

## The National FINRISK Study

### Information for researchers interested in using stored samples and data

#### Contents

Introduction.....	1
Ethical considerations.....	2
A short history of FINRISK surveys.....	3
FINRISK samples available for biobank research.....	4
FINRISK phenotype data available for biobank research .....	5
Data collected by questionnaires .....	5
Registry data .....	5
Physical examination data.....	5
Biological measurements .....	5
FINRISK omics data available for biobank research .....	6
Genomics data.....	6
Other omics data in FINRISK.....	6
FINRISK sub-studies .....	7
Summary table of sub-studies.....	7
DILGOM .....	9
FINDIET .....	9
Research group.....	10

#### Introduction



The FINRISK cohorts comprise the respondents of representative, cross-sectional population surveys that were carried out every 5 years between 1972 and 2012, to assess the risk factors of chronic diseases (e.g. CVD, diabetes, obesity, cancer) and health behavior in the working age population, in 3-6 large study areas of Finland. The FINRISK surveys were conducted by the Finnish Institute for Health and Welfare, THL (previously National Public Health Institute, KTL).

Data was collected from each participant at baseline via questionnaire and health examination. The baseline data includes background information on socioeconomic status, medical history, smoking, diet, physical activity, as well as information from the health examination, such as blood pressure, height and weight. Blood samples were collected during the health examination and a large spectrum of laboratory measurements from serum and plasma samples is available. The number of participants was 6 000-8 800 per survey (while 10 000-13 500 individuals per study were invited). The cohorts are followed up by linking

them to national health registers. More detailed information about the sampling is available in Table 1 and in [FINRISK-reports](#) (in Finnish).

The FINRISK cohorts that have been transferred to THL Biobank are those with available DNA samples for the full cohort, survey years: 1992, 1997, 2002, 2007 and 2012, as well as the Kuusamo Health Examination 2011 (pilot study for FINRISK 2012). Plasma and serum samples are still available for use for the 2002-2012 cohorts. In addition to FINRISK surveys, DILGOM 2007 survey (a sub-study of FINRISK 2007) and its follow-up survey DILGOM 2014 have been transferred to THL Biobank.

The FINRISK surveys represent a 40 year tradition of systematic and standardized health examinations, providing health planners and policy makers invaluable information to guide health promotion work. The FINRISK Calculator, an online tool to calculate a person's 10-year risk for cardiovascular diseases based on FINRISK data, is in regular use among health care professionals in Finland (<http://www.thl.fi/finriski-laskuri>).

**Table 1.** Sampling details of FINRISK Surveys 1992-2012 and DILGOM 2007 and 2014

Sample collection	Gender	Participant age (years)	# Study areas	Study areas
FINRISK 92	M&F	25–64	4	North Karelia, North Savonia, Turku and Loimaa, Helsinki and Vantaa
FINRISK 97	M&F	25–74	5	North Karelia, North Savonia, Turku and Loimaa, Helsinki and Vantaa, Northern Ostrobothnia and Kainuu
FINRISK 02	M&F	25–74	6	North Karelia, North Savonia, Turku and Loimaa, Helsinki and Vantaa, Northern Ostrobothnia and Kainuu, Lapland
FINRISK 07	M&F	25–74	6	North Karelia, North Savonia, Turku and Loimaa, Helsinki and Vantaa, Northern Ostrobothnia and Kainuu, Lapland*
FINRISK 12	M&F	25–74	5	North Karelia, North Savonia, Turku and Loimaa, Helsinki and Vantaa, Northern Ostrobothnia and Kainuu
Kuusamo Health Examination 2011	M&F	25–74	1	Kuusamo area
DILGOM 2007	M&F	25–74	5	North Karelia, North Savonia, Turku and Loimaa, Helsinki and Vantaa, Northern Ostrobothnia and Kainuu
DILGOM 2014	M&F	32–81	5	North Karelia, North Savonia, Turku and Loimaa, Helsinki and Vantaa, Northern Ostrobothnia and Kainuu

\*no samples collected, not included in THL Biobank

### Ethical considerations

The FINRISK 1992 survey precede current legislation on ethics in medical research and specific ethical approval was not required. The participants were fully informed about the study and they participated in the study voluntarily. Agreeing to participate in the baseline clinical visit was taken to indicate informed consent.

