

The Pro006 data product

Original number of samples	1,140
Number of samples (per 23.09.2026)	1,138
Number of unique participants	1,133
Biological sample type	Plasma
Participant type(s)	MoBa mothers
Collection timepoint	17-18 weeks' gestation
Selection criteria	Attention deficit hyperactivity disorder (ADHD)
Biomarker type(s)	Thyroid function biomarkers
Original reference article	Engel et al. 2018
Analytical method(s)	Quantitative chemiluminescent immunoassay
Related MoBaBIO product(s)	Mab015, Mab016, Mab017, Gtp002
FHI Project number(s)	PDB1040

The project that generated these data

Prenatal Phthalate, Phenol and organophosphate (OPs) exposure and symptoms of ADHD in Norway

Project lead: Heidi Aase

The main purpose of this project was to investigate the link between exposures to pesticides and endocrine disruptors in pregnancy, and the development of ADHD during childhood. The specific aims of this project were to study organophosphate and phthalate exposure during pregnancy and the effect this has on risk for developing ADHD in childhood, to investigate thyroid hormone exposure during pregnancy and the effect this has on the risk for developing ADHD in childhood, as well as the effect of phthalate exposure during pregnancy and how this affects maternal and neonatal thyroid biomarkers. Genetic modification of the association between ADHD in childhood and organophosphate exposure was a further investigative aim, using genotype data on important loci involved in xenobiotic metabolism and specific mutations that are known to be linked.

Study population

The Pro006 proteomics data source is based on plasma samples from **1,133 mothers** and the study population comprises a case-control study design. Cases in this context were defined as mothers of children with attention deficit hyperactivity disorder (ADHD). Mothers were eligible for inclusion if they had been pregnant in 2003 or after, had completed the questionnaire administered when the child was 36 months of age, the child did not have a diagnosis of Down's syndrome or cerebral palsy, urine and blood samples from mid-pregnancy were available, and they lived in a geographic area that made them eligible for inclusion in the ADHD substudy. Children born in 2003 or after were identified as cases based on a clinical diagnosis of ADHD from the Norwegian Patient Registry (NPR). Cases were included based on a minimum of two registrations of "Hyperkinetic disorder" (ICD-10 codes F90, F90.0, F90.1, F90.8 or F90.9). Two registrations were a prerequisite for inclusion in order to avoid false diagnoses or registrations. Controls were randomly selected from the population of eligible mothers that had been defined for this study.

For more information on sample selection, refer to the original article describing the sampling and data collection by [Engel et al. 2018](#).

Available biomarker measures (variable names in bold)

- Triiodothyronine (**T3**)
- Triiodothyronine resin uptake (**T3uptake**)
- Thyroxine (**T4**)
- Thyroid peroxidase antibody (**TPOAb**)
- Thyroid-stimulating hormone (**TSH**)

Definition of cases and controls in the dataset

The variable *CaseControlGrpAlt1* that is provided with the Pro006 dataset defines cases and controls according to the following categories:

- Case_ADHDClinic
- Case_ADHDClinic + Case_ADHDNPR
- Case_ADHDNPR
- Case_ADHDNPR + Control_MoBa
- Control_ADHDClinic
- Control_MoBa

Biological sampling and processing

Non-fasting blood samples were collected from mothers at 17-18 weeks' gestation into ethylenediaminetetraacetic acid (EDTA) tubes, centrifuged within 30 minutes, and temporarily placed in a refrigerator at 4 °C. They were shipped from the collecting hospital overnight to MoBa's biobank at the Norwegian Institute of Public Health (NIPH). The samples most often arrived at the biobank within 1–2 days of blood donation, where EDTA plasma were aliquoted onto polypropylene microtiter plates (96-well format, 300 µL per well), sealed with the use of heat-sealing foil sheets, and placed in long-term storage at –80 °C.

For more information on biological sampling, processing and storage, please refer to the original reference articles for NIPH's biobank by [Rønningen et al. 2006](#) and [Paltiel et al. 2014](#)

Analytical methodology

Triiodothyronine (T3), triiodothyronine uptake (T3uptake), thyroxine (T4), thyroid peroxidase antibody (TPOAb) and thyroid stimulating hormone (TSH), were measured using a **quantitative chemiluminescent immunoassay** on a Roche Cobas e602 blood analyzer.

Measurement units:

Triiodothyronine (T3): **ng/dL**

Triiodothyronine uptake (T3uptake): **%**

Thyroxine (T4): **µg/dl**

Thyroid peroxidase antibody (TPOAb): **IU/mL**

Thyroid-stimulating hormone (TSH): **mU/L**

Limit of quantification (LOQ):

Triiodothyronine (T3): **20 ng/dL**

Triiodothyronine uptake (T3uptake): **18%**

Thyroxine (T4): **0.50 µg/dl**

Thyroid peroxidase antibody (TPOAb): **0.25 IU/mL**

Thyroid-stimulating hormone (TSH): **0.01 mU/L**

Published articles using Pro006

This section also includes articles related to study design, sampling, and data collection.

- ❖ Choi G, Keil AP, Villanger GD, Richardson DB, Daniels JL, Hoffman K, Sakhi AK, Thomsen C, Herring AH, Drover SSM, Nethery R, Aase H, Engel SM. Pregnancy exposure to common-detect organophosphate esters and phthalates and maternal thyroid function. *Sci Total Environ*. 2021 Aug 15;782:146709.
- ❖ Villanger GD, Ystrom E, Engel SM, Longnecker MP, Pettersen R, Rowe AD, Reichborn-Kjennerud T, Aase H. Neonatal thyroid-stimulating hormone and association with attention-deficit/hyperactivity disorder. *Paediatr Perinat Epidemiol*. 2020 Sep;34(5):590-596.
- ❖ Engel SM, Villanger GD, Nethery RC, Thomsen C, Sakhi AK, Drover SSM, Hoppin JA, Zeiner P, Knudsen GP, Reichborn-Kjennerud T, Herring AH, Aase H. Prenatal Phthalates, Maternal Thyroid Function, and Risk of Attention-Deficit Hyperactivity Disorder in the Norwegian Mother and Child Cohort. *Environ Health Perspect*. 2018 May 10;126(5):057004.

Restrictions for use

None currently known.

Acknowledgements recommended for use

We recommend that any use of these data in analyses that are presented in peer-review publications acknowledges the original article describing sampling and data collection:

Engel SM, Villanger GD, Nethery RC, Thomsen C, Sakhi AK, Drover SSM, Hoppin JA, Zeiner P, Knudsen GP, Reichborn-Kjennerud T, Herring AH, Aase H. Prenatal Phthalates, Maternal Thyroid Function, and Risk of Attention-Deficit Hyperactivity Disorder in the Norwegian Mother and Child Cohort. Environ Health Perspect. 2018 May 10;126(5):057004.

Disclaimer

The data in Pro006 that are available for use are provided on an *as is* basis, and FHI does not provide any guarantees related to data quality and assurance of the original dataset. MoBa participants can retract their consent to participate in the MoBa study at any time, and results generated using biological samples will be removed from MoBa datasets accordingly. The descriptive information regarding sample sizes and data content in this product sheet is correct and up-to-date as of **23.09.2026**.