Worldwide dynamics and transitions of cardiometabolic conditions
Data, analytics and implications

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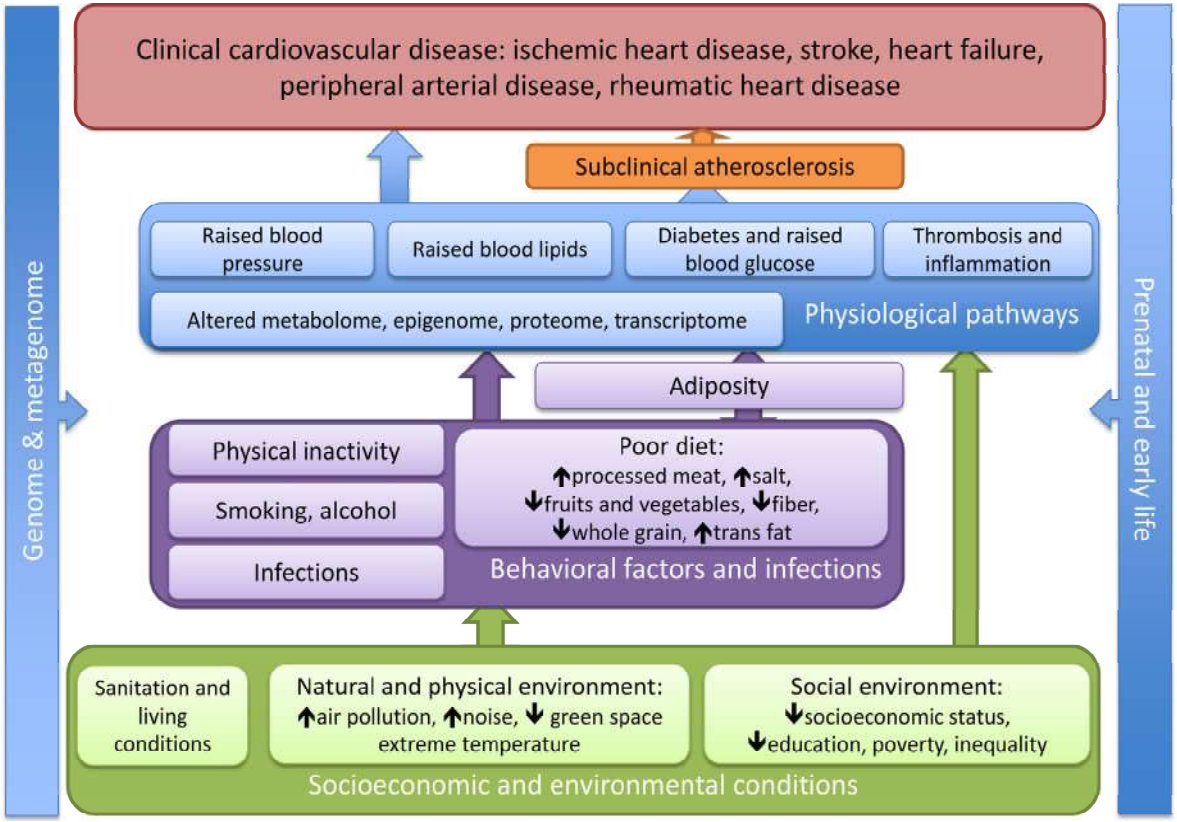
NCD·RisC
Risk Factor Collaboration

A simplified picture of cardiovascular disease aetiology



Tzoulaki et al *Circulation* 2016

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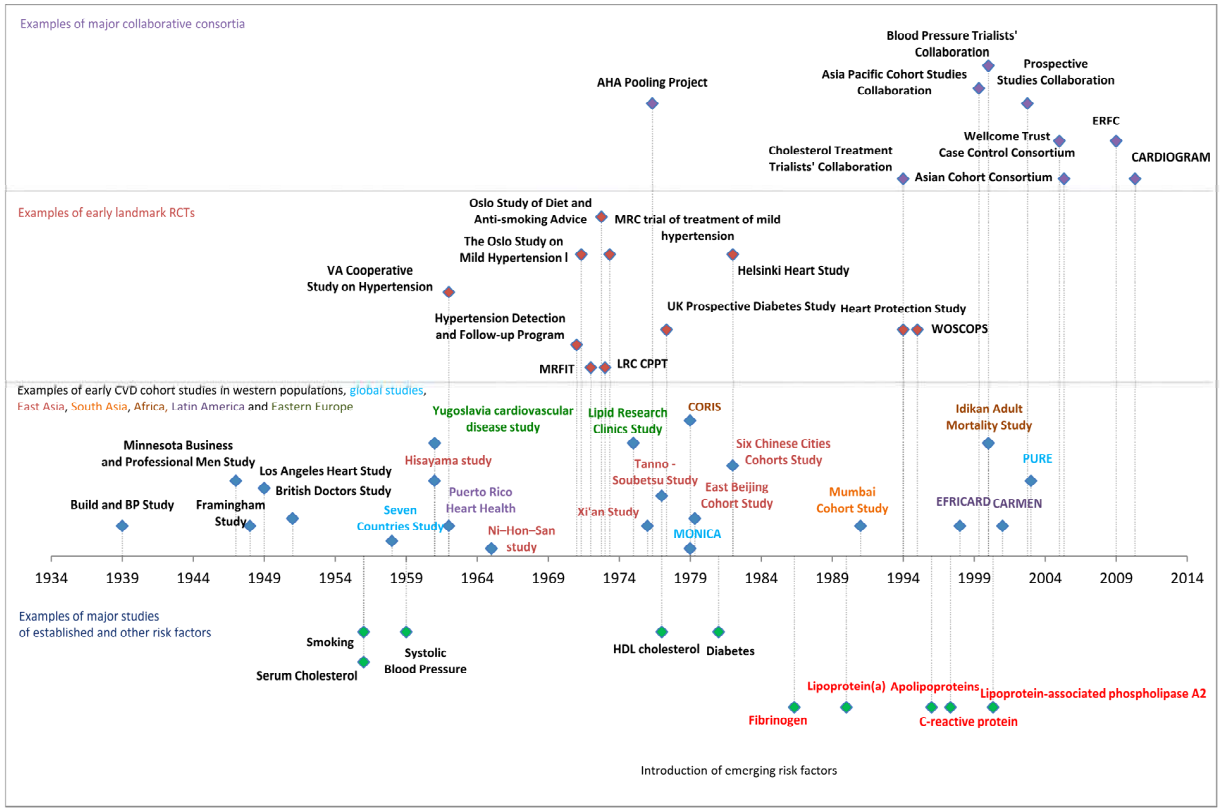
Major milestones in cardiovascular disease aetiology research



Tzoulaki et al *Circulation* 2016

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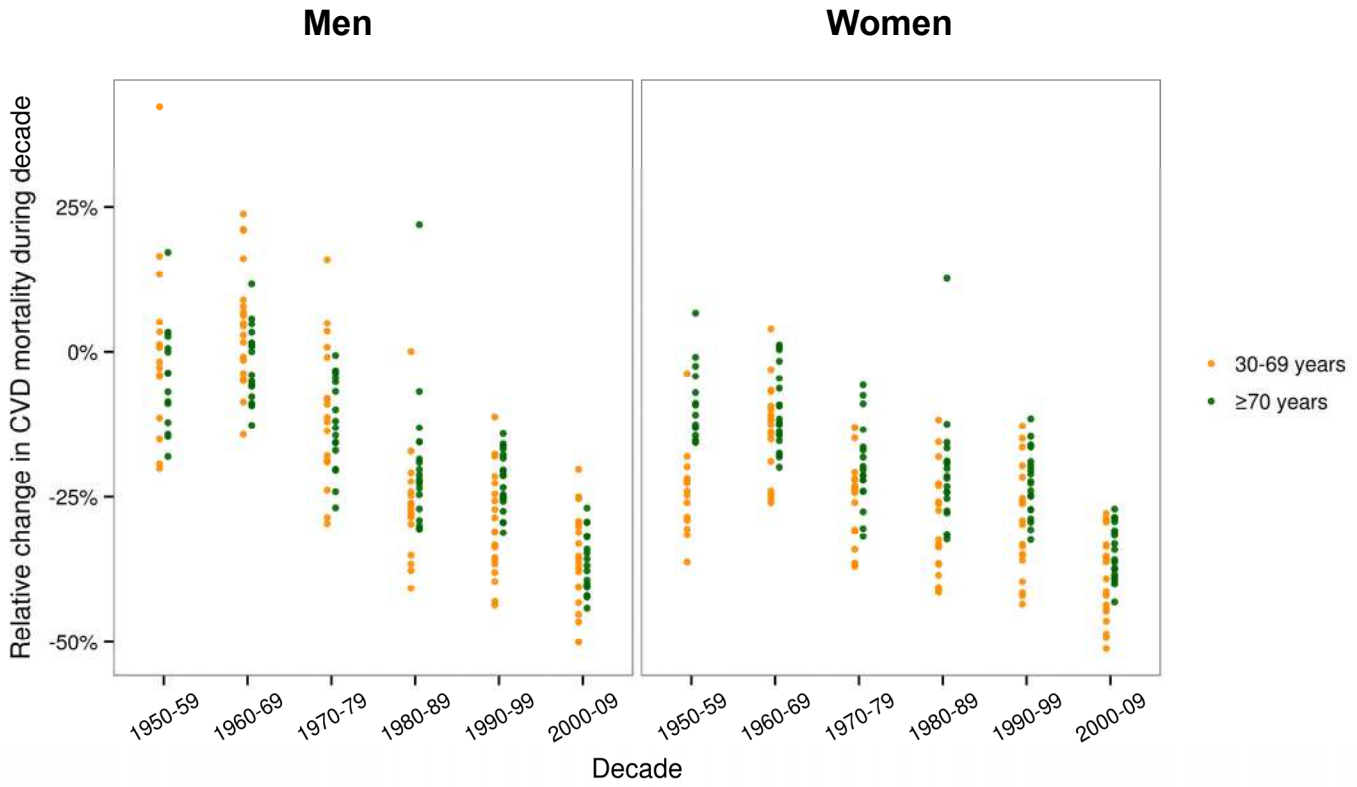
Decades of decline in vascular mortality in high-income countries



