Exposome Research:

Making Data Work for Health Protection

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Health protection increasingly specific

- ”Sickness” one entitity - cured by bloodletting.
- There are different diseases- with specific diagnosis the correct treatment can be found.

A Health Protection Advancement

Cervical cancer: Formerly caused by ”Sexual Lifestyle” (multiple STDs, zinc content of semen et c). Behaviour modification advocated.

1983: A specific virus (HPV) found to be likely cause.

Prospective evidence demanded as a basis for public health – difficult.

Incubation time from infection to cancer several decades.

Could we find several decades old samples, test them for HPV and see what the associated cancer risk was by linking to cancer registries?

Same procedure used for all projects:

Ethical & Computer Inspection permissions.

Find biobanks with very old samples in 5 countries.

Biobanks submit files of samples to Cancer registries, who link to identify samples taken before cancer.

Test coded samples for HPV (code key at cancer registries).

Calculate the risk over time if infected or not infected.

Very strong HPV-associated risks for cancers of the cervix, vulva, vagina, anus, penis and oropharynx.

-Vaccination prioritized. Now globally used.

Stronger prediction for cancer and cancer precursors than cytology screening method.

-Switch to cervical screening with HPV gave better cancer protection.

Pukkala, E., Andersen, A., Berglund, G., Gislefoss, R., Guðnason, V., Hallmans, G., Jellum, E., Jousilahti, P., Knekt, P., Koskela, P., Kyyrönen, P., Lenner, P., Luostarinen, T., Löve, A., Ögmundsdóttir, H., Stattin, P., Tenkanen, L., Tryggvadóttir, L., Virtamo, J., Wadell, G., Widell, A., Lehtinen, M., Dillner, J.

Nordic biological specimen banks as basis for studies of cancer causes and control – more than 2 million sample donors, 25 million person-years and 100,000 prospective cancers

Acta Oncol. 2007; **46**: 286-307

The reform of a system

>40% of the population has biospecimens on file (maternity care screening, cervical screening, newborn screening, pathology archives).

Throw everything out?

Standard system designed and launched:

Enhanced opt-out (individual information given) and broad consent.

Regional centers for handling consent retractions (for all specimens).

The work of Evert-Ben was **instrumental.**

Now chairs the Ethicolegal working group of the European Human Exposome Network.

106 million euros in EU grants to 126 research groups

- If an environmental exposure exists, it can be measured.

- Using systematic measures of environmental exposures, we seek to identify specific exposures that either promote or are dangerous for your health.

Towards Precision Public Health

- Environment and ”life style” critical for health.
- ”Junk food” is bad for you . ”Fruits and vegetables” is good for you
- Even traditional epidemiology finds more specific associations:
  - Bad: Sausages, in particular Frankfurters
  - Good: Legumes and beans, in particular black beans
- Could we for every consumer product measure how good/bad it is?

Towards Precision Public Health

- ”Pollution” is bad for you . ”Hygiene” is good for you

- Exposome monitoring can tell you exactly the compunds (mass spectrometry) and the micro-organisms in the environment.
- Could we for every compound and every microorganism measure how good/bad it is?

Exposome assessment using Sensors

Chemicals=
Mass spectrometry

Biologics=
Sequencing

Major Challenges

Measuring the exposures is not the challenge – straightforward.

*Huge amounts of data - difficult to manage effectively (Computing)