Participants of the FINRISK 1997-2012 surveys have all signed an informed consent, allowing the use of their data and samples for studying environmental and genetic risk factors of chronic diseases. Each FINRISK survey obtained ethical approval according to the law prevailing at that period:

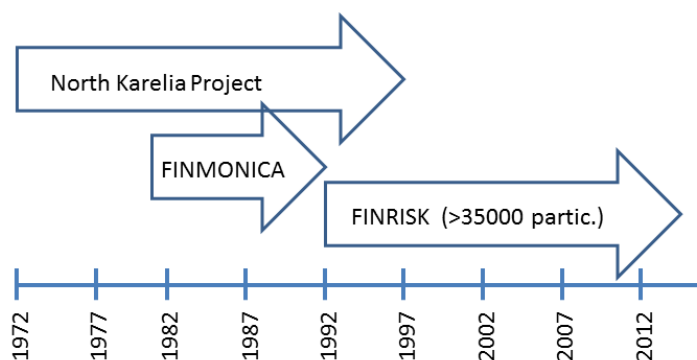
- FINRISK 1997 and FINRISK 1992 studies were approved by the Ethical Committee of the National Public Health Institute on 22 January 1997
- FINRISK 2002 study was approved by the Ethical Committee for Epidemiology and Public Health of the Hospital District of Helsinki and Uusimaa at 19 December 2001
- FINRISK 2007 study was approved by the Coordinating Ethical Committee of the Hospital District of Helsinki and Uusimaa at 14 November 2006
- Kuusamo Health Examination 2011 was approved by the Coordinating Ethical Committee of the Hospital District of Helsinki and Uusimaa at 30 March 2011.
- FINRISK 2012 study obtained final approval by the Coordinating Ethical Committee of the Hospital District of Helsinki and Uusimaa at 8 August 2013

The FINRISK sample collections from years 1992 to 2012 have been transferred to THL Biobank in June 2015, following a public announcement that appeared in newspapers on March 2015. THL Biobank hosts samples and data only from individuals who have donated samples in the FINRISK 1992-2012 surveys, and who have not prohibited the transfer of their samples and data to THL Biobank. The transfer of the FINRISK sample collections to the biobank has been approved by the Coordinating Ethics Committee of Helsinki University Hospital on 10 October 2014 and by the Ministry of Social Affairs and Health on 9 March 2015.

### A short history of FINRISK surveys

The first FINRISK survey was done in 1972 in North Karelia, with the aim of implementing an intervention program (the North Karelia Project) to combat the world's highest CHD incidence rates at the time. The intervention program's key elements were reduced intake of saturated fat and sodium, increased consumption of vegetables and reduced smoking rates. The intervention program was highly successful, substantially decreasing serum total cholesterol levels, blood pressure levels and smoking prevalence, and consequently lowering CHD incidence. Later, this intervention program was successfully introduced to the whole country with support of the National Public Health Institute. Since launching of the North Karelia Project, CHD mortality rate decreased by 80% in the working aged population, which is clear evidence that lifestyle intervention can prevent disease.

The first and second surveys in 1972 and 1977 were carried out in Eastern Finland (North Karelia and Kuopio area) to evaluate the North Karelia Project. Additional areas were added in later years to improve the national representativeness of the monitoring. In 1992 following areas were included: North Karelia, Kuopio area, Southwest Finland (city of Turku and Loimaa area), and Helsinki area (cities of Helsinki and Vantaa). From 1997 onward also Northern Ostrobothnia and Kainuu as Oulu area were added in the survey.



**Figure 1.** History of FINRISK surveys

The FINRISK cohorts of 1982-1992 were also part of the international WHO MONICA (Multinational **MON**itoring of trends and determinants in **CA**rdiovascular disease) project established in the early 1980s. The project aimed to monitor trends in cardiovascular diseases, and to relate these to risk factor changes in the population over a ten year period. For more information see: <http://www.thl.fi/monica/index.html>. FINRISK is included in the MORGAM (MONica Risk, Genetics, Archiving and Monograph) Project, a multinational collaborative study exploring the relationships between the development of cardiovascular diseases, their classic and genetic risk factors and biomarkers (<http://www.thl.fi/morgam/>).

