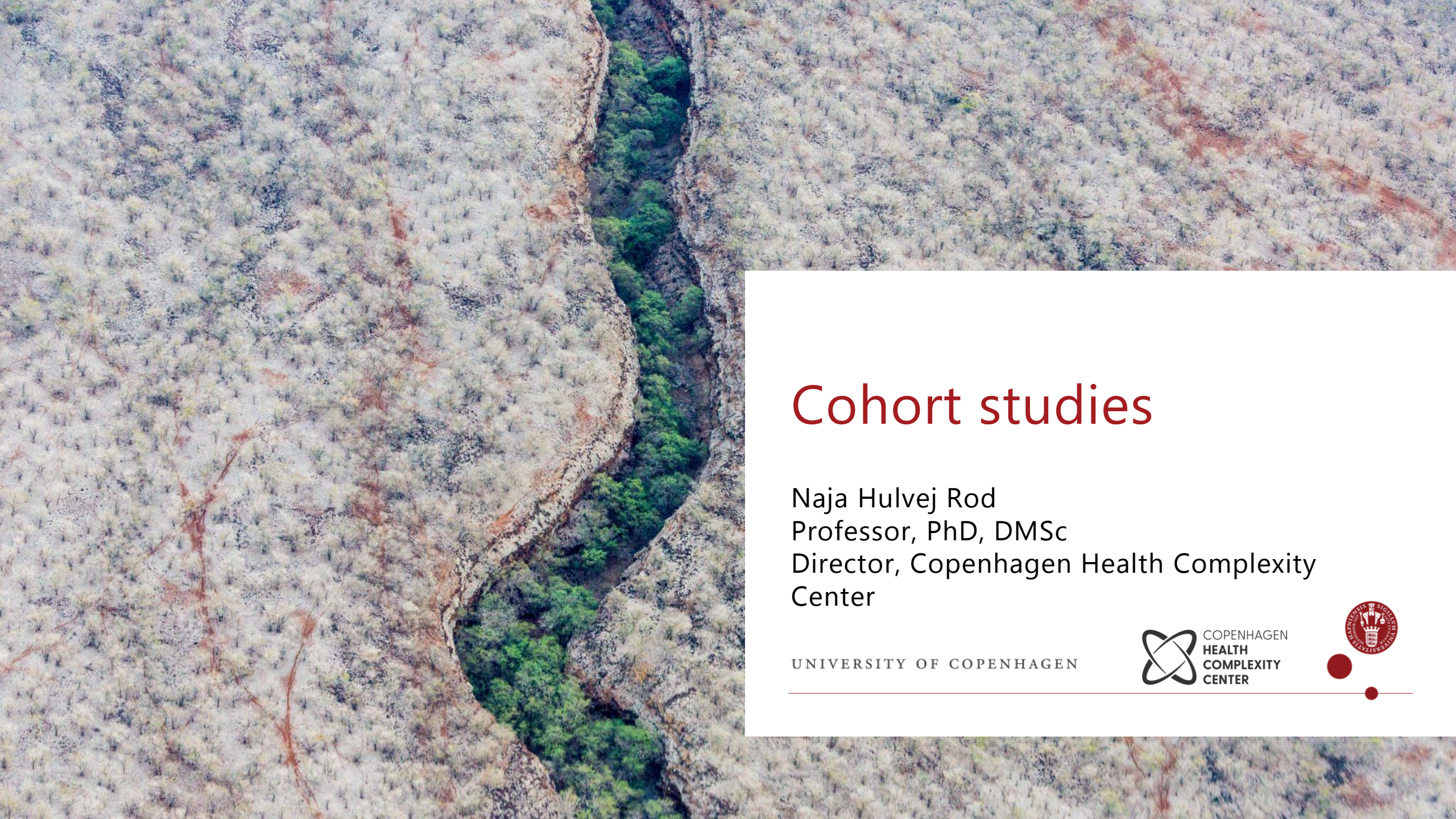


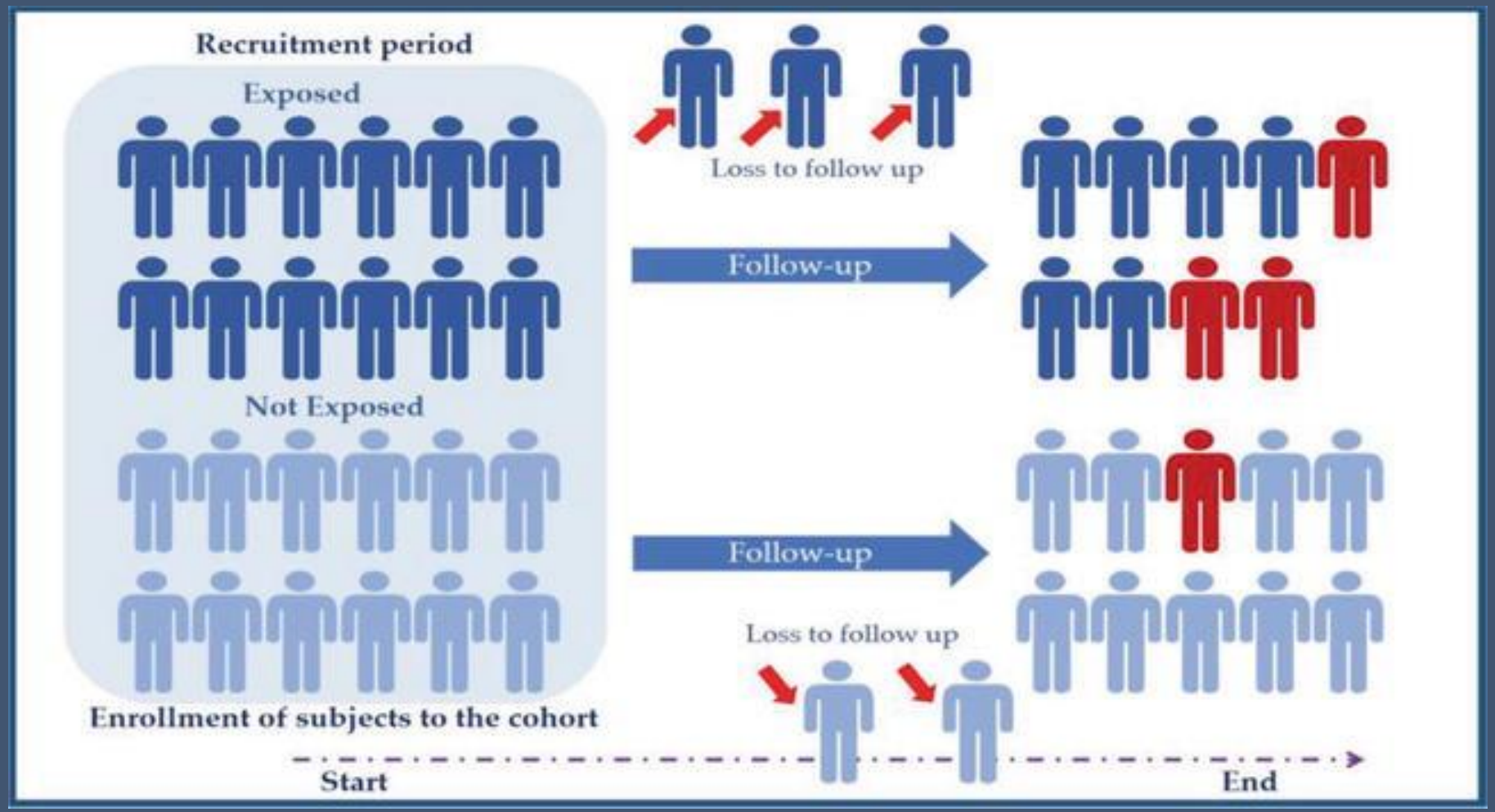
Cohort studies

Naja Hulvej Rod
Professor, PhD, DMSc
Director, Copenhagen Health Complexity Center

UNIVERSITY OF COPENHAGEN

COPENHAGEN HEALTH COMPLEXITY CENTER

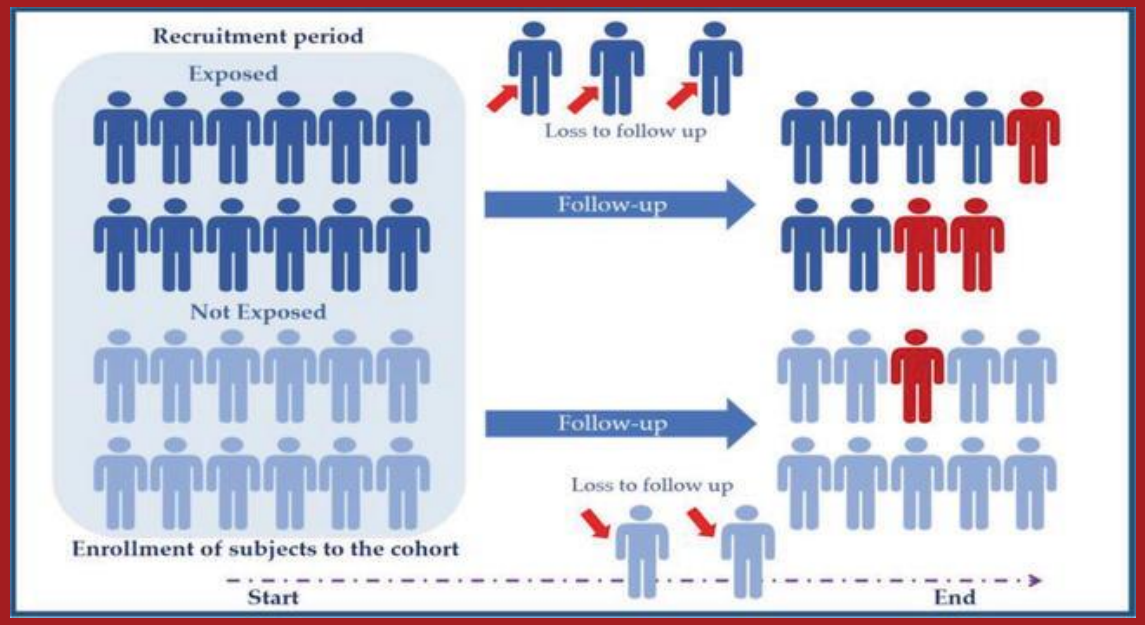
Cohort study



Barría RM. Introductory Chapter: The Contribution of Cohort Studies to Health Sciences [Internet]. Cohort Studies in Health Sciences. InTech; 2018. Available from: http://dx.doi.org/10.5772/intechopen.80178

Value of cohort studies

- Temporality
- Multiple outcomes
- Rare exposures
- Reducing recall bias
- Longitudinal data collection
- Data across scales



Framingham Heart Study

- Initiated: 1948
- Participants: 5,209 adults from Framingham, MA
- Contributions: Identified key cardiovascular disease risk factors such as high blood pressure, cholesterol levels, and smoking. It has led to over 3,000 publications influencing public health policies.

Nurses' Health Study

- Initiated: 1976
- Participants: Over 121,000 female registered nurses
- Contributions: Investigated long-term health impacts of contraceptive use and dietary factors, providing insights into women's health issues and influencing healthcare practices.

Whitehall Studies