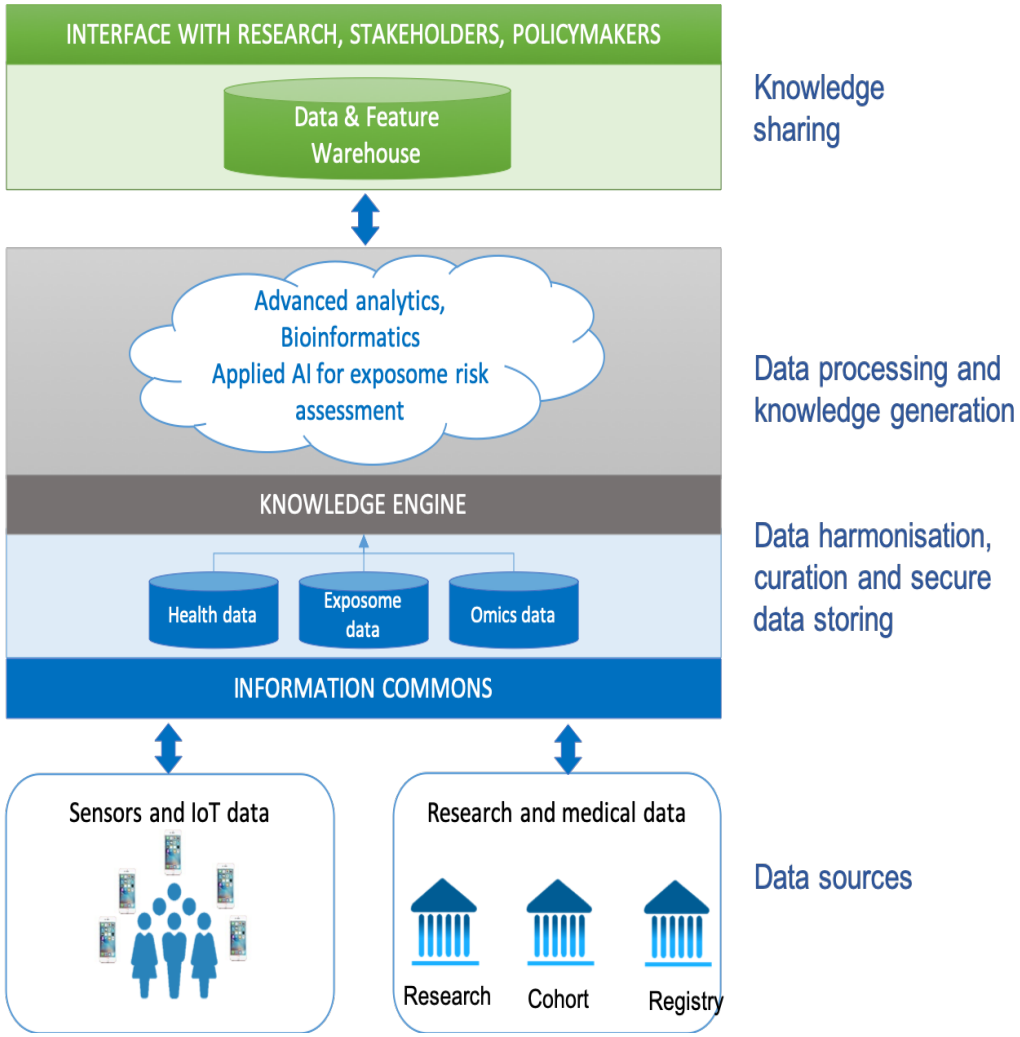
*Difficult to re-use data from other studies (Standardisation)

*International collaborative research using personally identifiable data is difficult (Sound ethical and legal basis)

The Human Exposome Assessment Platform

1) Launch an integrated and reproducible informatics platform that can be deployed in computer clusters and computing centres worldwide.

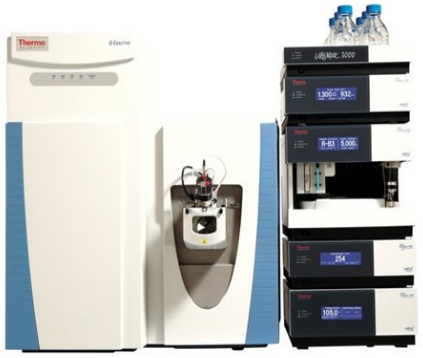
2) Populate the platform with data from modern exposome assessment



