: Variable: tupakointitunnus	Smoke=0 if tupakointitunnus=1 Smoke=1 if tupakointitunnus=2-4 Smoke=9 if tupakointitunnus=9 (unknown) or missing.	Obtained from Register: Medical Birth Registry of Norway Variable: royk_beg and royk_avsl	Information smoking at start and pend of pregnancy sobtained from royk beg and royk_avsl, Pespectively. Both variables are coded as TI = No	Obtained from Socialstyrelse n Register: Medicinska födelseregistre t Variable: rok1	The variable rok1 pertains to smoking habits at registration with maternal health (usually at 8-12 weeks of pregnancy). If the woman was smoking >=1 cigarette/day at registration (rok1 coded 2 or 3), the variable smoke was coded = 1. If the woman was not smoking (rok1 coded 1) the variable smoke was coded = 0. If data was missing the variable smoke was coded = 9 (missing). (There is another variable, rok2, which pertains to smoking habits at pregnancy week circa 30-32. This was not included due to very poor data quality 1990-1999, and poor completeness thereafter (Source publication: Graviditeter, förlossningar och nyfödda barn (socialstyrelsen.se), Statistikdatabaser - Förlossningsstatistik - Val (socialstyrelsen.se))

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"CPR-

Registeret"

"MFR" from

"Fødselsregist

eret" before

"MFR"(from MFR).

"levendefødt"

Register:

1997 and

onwards,

1997

Table:

(From

ret)

Obtained from	MFR
the Danish	Children are categorized
National	as:
Health Data	0="no" if there is an
Agency.	indication of multiple ch
Register:	delivery (diagnosis code

delivery (diagnosis code) or there is registered another child born by the same mother within 1 day from the child's birthday

Register

Table:

1="yes" if there is no indication of multiple child delivery ("Flerfoldsgraviditet"=missi

Fødselsregisteret Children are categorized 0="no" if C PLAC>0 or

fødselsregister there is registered another et) child born by the same Variable: "Flerfoldsgravi mother within 1 day from ditet" (MFR), the child's birthday C PLAC

1="yes" if C PLAC=0 and (fødselsregiste no child born by the same mother within 1 day from the child's birthday

Obtained from Children are categorized Register: Birth more Variable: sikioita

0="no" if sikioita=2 or

1="yes" if sikioita=1

Obtained from Register: Medical Birth Registry of Norway Variable: flerfodsel

same month (N = 13). Otherwise singleton is

singleton is coded as 0 if flerfodsel or if another character is born to the same nother in the

Obtained from Socialstyrelse Register: Medicinska födelseregistre Variable: bordf2

1="Enkelbörd" was left unaltered (=1 "Yes"). 2="Flerbörd" was recoded to 0 "No".

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	The variable from MFR contains information on number of fulfilled pragnancies including stillbirths. Before 1997 the variables V_TIDLLEV(previous live	Obtained from Register: Birth Register Table: Variable: aiemmatsynnytyks	Number of the child ="Aiemmatsynnytykset" (previous births) minus "kuolleenasynt" (=stillbirths) plus 1	Obtained from Register: Medical Birth Registry of Norway	parity is defined as paritet + 100. The variable paritet is defined by MBRN as the	Obtained from Socialstyrelse n	The child's order, based on the number of children previously
Registeret" Register: "MFR" from 1997 and onwards, "Fødselsregist eret" before 1997 Table: "MFR"(from MFR), "levendefødt" (From fødselsregister et) Variable: "paritet" (MFR), V_TIDLLEV, V_TIDLDOD (fødselsregister ret)	births)+V_TIDLDOD (previous still births) has been added plus 1(current delivery), to simulate the information from MFR. Second, a counting method is applied using the registered parity	et Variable: kuolleenasynt	multiple delivered children are identified, and parity is recoded to the lowest value i.e., twins with 1 older sibling will both be coded with child order=2	Variable: paritet	highest value of the variables paritet_mor and paritet_mfr, where paritet_med is number of previous deliveries as stated by Hother and paritet_mod is number of previous deliveries registered by MBRN. Stillbirths are included in paritet.	Register: Medicinska födelseregistre t Variable: paritet	born by the mother, including this birth. Twins were given the same number, the lowest within the set.
Link to <u>Contents</u>					oyrigh:		34

Table: Vaccines

	Denmark		Finland		Norway	986	Sweden	
Variable	Source and Description	Important notes and data preparation	Source and Description	Important notes and data preparation	Source and Description	Important notes and data preparation⊃	Source and Description	Important notes and data preparation
<u>Þ</u>	Original name in the Danish data: "pnr". Pseudonomised unique personal identification number for linkage between registers, created by Statistics Denmark. It is linkable (by Statistics Denmark) to the original personal identification number (CPR number) assigned to all Danish residents and used when reporting to all national registers.	string	Obtained from Register: Vaccination Register Table: Variable: hetu THL pseudonymised the original personal identification code (hetu) to unique personal identification number for linkage between registers. THL data management can link the id back to original personal identification code.	Statistics Finland pseudonymised "hetu" with their own id for the remote user system.	Obtained from Register: Norwegian Immunisation Registry (SYSVAK)	10 February 2023. Downloaded from http://bmjopen.bmj.c	Created by Statistics Sweden Pseudonomised unique personal identification number for linkage between registers	String
vacdate	Obtained from the state serum institue. Register: "vaccinationsregi steret" Variable: "EffectuationDat e"	Date Format (%dD_m_Y)	Obtained from Register: Vaccination Register Table: Variable: Recorddate	Date Format (%dD_m_Y)	Obtained from Register: Norwegian Immunisation Registry (SYSVAK) Variable: konsultasjonsdato	Renamed from Nonsultasjonsdate Date Format (%dD_m_Y) April 19, 2024	Obtained from The Public Health Agency of Sweden (PHAS) Register: The National Vaccination Registry (NVR) Variable: vaccination_date	Date Format (%dD_m_Y)

