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Denmark's approach to health data

Register-based research in Denmark



Registers

- Nordic register tradition
 - Denmark
 - Sweden
 - Norway
 - Finland
 - Iceland
- Unique personal identification number (CPR-number)
- Tax-funded health care and social benefit systems

History - Denmark

- Long tradition for registers of the Danish population
- Births and deaths registered in church records since 1645
- First Danish census in 1769 (27 censuses until 1970)
- Danish population register in 1924 (each town and parish)

Parochie	Beskrivelse af Parochien	Antallet af Indbyggere	Antallet af Mandfolk	Antallet af Kvindfolk	Antallet af Børn	Antallet af Fremmede	Antallet af Døde	Antallet af Levende	Antallet af Uægte Børn	Antallet af Slaver	Antallet af Friboer
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History

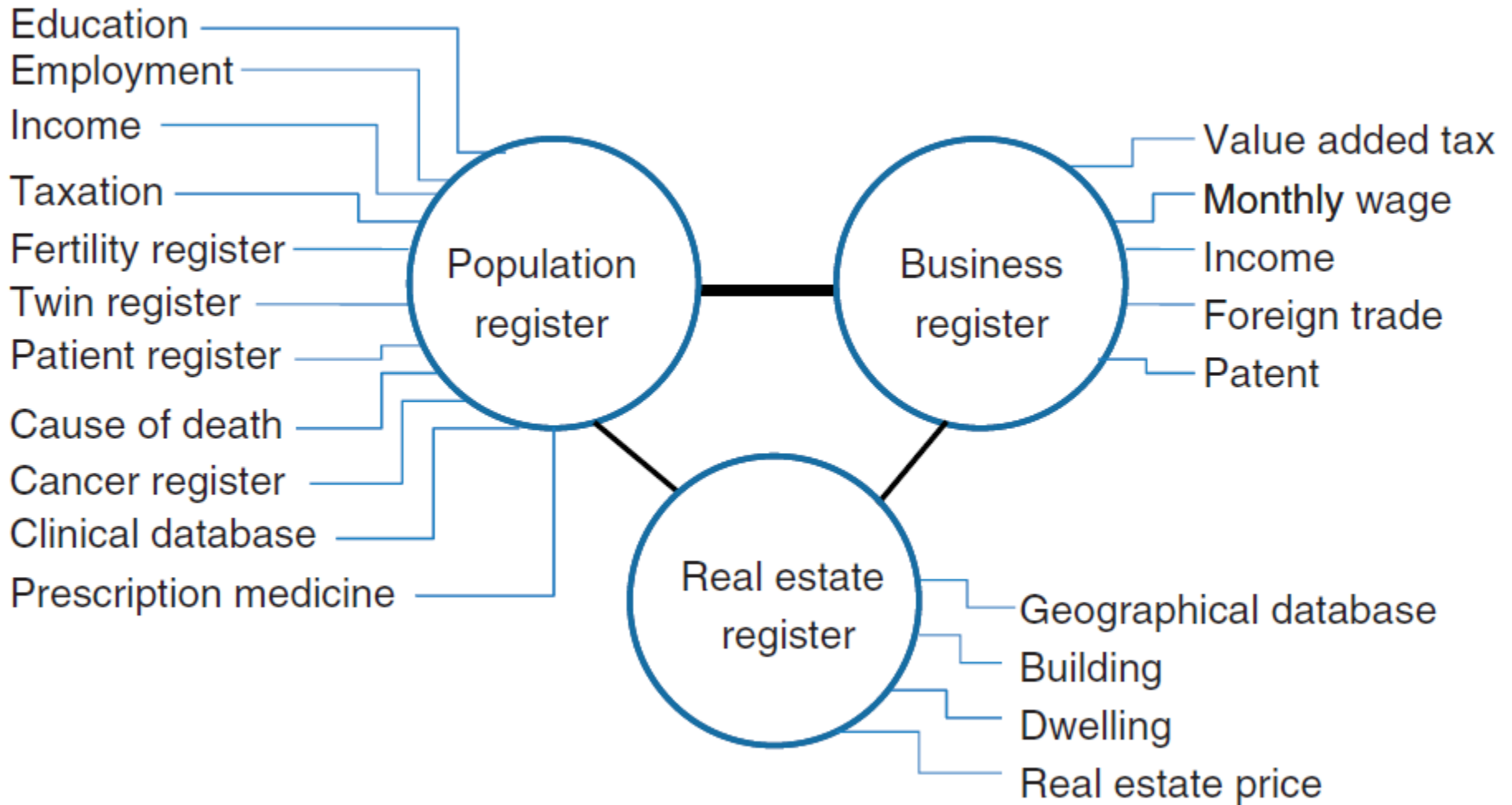
- Introduction of the Danish CRP-number
 - unique personal identification number
- 2 April 1968
- Denmark performed the first register-based census in 1981 (Finland in 1990)