- Whitehall I (1967): Focused on social determinants of health among British civil servants.
- Whitehall II (1985): Examined psychosocial factors affecting health and chronic diseases.
- Contributions: Highlighted the impact of socioeconomic status on health outcomes and mortality.

Framingham Heart Study

FRAMINGHAM RISK SCORE (FRS)

Estimation of 10-year Cardiovascular Disease (CVD) Risk

Date: _____

Patient's Name: _____

Step 1[1]

In the "points" column enter the appropriate value according to the patient's age, HDL-C, total cholesterol, systolic blood pressure, and if they smoke or have diabetes. Calculate the total points.

Risk Factor	Risk Points		Points
	Men	Women	
Age			
30-34	0	0	
35-39	2	2	
40-44	5	4	
45-49	6	5	
50-54	8	7	
55-59	10	8	
60-64	11	9	
65-69	12	10	
70-74	14	11	
75+	15	12	
HDL-C (mmol/L)			
> 1.6	-2	-2	
1.3-1.6	-1	-1	
1.2-1.29	0	0	
0.9-1.19	1	1	
< 0.9	2	2	
Total Cholesterol			
< 4.1	0	0	
4.1-5.19	1	1	
5.2-6.19	2	3	
6.2-7.2	3	4	
> 7.2	4	5	
Systolic Blood Pressure (mmHg)	Not Treated / Treated	Not Treated / Treated	
< 120	-2 / 0	-3 / -1	
120-129	0 / 2	0 / 2	
130-139	1 / 3	1 / 3	
140-149	2 / 4	2 / 5	
150-159	2 / 4	4 / 6	
160+	3 / 5	5 / 7	
Smoker Yes	4	3	
Smoker No	0	0	
Diabetes Yes*	3	4	
Diabetes No	0	0	
Total Points			

Step 2[1]

Using the total points from Step 1, determine the 10-year CVD risk* (%).