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Obtained from the state serum institute. Register: "vaccine categorization") Unplicates were handled as follows, so that only one entry was kept same ATCCode: duplicate removed same group of vaccines (see appendix vaccine) appendix vaccine (see coding in appendix vaccine) categorization") Unplicates were handled as follows, so that only one entry was kept: - same ATCCode: duplicate removed same group of vaccines (see appendix vaccine) appendix vaccine (see appendix vaccine) categorization in publicates were handled as follows, so that only one entry was kept: - same ATCCode: duplicate removed same group of vaccines (see appendix vaccine) appendix vaccine categorization) within 14 days: the entry most likely to have been administered according to the national vaccination schedule at the time was kept Hib-vaccine given within 14 days of a multivalent Hib-containing vaccines: was removed Duplicates were handled as follows, so that only one entry was kept: - same ATCCode: duplicate removed same group of vaccines (see appendix vaccine categorization) within 14 days: the entry most likely to have been administered according to the national vaccination schedule at the time was kept Hib-vaccine given within 14 days of a multivalent Hib-containing vaccines: was removed Eaglister: Variable: V							N N		
Institue Register Vaccinationsregi steret' Vaccinationsregi steret' Variable: Unificates were handled as follows, so that only one entry was kept: - same ATCcode: duplicate removed same group of vaccines (see appendix vaccine categorization) Unplicates were handled as follows, so that only one entry was kept: - same ATCcode: duplicate removed same group of vaccines (see appendix vaccine categorization) Within 14 days: the entry most likely to have been administered according to the national vaccination schedule at the time was kept Hib-vaccine given within 14 days of a multivalent Hib- containing vaccine: was removed - IPV given within 14 days of a multivalent Hilb- containing vaccine: was removed - IPV given within 14 days of a multivalent Hilb- containing vaccine: was removed - IPV given within 14 days of a multivalent Hilb- containing vaccine: was removed - IPV given within 14 days of a multivalent Hilb- containing vaccine: was removed - IPV given within 14 days of a multivalent Hilb- containing vaccine: was removed - IPV given within 14 days of a multivalent Hilb- containing vaccine: was removed - IPV given within 14 days of a multivalent Hilb- containing vaccine: was removed - IPV given within 14 days of a multivalent Hilb- containing vaccine: was removed - IPV given within 14 days of a multivalent Hilb- containing vaccine: was removed - IPV given within 14 days of a multivalent Hilb- containing vaccine: was removed - IPV given within 14 days of a multivalent Hilb- containing vaccine: was removed - IPV given within 14 days of a multivalent Hilb- containing vaccine: was removed - IPV given within 14 days of a multivalent Hilb- containing vaccine: was removed - IPV given within 14 days of a multivalent Hilb- containing vaccine: was removed - IPV given within 14 days of an multivalent - IPV given within 14 days of an multivalent - IPV given within 14 days of an multivalent - IPV given within 14 days of an multivalent - IPV given within 14 days of an multivalent - IPV given within 14 days of an multiv		Obtained from		Obtained from	Categorical (see	Obtained from			
Register: "Variacinationsregi steret" "ATCCode" "ATCCode" "ATCCode" "ATCCode" "ATCCode" "ATCCode" "ATCCode" "ATCCode" "ATCCode an exponsible at code and provided as follows, so that only one entry was kept same ATCCode: duplicate removed same group of vaccines (see appendix vaccine categorization) within 14 days: the entry most likely to have been administered according to the national vaccination schedule at the time was kept Hib-vaccine given within 14 days of a multivalent Hib-containing vaccine: was removed - IPV given within 14 days of an multivalent Hib-containing vaccines: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed - IPV given within 14 days of an multivalent IPV-containing vaccines: was removed		the state serum	coding in appendix	Register:	coding in appendix	Register:	in appendix "vac o nne	PHAS	in appendix "vaccine
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credibility	Variable generated based on data preparation	1=no duplicate 2= duplicate same vaccine removed 3=duplicate related vaccine removed (keep vaccine that aligns with vaccination schedule) 4= duplicate related vaccine removed (none of the vaccines align with vaccination schedule) 5= duplicate related vaccine removed (vaccines given outside usual vaccination ages	Variable generated based on data preparation	1=no duplicate 2= duplicate same vaccine removed 3=duplicate related vaccine removed (keep vaccine that aligns with vaccination schedule) 4= duplicate related vaccine removed (none of the vaccines align with vaccination schedule) 5= duplicate related vaccine removed (vaccines given outside usual vaccination ages within the national immunisation	Variable generated based on data preparation	1=no duplicate of the vaccine removed vaccine removed (keep vaccine that alighed with vaccination schedule) 4= duplicate related vaccine removed (none of the vaccines affign with vaccination of the vaccine removed (none of the vaccines affign with vaccination of the vaccines affign with vaccines given autside usual vaccination ages within the nation of the vaccines affigurates a	Variable generated based on data preparation	1=no duplicate 2= duplicate same vaccine removed 3=duplicate related vaccine removed (keep vaccine that aligns with vaccination schedule) 4= duplicate related vaccine removed (none of the vaccines align with vaccination schedule) 5= duplicate related vaccine removed (vaccines given outside usual vaccination ages within the national immunisation programme)
TB_endemic		within the national immunisation programme) 9= not relevant		9= not relevant	ien c	immunisation programme) com/ on April 19, 2024 by guest. Protected	Obtained from Statistics Sweden Register: RTB Variable: fodelselandnamn	If the child, mother OR father was born in a country with high or very high incidence of tuberculosis ie. >25 cases per 100,000 inhabitants (as listed in WHO:s Global TB report 2018, link), the child was coded 1=risk group, as this corresponds to eligibility for BCG-vaccination. All other children were coded = 0.

