Burden of disease of heavy metals in population clusters: towards targeted public health strategies

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Heavy metals in food

Humans are exposed to toxic heavy metals through a wide range of foods:

Methylmercury (MeHg): neurotoxicity in unborn children (via their mothers)

Inorganic arsenic (iAs): carcinogenicity

Cadmium (Cd): nephrotoxicity





Heavy metals in food

> 1 million global illnesses due to heavy metals in 2015 (MeHg, iAs, Cd, Pb) (Gibb et al. 2019)

– Large subregional differences

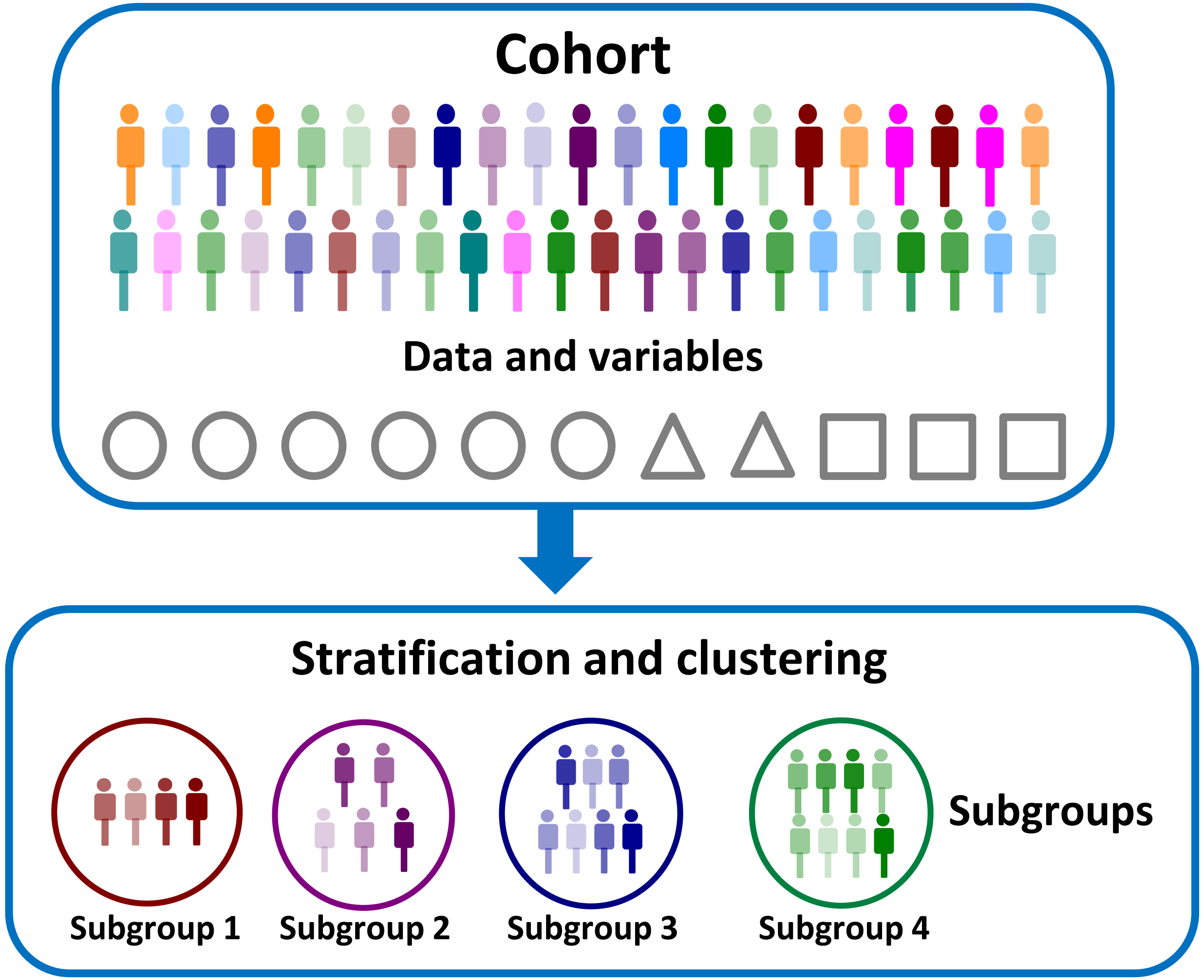
– Demographics, socioeconomic factors, dietary patterns?

Will the burden of disease due to heavy metals vary by subgroups at national level?

What are the determinants of potential differences between subgroups?

Who should public health interventions be targeted to mitigate the burden?