Ezzati et al. *Nature Reviews Cardiology* 2015

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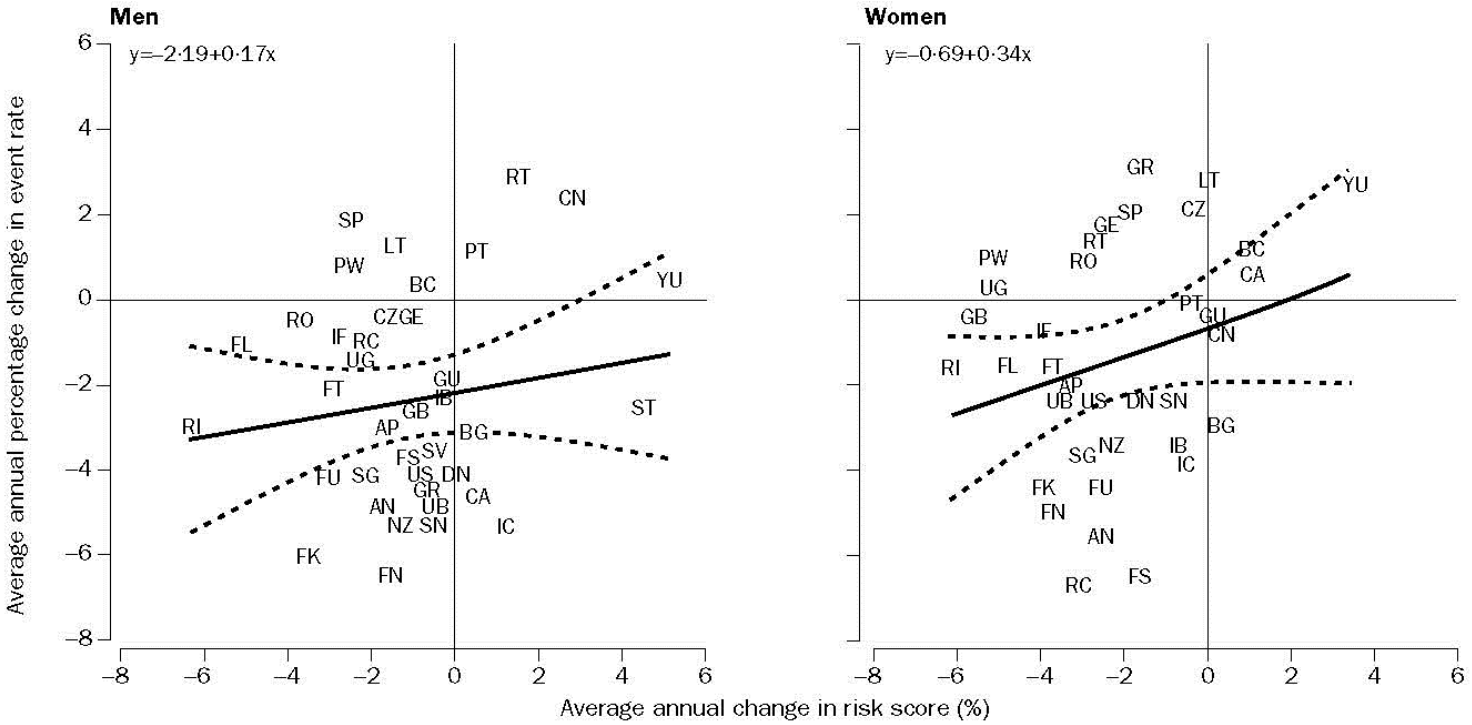
Associations of change in treatment score with change in an aggregate risk factor score in MONICA



Kuulasmaa et al. *Lancet* 2000

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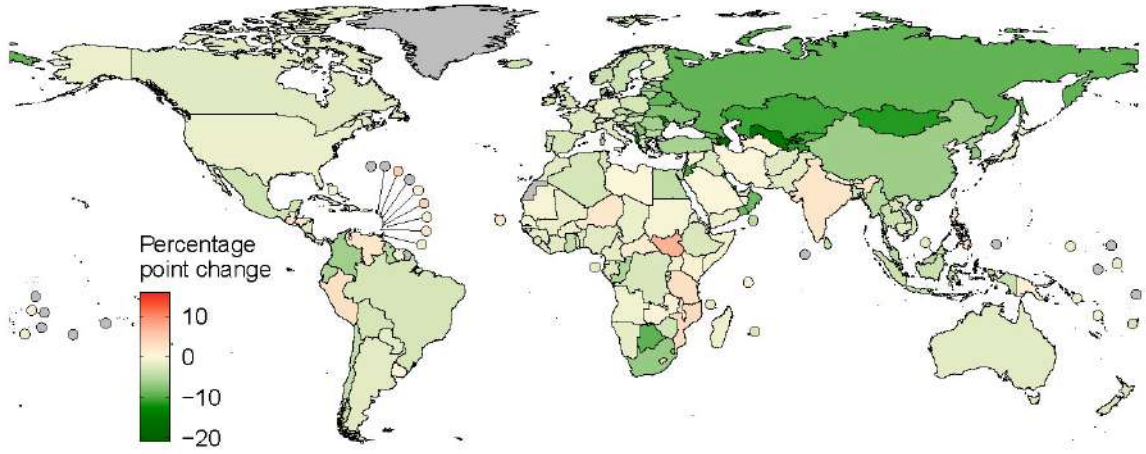
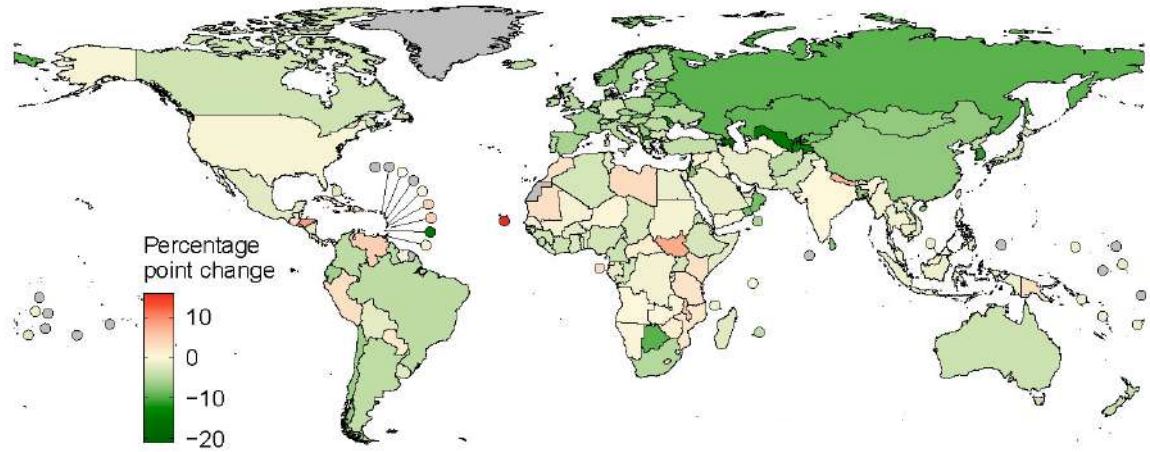
NCD mortality declined in ~80% of countries from 2010 to 2019

Female



Male



Probability of dying from an NCD between birth and 80 years of age in the absence of competing causes of death

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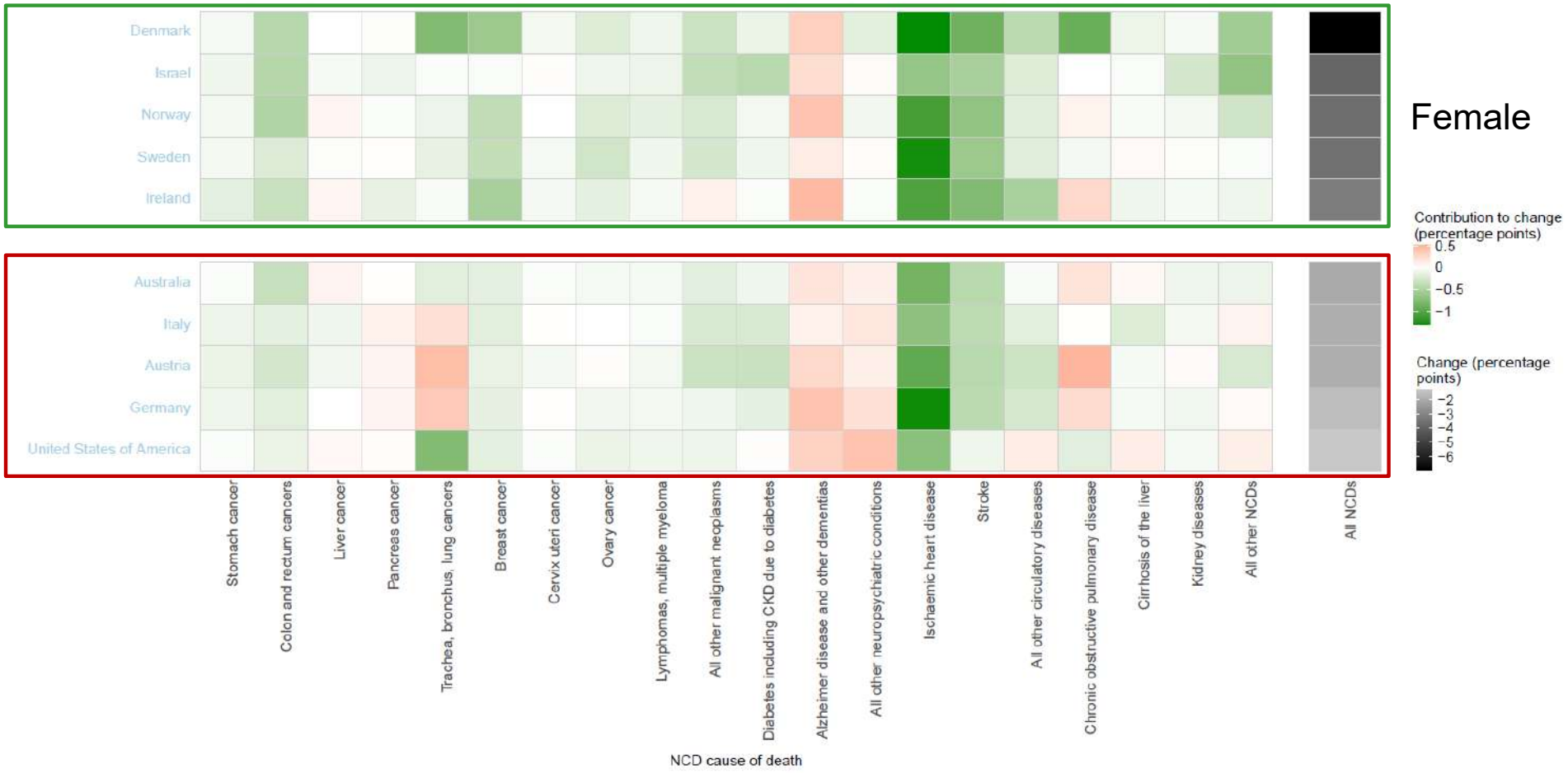
NCD Countdown Collaborators *Lancet* 2025