Total Points	10-Year CVD Risk (%)*	
	Men	Women
-3 or less	< 1	< 1
-2	1.1	< 1
-1	1.4	1.0
0	1.6	1.2
1	1.9	1.5
2	2.3	1.7
3	2.8	2.0
4	3.3	2.4
5	3.9	2.8
6	4.7	3.3
7	5.6	3.9
8	6.7	4.5
9	7.9	5.3
10	9.4	6.3
11	11.2	7.3
12	13.2	8.6
13	15.6	10.0
14	18.4	11.7
15	21.6	13.7
16	25.3	15.9
17	29.4	18.5
18	> 30	21.5
19	> 30	24.8
20	> 30	28.5
21+	> 30	> 30

Step 3[1]

Using the total points from Step 1, determine heart age (in years).

Heart Age, y	Men	Women
< 30	< 0	< 1
30	0	
31		1
32	1	
34	2	2
36	3	3
38	4	
39		4
40	5	
42	6	5
45	7	6
48	8	7
51	9	8
54	10	
55		9
57	11	
59		10
60	12	
64	13	11
68	14	12
72	15	
73		13
76	16	
79		14
> 80	≥ 17	15+

* Double cardiovascular disease risk percentage for individuals between the ages of 30 and 59 without diabetes if the presence of a positive history of premature cardiovascular disease is present in a first-degree relative before 55 years of age for men and before 65 years of age for women. This is known as the modified Framingham Risk Score.[3]

Step 4[2,3,4]

Using 10-year CVD risk from Step 2, determine if patient is Low, Intermediate or High risk.[1]

Risk Level[1]	Initiate Statin Treatment if:	Consider Add-on Therapy or Treatment Intensification
High FRS ≥ 20%	Consider treatment in **all** (Strong, High)	If LDL-C ≥ 2 mmol/L **or** Non-HDL-C > 2.6 mmol/L **or** ApoB ≥ 0.80 g/L on maximally tolerated statin dose
Intermediate FRS 10-19%	If LDL-C ≥ 3.5 mmol/L **or** (Strong, Moderate) If LDL-C < 3.5 mmol/L initiate if: • non-HDL-C ≥ 4.3 mmol/L **or** • ApoB ≥ 1.05 g/L **or** (Strong, Moderate) • Men ≥ 50 yrs and women ≥60 yrs with 1 additional risk factor: low HDL-C, impaired fasting glucose, high waist circumference, smoker, or hypertension, **or** with the presence of other risk modifiers: hsCRP ≥ 2 mg/L, CAC > 0 AU, family history of premature CAD, Lp(a) ≥ 100 mol/L (≥ 50 mg/dL)	If LDL-C ≥ 2 mmol/L **or** Non-HDL-C > 2.6 mmol/L **or** ApoB ≥ 0.80 g/L on maximally tolerated statin dose
Low FRS < 10%	Statins generally not indicated	N/A
Statin-indicated Conditions** (Consider treatment in **all**; Strong, High)		
LDL-C ≥ 5 mmol/L or non-HDL-C ≥ 5.8 mmol/L **or** ApoB ≥ 1.45 g/L (FH or genetic dyslipidemia)		If LDL-C ≥ 2.5 mmol/L, **or** < 50% reduction, **or** non-HDL-C ≥ 3.2 mmol/L, **or** ApoB ≥ 0.85 g/L
Most patients with diabetes: • Age ≥ 40 yrs old **or** Age ≥ 30 yrs & DM ≥ 15 yrs duration **or** Microvascular disease **Chronic Kidney Disease:** • Age ≥ 50 yrs & eGFR < 60 mL/min/1.73 m² **or** ACR > 3 mg/mmol		If LDL-C ≥ 2.0 mmol/L **or** non-HDL-C ≥ 2.6 mmol/L **or** ApoB ≥ 0.80 g/L on maximally tolerated statin dose
Atherosclerotic Cardiovascular Disease (ASCVD): • Myocardial infarction (MI), acute coronary syndrome (ACS), **or** • Stable angina, documented coronary artery disease (CAD) using angiography, **or** • Stroke, TIA, documented carotid disease, **or** • Peripheral arterial disease, claudication, and/or ankle-brachial index (ABI) < 0.9, **or** • Abdominal aortic aneurysm (AAA) – abdominal aorta > 3.0 cm or previous aneurysm surgery		If LDL-C ≥ 1.8 mmol/L, **or** non-HDL-C ≥ 2.4 mmol/L, **or** ApoB ≥ 0.70 g/L on maximally tolerated statin dose

** Statin-indicated condition refers to any condition for which pharmacotherapy with statins is indicated, and consists of all documented ASCVD conditions, as well as other high-risk primary prevention conditions in the absence of ASCVD.

1 Adapted from: D'Agostino RB et al.(). General cardiovascular risk profile for use in primary care. The Framingham Heart Study. Circ 2008;117:743-53.
2 Adapted from: Genest J et al.(). 2009 Canadian Cardiovascular Society/Canadian guidelines for the diagnosis and treatment of dyslipidemia and prevention of cardiovascular disease in the adult. Can J Cardiol. 2009;25(10):567-579.
3 Adapted from: Anderson T et al.(). 2012 Update of the Canadian Cardiovascular Society guidelines for the diagnosis and treatment of dyslipidemia for the prevention of cardiovascular disease in the adult. Can J Cardiol. 2012;28(2):151-167.
4 Adapted from: Pearson G et al.(). 2021 Canadian Cardiovascular Society Guidelines for the Management of Dyslipidemia for the Prevention of Cardiovascular Disease in Adults. Can J Cardiol. 2021;37(8):1129-1150.
† apoB: apolipoprotein B mass, CVD: cardiovascular disease, FRS: Framingham Risk Score, HDL-C: high-density lipoprotein cholesterol, LDL-C: low-density lipoprotein cholesterol.
* For most patients with diabetes, calculating their FRS is not needed for treatment decisions in primary prevention as a statin would be indicated in most of this population, including: age ≥ 40 yrs old **or** age ≥ 30 yrs & DM ≥ 15 yrs duration **or** microvascular disease.