Clustering



Answers may be found in the multidimensionality and complexity of dietary patterns and lifestyle

May not be answered by typical epidemiological methods

Dividing study cohort into homogenous clusters can help identifying specific patterns

Illustration by J. A. Herrera Romero

Self-Organizing Maps (SOMs)

Kohonen neural networks – unsupervised machine learning method

Identification of unknown patterns

Reduction of high-dimensional data into low-dimensional output

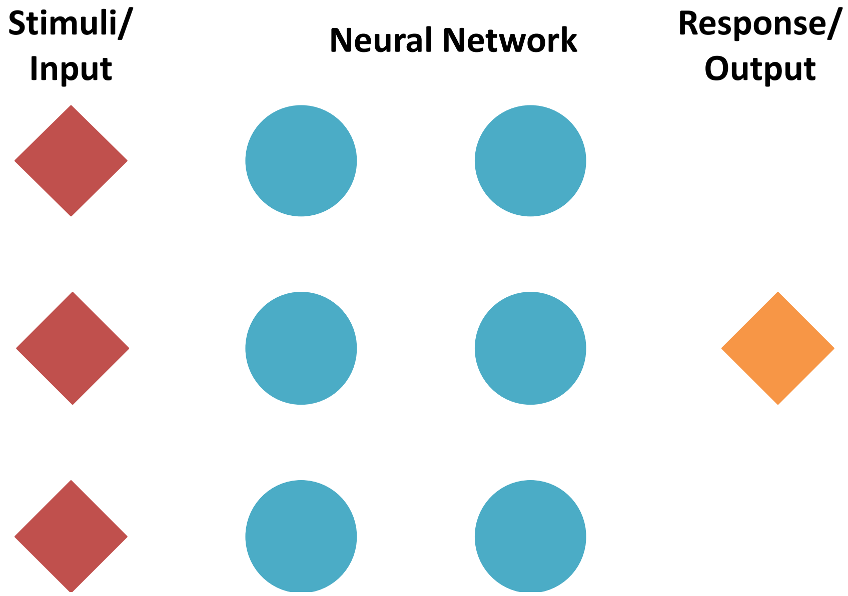
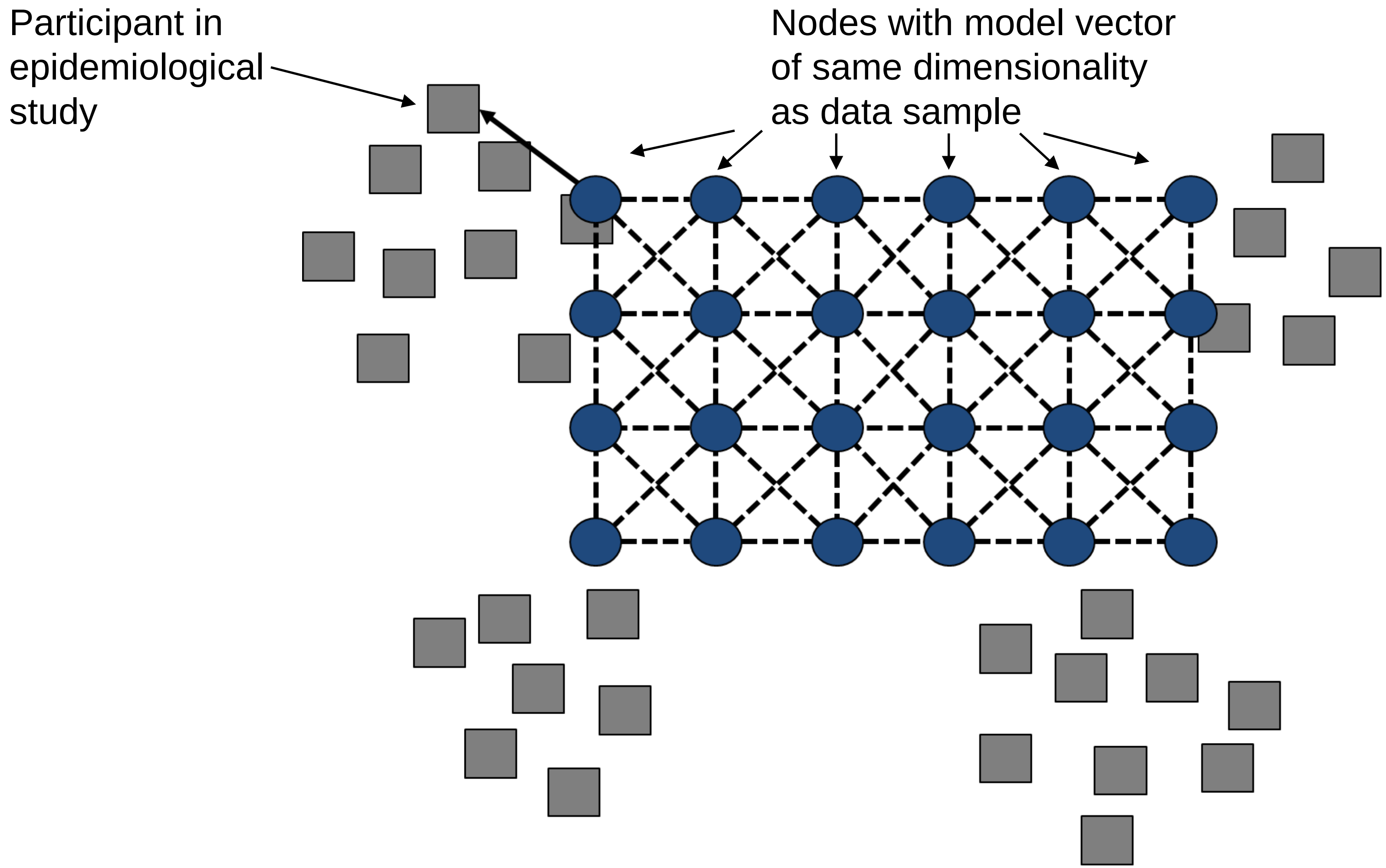