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HepB_endemic	9=not relevant	9=not relevant	9=not relevant 9=not	Obtained from Statistics Sweden Register: Table: Variable: fodelselandnamn	If the child, mother OR father was born in a country with an intermediary or high prevalence of hepatitis B in the population (> 2 percent HbsAg-positive), the child was coded 1=risk group. * If the child and both parents came from low prevalence countries, the child was coded = 0. (This included all nativeborn children.) If the child came from a country with an unknown prevalence, it was coded as missing.
	., Horn J, Mikolajczyk RT, Krause G, Ott JJ. Estir 5;386(10003):1546-55. DOI:https://doi.org/10.10		ronic nepatitis o virus infection. a systema	lic review of data publis	nieu between 1905 and

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Link to <u>Co</u> Table:	ontents socio_econon	ny				omjopen-2022-06598		
	Denmark		Finland		Norway	98	Sweden	
Variable	Source and Description	Important notes and data preparation	Source and Description	Important notes and data preparation	Source and Description	Important notes and data preparation	Source and Description	Important notes and data preparation
þį	Original name in the Danish data: "pnr". Pseudonomised unique personal identification number for linkage between registers, created by Statistics Denmark. It is linkable (by Statistics Denmark) to the original personal identification number (CPR number) assigned to all Danish residents and used when reporting to all national registers.	Renamed from "pnr"	Obtained from Register: Population register Table: Variable: hetu THL pseudonymised the original personal identification code (lapsi_hetunnus) to unique personal identification number for linkage between registers. THL data management can link the id back to original personal identification code.	Statistics Finland pseudonymised "hetu" with their own id for the remote user system.	1º4	Renamed from "pasientlopenr_pdb240" and proper pdb240 pownloaded from http://bmjopen.bmj.com/ on	Created by Statistics Sweden Pseudonomised unique personal identification number for linkage between registers Variable: lopnr	Renamed from lopnr