Multiple NCDs contributed to good and poor performance



NCD Countdown Collaborators *Lancet* 2025

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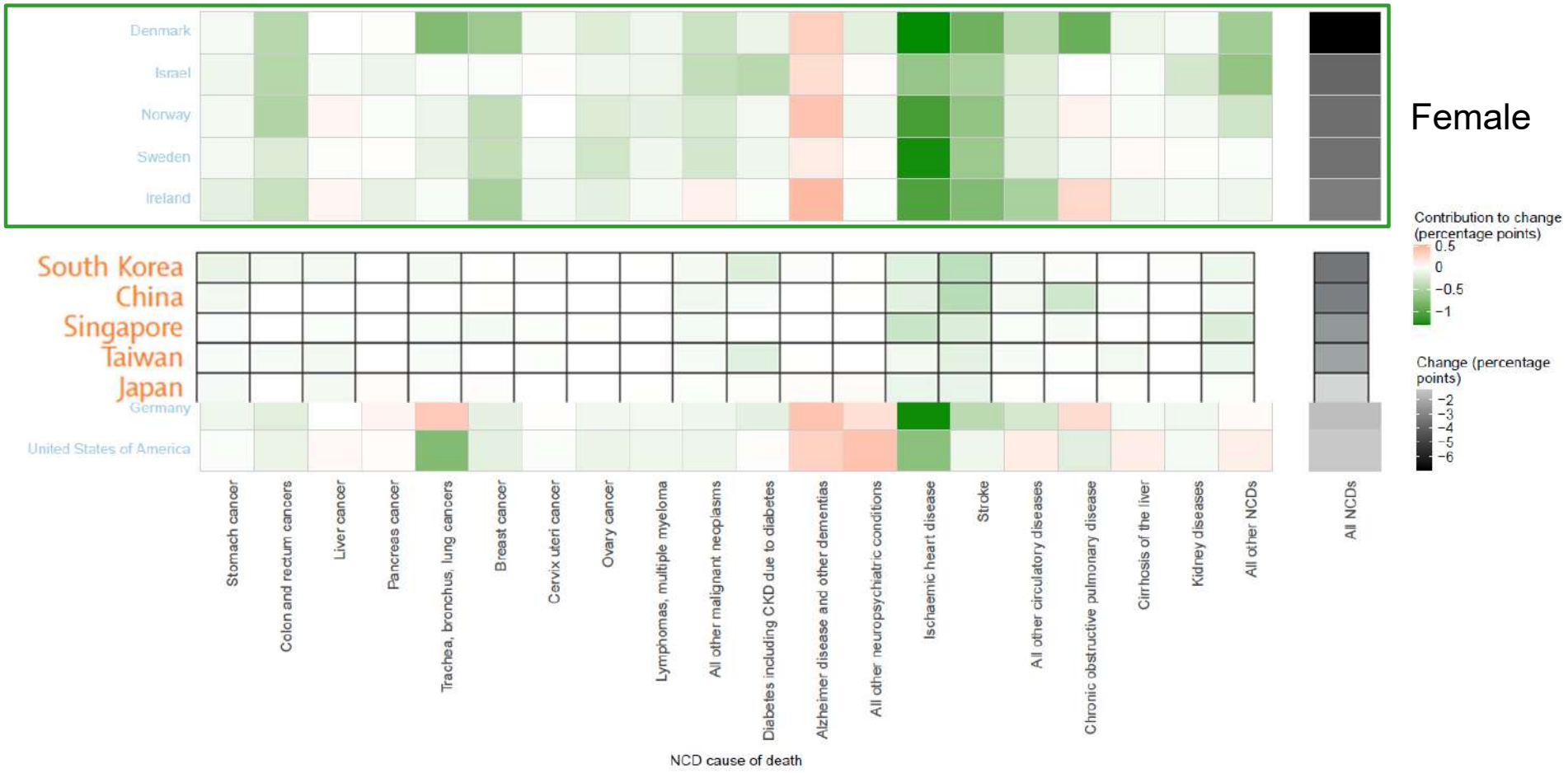
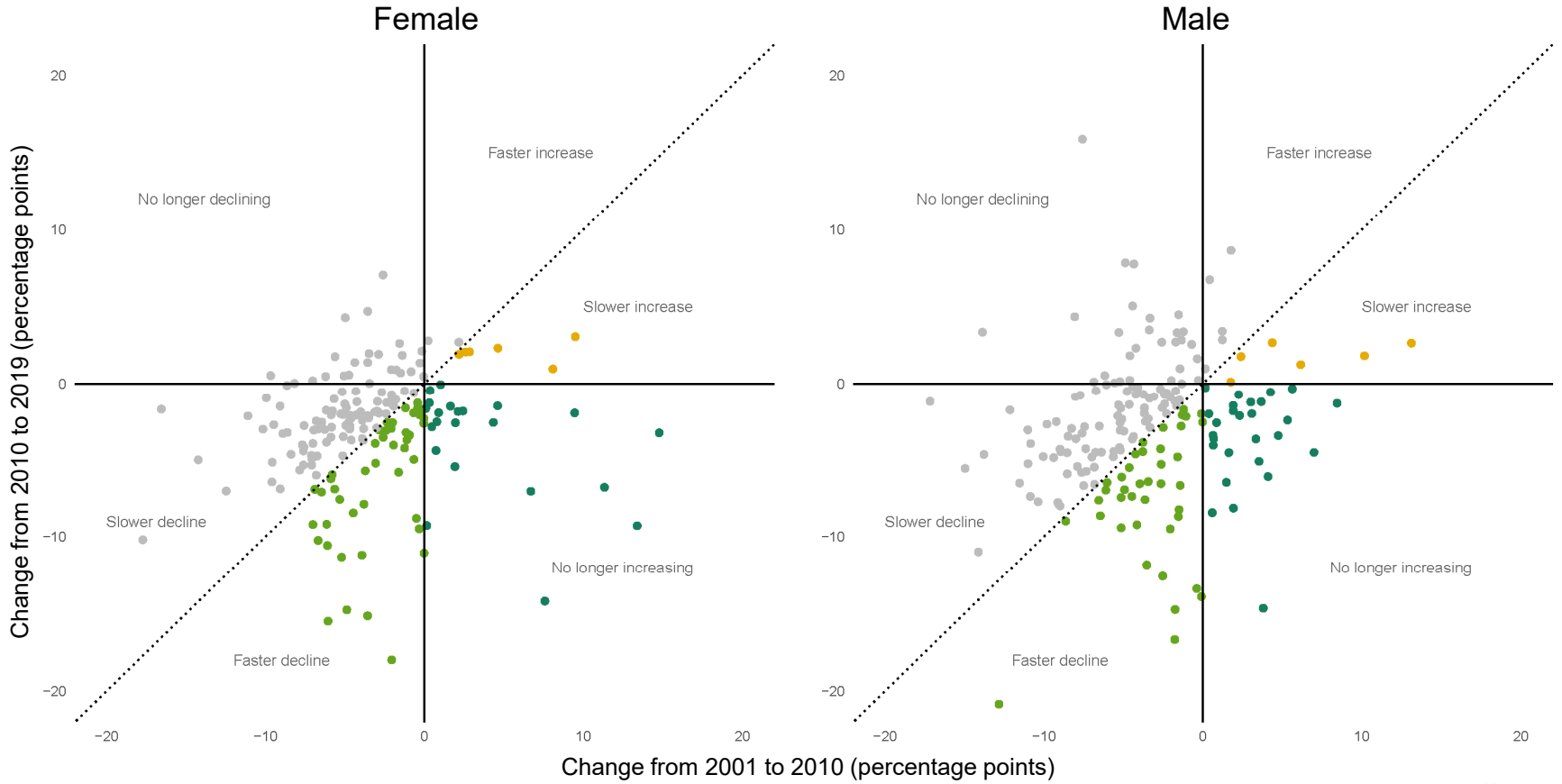


NCD Countdown Collaborators *Lancet* 2025

In ~40% of countries, the size or direction of change improved from 2001-2010 to 2010-2019



NCD Countdown Collaborators *Lancet* 2025

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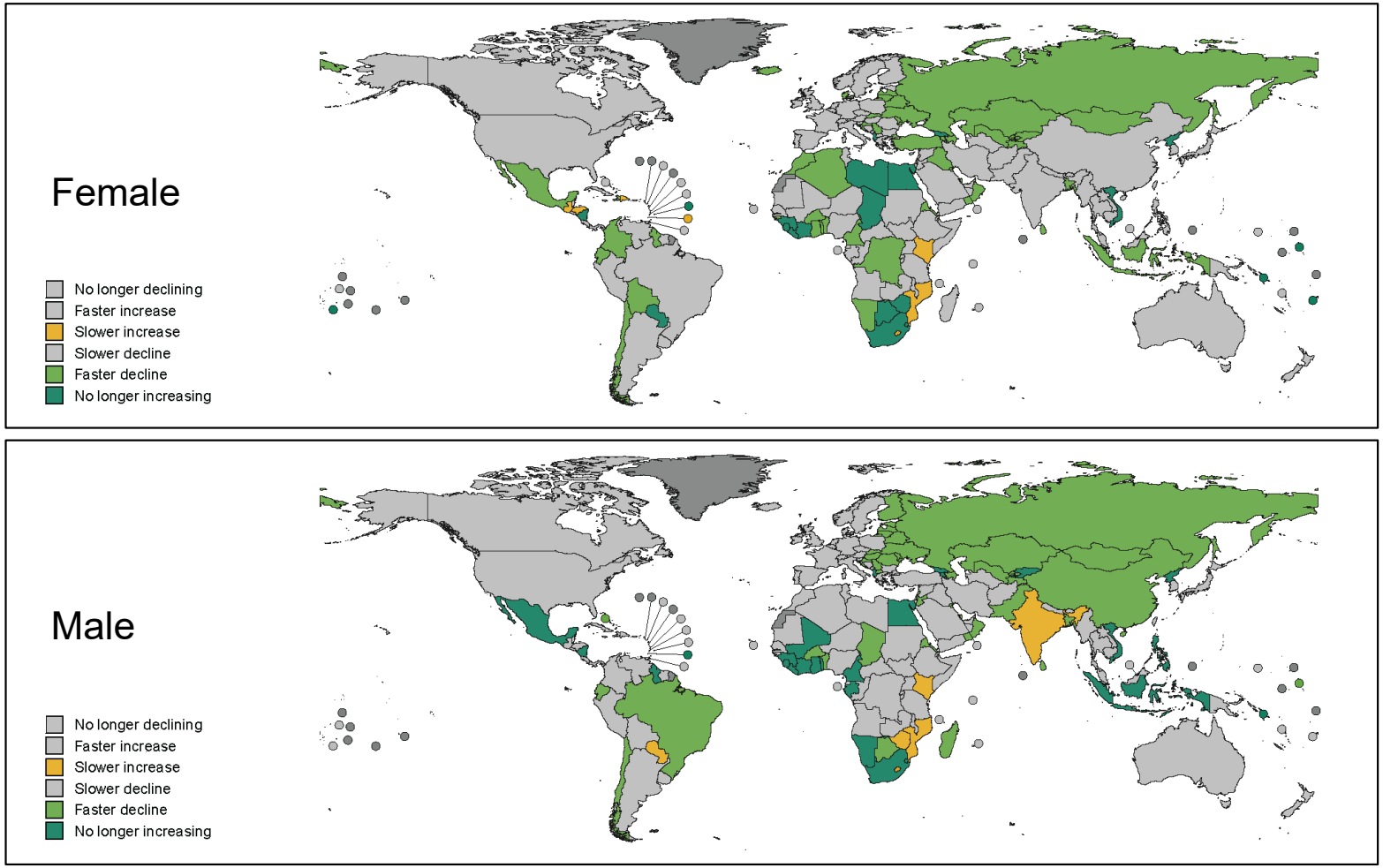