Illustration by J. A. Herrera Romero

Self-Organizing Maps (SOMs)



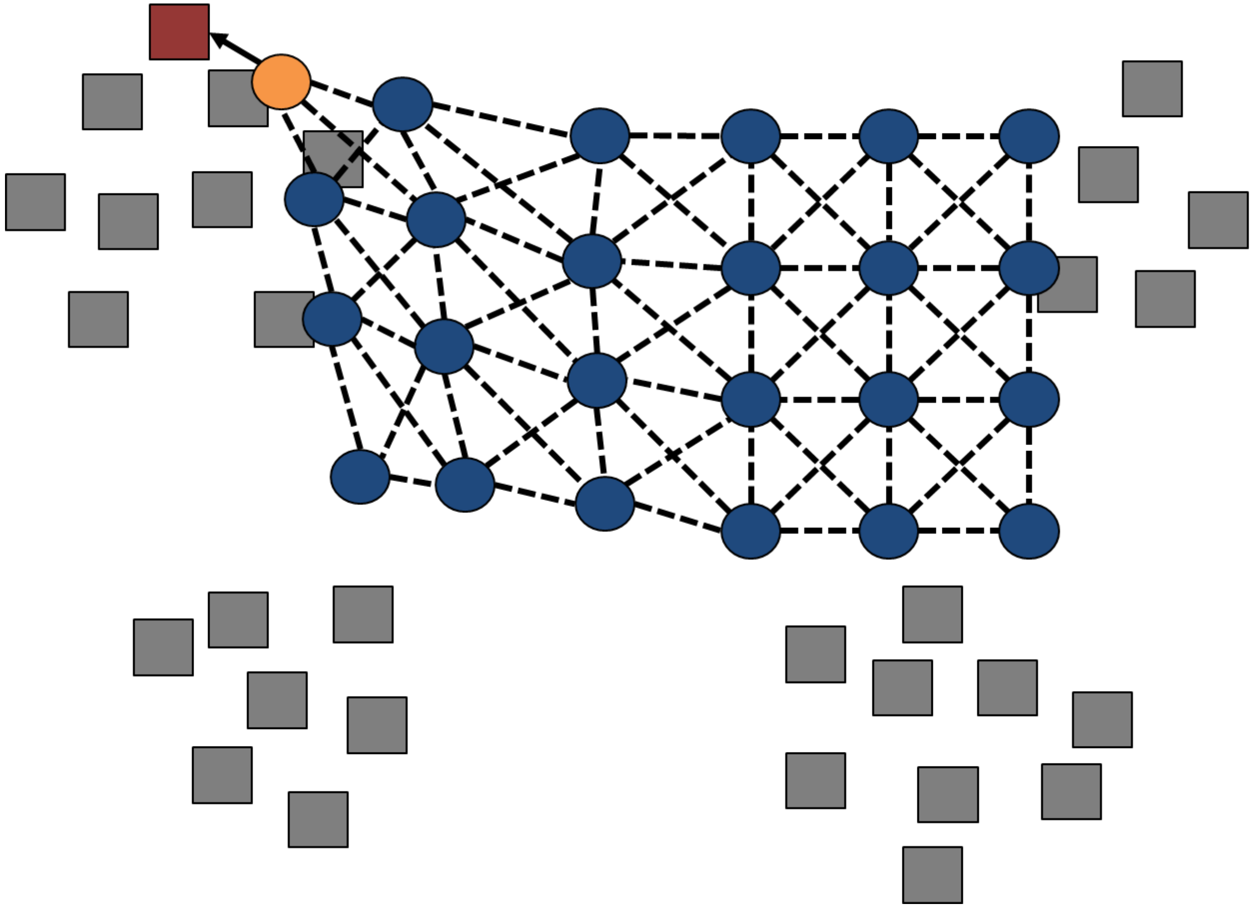
Step 1

Find participants “best friends”

– node that is most similar to the participant

Illustration by J. A. Herrera Romero

Self-Organizing Maps (SOMs)



Step 2

Adjust node to be closer to the participant via regression of the node's model vector