Base registers

- Base registers must be able to provide data for different populations
- Contain all objects
- In all Nordic countries, at least 3 base registers are defined:
 - Register on persons
 - Business register
 - Register on properties

Det Centrale Personregister
Det Centrale Virksomhedsregister
Bygnings- og Boligregistret (BBR)

Organisation: Base registers



Central registers

- Civil Registration System (1968-) Base register
- National Patient Register (1977-) Hospital care
- Register of Causes of Death (1875-) Mortality
- National Prescription Registry (1995-) Prescriptions
- Health Service Register (1990-) Primary health care
- Disease specific registers, e.g.
 - Cancer (1943-)
 - Sclerosis (1950-)
 - Psychiatry (1970-)
- Registers on social factors (~1980-) Education, income, etc
- Municipality service data (2008-) Municipal services

Danish Civil Registration System

- Established 1968
- Individual information on the name, gender, date of birth, place of birth, citizenship and identity of parents / children
- Continuously updated information on vital status, place of residence and spouses
- One record (line) per inhabitant
- Historical data stored

CPR	Sex	Age	Date of Birth	Muni	CPR spouse	Type of family	C_status	C_status_h en_start
070761-4285	1	69	07/07/1961	101	...	1	01	27/03/2012
...	2	71	21/11/1916	181	...	1	90	16/03/1976
...	2	23	17/10/1967	175		4	80	18/11/2001

The Danish National Prescription Registry

- Individual-level data on all prescription drugs sold in Danish community pharmacies
- Contains information on dispensed prescriptions (drug user, prescriber, pharmacy)
- Possibly many records (line) per inhabitant, continuously updated
- Using ATC codes

CPR	ATC	Date	DDD	Unit	Dose	Type	Price
070761-4285	J01CE	10/03/2001	8	mg	800	Tablet	
070761-4285	D01BA	02/07/2004		Mg			
...	C03CA	18/03/2004					
	N03AX	05/06/1997	28	mg	150		

The Danish Register of Causes of Death

- Since 1875, the National Board of Health registered all deaths among citizens dying in Denmark
- 1970 computerised individual records
- Using ICD-10 codes (1994-)
- Low autopsy rate!

CPR	Underlying cause	Contributory cause I	Contributory cause II	Contributory cause III	Manner of death	Date
...	M545	4919	-	-	1	2007-12-26
...	R999	-	-	-	2	2007-02-05
...	I421	G039	4919	-	0	2007-05-15

The Danish National Patient Register

- Established 1977
- At onset included inpatients in somatic wards
- Content gradually expanded
 - Emergency and outpatient since 1995
 - Since 2007 included information on all patients in Danish hospitals
- Using ICD-10 codes (1994-)

CPR	Date of admission	Date of discharge	Age at admission	Pattype	Gender	A_diag
070761-4285	04111997	03041998	17	0	1	C329
070761-4285	24022002	01032002	17	1	1	I200
...	25091998	27091998	80	2	2	R559
	01091998	02091998	44	0	2	K449

The Danish National Health Service Register

- Established 1990
- Activities of health professionals contracted with the tax-funded public health care system
- General practitioners, practising medical specialists, physiotherapists, dentists, psychologists, chiropractors, and chiropodists
- Service codes, no diagnoses

CPR	Age	Gender	GP provider number	Service	Speciale	Year	Week
070761-4285	17	1	87305	201	80	2010	35
070761-4285	18	1	87305	2601	80	2011	20
...							