NCD Countdown Collaborators *Lancet* 2025

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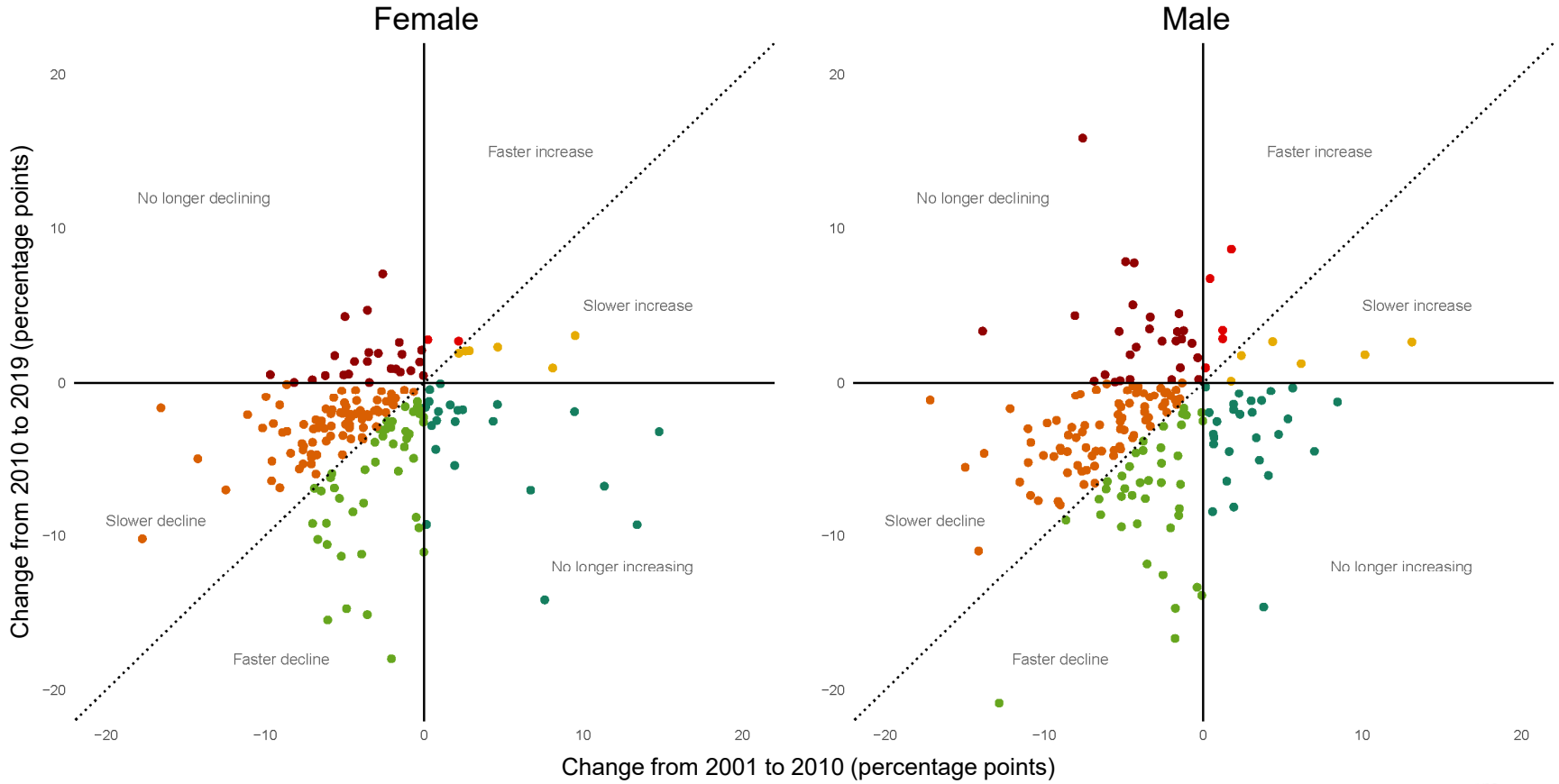
In ~60% of countries, the size or direction of change deteriorated from 2001-2010 to 2010-2019



NCD Countdown Collaborators *Lancet* 2025

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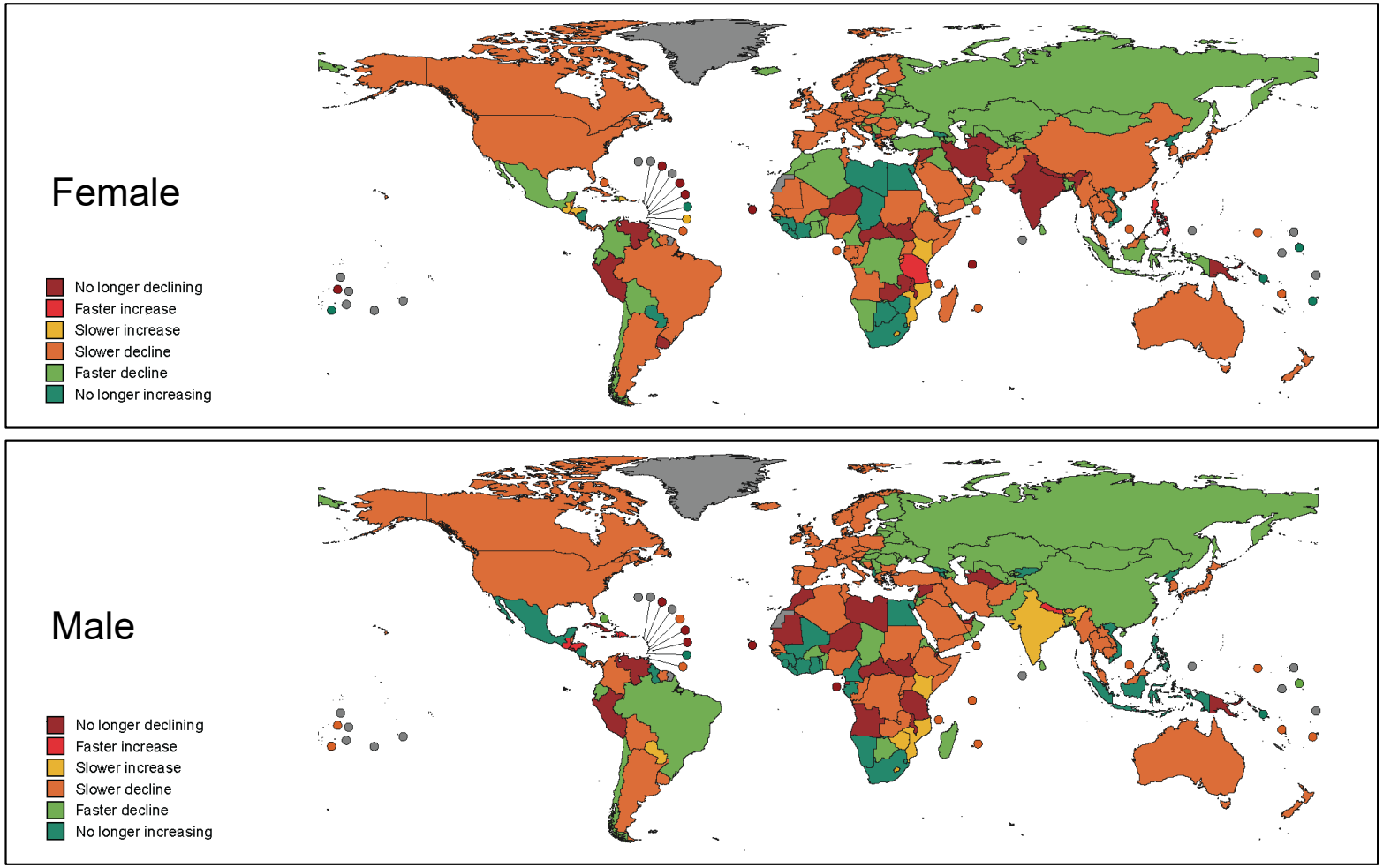