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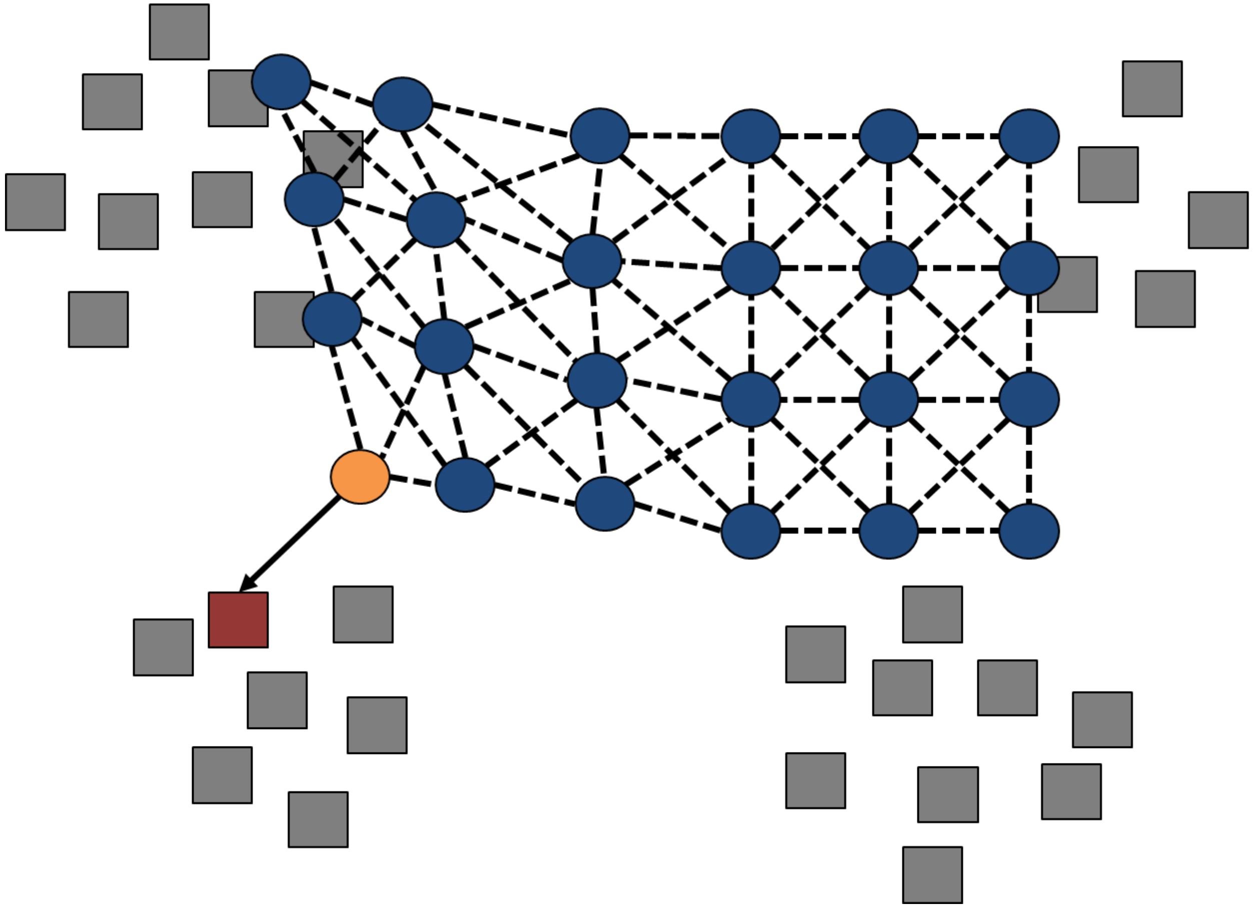
Self-Organizing Maps (SOMs)



Step 3

Repeat for next participant

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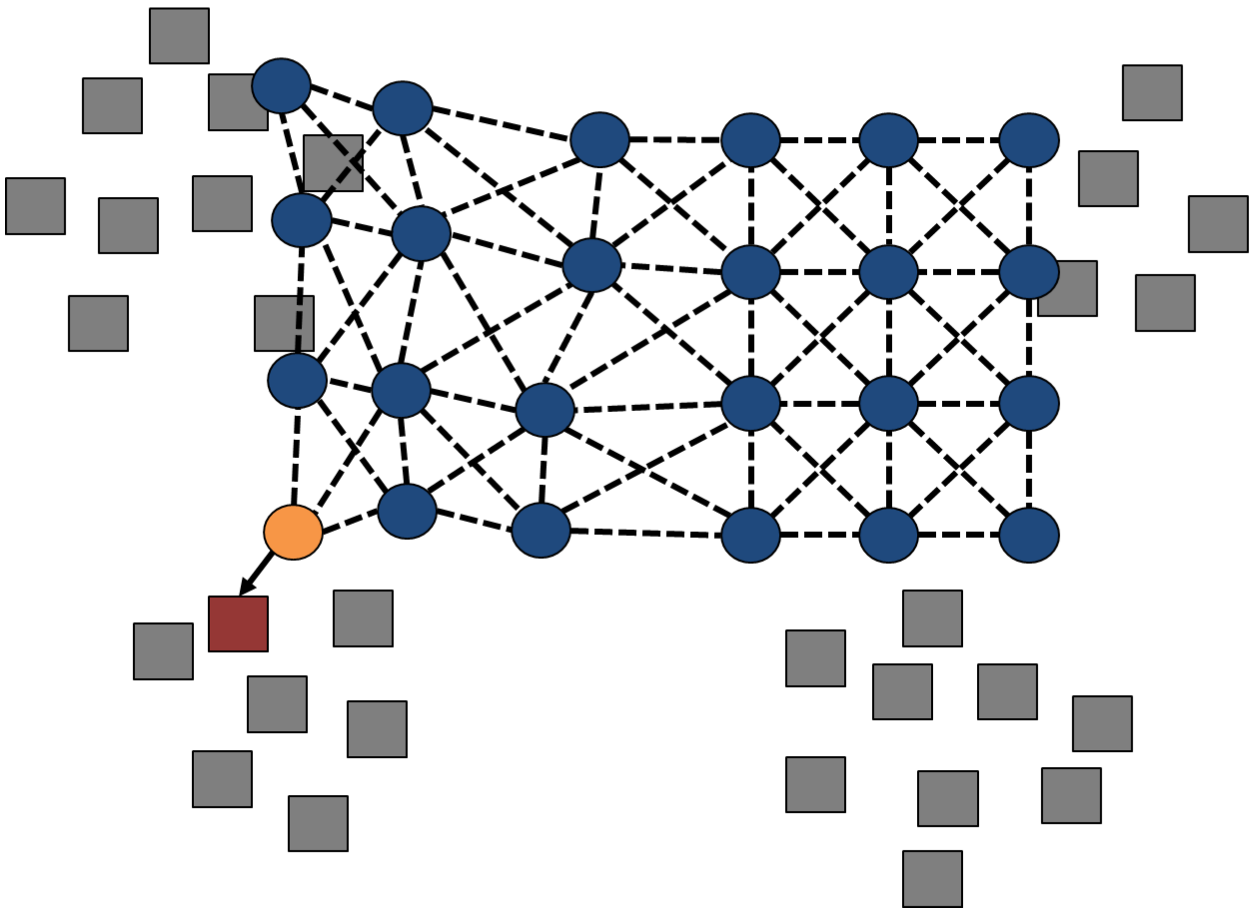
Self-Organizing Maps (SOMs)