Income Statistics Register

- Statistics Denmark
- Income composition of the Danish population since 1970
- Contains >160 variables including salaries, entrepreneurial income, taxes, public transfers, capital income, private pension
- Specific income transfers, including sickness benefit, old age pension, disability pension, and unemployment benefits
- One record (line) per inhabitant per year

CPR	Gross income (kr)	Disposable income (kr)	Classification employment	Classification socio-economic status
070761-4285	416298	289456	4	134
...	166700	134589	10	210
...	1713968	1561423	4	132

Clinical databases

Measure quality of clinical treatment for specific patient groups

Treating hospital departments report by clinical personnel

Steps through treatment course

Clinical databases

Both national and regional databases

Challenge:

Decentralized organization

71 approved (by 29 January 2016)

Biobanks

Danish National Biobank (2012)

Routinely collected biological material

Main purpose:

Overview/access to >16 mill samples

Danish Biobank Register–search function

When an Entire Country Is a Cohort

Denmark has gathered more data on its citizens than any other country. Now scientists are pushing to make this vast array of statistics even more useful

For years, any woman who got an abortion had to accept more than the loss of her fetus: For some unknown reason, she also faced an elevated risk for breast cancer. At least that was what several small case-control studies had suggested before Mads Melbye, an epidemiologist at the Statens Serum Institute in Copenhagen, undertook the largest effort ever to explore the link. He and his colleagues obtained records on 400,000 women in Denmark's national Abortion Register, then checked how many of the same women were listed in the Danish Cancer Register. Their foray into the two databases led to a surprising result: As they reported in *The New England Journal of Medicine* in 1997, there appears to be no connection between abortion and breast cancer.

Their success underscores the value of a trove of data the Danish government has accumulated on its citizens, which today totals about 5 million people. Other Scandinavian countries have created powerful database systems, but Denmark has earned a preeminent reputation for possessing the most complete and interwoven collection of statistics touching on almost every aspect of life. The Danish government has compiled nearly 200 databases, some begun in the 1930s, on everything from medical records to socioeconomic data on jobs and salaries. What makes the databases a plum research tool is the fact that they can all be linked by a 10-

digit personal identification number, called the CPR, that follows each Dane from cradle to grave. According to Melbye, "our registers allow for instant, large cohort studies that are impossible in most countries."



Beasty in numbers. These Danish twins starred in a variety show at the turn of the 20th century; now it's their medical records, part of a database, that are in demand.

But Melbye and other scientists think they can extract even more from this data gold mine. They argue that not enough money is being spent on maintaining and expanding existing databases, and they say that red tape is hampering studies that require correlation of health and demographic data. The problem is that, while they have unfettered access to more than 80 medical databases maintained

by the Danish hospitals, their databases covers Denmark is tight mark won't also its premises databases for access and e-Statistics Denmark to release data concerns. "The data that infuse individuals does not exist," says

enter the data bank can be told. Scientists can't use the U.S. twin registries because of the lack of a unique identifier for each twin. The Danish twin registries are more than 80 years old. Christian genes about a man longevity by the umbilical cord of the Danish twin registries. The health care system is smaller than

The Epidemiologist's Dream: Denmark

If the planners of a U.S. study of children's health could work in an ideal world, it might be Denmark. Epidemiologists there finished enrolling a cohort of 100,000 pregnant women into a mother-and-child research project last September and expect to finish collecting data from the children over the next year. The entire survey—which is large for this country of 70,000 annual births—is to be completed in 2005 for about \$15 million, a tiny fraction of what the cost would be in the United States.

The Danes didn't design their Better Health for Mother and Child cohort study to answer specific questions or conduct long-term follow-up, as the Americans plan to do (see main text). Instead, they aim to create a databank that generations of researchers can mine and use as a starting point for studies of how medications, infections, nutrition, and even psychological factors affect pregnancy and child health.