Canadian Cardiovascular Society

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ARTICLE

Lifetime Smoking History and Risk of Lung Cancer: Results From the Framingham Heart Study

Hilary A. Tindle, Meredith Stevenson Duncan, Robert A. Greevy, Ramachandran S. Vasan, Suman Kundu, Pierre P. Massion, Matthew S. Freiberg

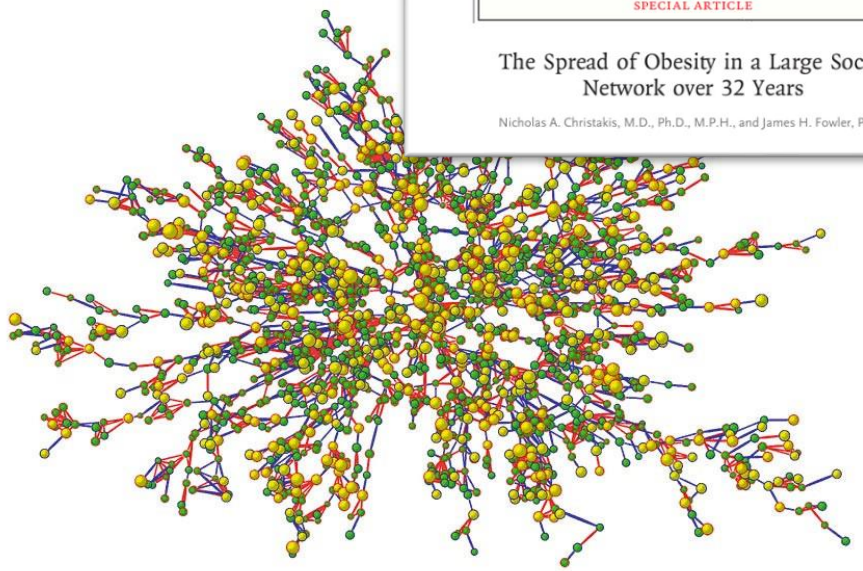
See the Notes section for the full list of authors' affiliations.
Correspondence to: Hilary A. Tindle, MD, MPH, Vanderbilt University Medical Center, 2525 West End Ave, Suite 370, Nashville, TN 37203 (e-mail: hilary.tindle@vanderbilt.edu).

The NEW ENGLAND JOURNAL of MEDICINE

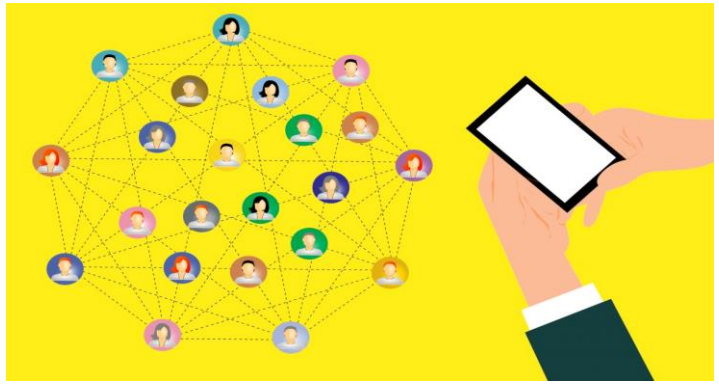
SPECIAL ARTICLE

The Spread of Obesity in a Large Social Network over 32 Years

Nicholas A. Christakis, M.D., Ph.D., M.P.H., and James H. Fowler, Ph.D.