Step 4

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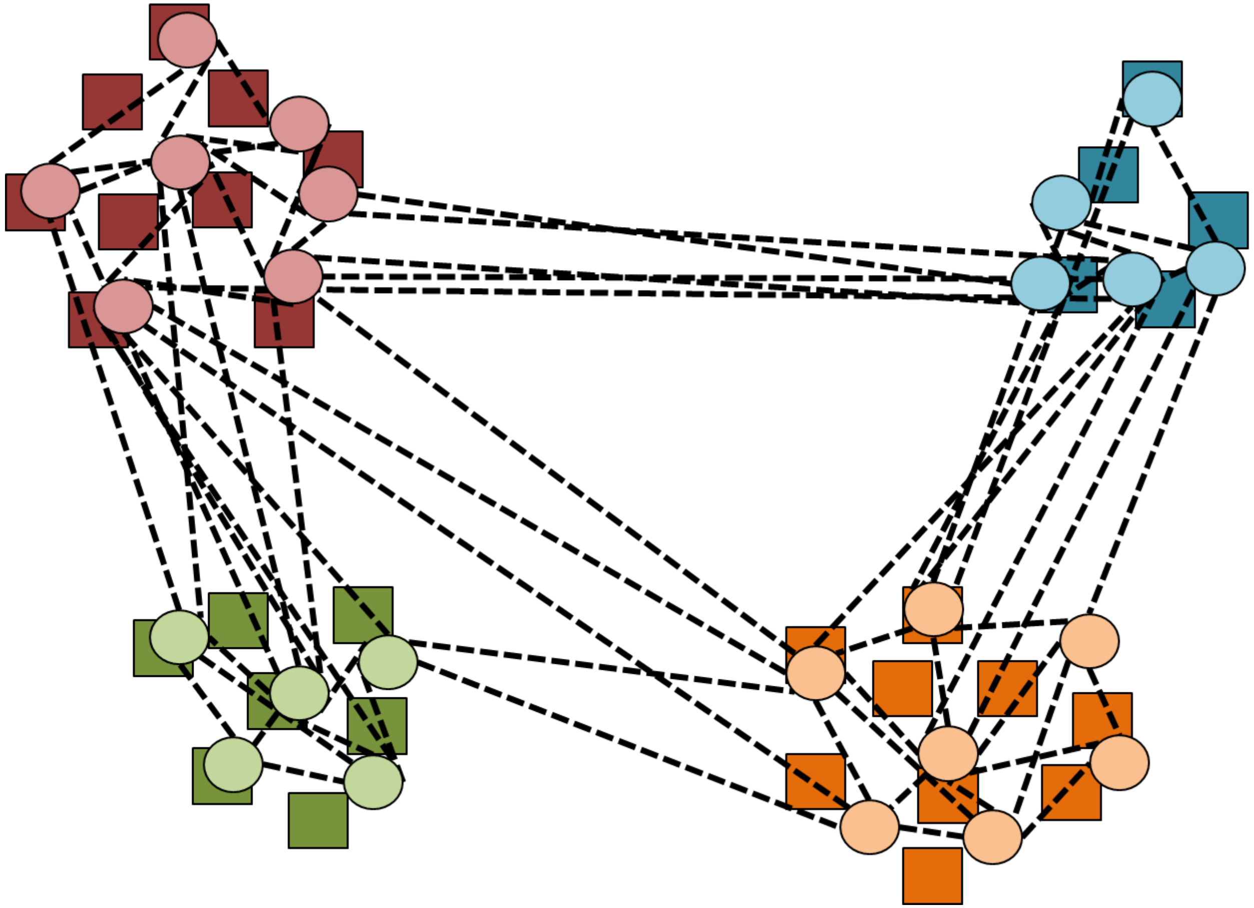
Self-Organizing Maps (SOMs)