Physicians have recruited volunteers among women making their first pregnancy visit. Participants give two blood samples during pregnancy and cord blood when the baby is born. The samples are saved for later use, including possibly for genetic studies. The mothers also answer a detailed questionnaire concerning nutrition; in an 18-month follow-up, they give information on their health and environmental exposures. The public health system is funding the study, with support from private and public foundations.

"Because the Danish population is probably the world's best registered, Denmark is the ideal place for such studies," says epidemiologist Mads Melbye, a steering group member from Statens Serum Institute

in Copenhagen. Each citizen has a personal identification number that can be used to track data in centralized health care records, disease registries, and a population registry. Even centralized school records may be used. "It's an epidemiologist's dream," says Mark Klebanoff of the U.S. National Institute of Child Health and Human Development, who says tracking subjects is one of the costliest aspects of long-term U.S. studies.

Norway, which has a system like Denmark's, is launching a mother-child study that will pool data with the Danish group's. Both benefit from streamlined management. It's difficult to get things done with too many decision-makers, says Melbye: "Running such a large study has taught us many things, but the chief lesson is that it is essential to put a very small group of people in charge."

Results are already beginning to trickle out of the Danish study. For example,

one group published an article in *The Lancet* last November that disproved the existing consensus view that a fever early in pregnancy increases the risk for miscarriage. That's just the beginning; Denmark's scientific ethics committee has so far given the green light to more than 70 research protocols based on the mother-child study.