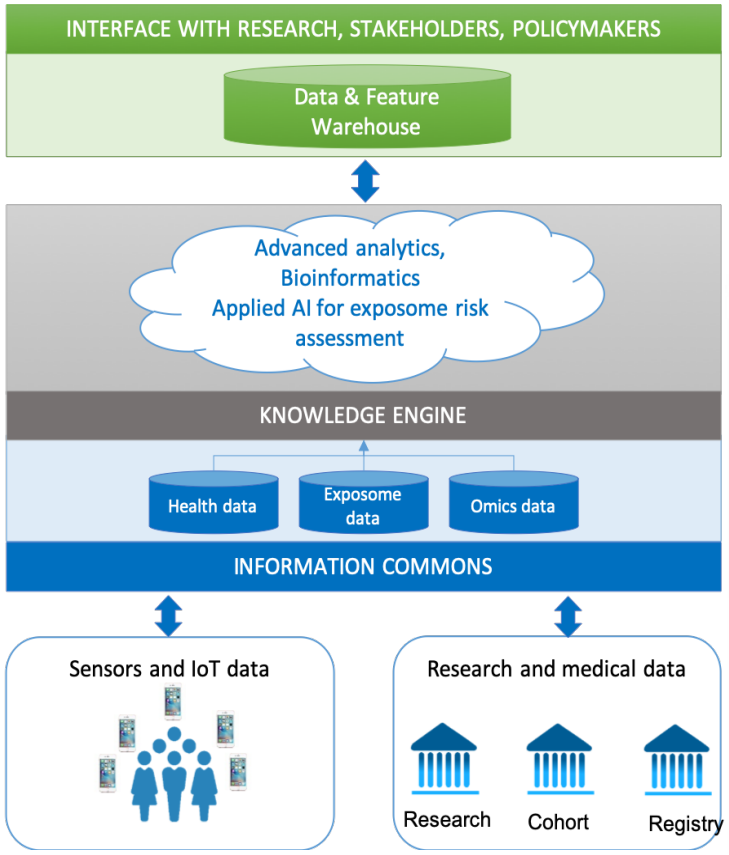
Populate the platform with data from exposome assessment

Exposome assessment using Sensors

Chemicals=
Mass spectrometry



Biologics=
Sequencing



-Population-based sample cohorts with advanced analyses (e.g. Metagenomics, epigenomics)

Exposome assesment using Consumer Receipts

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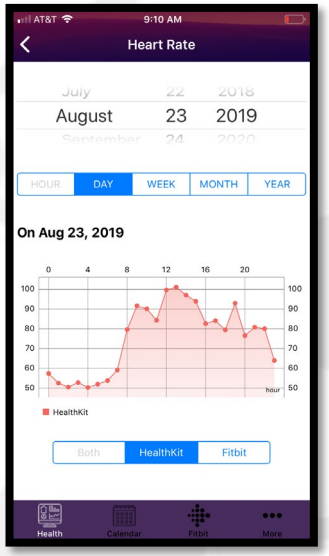
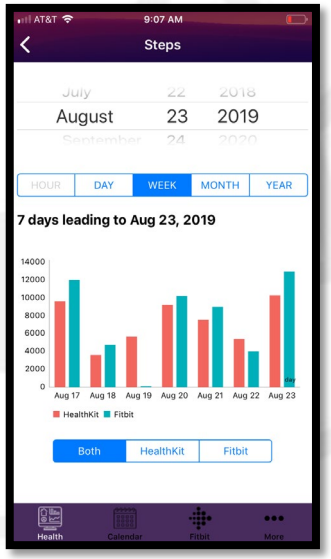
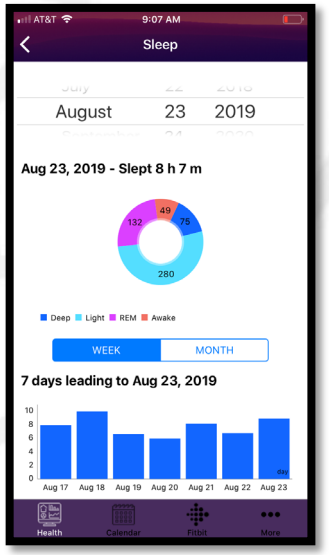
Highlight: Wearable exposome sensor