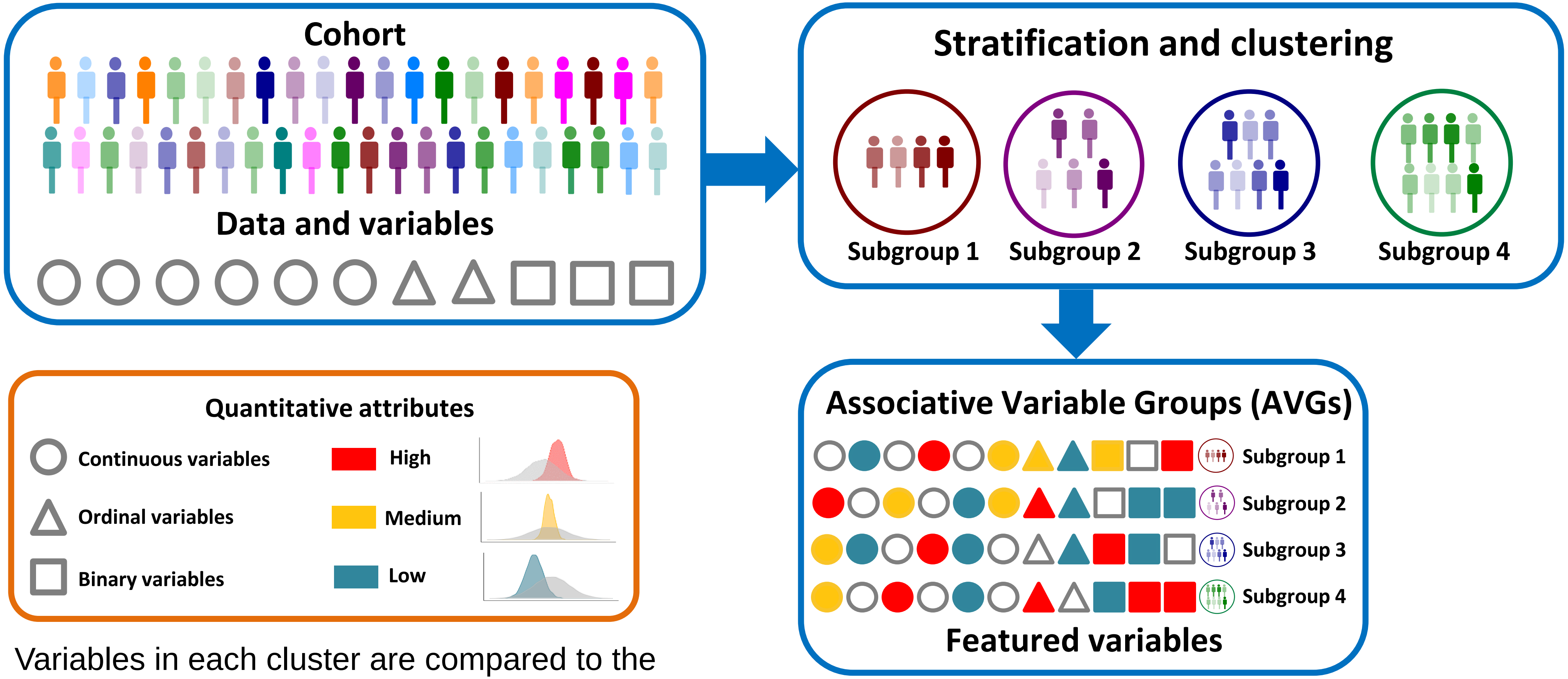
Step 5

Each node with a number of participants assigned to it as well as a model vector – pattern of interest

“Hotspots” where we are more likely to find strong associations

Illustration by J. A. Herrera Romero

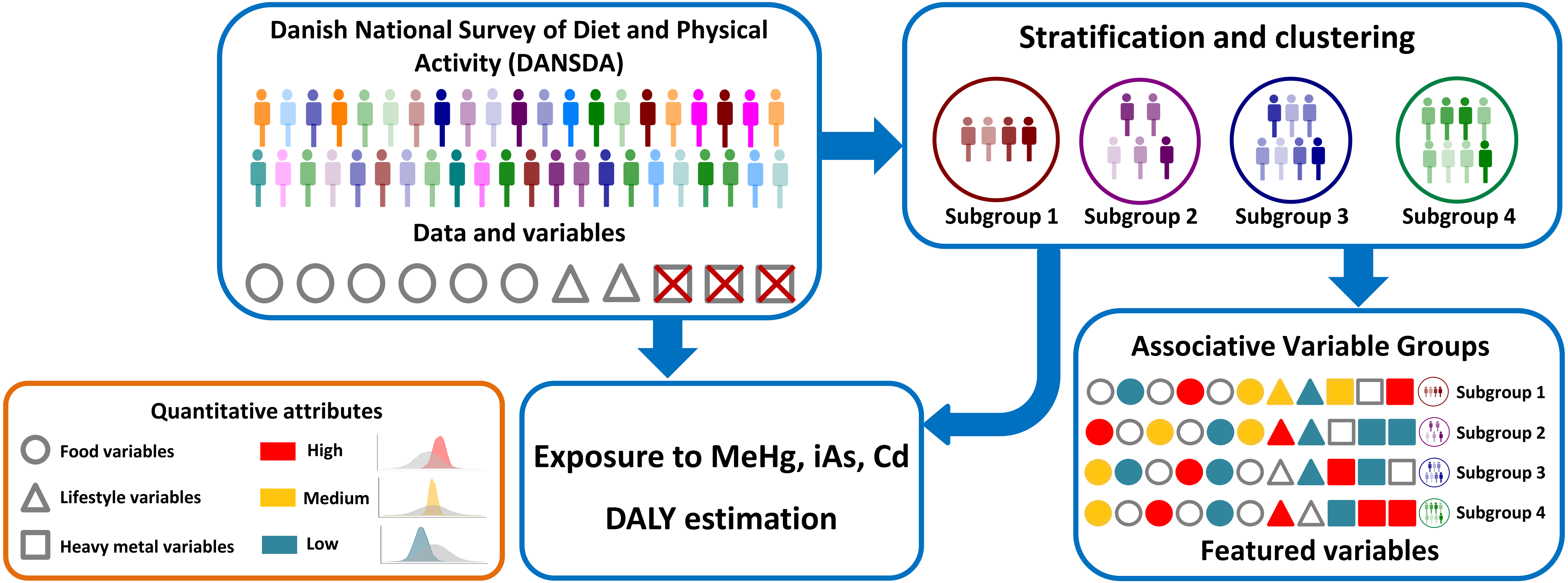
Associative Variable Groups (AVGs)