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	Obtained from Statistics	Birth year 2016 and higher do not have	Obtained from Register:	Only available in Fiona remote	Obtained from Statistics	Based on the variable of "ies_eu", defined as total after-tax income for the	Obtained from Statistics Sweden	In Sweden, disposable income is defined as the
	Denmark.	information on family	Statistics	user system.	Norway	after-tax income for the	Register:	sum of all household
	Table: "FAIK"	income at birth.	Finland	Renamed from	Variable: ies_eu	household per consumption	Longitudinell	members' all forms of
	(tables for each	No children have	Table:	"kturaha ak lap		unit calculated according to	integrationsdataba	income (including wages,
	year)	information from the	Variable:	si" at the year		the EU scale. Total aftet-tax	s	capital gains, and different
	Variable:	year they are born,	kturaha_ak_laps	when child was		income is calculated as , the	för	forms of financial
	"FAMAEKVIVADIS	because the statistics	i	born.		sum of the household'	Sjukförsäkrings-	support/social assistance)
	P_13" (Equated	are made on the first		Calculation of		wages and salaries, ingome	och	minus taxes and other
	disposable family	of January each year.		quintiles are		from self-employment, a	Arbetsmarknadsst	negative transfers
	income)	Include information from the year after		done separately for each		property income and Notransfers received min	udier (LISA) Variable:	(<u>Statistikskolan: Att</u> jämföra inkomster för
Δ	Link between each	birth. If no info from		calendar year.		total assessed taxes and	DisplnkFam	hushåll (scb.se))
ا _ ا	child and family is	that year, the child is		E.g. calculating		negative transfers. Each	Biopinia din	The information <i>primarily</i>
· <u>≒</u>	obtained from	coded with unknown		income quintiles		income year includes 🏖		came from the information
inc_quin_b	Statistics	(9).		for 2008 include		persons residing in No <u>≖</u> way		registered for the
ပ္င'	Denmark:	Note: quintiles made		all children who		and resident in a priva ⊛		household of the mother in
_≟.	Table: BEF (tables	separately for each		use income		household as of 31st $\frac{30}{6}$		the year of birth of the
	for each year)	calendar year for the		information from		December of the income		child. If this was missing,
	Link variable: FAMILIE_ID	children born the year before.		2008 to assess the income		year. Household incon in year of birth is used to∃		the information was instead taken from the
	(combined with	belore.		quintile at birth		define inc quin b. Income		father. Thus, the child was
	calendar year)			kturaha ak laps		quintiles are made		primarily assumed to be
	,			i = NA, coded as		separately for each bir		part of the mother's
				9 = "Unknown"		cohort. Available for chidren		household, and secondly
						born 2004–2018.		of the father's.
						ěn		Income quintiles was then calculated based on all
						.br		children in each birth
						nj.		cohort.
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inc_quin_10y	Obtained from Statistics Denmark. Table: "FAIK" (tables for each year) Variable: "FAMAEKVIVADIS P_13" (Equated disposable family income) Link between each child and family is obtained from Statistics Denmark: Table: BEF(tables for each year) Link variable: FAMILIE_ID (combined with calendar year)	Birth year 2007 and higher do not have info on family income at ten years. If no info from the year the child turn 10 years the variable is coded with unknown (9). Note: quintiles made separately for each calendar year for the children turning 10 years that year.	Obtained from Register: Statistics Finland Table: Variable: kturaha_ak_laps i	Only available in Fiona remote user system. Renamed from "kturaha_ak_lap si" at the year when child was 10 years old. Calculation of quintiles are done separately for each calendar year. E.g. calculating income quintiles for 2008 include all children who use income information from 2008 to assess the income quintile at birth kturaha_ak_laps i = NA, coded as 9 = "Unknown"	Obtained from Statistics Norway Variable: ies_eu	Based on the variable Ofices_eu", see definition above. Household income in the year of the child's of the birthday is used to define inc_quin_10y. Income 10 quintiles are made separately for each birthcohort. Available for cladren born 1994–2008.	As above.	As above, but from the year the child turned 10 years old.
inc_quin_m_b					Obtained from Statistics Norway Variable: wies	Based on the variable of "wies", defined as a person's after-tax income. After dax income is calculated agethe sum of wages and salaries, income from self-employment, property income and transfers of received minus total passessed taxes and assessed taxes and negative transfers. The mother's income in the child's year of birth is the define inc_quin_m_2 lncome quintiles are neede separately for each birth cohort. Available for children born 1993–2018.	Obtained from Statistics Sweden Register: Longitudinell integrationsdataba s för Sjukförsäkrings- och Arbetsmarknadsst udier (LISA) Variable: Displnk	Information about disposable income of the mother in the year of birth of the child. Income quintiles was then calculated based on all children in each birth cohort. See also above.
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inc_quin_m_10y					Obtained from Statistics Norway Variable: wies	Based on the variable of "wies", see definition apove. The mother's income in the year of the child's 10th of birthday is used to define inc_quin_m_10y. Income quintiles are made quintiles are made separately for each birthday is used to define inc_quin_m_10y. Income quintiles are made quintiles are made separately for each birthday is used to define the cohort. Available for children born 1990–2008.	As above.	As above, but from the year the child turned 10 years old.	
n_children_b	Obtained from Statistics Denmark. Table: "FAM" (tables for each year) Variables: Sumarized from the variables ANTB00-ANTB17 (number of children in the family age 0, 1, 2,17) Link between each child and family is obtained from Statistics Denmark: Table: BEF(tables for each year) Link variable: FAMILIE_ID (combined with calendar year)	Birth year 2018 do not have info on number of children at birth. No children have information from the year they are born, because the statistics made on the first of January each year. Include information from the year after birth. If no info from that year the child is code with unknown (99). Some children end-up with a count of 0 children, as this is not a legal value they are recoded to 99. Based on the values on family_type, it is judged that the children with a count of 0, are children who are registered as the main person in a family and therefore are not counted as a child although they are children.	Obtained from Register: Statistics Finland Table: Variable: lkm_lapsi	Only available in Fiona remote user system. Renamed from "Ikm_lapsi" at the year when child was born.	Obtained from Statistics Norway Variable: barn_i_regstat_f amnr	Based on variable "barn_i_regstat_famnron" number of children in the family. Persons are considered children if the are below 18 years and registered as resident that the family of at least one persons resident in the same dwelling and related to each other as spouse, the registered partner, cohabitant, and/or parent and child (regardless of the child's age). At most, and family may consist of two subsequent generations and one couple only. The variable includes residents of Norway as of January 1 each year. We have therefore used number of children in the year after the child's year of birth. Individuals registered with 0 number of children in their family have been recorded to 1. Available for children born 2004–2018.	Obtained from Statistics Sweden Register: LISA Variable: Barn0_3, Barn4_6, Barn7_10, Barn11_15, Barn16_17	Created as the sum of children in variables Barn0_3, Barn4_6, Barn7_10, Barn11_15 and Barn16_17. The sum denotes the number of children living in the household on 31 Dec in the year of birth of the child. The child itself is part of the count. The information <i>primarily</i> came from the information registered for the mother in the year of birth of the child. If this was missing, the information was instead taken from the father.	
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Stat Den Tab (tab year Vari Sum the ANT (nur child fam 2, Link child obta Stat Den Tab for e Link FAM (cor	rained from tistics Imark. Ide: "FAM" Ides for each Ir) Idables: Imarized from Variables TB00-ANTB17 Ides of I	Birth year 2009 and higher do not have info on number of children at 10 years. If no info from the year the child turn 10 years the variable is coded with unknown (99). Some children end-up with a count of 0 children, as this is not a legal value they are recoded to 99. Based on the values on family_type, it is judged that the children with a count of 0, are children who are registered as the main person in a family and therefore are not counted as a child although they are children.	Obtained from Register: Statistics Finland Table: Variable: Ikm_lapsi	Only available in Fiona remote user system. Renamed from "Ikm_lapsi" at the year when child was 10 years old.	Obtained from Statistics Norway Variable: barn_i_regstat_f amnr	2024 by guest. Protecte	er e	As above, but from the year the child turned 10 years old.
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single_parent_b	Obtained from Statistics Denmark. Table: "FAM" (tables for each year) Variable: FAMILIE_TYPE Link between each child and family is obtained from Statistics Denmark: Table: BEF(tables for each year) Link variable: FAMILIE_ID (combined with calendar year)	Birth year 2018 do not have info on single parenthood at birth. No children have information from the year they are born, because the statistics made on the first of January each year. Include information from the year after birth. If no info from that year the child is code with unknown (9). I also set children who originally were coded with 0 children on n_children_b as unknown (9) because it is judgded that these are children registered as the main person in the family?).	Obtained from Register: Statistics Finland Table: Variable: pety_lapsi	Only available in Fiona remote user system. Calculated from "pety_lapsi" at the year when child was born. If pety_lapsi is 2 (married couple and children) or 5-6 (couple with children) -> single parent =0 (no) If pety_lapsi is 3 or 4 (mother or father with children) -> single parent = 1 (yes). If pety_lapsi is unknown -> single parent = 9	Obtained from Statistics Norway Variable: regstat_famtyp	Based on the variable of "regstat_famtyp", a detailed classification of family type, where family is defined as described above. The same variable includes residents of Norway as of January 1 each year. We have therefore used the value of family type in the year after a child's year of birth to define single_parent_biff the registered family type is either "married couple with small children (youngest child aged 0-5 years)" or "cohabitants with smalls children (youngest child aged 0-5 years)" on single_parent_b is coded as 0. If the registered family type is either "mother with small children (youngest child aged 0-5 years)" or "single_parent_b is coded as 0. If the registered family type is either "mother with small children (youngest child aged 0-5 years)" or "father with small children (youngest child aged 0-5 years)" or "father with small children (youngest child aged 0-5 years)" or "father with small children (youngest child aged 0-5 years)" or "father with small children (youngest child aged 0-5 years)" or "father with small children (youngest child aged 0-5 years)" or "father with small children (youngest chil	Obtained from Statistics Sweden Register: LISA Variable: FamTypF	The information came from the information registered for the mother in the year of birth of the child. Codes FamTypF=41, 42 classifies the mother as a single parent, and 50 denotes Other singles. These codes were included when coding single_parent_b=1 (yes). If FamTypF was missing, single_parent_b was coded as 9 (missing). All other FamTypF-codes were recoded as 0 (no).
sing		unknown (9) because it is judgded that these are children registered as the main person in	700	(yes). If pety_lapsi is unknown ->	ieh	single_parent_b is coded as 0. If the registered fam∰y type is either "mother with small children (youngest		