- Capture **virus particles, bacteria, fungal spores, animal debris, and plant pollens, ranging from 50 nm to 100 µm in size**, and sorbents which collects **aerosol chemicals**
- Measure **temperature, humidity, airflow rate and GPS coordinates**
- Equipped with **Bluetooth** to connect with smartphones for data transportation and allow users to **browse real-time reporting through a mobile App**
- **First volunteers enrolled (pregnant women) who continuously wear the sensor + provide blood and buccal samples.**







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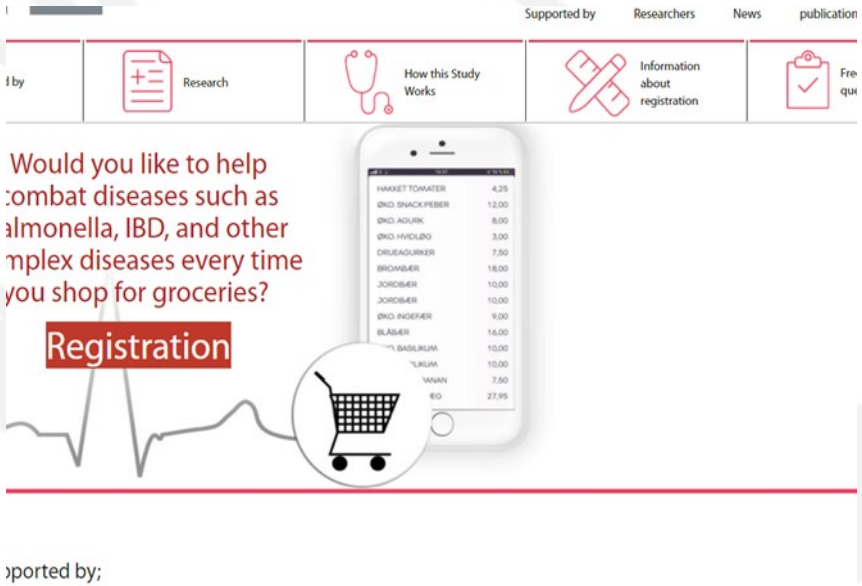
Highlight: Consumer receipts cohort

Systematic assessment of consumer products link to health and disease

-First papers on chronic disease (diabetes risk)

-”exposure matrix” using the content of each product: ongoing for cosmetics content and skin diseases



Strategic importance of HEAP

1. Moving away from “One project on One exposure and One Disease”

Open Science: Multiple projects (also by others) on Multiple Exposures and Multiple Diseases.

Improved Integrity protection: Clear rules and security standards for data access

2. **Furthering Advances** being made in different countries using international collaboration. E.g. on:

-Improved **environmental safety:** Continuous exposure measurements using sensors

-Improved **consumer protection:** Continuous measuring if specific purchases affect health

-Improved **understanding of environmental determinants of disease**: Towards new strategies for healthy childbearing and cancer prevention

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Thank you to the HEAP Partners

Partner	Country
Karolinska Institutet ((KI)	Sweden
Statens Serum Institut (SSI)	Denmark
Tampere University Hospital (TAUH)	Finland
MLC Foundation ((MLCF)	**The Netherlands**
Medical University of Graz (MUG)	Austria
University of Warsaw (ICM)	Poland
Logical Clocks AB (LC)	Sweden
International Agency for Research on Cancer (IARC)	France
UNIVERSITAET INNSBRUCK - UIBK	Austria
Oulu University (OULU)	Finland
IT Center for Science (CSC)	Finland