Variables in each cluster are compared to the average and assigned a categorical attribute

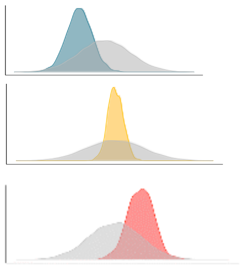
Illustration by J. A. Herrera Romero

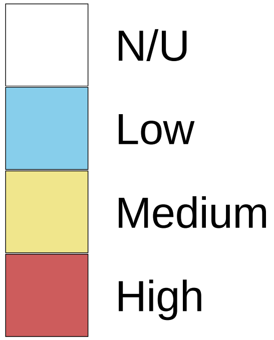
Identifying clusters in the Danish population

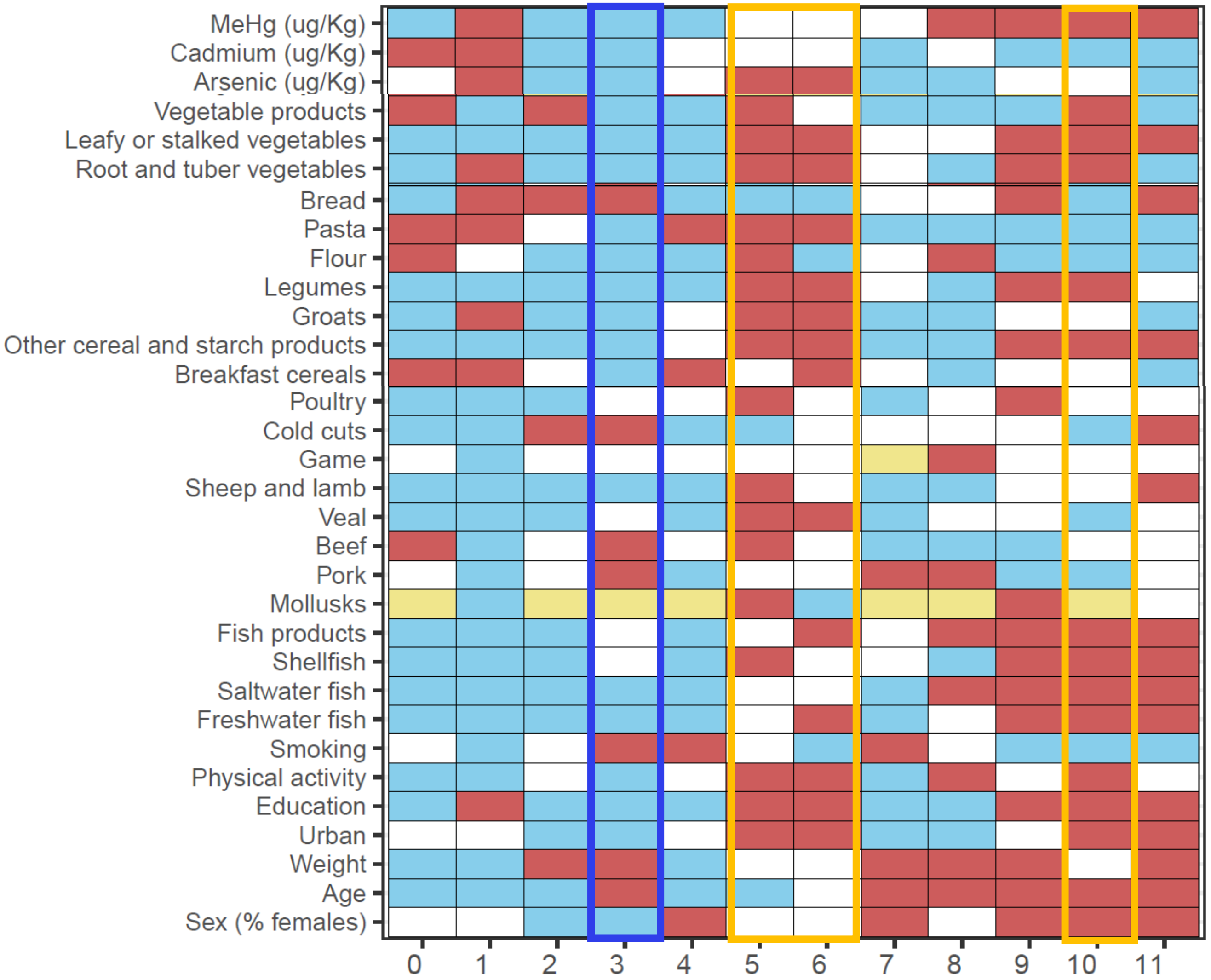


Adapted from illustration by J. A. Herrera Romero

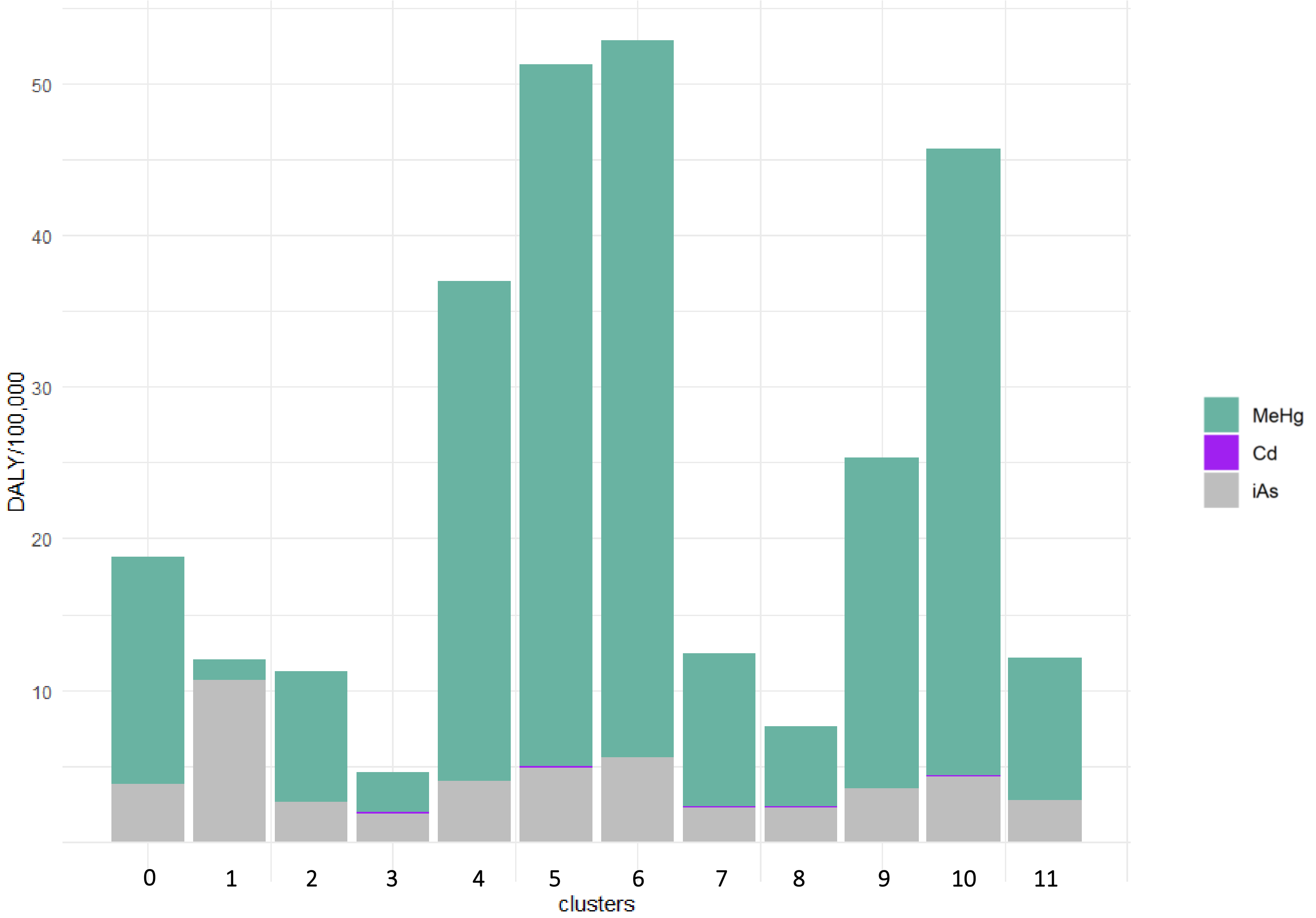
Patterns for clusters of the Danish population







Burden of disease in population clusters



Healthy dietary patterns → high burden of disease of heavy metals?

High heavy metal exposures not necessarily causing high burden

Burden of disease depends on which individuals are affected

To a large degree driven by age and sex

Key messages

Machine Learning methods such as SOMs are useful to identify population clusters based on dietary, lifestyle and socio-demographic factors

Dietary patterns considered as ”healthy” associated with higher disease burden due to heavy metals

High heavy metal exposure was not necessarily associated with a high burden of disease

- Need to account for population characteristics (age, gender)
- Importance of summary measures of population health such as DALYs

Beneficial effects of dietary patterns should also be considered

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