### FINRISK samples available for biobank research

Table 2 provides information on the samples collected in the FINRISK surveys. Most of the samples are still available for research. For FINRISK 1992 and 1997, most of the serum and plasma samples have been depleted.

**Table 2.** Samples collected in FINRISK Surveys 1992-2012 and available for use through THL Biobank

Sample collection	Collected samples	Samples stored in biobank	# Sample donors
FINRISK 92	Blood	DNA	6024
FINRISK 97	Blood	DNA	8387
FINRISK 02	Blood	DNA, serum, plasma, urine*, stool*	8775
FINRISK 07	Blood	DNA, RNA*, serum, plasma	6219
FINRISK 12	Blood	DNA, RNA*, serum, plasma, frozen cells*, urine*	5813
Kuusamo Health Examination 2011	Blood	DNA, RNA, serum, plasma, frozen cells	250
DILGOM 2007	Blood	RNA*, serum, plasma	4977
DILGOM 2014	Blood	DNA, RNA*, serum, plasma, frozen cells*	1294

\*available only for a subset of the participants

In addition to these samples, there are also cryopreserved peripheral blood mononuclear cells (PBMC) available for research use as detailed in Table 3. Ten ml of blood was collected in Li-Heparin tube for PBMC extraction. Cells were isolated by Ficoll-Hypaque-method. Two vials containing ~2-8x 10<sup>6</sup> PBMC were cryopreserved in FBS + 10% DMSO and stored in vaporous phase of liquid nitrogen.

**Table 3.** Cryopreserved peripheral blood mononuclear cells

Sample collection	Number of subjects	Cell type	Max. time between sampling and isolation
Kuusamo 2011	240	PBMC	48h
FINRISK 2012	1860	PBMC	30h
DILGOM 2014	600	PBMC	30h

## FINRISK phenotype data available for biobank research

FINRISK is using the standardized MONICA (<http://www.thl.fi/publications/monica/manual/part3/iii-1.htm>) and EHES (<http://www.ehes.info/>) procedures for phenotype collection.

The list below provides details on the baseline data that is available for sharing for all/most FINRISK participants from survey years 1992-2012. This data is actively used for various epidemiological and medical studies. The full list of variables can be accessed via KITE (<https://kite.fimm.fi/>) and is also available from THL Biobank's sample collection page.

### Data collected by questionnaires

- Sociodemographic and socioeconomic characteristics
- Life habits / behaviors
  - ✓ Smoking
  - ✓ Alcohol use
  - ✓ Exercise
  - ✓ Sleep
  - ✓ Other information
- Nutrition
  - ✓ Diet / nutrition habits
  - ✓ Food Frequency Questionnaire
  - ✓ Specific food items
- Health status
  - ✓ Symptoms
  - ✓ Use of health services
  - ✓ Medication
  - ✓ Work- and functional ability
  - ✓ History of chronic diseases and their treatment
- Family history of disease
- Women's questions

### Registry data

Data from Finnish National Registers (such as National Social Welfare and Health Care registers e.g. Care Register for Health Care, Cancer Registry, Statistics Finland's registers, Kela's registers e.g. Drug Reimbursement Registers) can be linked to all sample donors by a separate application process.

### Physical examination data

- Weight, height, BMI, waist and hip circumference
- Blood pressure and pulse rate

### Biological measurements

Various laboratory measurements were done using samples collected from the participants at baseline. Table 4 includes laboratory measurements that are available for >3000 participants. In addition to these, there are also measurements that were done on smaller sets of participants as part of different sub-studies. For detailed information about measurements in each study please see variable descriptions –files at the THL Biobank sample collection page.

**Table 4.** Number of participants with laboratory measurements in the original FINRISK studies 1992-2012. Number of results available for use through THL Biobank might be a bit smaller.