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Statistics have interpretation parenth parenth parenth (tables for each year) the varivariable: FAMILIE_TYPE set child and family is obtained from Statistics penmark: Table: BEF(tables have interpretation parenth p	ear 2018 do not a fo on single nood at birth. For from the year dd turn 10 years iable is coded known (9). If the work of the	Only available in Fiona remote user system. Calculated from "pety_lapsi" at the year when child was 10 years old. If pety_lapsi is 2 (married couple and children) or 5-6 (couple with children) -> single parent =0 (no) If pety_lapsi is 3 or 4 (mother or father with children) -> single parent = 1 (yes). If pety_lapsi is empty -> single parent = 9 (unknown)	Obtained from Statistics Norway Variable: regstat_famtyp	Based on the variable of "regstat_famtyp", see above. The variable includes or residents of Norway as of January 1 each year. We have therefore used the value of family type in the year after the year of abchild's 10th birthday to define single_parent_By. If the registered family type is either "married couple with small children (youngest child aged 0-5 years)", or "married couple with object children (youngest child aged 6-17 years)" on "cohabitants with small children (youngest child aged 0-5 years)", or "cohabitants with olders children (youngest child aged 6-17 years)", single_parent_10y is coded as 0. If the registered family type is either "mother with small children (youngest child aged 0-5 years)", or "for "mother with older children (youngest child aged 0-5 years)", or "for "mother with older children (youngest child aged 0-5 years)", or "for "the with older children (youngest child aged 0-5 years)", or "for "the with older children (youngest child aged 0-5 years)", or "for "the with older children (youngest child aged 0-5 years)", or "for "the with older children (youngest child aged 0-17 years)", single_parent_10y is coded as 1. Otherwise (family aype is any other category on missing), single_parent_10y is coded as 9. Available for children born 1994–2069.	As above.	As above, but from the year the child turned 10 years old.
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Link to Contents	Statistics Denmark. Table: "UDDF" Variable: "hfaudd" "hfaudd" i linked with format from statistics Denmark grouping the Danish education classification into ISCED 2011, based on which maternal education is grouped. Link to mother is available from the dataset "population1"	obtained education for the mother on the date of birth of the child. There is no information on this for children born 2017 or later. Statistics Denmark had a format available for transforming national Danish education	Register: Statistics Finland Table: Variable:ututku_ aiti and koulutusaste_tas o_1 and birthday of child obtained	classified by ISCED-11, although the classes 0-2 are not available for us. In Finland, we have compulsory education during which the ISCED level 2 is achieved and thus we classified education: NA= 1 low education level 3-4 = 2 medium education level 5-8 = 3 high education level 9 = no information of the mother's Education at	Statistics Norway Variable:	Based on the variable 6 "bu_niva_YYYY". The or variables contain information on highest level of education as of October 1 of the pear YYYY. Mother's level of education from the chiefs year of birth was used be define m_education_based education is classified according to The Norwegian Standard Classification of Education (NUS). If the NUS-level is 0 (corresponding to SCED2011 levels 01, 10 (corresponding to SCED2011 level 1 and 2, respectively), m_education is coded as 1. If the NUS level is 3 or 4 (corresponding to SCED2011 = 3), m_education is coded as 2. If the NUS-level is 6, 7 or 8 (corresponding to ISCED2011 level 6, 7, and 8, respectively), m_education is coded as 2. If the NUS-level is 6, 7 or 8 (corresponding to ISCED2011 level 6, 7, and 8, respectively), m_education is coded as 3 (https://www.ssb.no/utainning/artikler-og-publikasjoner/ attachment/2 40569? ts=150ebb99 0, page 25). NUS-level 5 is defined as tertiary vocational educational level not approved as higher education. Tertiary education with duration education with duration scase, m_education_b should be coded as 2. Tertiary education with duration of 2 years corresponds to ISCED2011 level 5, and m_education_b should be coded as 3. However, we do not have information on type or duration of the tertiary	Statistics Sweden Register: LISA Variable:	highest level of education achieved during the spring semester in the year the child was born. That means, that if the mother achieved a higher level of education mid-year, it will only be visible in the register for the following year. Level of education was recoded from Sun2000 to ISCED by a translational key available from Statistics Sweden: Svensk utbildningsnomenklatur (SUN) (scb.se) (retrieved 2021-08-20).
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	1	T	T	T =	T	N		
	Obtained from Statistics	Use the highest obtained education for	Obtained from Register:	Education is classified by	Obtained from Statistics	Mother's highest level of education as of October 1 in	As above.	As above, but from the year the child turned 10
	Denmark.	the mother on the date	Statistics	ISCED-11.	Norway	the year of child's 10-year		years old.
	Table: "UDDF"	of the child turns 10	Finland	although the	Variable:	birthday was used to define		years old.
	Variable: "hfaudd"	years.	Fillialiu	classes 0-2 are	bu_niva_YYYY	m education b. For		
	"hfaudd" i linked	There is no	Table:	not available for	Du_IIIVa_1111	definitions and coding, Ree		
	with format from	information on this for	Variable:	us. In Finland,		above. Available for children		
	Satistics Denmark	children born 2007 or	ututku aiti and	we have		born 1990–2009.		
	grouping the	later.	koulutusaste tas	compulsory		Doin 1990–2009.		
	Danish education	later.	o_1 and birthday	education during		ua		
	classification into		of child obtained	which the		⋜		
	ISCED 2011,		from population1	ISCED level 2 is		20		
	based on which		ITOTTI POPUIALIOITT	achieved and		123		
	maternal			thus we		<u> </u>		
	education is			classified		0		
	grouped.			education: NA=		<u> </u>		
	grouped.			1 low education		l io		
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6	available from the	•		3-4 = 2 medium		e c		
─	dataset			education level		1 fr		
⊆'	"population1"		, - N-	5-8 = 3 high		On On		
윤	(originally			education level		<u> </u>		
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m_education_10y				Education when		jö		
=				child is 10 years		ре		
				old.		n.k		
				If education was		l ă		
				lower than		j.c		
				m_education_b		om		
				it was coded to		7		
				be the same as		S S		
				at birth, also if				
				education was) <u>) </u>		
				unknown when		12		
				child was ten,		9		
				but it was known		20		
				when child was		24		
				born, the m education b		b		
				was used as		/ 9		
				m_education_10		ue		
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Appendix: Vaccine categorization: presentation of ATC codes for vaccines identified in the vaccination registries in each of the Nordic countries and categorisation hereof into common vaccine categories "vaccine". The vaccines are further grouped by "type" i.e. vaccines against a similar set of diseases. NB in Sweden only vaccines that are included in the national immunisation programme is registered in the vaccination register.