Example: Smartphones and population health



Concerns about how mobile phones affect our

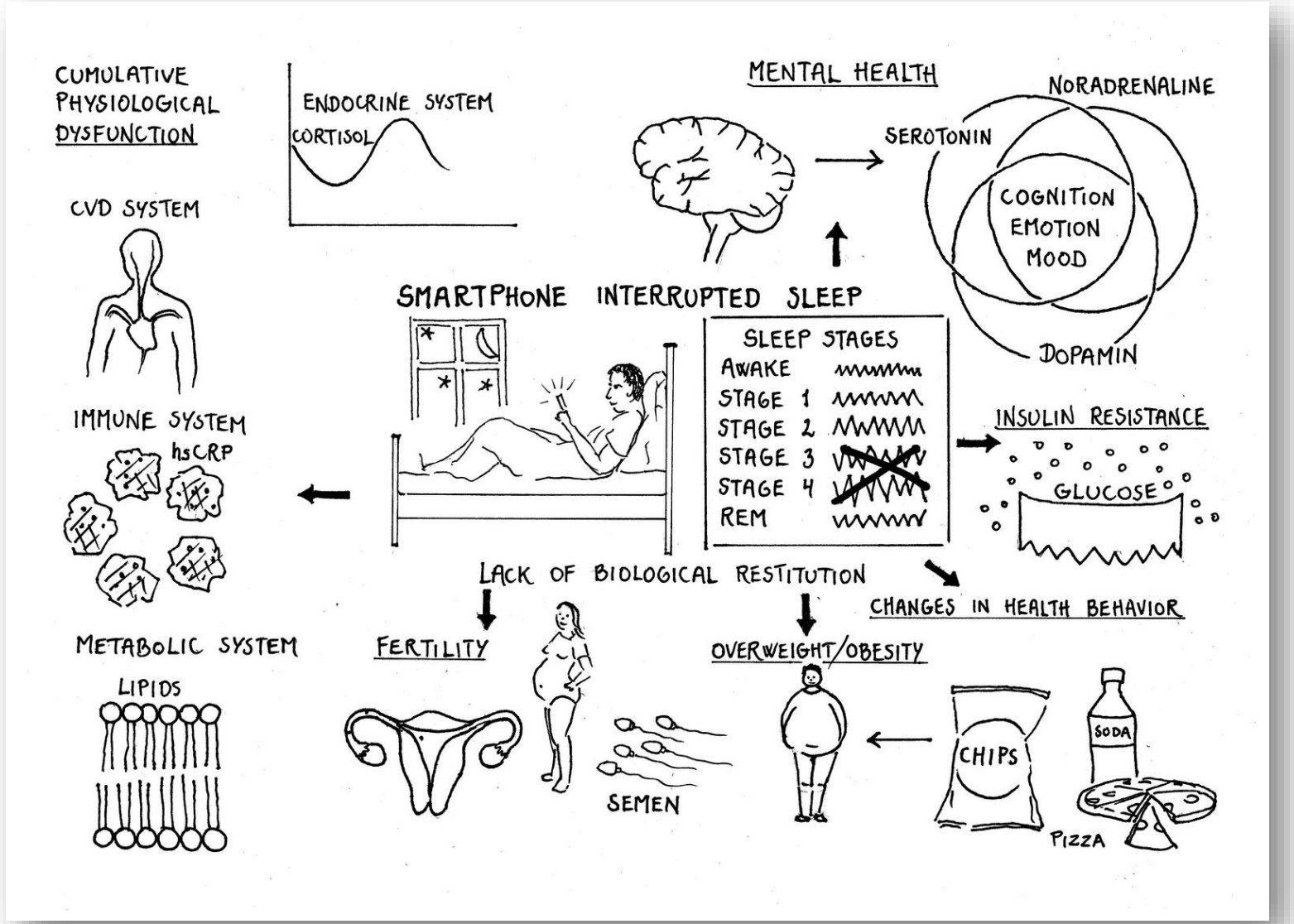
Physical activity

Social relations

Sleep and performance

Sleep is essential for biological restitution, health and performance

Does smartphone interrupted sleep impact health?



INDEPENDENT RESEARCH FUND DENMARK

The *SmartSleep* study design

Social and behavioral phenotyping

Why use smartphones at night?
What characterizes those who do?

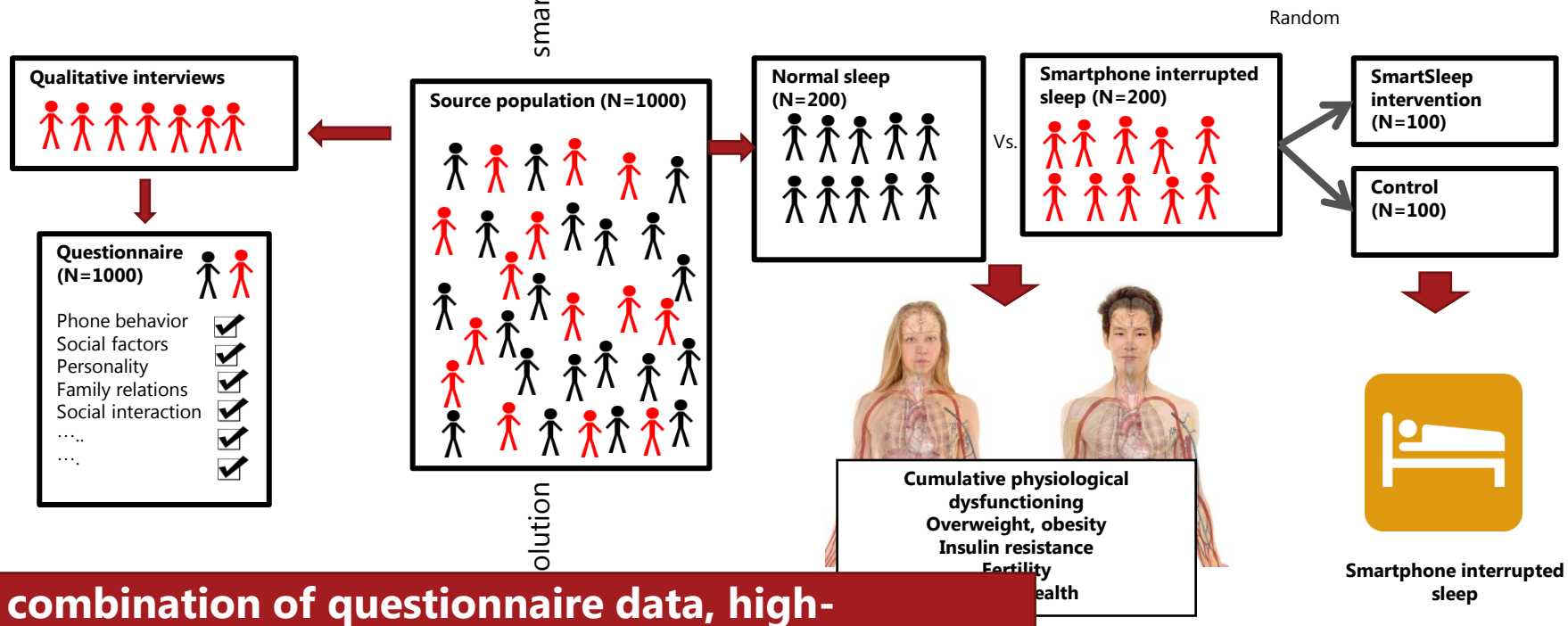
smartphone mapping

Biological phenotyping

What is the impact of smartphone interrupted sleep on physiological functioning?

SmartSleep proof of concept intervention

How can we intervene to reduce smartphone interrupted sleep?



Unique combination of questionnaire data, high-resolution smartphone tracking data, clinical and biological data, and register data