Laboratory measurement	1992	1997	2002	2007	2012	TOTAL
Adiponectin				4980		4980
Alanine aminotransferase			8747		5817	14564
Aspartate aminotransferase					5817	5817
Albumin					5817	5817
Apolipoprotein A-I	982	7817	8747	6236	5817	29599
Apolipoprotein B	1197	7818	8747	6236	5817	29815
Arachidonic acid %					5817	5817
Calcium			3548		5817	9365
Carbohydrate deficient transferrin		8026	184	1286		9496
Cotinine	5852		166	1158	1681	8857
C-reactive protein, high sensitivity	1103	7818	8747	6236	5817	29721
Creatinine			8747	4997	5817	19561
Fibrinogen	2277	1387				3664
Follicle-stimulating hormone				3151		
Free fatty acids, 0h-value				5011		5011
Free fatty acids, 2h-value				4784		4784
Gammaglutamyltransferase	6022	8386	8775	6236	5817	35236*
Glucose in OGTT, 0h-value	2081		3738	5011		10830
Glucose in OGTT, 2h-value	1985		3618	4784		10387
HDL cholesterol	6024	8388	8775	6236	5817	35218*
Hemoglobin A1c, glycated			7817		5784	13601
Insulin in OGTT, 0h-value	1939		3737	5000		10676
Insulin in OGTT, 2h-value	1843			4747		6590
Interleukin 1				4980		4980
LDL cholesterol (calculated)	6024	8388	8775	6236	5817	35218*
LDL cholesterol (measured)			8747	4997		13744
Lipopolysaccharide	816	6782				7598
Total cholesterol	6024	8388	8775	6236	5817	35218*
Triglycerides	6024	8388	8775	6236	5817	35218*

\*These measurements are also available for some/all of the previous FINRISK surveys

## FINRISK omics data available for biobank research

### Genomics data

Genome-wide genotypes are available for nearly all FINRISK 1992-2012 participants as genotyped chip variants as well as genotypes imputed to a population-specific imputation panel. Whole-genome and exome sequencing is available for a subset of samples. For detailed availability of omics data, see the THL Biobank Omics data availability table' at the THL Biobank sample collection page.

### Other omics data in FINRISK

FINRISK samples have been used for other omics analysis as described below.

Nuclear magnetic resonance (NMR) based biomarker analysis assay by Nightingale Health: Nightingale Health has produced high quality NMR metabolomics data for THL Biobanks large population-based cohorts. A total of 36,960 serum samples have been successfully analyzed during 2018-2019 for a panel of >200 biomarkers. In the National FINRISK Study data is available from collection years 1997-2012, including FINRISK 2007 follow-up studies DILGOM 2007 and DILGOM 2014 (including >1000 samples with metabolite data from two timepoints 7 years apart).

The DILGOM Helsinki multi-omics study: Several omics platforms have been analyzed for a total of 518 individuals from the Helsinki area who participated in the SOKRAS/DILGOM sub-study in 2007, and for whom bioimpedance and glucose tolerance test data are available in addition to the standard baseline data. The available omics data:

- RNA expression data analyzed with Illumina HumanHT-12 Expression BeadChips
- Genome-wide SNP variation data using Illumina 610-Quad SNP array
- Serum NMR metabolomics data (228 metabolic measures)
- Methylation analysis with Illumina Infinium HumanMethylation450 BeadChip Kit

A total of 350 individuals also participated in the follow up study DILGOM 2014 with questionnaire data, laboratory measures and transcriptomic data from two time points.

For more information see Inouye et al. 2010, Molecular Systems Biology 6, article 441; Inouye et al. 2010, PLoS Genetics 6(9): e1001113.

Telomere length study: Mean telomere length has been analyzed for 4083 participants of the DILGOM/SOKRAS 2007 sub-study by quantitative PCR-based technique in the Neurogenomics Laboratory of Dr. Iiris Hovatta, University of Helsinki (<http://www.helsinki.fi/neurogenomics/>). For more information see Codd et al. 2013, Nature Genetics 45:422-427.

Biomarker study: 30 selected biomarkers representing lipid metabolism, inflammation, hemodynamic physiology, vascular function, oxidative stress, coagulation, renal function, angiogenesis, and myocardial necrosis have been analyzed in the full FINRISK 1997 cohort (N=7915) at the University Medical Center Hamburg-Eppendorf. For more information see Blankenberg et al. 2010, Circulation 121:2388-2397. FINRISK 1997 and FINRISK 2002 are currently part of the BiomarCaRE consortium (<http://www.biomarcare.eu/>): Biomarker for Cardiovascular Risk Assessment in Europe.