		DENMARK	Finland	Norway	Sweden
Vaccine	Туре		A	ATC Code	23. [
1= "DTaP-IPV-Hib"		J07CA06	J07CA06	J07CA06	§J07CA06
2= "DTaP-IPV-Hib-HepB"		J07CA09		J07CA09	g J07CA09
3= "DTaP-IPV"]	J07CA02 J07CA02	J07CA02 J07CA02	J07CA02 J07CA02	្ឋីJ07CA02 ទី
4= "DT-Pol"		J07CA01		J07CA01	tto.∕
5= "DT-HepB"		J07CA07			(bmj
6= "DTwP-HepB"		J07CA05			open
7= "DTwP-Hib-HepB"	1	J07CA11			bmi
8= "DTaP-IPV-HepB"		J07CA12			J07CA12
10= "DTaP"		J07AJ52	J07AJ52	J07AJ52	BJ07AJ52
11= "DTwP"		J07AJ51		J07AJ51	Apri
12= "DT"		J07AM51	J07AM51	J07AM51 J07AM52	ជ្ឈ07AM51
13= "D"		J07AF01		J07AF01	₹J07AF01
15= "T"		J07AM01		J07AM01	្គ្លីJ07AM01
20= "PCV"	2	J07AL02	J07AL02	J07AL52 J07AL02	ម្ចី07AL52 គ្គីJ07AL02
21="PPV"		J07AL01	J07AL01	J07AL01	ي 107AL01

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25="HepA"		J07BC02	J07BC02	J07BC02	-065
26= "HepAB"	3	J07BC20	J07BC20	J07BC20	984
27= "HepB"	3	J07BC01	J07BC01	J07BC01	on 1
28= "HepA-Thyphoid"		J07CA10		J07CA10) Fe
30= "HPV4"		J07BM01		J07BM01	5 J07BM01
31="HPV2"	4	J07BM02	J07BM02	J07BM02	်ပ္ပ07BM02
32="HPV9"		J07BM03	J07BM03	J07BM03	²³ J07BM03
35= "Hib"		J07AG01	J07AG01	J07AG01	₹J07AG01
36= "Hib-MenC"		J07AG53			hload
37= "Hib-Pol"	5			J07CA04	led from
38= "Hib-HepB"		J07CA08			h#p
40- "Influenza (non live)"		J07BB01		J07BB01	://ba
40= "Influenza (non-live)"	6	J07BB02	J07BB02	J07BB02	gio De
41= "Influenza (live)"		J07BB03	J07BB03	J07BB03	p b
45= "wP"	7	J07AJ01		J07AJ01	e. 8
46= "aP"	,	J07AJ02		J07AJ02	<mark>0/</mark> 0
50= "MMR"		J07BD52	J07BD52	J07BD52	₿J07BD52
51= "MMR-Varicella"		J07BD54	J07BD54		ii 19
52= "Measles"	8	J07BD01		J07BD01	20:
53= "Measles-Mumps"		J07BD51		J07BD51	⁷ 4 by
54= "Measles-Rubella"		J07BD53		J07BD53	дше
55= "Rubella"		J07BJ01		J07BJ01	st F
56= "Mumps"		J07BE01		J07BE01	rote
60= "OPV"	9	J07BF01		J07BF04 J07BF01	ted by copy