NCD Countdown Collaborators *Lancet* 2025

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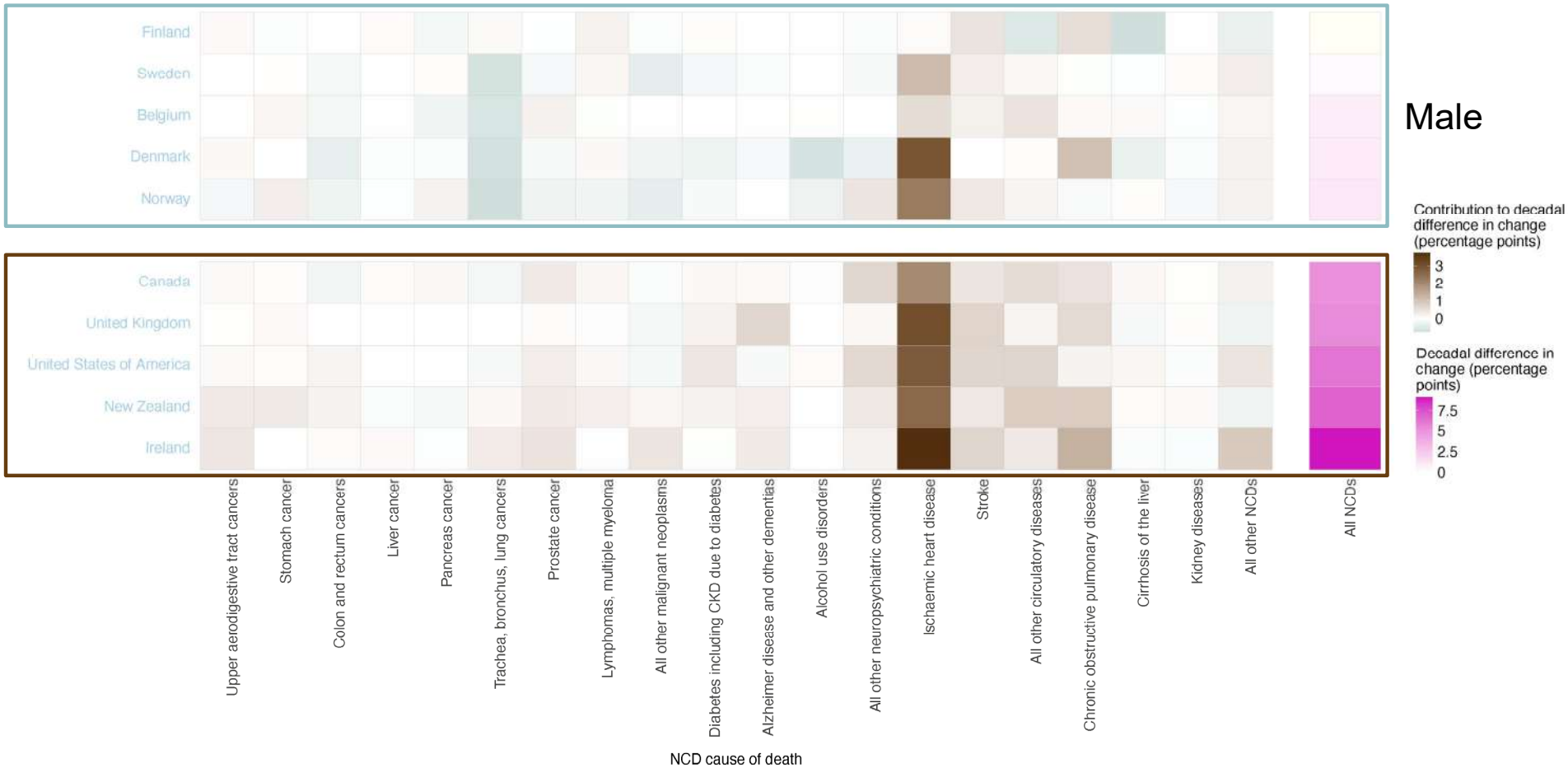
Multiple diseases also contributed to decadal improvement or deterioration of trends



NCD Countdown Collaborators *Lancet* 2025

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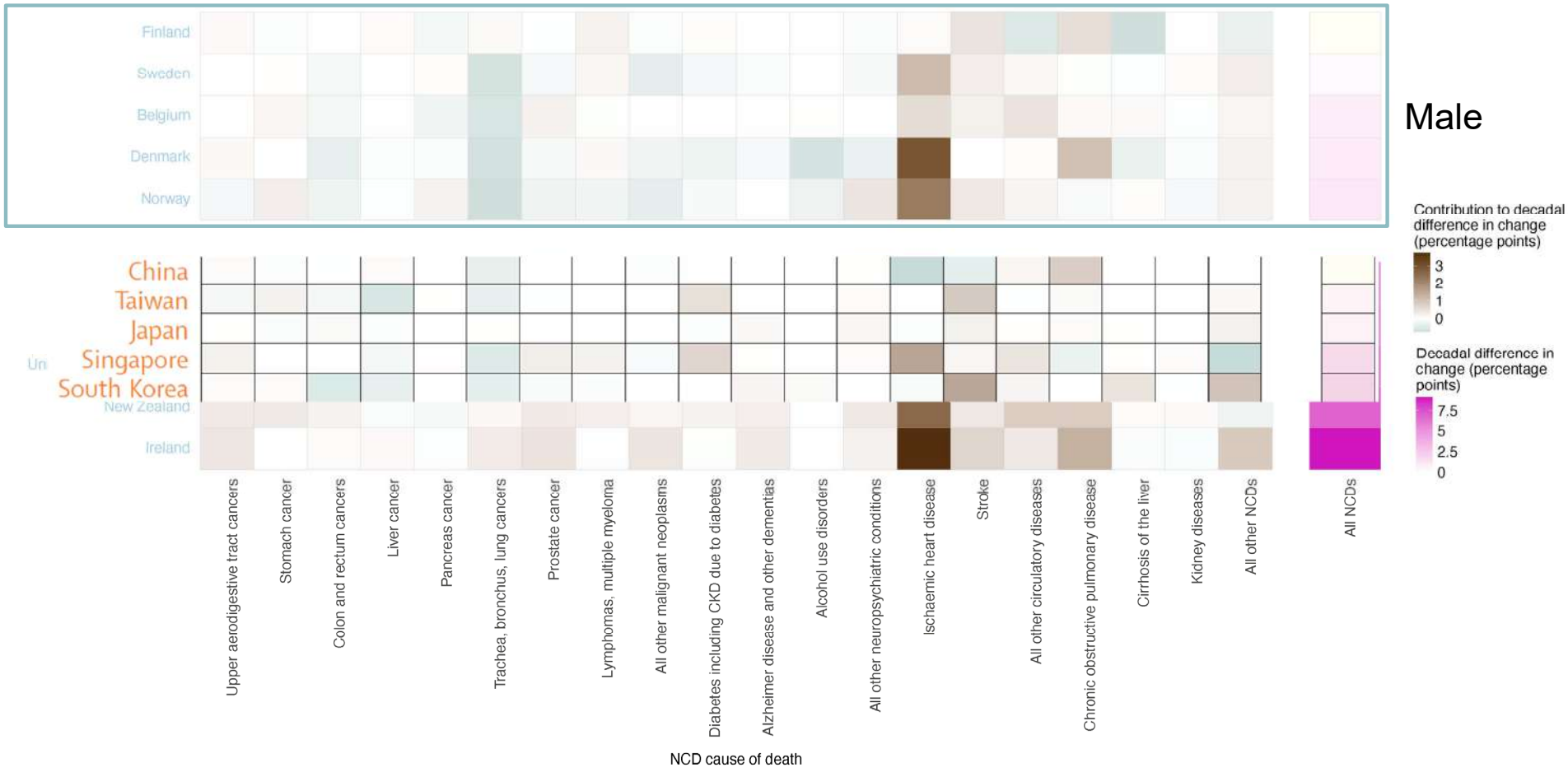

NCD Countdown Collaborators *Lancet* 2025

Non-Communicable Disease Risk Factor Collaboration (NCD-RisC)

- Global network of ~2,000 scientists/practitioners; working closely with the WHO
- Pool and analyse population-based data on cardiometabolic conditions
  - Over 4,000 studies with >200 million participants in 197 countries
  - Rigorous assessment that data are representative of general population with high-quality measurement
- Country results and visualisations at www.ncdrisc.org

NCD·RisC
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NCD-RisC selected scientific outputs

Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults

NCD Risk Factor Collaboration (NCD-RisC)*

Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19·2 million participants

NCD Risk Factor Collaboration (NCD-RisC)*

Height and body-mass index trajectories of school-aged children and adolescents from 1985 to 2019 in 200 countries and territories: a pooled analysis of 2181 population-based studies with 65 million participants

NCD Risk Factor Collaboration (NCD-RisC)*

oa

Worldwide trends in underweight and obesity from 1990 to 2022: a pooled analysis of 3663 population-representative studies with 222 million children, adolescents, and adults

NCD Risk Factor Collaboration (NCD-RisC)*

oa

Article

Global variation in diabetes diagnosis and prevalence based on fasting glucose and hemoglobin A1c

Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4·4 million participants

NCD Risk Factor Collaboration (NCD-RisC)*

Worldwide trends in diabetes prevalence and treatment from 1990 to 2022: a pooled analysis of 1108 population-representative studies with 141 million participants

NCD Risk Factor Collaboration (NCD-RisC)*

eLIFE

A century of trends in adult human height

NCD Risk Factor Collaboration (NCD-RisC)*

Article

Diminishing benefits of urban living for children and adolescents' growth and development

LETTER

OPEN

Rising rural body-mass index is the main driver of the global obesity epidemic in adults

NCD Risk Factor Collaboration (NCD-RisC)*

General and abdominal adiposity and hypertension in eight world regions: a pooled analysis of 837 population-based studies with 7·5 million participants

NCD Risk Factor Collaboration (NCD-RisC)*

Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19·1 million participants

NCD Risk Factor Collaboration (NCD-RisC)*

Long-term and recent trends in hypertension awareness, treatment, and control in 12 high-income countries: an analysis of 123 nationally representative surveys

NCD Risk Factor Collaboration (NCD-RisC)*

Worldwide trends in hypertension prevalence and progress in treatment and control from 1990 to 2019: a pooled analysis of 1201 population-representative studies with 104 million participants

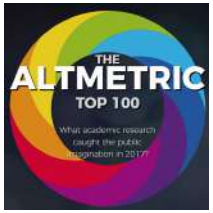
NCD Risk Factor Collaboration (NCD-RisC)*

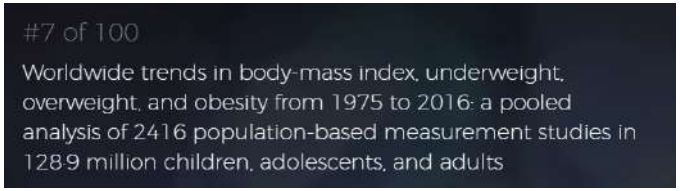
oa

Article

Repositioning of the global epicentre of non-optimal cholesterol

NCD Risk Factor Collaboration (NCD-RisC)*





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NCD-RisC policy and engagement outputs and outreach

Since launch in April 2016	
Total users	464,799
Total sessions	581,676
Total page views	1,758,956
Users (per day)	191
Sessions (per day)	239
Page views (per day)	723