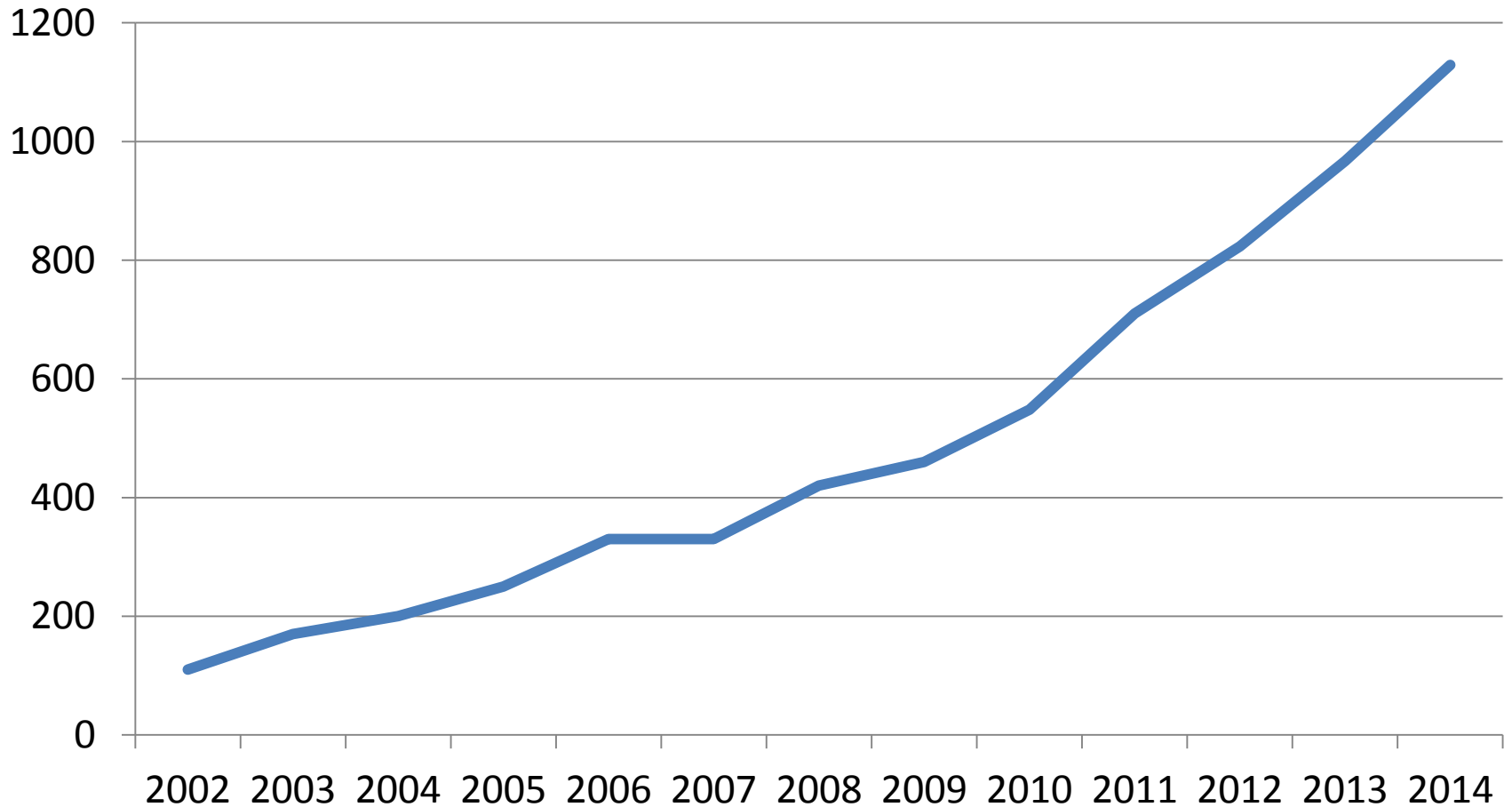
—LOUIE FRANK

Louise Frank is a science writer in Copenhagen.



Ready subjects. Denmark's 18-month-long birth cohort survey will collect data from mothers and newborns for a new database.

Statistics Denmark: Active projects



Why register-based research

- Population-based studies – total population
- Long follow-up time – valuable time has passed
- No need to contact individuals
- No non-response bias (participation, reporting)
- Data independent of research question

Register-based research

- **Unique opportunities**

- Fast and efficient answers
- Economy - low cost
- Whole population

Challenges

- Bias
- Confounding
- Validity
- Completeness

One example

Statin use and cancer mortality

- A reduction in the availability of cholesterol could lead to decreased proliferation
- Statin use begun before a cancer diagnosis may reduce cancer-related mortality