	J07BF02		J07BF02	2-065
61= "IPV"	J07BF03	J07BF03	J07BF03	207BF03
65= "Rota"	J07BH01		J07BH01	on 1
05- Nota	J07BH02	J07BH02	J07BH02	0 F
67= "BCG"	J07AN01	J07AN01	J07AN01	brus
			J07BK03	V 20
70="Varicella"	J07BK01		J07BK02	23
	J07BK02	J07BK01	J07BK01	Doy
71= "yellow fever"	J07BL01	J07BL01	J07BL01	/nlo
72= "Japanease Encephalitis"	J07BA02	J07BA02	J07BA02	d e d
73= "Tick borne Encephalitis"	J07BA01	J07BA01	J07BA01	fron
	J07AE51			b#c
74 = "Cholera"	J07AE02			<u>√//br</u>
	J07AE01	J07AE01	J07AE01	<u>p</u> iop
			J07AH07	en b
	J07AH08	J07AH08	J07AH08	<u>B.</u> Q
	J07AH09	J07AH09	J07AH09	DB /
75= "Meningococcal	J07AH03		J07AH03	on A
vaccine"	J07AH04		J07AH04	b
	J07AH06		J07AH06	April 19, 2024
	J07AH05			024
	J07AH02			у с
	J07AH01		J07AH01	K Q B B
	J07AP01	J07AP01	J07AP01	L Pr
76= "Typhus"			J07AP02	otec
	J07AP10			Protected by co
			J07AP	K

	J07AP03		J07AP03	2-065
77= "Rabies"	J07BG01		J07BG01	984
78= "Smallpox"			J07B01	on 1
76- Silialipox	J07BX01			0 F
79="Anthrax"			J07AC01	brus
80="covid-19 vaccine"		J07BX03	J07BX03	₹ 2
99="other vaccines"	ATC code missing	ATC code missing	ATC code missing	ATC code missing
				Downloaded from http://bmjopen.bmj.com/ on April 19, 2024 by guest.

Online supplementary files

sTable 1: Vaccination coverage¹ at 2 years of age according to year of birth among children born in the respective countries

sTable2: Human papilloma virus vaccination coverage¹ before 14 years of age of vaccination among girls² born in the respective countries

sTable 3: Socio-economic factors at 10 years of age

Appendix 3: ATC codes obtained for the study population in each country within NONSEnse

sTable 1: Vaccination coverage¹ at 2 years of age according to year of birth among children born in the respective countries

Denmark	(
Year of	Eligible ²	DTP1 %	DTP2 %	DTP3 %	MMR1 %	
birth	Children	(95% CI)	(95% CI)	(95% CI)	(95% CI)	
1997	66,406	98.9	96.0	82.2	81.5	
1998	64,936	99.0	97.0	85.0	83.6	
1999	64,996	99.0	97.0	84.9	84.5	
2000	65,811	99.0	97.3	86.2	85.9	
2001	64,207	99.1	97.4	86.4	85.5	
2002	62,948	99.1	97.0	84.1	84.9	
2003	63,462	98.9	96.6	82.5	85.2	
2004	63,339	98.9	96.5	82.7	86.8	
2005	62,912	98.9	96.0	80.1	84.8	
2006	63,769	99.0	95.8	78.7	84.4	
2007	63,006	99.0	96.4	80.9	82.6	
2008	63,892	99.2	97.2	83.9	83.7	
2009	61,676	99.3	97.6	86.6	86.2	
2010	62,200	99.2	97.9	88.8	87.3	
2011	57,892	99.2	98.0	89.7	86.7	
2012	56,842	99.2	98.0	90.0	86.4	
2013	54,881	98.9	97.6	88.5	88.3	
2014	55,753	98.8	97.5	87.6	88.4	
2015	57,100	98.9	98.0	93.2	90.3	
2016	23,103	99.0	98.3	94.7	90.7	
Finland						
Year of	Eligible ²	DTP1 %	DTP2 %	DTP3 %	MMR1 %	Rota virus
birth	Children	(95% CI)	(95% CI)	(95% CI)	(95% CI)	vaccine %
						(95% CI)
2009	59,934	94.0	92.7	89.4	87.8	63.8
2010	60,560	96.7	94.2	90.8	91.6	90.7
2011	59,645	97.0	95.1	90.4	92.3	90.8
2012	59,309	95.7	94.5	90.3	91.9	91.2
2013	58,249	97.5	95.7	91.8	93.3	90.4

2014	57,693	97.6	96.5	89.3	92.6	91.6			
2015	55,569	98.0	96.6	88.1	93.4	92.1			
Norway									
Year of	Eligible ²	DTP1 %	DTP2 %	DTP3 %	MMR1 %	Rota virus			
birth	Children	(95% CI)	(95% CI)	(95% CI)	(95% CI)	vaccine %			
						(95% CI)			
1995	59964	98.5	97.9	95.8	94.7				
1996	60652	98.2	97.4	95.4	94.3				
1997	59431	98.5	98.0	96.2	94.4				
1998	57999	98.7	98.2	96.4	94.1				
1999	58975	98.8	98.3	96.4	94.1				
2000	58907	98.6	98.0	96.1	89.2				
2001	56405	98.7	98.3	96.1	89.3				
2002	55232	98.8	98.5	96.7	92.7				
2003	56301	99.0	98.6	96.8	94.2				
2004	56734	99.1	98.8	97.5	94.7				
2005	56531	99.2	99.0	97.6	94.4				
2006	58316	99.1	98.8	97.3	94.2				
2007	58199	99.0	98.6	96.7	94.0				
2008	60284	99.0	98.5	96.6	93.8				
2009	61465	98.9	98.6	97.4	94.4				
2010	61080	98.9	98.5	97.3	95.0				
2011	59855	98.8	98.4	97.2	94.8				
2012	59937	98.6	98.2	96.6	95.0				
2013	58745	98.6	98.0	96.5	95.5				
2014	58839	98.7	98.3	96.6	95.9				
2015	58954	98.6	98.1	96.6	95.7	94.1			
2016	58975	98.5	97.8	96.3	95.9	94.8			
Sweden									
Year of	Eligible ²	DTP1 N (%)	DTP2 N (%)	DTP3 N (%)	MMR1 (%)				
birth	Children								
2013	113,457	97.6	95.1	83.3	89.1				
2014	114,639	98.0	95.9	86.1	90.7				
2015	114,542	98.1	96.3	87.8	91.8				

Abbreviations: DTP1: First dose of Diphtheria, Tetanus, and acellular Pertussis containing vaccine; DTP2: Second dose of Diphtheria, Tetanus, and acellular Pertussis containing vaccine; DTP3: Third dose of Diphtheria, Tetanus, and acellular Pertussis containing vaccine; MMR: Measles-Mumps-Rubella vaccine; Rota: Rota virus vaccine.