63 countries have ≥1000 sessions
204 countries have ≥10 sessions
234 countries have at least 1 session

NCD·RisC
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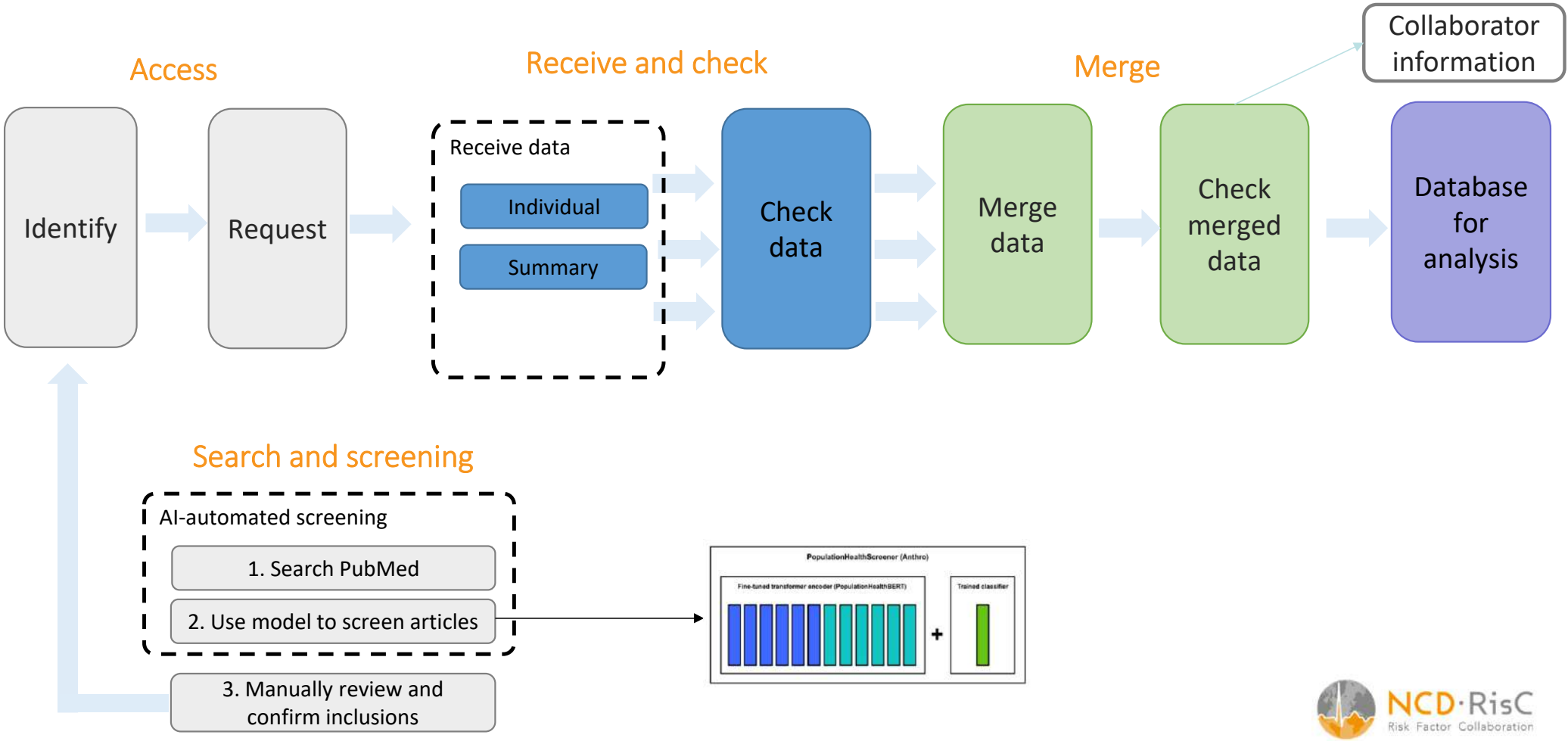
NCD-RisC data pipeline



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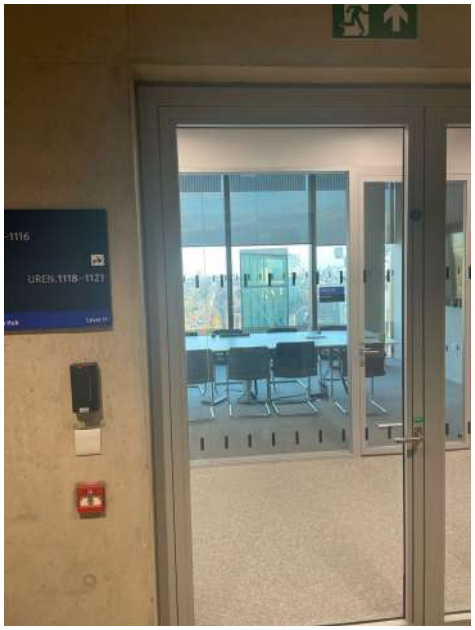
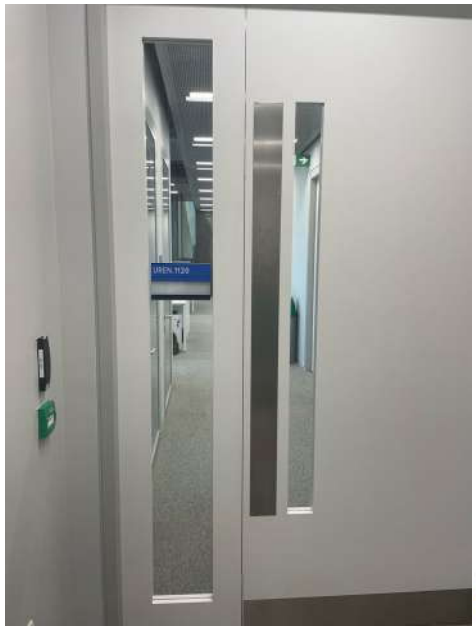
NCD-RisC data security and operation

- Data maintained on access-controlled servers; certified for ISO 27001 and ISO 9001
- NCD-RisC team in dedicated area with five layers of ID-controlled access
- Data use agreements with NCD-RisC PI and/or Imperial College London when needed by data providers





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Rigorous and systematic inclusion and re-analysis

Re: NCD-RisC, query on diabetes data from [redacted]

[redacted]

To: [redacted]

Dear [redacted],
I have just sent you via [redacted] an additional file "[redacted].csv" containing the variable "diabetes2", coded "0" for "undiagnosed diabetes" and "1" for "diabetes already diagnosed before the study".
The password to recover the file is:
[redacted]
Hoping to respond to your request.
Best regards,
[redacted]

[redacted]

Dear [redacted]

I hope this email finds you well. I am writing with a query regarding diabetes diagnosis data from the [redacted] study you kindly shared with us.

In light up upcoming diabetes analysis we have been systematically checking the data and noticed that all individuals from [redacted] with elevated fasting glucose levels (variable 'fglucose'), also have diagnosed diabetes (variable 'diabetes') - i.e there are no undiagnosed diabetics in the data. Can you please confirm whether the variable 'diabetes' is based on self-reported diabetes diagnosis exclusively or whether it is also based on glucose measurements from the study?

Any further insight you had would be greatly appreciated, or if you could help connect us with someone who might be able to assist with the query. Please let me know if you any questions.

Thank you for your help in advance.

RE: NCD-RisC data query: [redacted]

[redacted]

Thanks [redacted]
That's news to me, so good to know.
Clearly, my reading of the documentation was different to what they had done, so really good that you were in contact with them.
Thanks again.
[redacted]

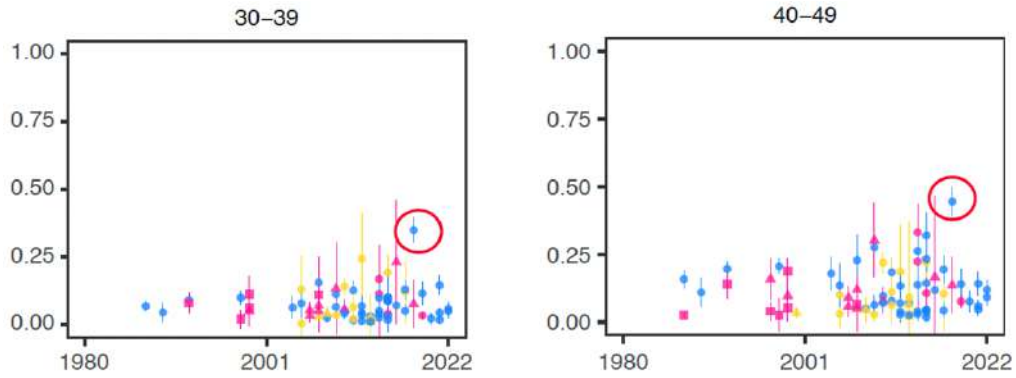
From: [redacted]
Sent: [redacted]
To: [redacted]
[redacted]
Subject: RE: NCD-RisC data query: [redacted]

Dear [redacted]

Thank you for getting back to me with the glucose device details. Since my initial query I have been in contact with the manufacturers of the [redacted], and they have told me that the device does not present plasma equivalent values. Given this, we will consider the glucose data (variable 'glucose_[redacted]') as whole blood values. Please provide any additional information that supports otherwise if available.

Thank your time spent on this.