## FINRISK sub-studies

### Summary table of sub-studies

Each FINRISK survey included also several sub-studies. Each sub-study has focused on a certain topic and included additional questionnaires, samples, and/or measurements. Information on the main FINRISK sub-studies is available in Table 5. Please note that in certain sub-studies the data is available through the sub-study research group and the use of collected data is done in collaboration with them

**Table 5.** FINRISK sub-studies

Substudy topic	Unique features	Number of participants				
		FR92	FR97	FR02	FR07	FR12
Alcohol	25-74 years old participants from Helsinki area, Southwestern Finland, and Kuopio area. Audit10 questionnaire and alcohol usage interview.				2421	
Allergy (Finallergia)	25-54 years old from North Karelia. Nitric oxide measurement and questionnaire.		790		680	

Alopecia	All men participating in the survey: Alopecia degree, interview about hair loss and alopecia among relatives			4482		
Anti-oxidants	25-64 years old men in North Karelia: Laboratory measurements of anti-oxidants	242				
Balance tests	Done during clinical visit in Southwestern Finland to persons participating in Functional ability substudy.				705	
Blood pressure measurements (RRS)	25-74 years old from Southwestern Finland who participated in DILGOM study. Blood pressure measurement, pulse wave, ECG, heart structure images, carotid artery ultrasound examination, laboratory samples.					493
Coagulation factors	45-64 years old men and women from Helsinki area, Southwestern Finland and North Karelia, specific laboratory measurements	2378				
Cell lines	25-74 years old participants visiting Helsinki, Vantaa, Turku, Kuopio, Oulu and Joensuu sampling centres. Additional blood samples were taken for creating different cell lines.					1761
DEGA	45-64 years old men from North Karelia and Helsinki area that were participating in stress substudy. Additional laboratory samples.		369			
Environmental toxins	Participants of the DILGOM substudy from Kuopio area, Southwestern Finland and Oulu area. Measurements for permanent organic toxin levels from serum.				3184	
Exercise	All participants aged 25-74 years, excluding persons participating in FINDIET and/or passive smoking substudies. Questionnaire and 5-7 minute pulse measurement			6513		
Exposure to hot and cold	FR97: 25-74 years old from North Karelia and Helsinki area. Questionnaire; FR02: 25-74 years old participants from North Karelia, Kuopio area, Helsinki area, Southwestern Finland and Oulu area excluding those participating in FINDIET substudy. Questionnaire; FR07: 25-74 years old participants from North Karelia, Kuopio area, Helsinki area, Southwestern Finland and Oulu area excluding those participating in FINDIET substudy. Questionnaire; FR12: All persons 25-74 years old excluding those participating in FINDIET substudy. Questionnaire.		3233	7316	4007	3307
FINDIET (Finravinto)	Participants from different study areas aged between 25-74 years from all survey years. Food diaries or questionnaires, interviews, blood and nail samples.	2148	3233	2007	2038	1708
Fitness tests	25-74 years old participants from Joensuu, Kuopio, Turku, Helsinki, Oulu and Kajaani sampling centres. Fitness test for measuring maximal oxygen intake and muscle functional status.					1422
Functional ability	FR97: 65-74 years old men and women from North Karelia and Helsinki area. Questionnaire and health and functionality examination; FR07: All participants aged 25-74 years, excluding persons participating FINDIET substudy. Questionnaire		1288		4014	
Iron	Blood sample from 25-74 year old men and women from Helsinki area that are participating in FINDIET substudy.		704			
Lead exposure	Subsample of men and women from Helsinki area, specific laboratory measurements	288				
Mercury exposure	Hair samples from 25-44 years old women participating in FINDIET substudy.	537				
Minerals	All FINDIET substudy participants from Southwestern Finland and Oulu area. Blood and urine sample collected.		1151			
Mould exposure	All participants from Kuopio area, specific laboratory measurements	1476				
Nicotine dependence	Questionnaire for smokers/ex-smokers from North Karelia, Oulu area, Helsinki area, Southwestern Finland, Kuopio area who participated in the DILGOM substudy				2542	