al design

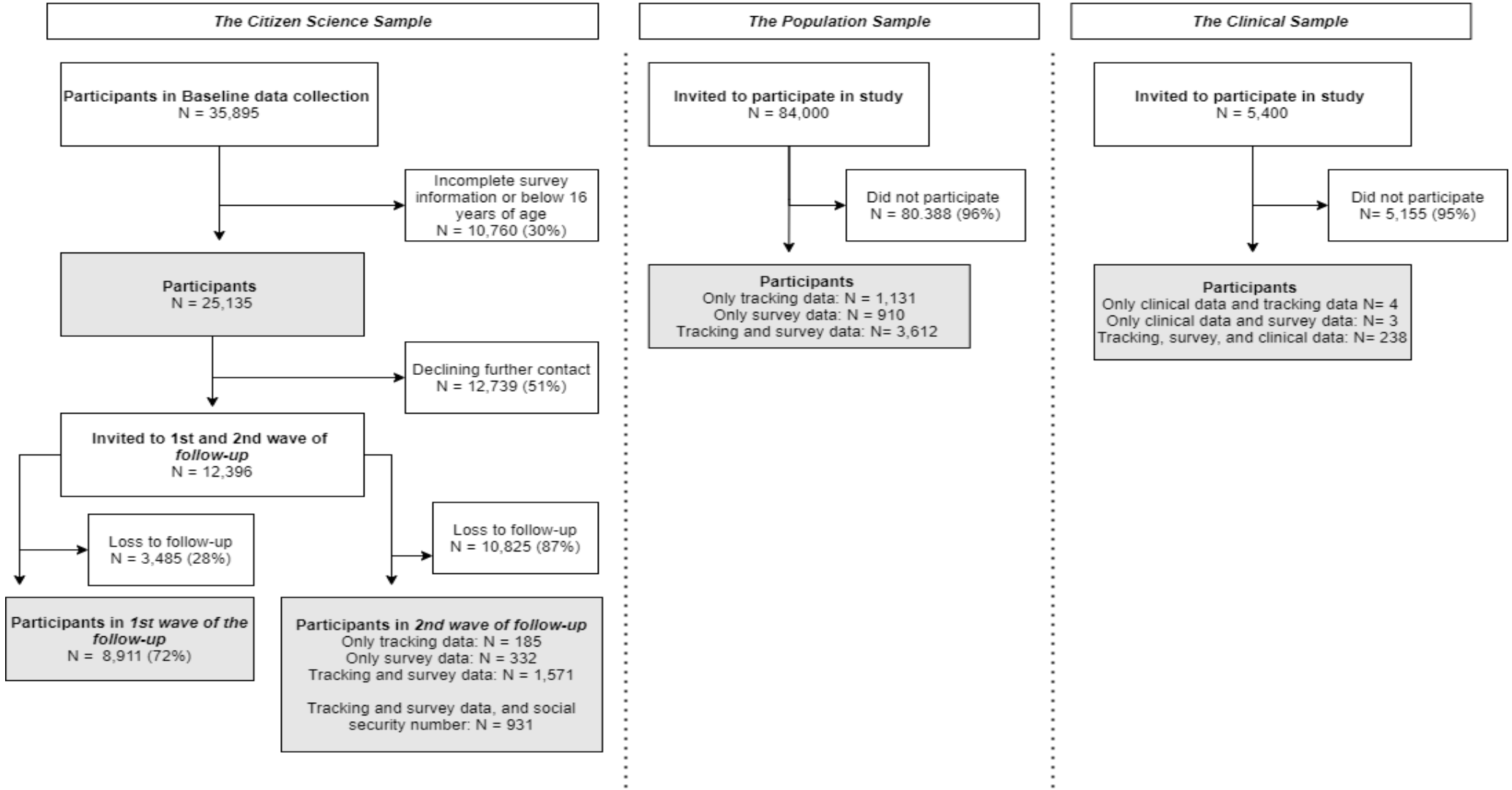
Controlled intervention study

Smartphone interrupted sleep

Normal sleep (i.e. not interrupted by smartphone activity)

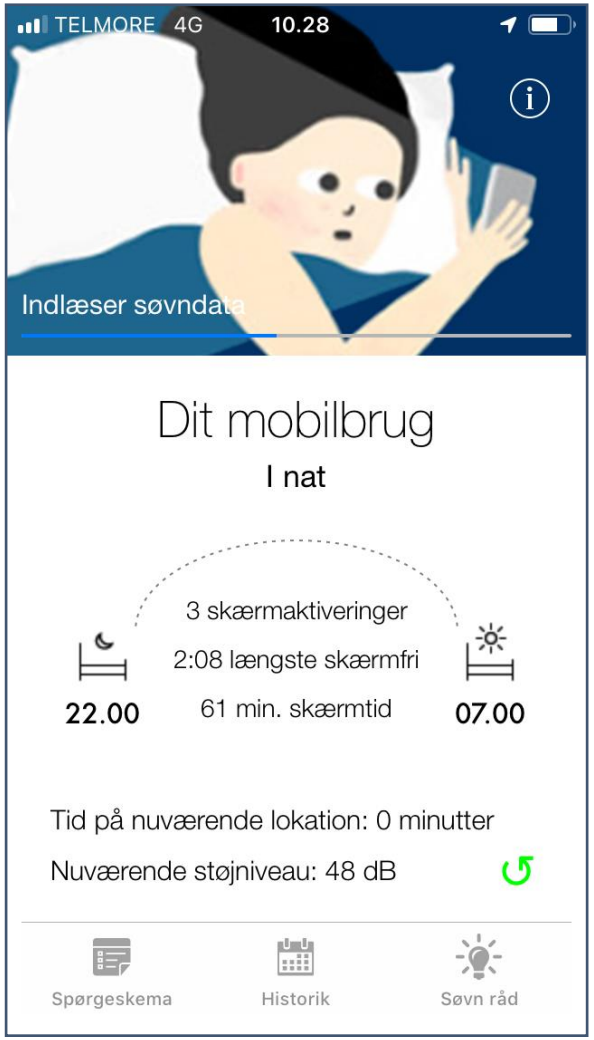
Rod et al. BMJ Open 2023

The SmartSleep Study



Rod et al. BMJ Open 2023

SmartSleep app

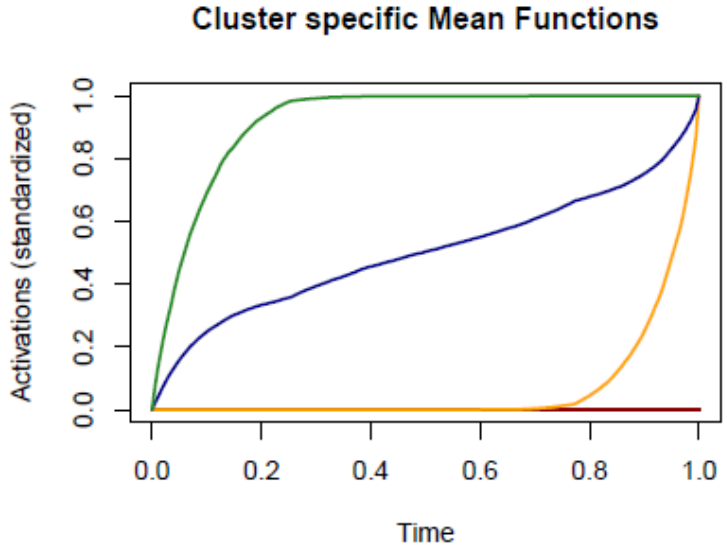


- The app **automatically tracks** screen activation and accelerometer data round-the clock.
- The app provides **direct feedback** to the users in terms of nighttime use
- Data can be used to discover and identify **clusters of temporal trajectories** of nighttime smartphone usage that characterizes distinct usage patterns

Clusters of temporal trajectories of night-time smartphone use

High-resolution smartphone data
Smartphone activity patterns during sleep hours for up to 14 nights from 4,781 individuals