¹The coverage reflects the number of registered vaccines and may thus underestimate the actual vaccination coverage in the countries. ² Including children born in the country from birth cohorts where vaccines administered between 0-2 years of age are registered in the vaccination registers (data availability period).



BMJ Open STable 2: Human papilloma virus vaccination coverage¹ before 14 years of age of vaccination among girls² born in the respective countries

	Denmark F				Finland			Norway 5			Sweden		
	Deminar	N.		i iiiiaiia			Norway		0 F	Sweder	•		
Year	Eligible	HPV1	HPV2	Eligible ³	HPV1	HPV2	Eligible	HPV1	HPV2 g	Eligible	HPV1	HPV2	
of	3	vaccinated	vaccinated	children	vaccinated	vaccinated	3	vaccinated	vaccinated	3	vaccinated	vaccinated	
birth	children	N (%)	N (%)		N (%)	N (%)	children	N (%)	N (%) 2023.	children	N (%)	N (%)	
1998	34,392	85.7	81.2				30,914	76.5 (76.0,	75.8 P				
				0				77.0)	vnloa				
1999	34,484	86.8	82.4		0		31,391	78.5	77.7 e				
2000	34,881	86.5	82.3				31,490	80.2	79.5 (79. €),				
					- C	<i>/</i> -			79.9)				
2001	34,030	81.4	74.5				30,546	82.7	82.0				
2002	33,241	73.6	57.6	4053	71.1	69.3	30,213	84.5	83.7				
2003	33,762	52.3	36.1	27,310	69.8	67.2	30,925	84.8	84.0	53,623	77.9	72.4	
2004	13,184	58.4	43.0				31,208	86.8	85.8				

Abbreviations: HPV1: First dose of Human papilloma virus vaccine; HPV2: Second dose of Human papilloma virus vaccine

¹The coverage reflects the number of registered vaccines and may thus underestimate the actual vaccination coverage. ² Including girls from birth cohorts where HPV vaccination has been offered from 1 year before age of recommended vaccination until 14 years of age and where vaccinations were registered in the vaccination registers. The years with available data is defined based on introduction of HPV vaccinations into the National immunization programme or introduction of vaccination register which have comes last until last date with available data from both the population register and vaccination register.

sTable 3: Socio-economic factors at 10 years of age

	Denmark		Finland		Norway		Sweden	
	N	(%)	N	(%)	N	(%)	N	(%)
Children present in country at birth from 2004-2015	793,471		687,721		726,257		1,205,112	
Birth cohorts included	1994-2005		1994-2005		1994-2005		1994-2005	
Income quintile at 10 y	ears of ag	е						
First (lowest)	147,098	18.5%	135,946	19.8%	141,762	19.5%	219,673	18.2%
Second	149,579	18.9%	136,334	19.8%	146,247	20.1%	241,503	20.0%
Third	149,865	18.9%	136,384	19.8%	146,604	20.2%	245,097	20.3%
Fourth	149,310	18.8%	136,259	19.8%	146,471	20.2%	245,138	20.3%
Fifth	146,712	18.5%	135,464	19.7%	144,939	20.0%	241,452	20.0%
Unknown	50,907	6.4%	7334	1.1%	234	0.0%	12,249	1.0%
Number of children in	the housel	nold the ye	ear the chil	d turns 1	0 years of	age		
1	103,585	13.1%	96,861	14.1%	119,295	16.4%	162,968	13.5%
2	405,367	51.1%	293,068	42.6%	336,480	46.3%	587,332	48.7%
3	213,413	26.9%	184,925	26.9%	208,045	28.6%	292,516	24.3%
>3	61,674	7.8%	103,561	15.1%	62,203	8.6%	105,595	8.8%
Unknown	9432	1.2%	9306	1.4%	234	0.0%	12,249	1.0%
Single parenthood in t	he years th	ne child tui	ns 10 yea	rs of age				
Yes	151,471	19.1%	124,986	18.2%	131,761	18.1%	268,484	22.3%
No	632,568	79.7%	553,429	80.5%	587,793	80.9%	924,379	76.7%
Unknown	9432	1.2%	9306	1.4%	6703	0.9%	12,249	1.0%
Highest attained educational level ¹ of the mother on the date the child turns 10 years of age								
Low education	135,466	17.1%	75,462	11.0%	138,351	19.0%	193,551	16.1%
Medium education	340,574	42.9%	281,479	40.9%	270,114	37.2%	515,407	42.8%
High education	303,384	38.2%	329,885	48.0%	305,368	42.0%	394,220	32.7%
Unknown	14,047	1.8%	895	0.1%	12,424	1.7%	101,934	8.5%

¹ Highest attained education was categorized based on the International Standard Classification of Education (ISCED) 2011 using the main groups (1).

Appendix 3: ATC codes obtained for the study population in each country within NONSEnse

ATC-Group	Denmark	Finland	Norway	Sweden
D	D	D07, D11AH	D	D02AF, D05
				D07, D11
				D01, D06, D08
J	J	J	J	J01-J06
				J07
R	R	R01, R03, R06	R	R01, R03, R06
S	S	S01G, S03	S	S01-S03
V	V01	V01 ¹	V01	V01

¹Data on redeemed prescriptions with ATC=V01 is only available from the Finnish Benefits Registry, which holds information only for reimbursable redeemed prescriptions.

References

1. UNESCO Institute for Statistics. International standard classification of education: ISCED 2011. 2012.