Best wishes,
[redacted]



NCD·RisC
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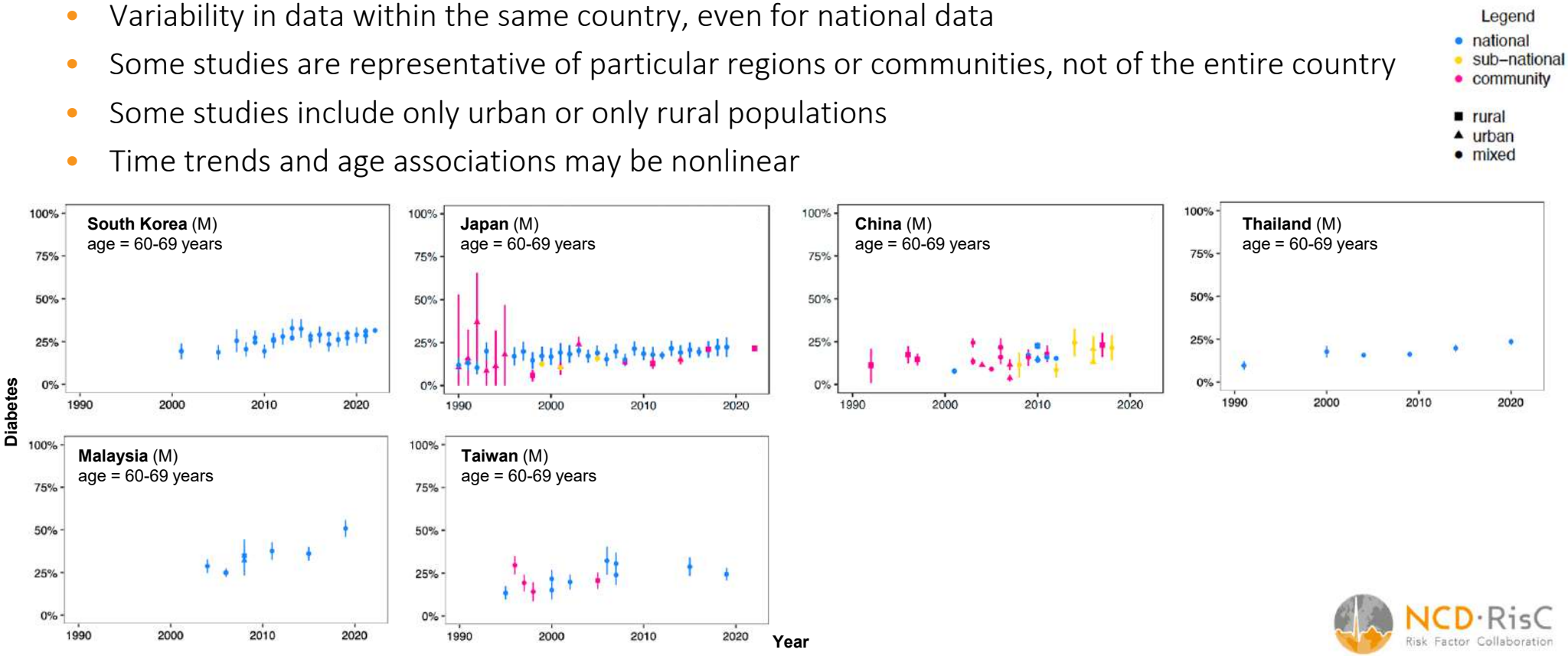
Using heterogeneous data for global estimation

- Amount of available data varies; data are sparse in some countries, age groups and years
- Variability in data within the same country, even for national data
- Some studies are representative of particular regions or communities, not of the entire country
- Some studies include only urban or only rural populations
- Time trends and age associations may be nonlinear



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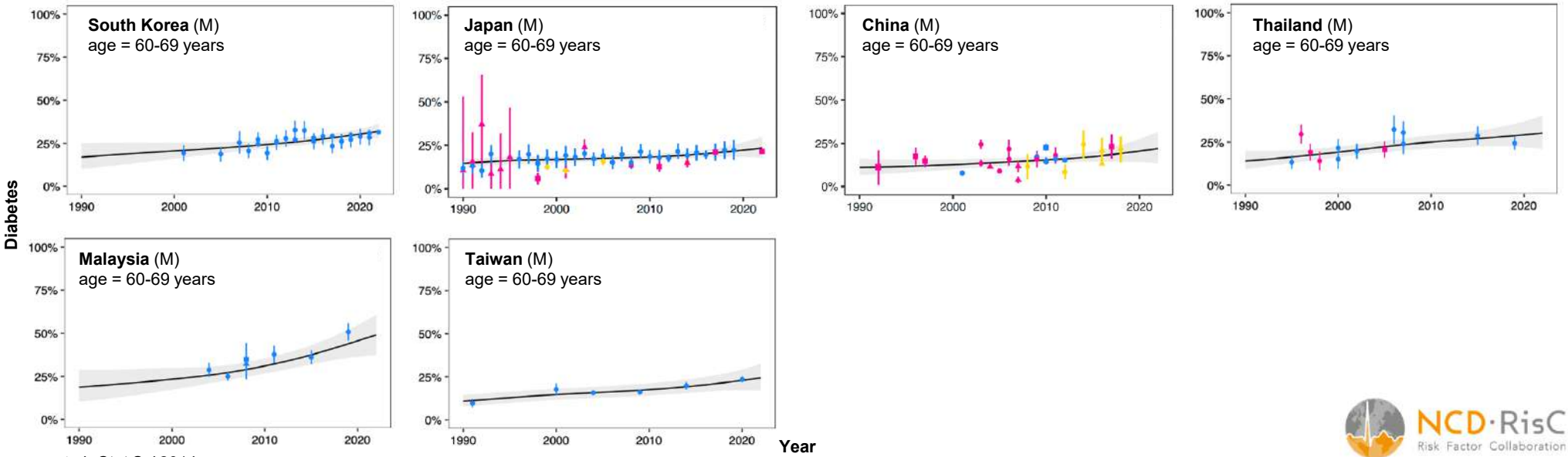
Bespoke statistical meta-regression to fit the data for global estimation

- Hierarchical linear and non-linear time trends
- Non-linear age associations, and allow time trends to vary by age
- Systematic and random differences among national and non-national data



Finucane et al. *Stat Sci* 2014

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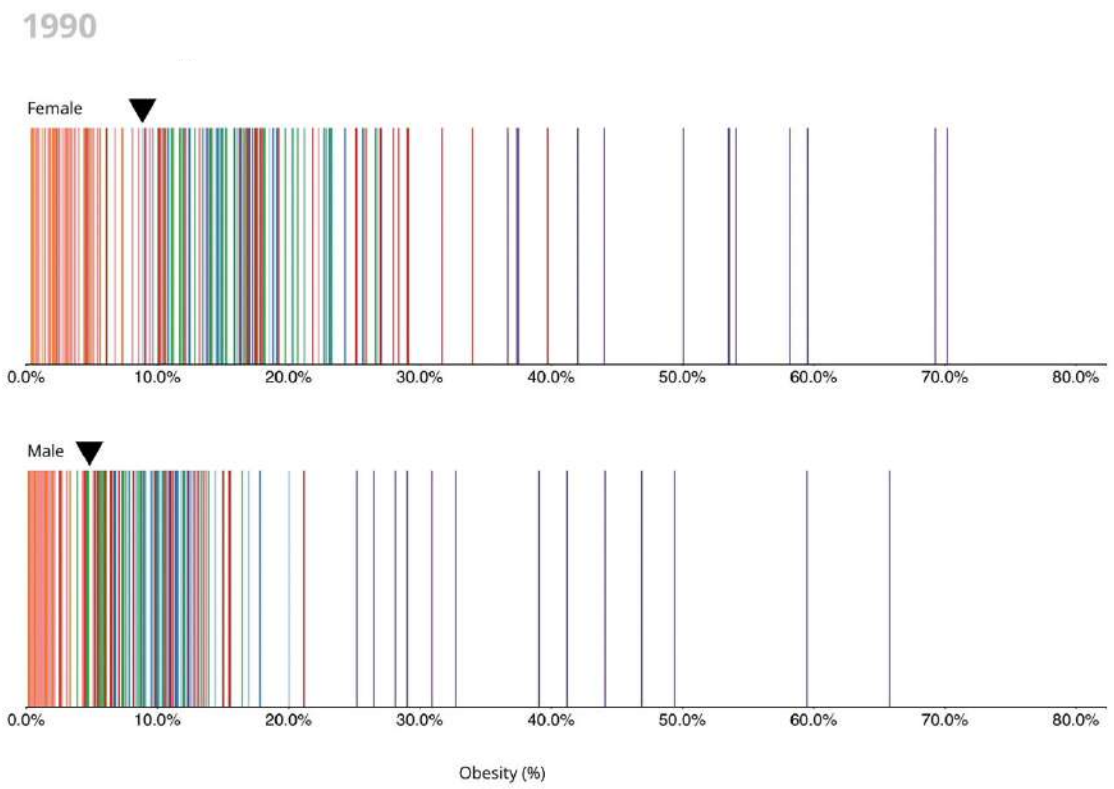
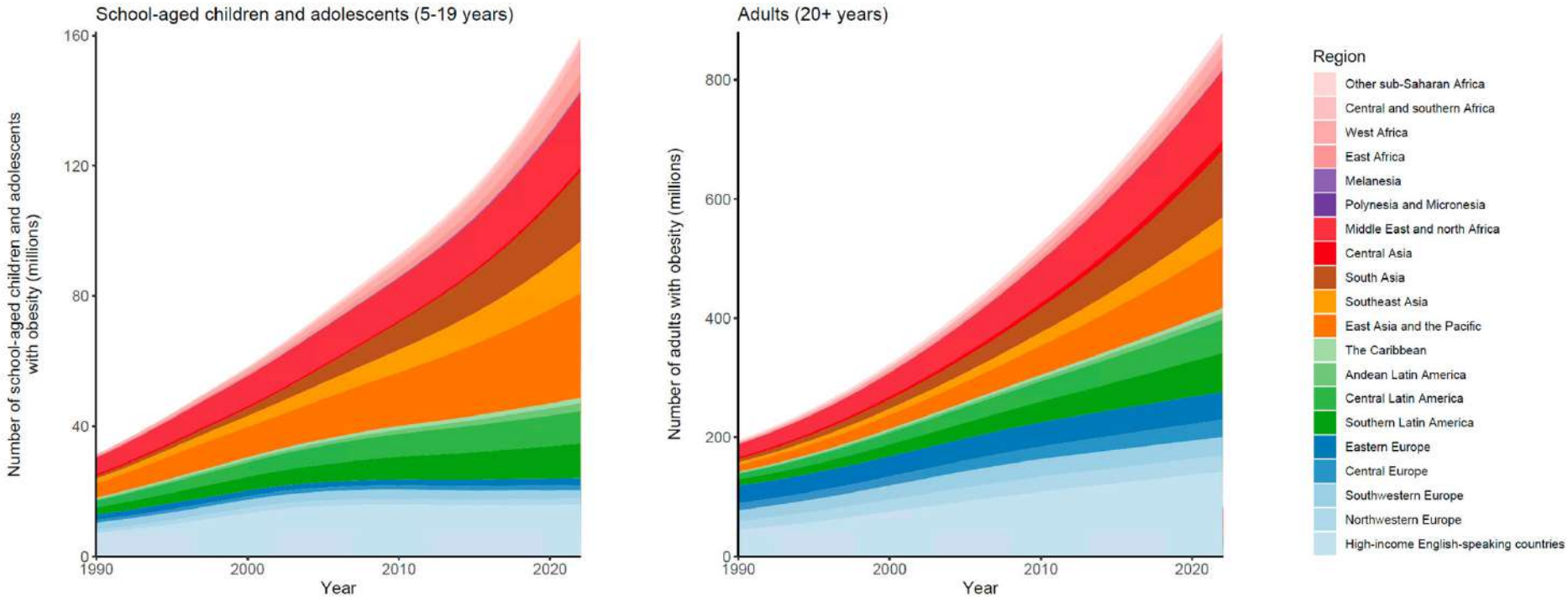
Prevalence of obesity has increased in almost all countries