Night clusters (20,643 nights)
Methods from functional data analysis by first mapping the event times into a function space and then perform a clustering of the functions



Cluster 0: Inactive cluster

Cluster 1: Cluster with activity before rising

Cluster 2: Cluster with continuous activity during sleep hours

Cluster 3: Cluster with activity after going to sleep

Subject clusters (4,781 individuals)
Multinominal likelihood based sequence clustering using a mixture Markov model

Example: Childhood adverisity and health

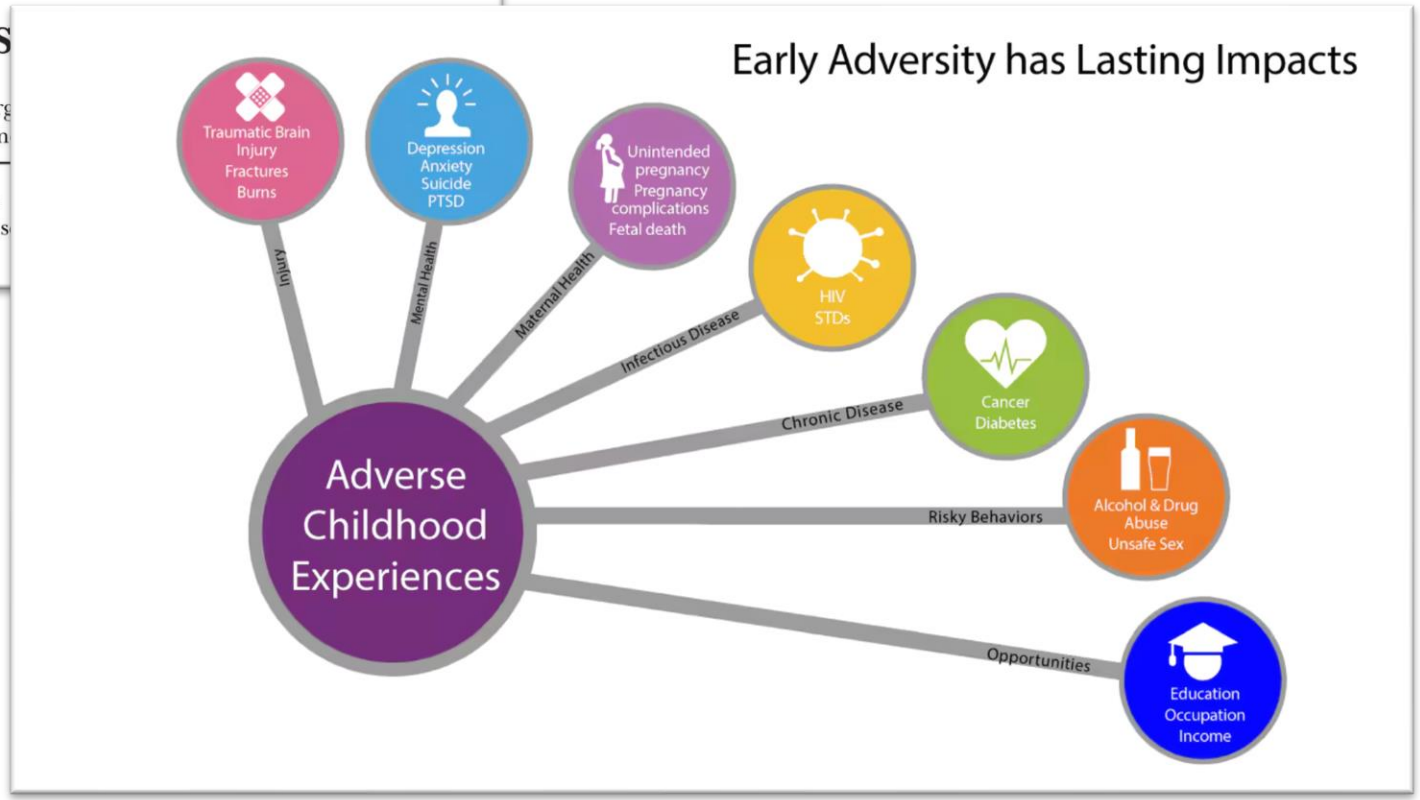
Original Articles

Relationship of Childhood Abuse and Household Dysfunction to Many of the Leading Causes of Death in Adults

The Adverse Childhood Experiences (ACE) S

Vincent J. Felitti, MD, FACP, Robert F. Anda, MD, MS, Dale Nordenberg
Alison M. Spitz, MS, MPH, Valerie Edwards, BA, Mary P. Koss, PhD, Jam

Background: The relationship of health risk behavior and disease in exposure to childhood emotional, physical, or sexual abus during childhood has not previously been described.



8,506 persons
Average age approx 52
Retrospective recall of ACE
1990s California

Adverse childhood experiences cluster, interact and accumulate in individuals, in families and over time