PAIS (the Finnish Platelet Aggregation and Inflammation Study)	45–74 year old men from North Karelia and Helsinki area. Serum samples collected.		1571			
Passive smoking	25-64 year old non-smokers who reported exposure to cigarette smoke. Questionnaire, organic vapor monitor, serum cotinine measurement.			123		
Periodontal diseases	25-74 years old DILGOM substudy participants. Dental inspection, saliva samples for bacterial, enzyme and cytokine measurements.				5056	
Physical activity measurement	25-74 years old FINDIET substudy participants. Week measurement with accelerometer and activity diary.					1204
Proteomics	All DILGOM study participants from Helsinki area. Additional laboratory samples for proteomics and RNA.					630
SOKRAS/DILGOM (Dietary, Lifestyle, and Genetic determinants of Obesity and Metabolic syndrome)	FR92: Participants aged 45-64 years old, glucose tolerance test; FR02: questionnaire and glucose tolerance test to >45 year old participants; FR07: 25-74 year old participants. Questionnaire, oral glucose tolerance test, bioimpedance	2037		3767	5024	
Stress	FR92: 25-64 years old from all survey areas. Stress questionnaire for men and women; FR97: 25-74 years old from all survey areas excluding persons participating FINDIET substudy. Stress questionnaire.	3903	5213			
Urine collection (24 h)	Urine collection and urine measurements from participants of the FINDIET substudy from North Karelia, Helsinki area and Southwestern Finland			1564		399

## DILGOM

DILGOM 2007 survey was a sub-study of The National FINRISK 2007. The follow-up survey was done seven years later as a DILGOM 2014 follow-up survey. The abbreviation DILGOM comes from the name Dietary, Lifestyle, and Genetic determinants of Obesity and Metabolic syndrome. The Surveys are population studies on how nutrition, diet, lifestyle, psychosocial factors, environment and genetics are linked to obesity and the metabolic syndrome.

5024 participants aged 25-74 years old from Helsinki area, Southwestern Finland, North Karelia, North Savonia and Oulu area was participated in DILGOM 2007. DILGOM 2014 survey was conducted in the same areas. Participants filled a questionnaire and oral glucose tolerance test and bioimpedance were done. In DILGOM 2014, oral glucose tolerance test was done only those from Helsinki area and Southwestern Finland. DILGOM 2007 sample collection was done within the framework of FINRISK 2007 and no additional sampling was done.

## FINDIET

The National FINDIET Survey (*in Finnish: Finravinto-tutkimus*) has followed the dietary habits and nutrient intake of the adult Finnish population since 1982. The FINDIET Surveys have been carried out as a sub-studies of the National FINRISK Surveys. Cohort data from survey year 1992 onwards is available through THL Biobank. About a third (30-33 %) of FINRISK 1992-2012 participants was invited to the FINDIET Survey in each year.

Participants of FINDIET 1992 were 25-64 years old from Helsinki area, Southwestern Finland, North Karelia and North Savonia. Participants filled food diary and blood and nail samples were also taken.

Participants of FINDIET 1997 and FINDIET 2002 were 25-64 years old from Helsinki area, Southwestern Finland, North Karelia, North Savonia and Oulu area and participants of FINDIET 2007 and FINDIET 2012 25-74 years old from the same areas.

In FINDIET 1997 participants filled food questionnaire and had a dietary interview about the previous day food intake. Laboratory samples were also taken. Participants of FINDIET 2002, FINDIET 2007 and FINDIET 2012 were interviewed and their 48-hour dietary recall data was recorded by dietary interviewers. The use of food supplements was also studied in FINDIET 2007 and FINDIET 2012. In FINDIET 2007, every second respondent was also asked to fill in a food record for the following three days. Those who returned a completed food record were sent another food record to fill in at the end of the year.

## Research group

### Principal Investigator

Pekka Jousilahti, THL

The analysis and reporting utilizing FINRISK collections is very active, and includes research on a very wide spectrum of topics. Over 1200 scientific articles and 90 doctoral theses have been published to date using FINRISK data. For an updated list of publications see:

[https://thl.fi/documents/10531/862648/FINRISKInjulkaisut\\_1972\\_2016.pdf/8c054d4d-0f29-4b6e-84fb-93f3a4cad1cf](https://thl.fi/documents/10531/862648/FINRISKInjulkaisut_1972_2016.pdf/8c054d4d-0f29-4b6e-84fb-93f3a4cad1cf) or FINRISK study websites (in Finnish) <https://thl.fi/fi/tutkimus-ja-kehittaminen/tutkimukset-ja-hankkeet/finriski-tutkimus/julkaisut>

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