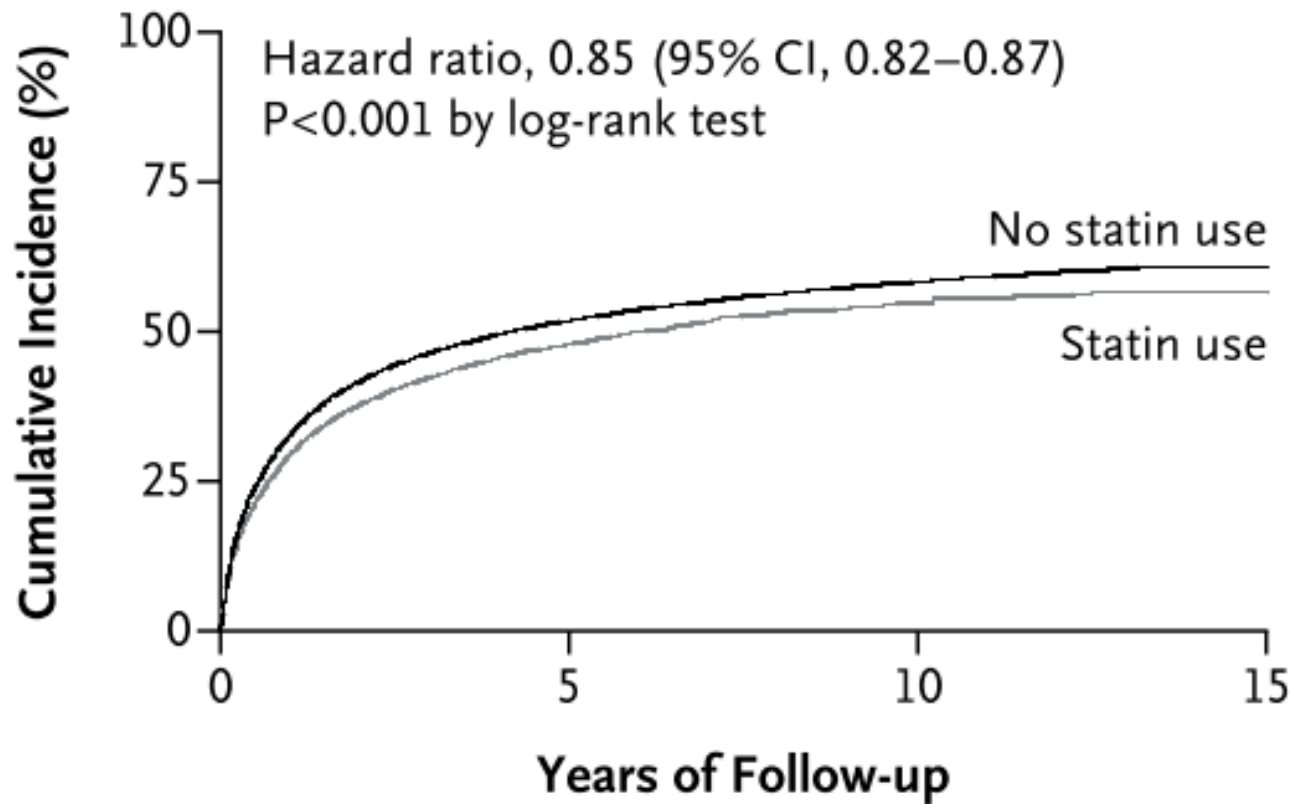
Material

- Population: Persons with cancer diagnosed 1995-2007
- Danish Cancer Registry (98% of all incident cancers in Denmark)
- Prescription Registry: All prescribed drugs dispensed at Danish pharmacies since 1995
 - ATC codes
 - Drug name
 - Date of dispensing
 - Total amount of the recommended defined daily dose

Other variables

- Age
- Sex
- Race (97% Danish descent)
- Cancer stage
- Treatment (radiotherapy, chemotherapy)
- CVD before cancer diagnosis
- Diabetes before cancer diagnosis
- Highest level of education
- Size of residential area

Death from Cancer



Cause of Death and Statin Dose	No. of Patients	No. of Deaths	Hazard Ratio (95% CI)	P Value
Any cause				
0.00	277,204	184,895	1.00	
0.01–0.75	9,780	5,730	0.82 (0.81–0.85)	<0.001
0.76–1.50	6,181	3,438	0.87 (0.83–0.89)	<0.001
>1.50	2,760	1,531	0.87 (0.81–0.91)	<0.001
Cancer				
0.00	277,204	153,327	1.00	
0.01–0.75	9,780	4,680	0.83 (0.81–0.86)	<0.001
0.76–1.50	6,181	2,810	0.87 (0.83–0.91)	<0.001
>1.50	2,760	1,250	0.87 (0.81–0.92)	<0.001
Cardiovascular cause				
0.00	277,204	13,512	1.00	
0.01–0.75	9,780	529	1.08 (0.99–1.19)	0.08
0.76–1.50	6,181	314	1.25 (1.21–1.41)	<0.001
>1.50	2,760	134	1.24 (1.03–1.48)	0.01

Access to data

Balance btw use of data and confidentiality

Public benefit vs privacy rights

No patient consent to be in registers

Research projects involving human tissue - ethics committee

Register-based projects not obliged to be accepted by an ethical committee - Data Protection Agency

Evaluating whether the study is for the public good

Need-to-know versus nice-to-know

Organization

Access to data

Two main institutions:

- **Statistics Denmark**
- **Health Data Agency**

Vast amount of data

Log-on to their servers

The end...

- Creative use of registers gives great possibilities
- Linkage with e.g. surveys and clinical data
- Always remember the limitations:
 - Validity
 - Completeness
 - Pre-determined data collection
 - Truncation
 - Bias and confounding

Scandinavian Journal of Public Health

“Danish population-based registers for public health and health-related welfare research

A description of Danish registers and results from their application in research”

July 2011; 39 (7 suppl)



Danish Epidemiology Society

538 members (50 PhD students)

Meeting next week:

Decreasing participation rates and
alternative data collection

Thank you for your attention

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