… and they are like to affect health and wellbeing throughout the life course

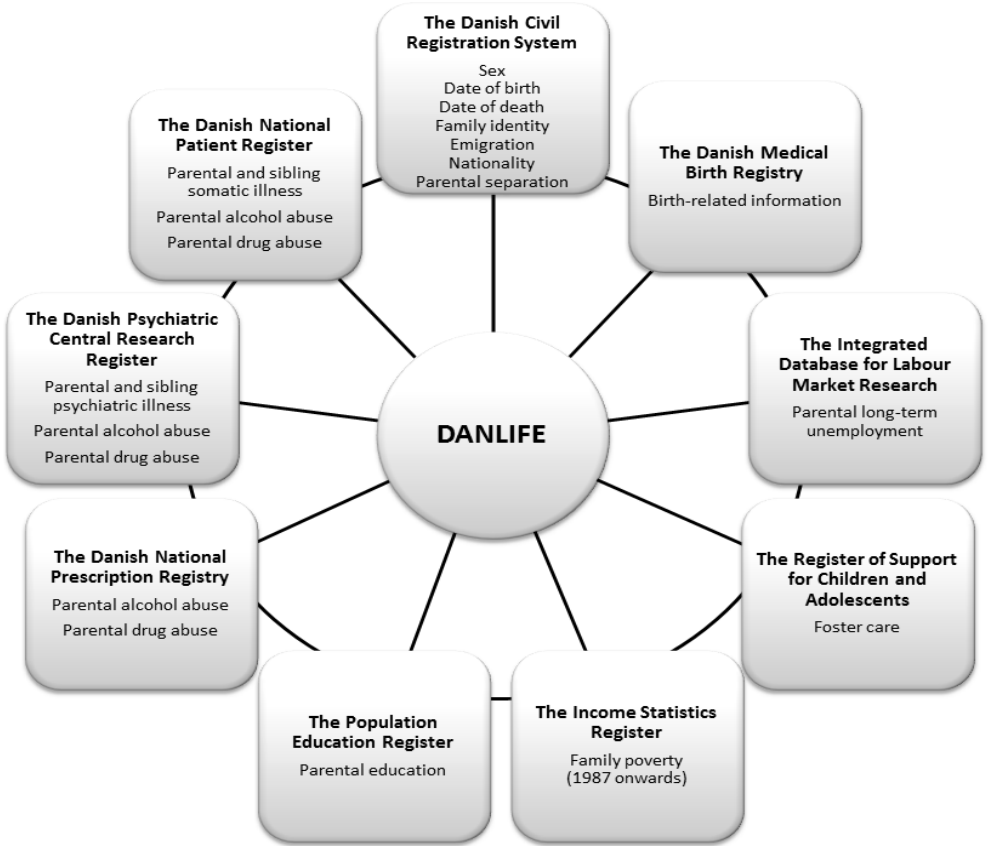
The Danish Life Course (DANLIFE) study

Full life histories

2+ million people nationwide

Childhood adversity
Hospitalizations
Prescriptions
Social and cognitive data
Conscription data

www.danlife.ku.dk

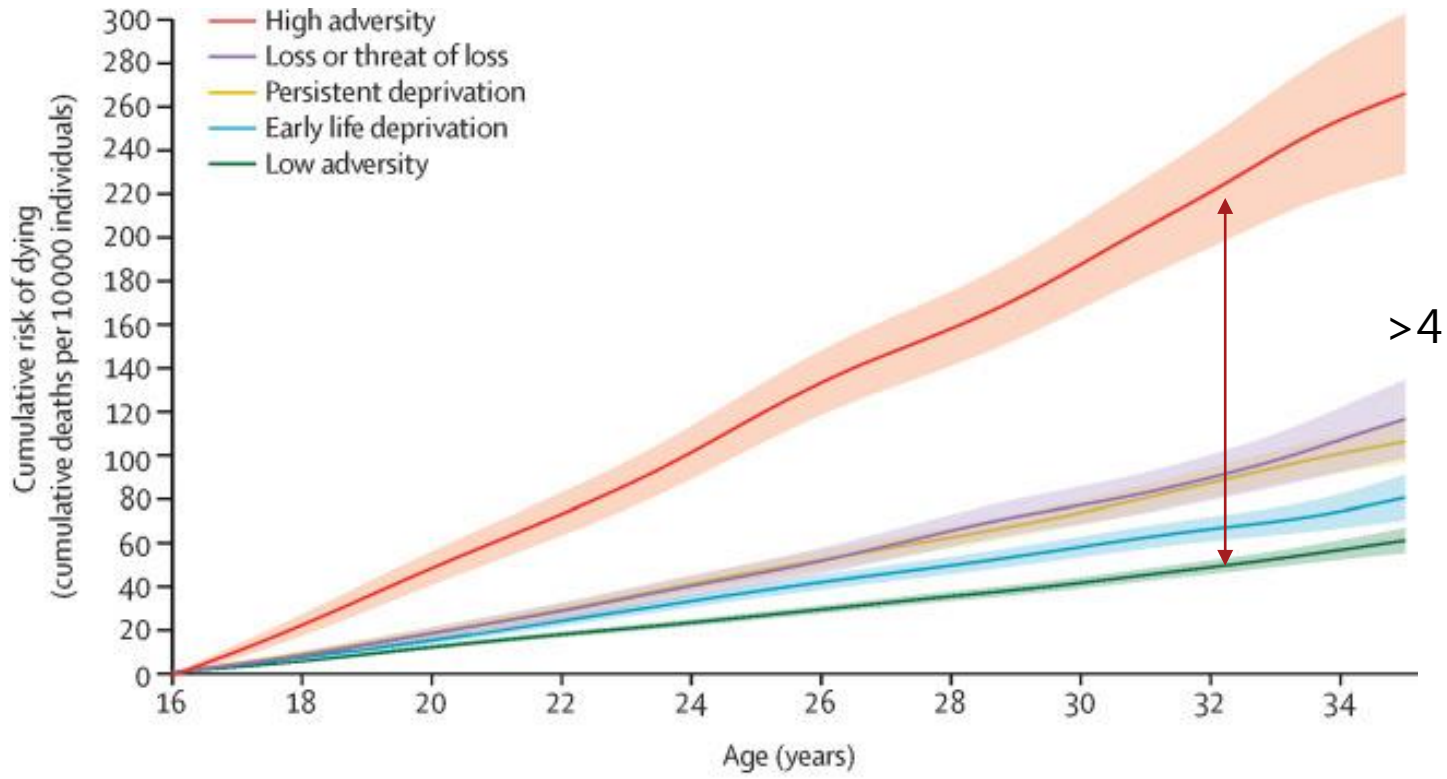


Bengtson J et al. BMJ Open 2019

Mortality

Childhood social adversity (family poverty, unemployment, disease, abuse) cluster in families and can lead to a markedly higher risk of mortality before age 35

Mortality



>4 times higher risk

Rod et al. The Lancet 2020

Data sharing

Comment

https://doi.org/10.1038/s41591-024-03246-6

The European Health Data Space can be a boost for research beyond borders

Andrea Ganna, Angel Carracedo, Christian F. Christiansen, Emanuele Di Angelantonio, Pearl A. Dykstra, Angel M. Dzhambov, Roland Eils, Sara Green, Katharina L. Schneider, Tibor V. Varga, Anna-Leena Vuorinen, Luisa Zuccolo, Naja Hulvej Rod & Klaus Hoeyer

Check for updates

The European Health Data Space provides an opportunity to benefit patients and the public.

data holders will be entitled to compensation for expenses related to making data available.

The EHDS entails a broad definition of health data, including information gathered within healthcare systems and data collected

- Opportunities to explore differences
- Access to real-world data
- Continuous public health surveillance
- Increased data diversity

The EHDS represents the most comprehensive legal initiative concerning health data in the history of the European Union

Ganna et al. Nature Medicine 2024