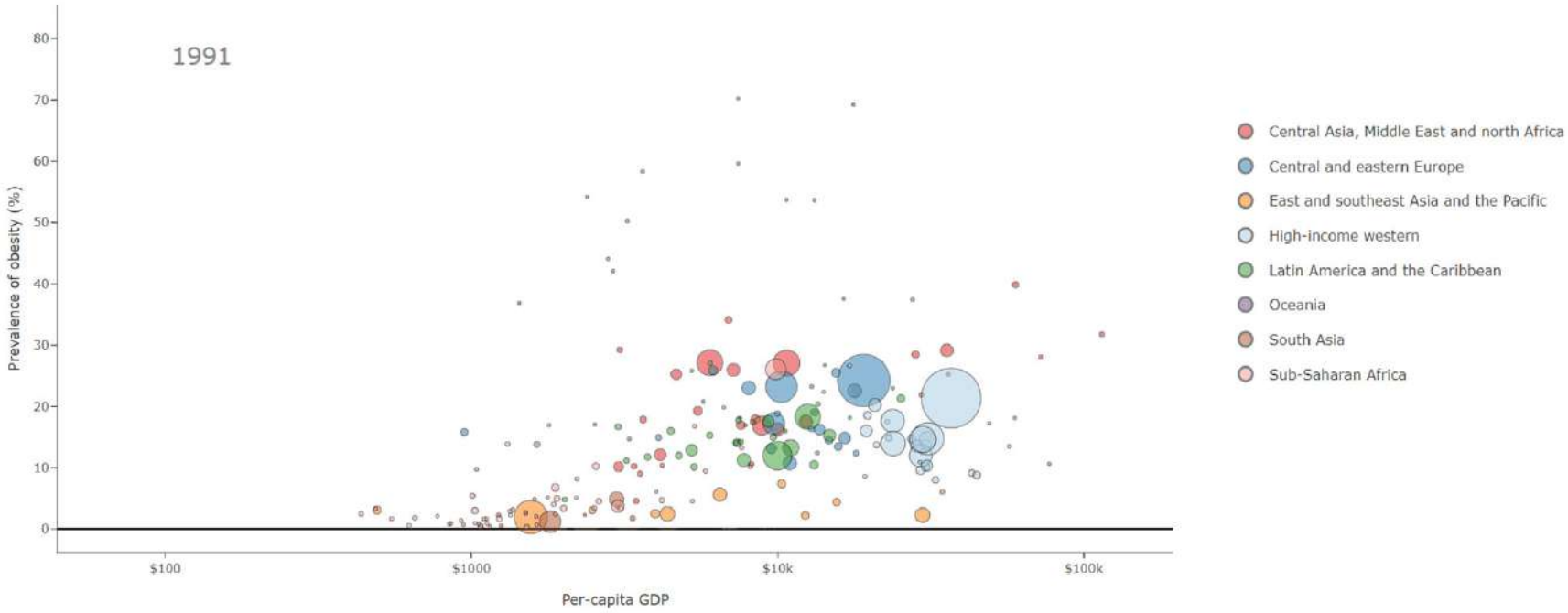
NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2024; www.ncdrisc.org

Over one billion school-aged children, adolescents, and adults lived with obesity in 2022



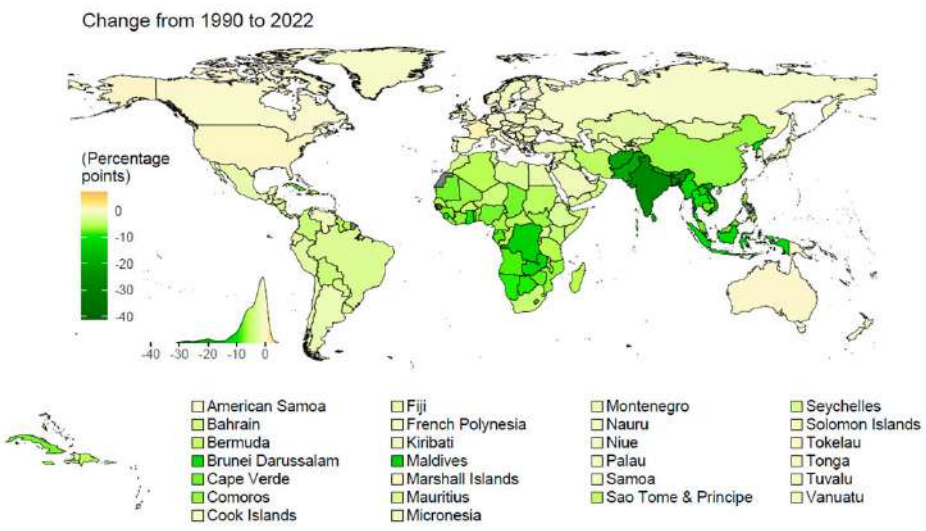
NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2024; www.ncdrisc.org

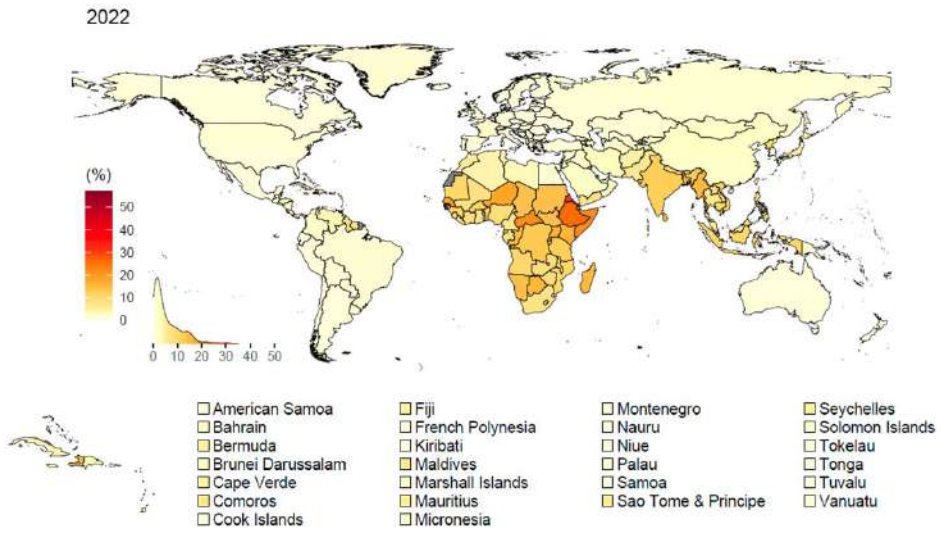
The shifting epicentre of obesity



NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2024; www.ncdrisc.org

Underweight has declined but remains prevalent in south and southeast Asia, and in males in parts of Africa





NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2024; www.ncdrisc.org

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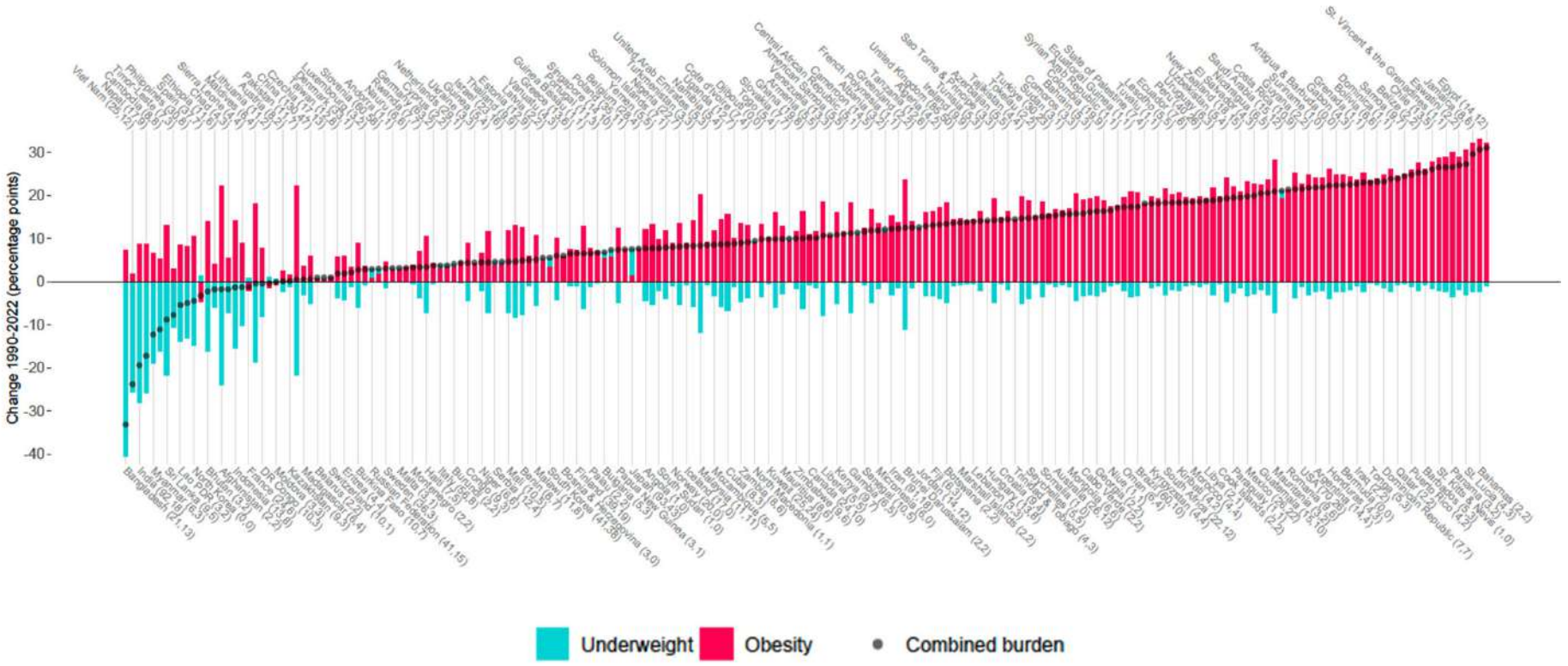
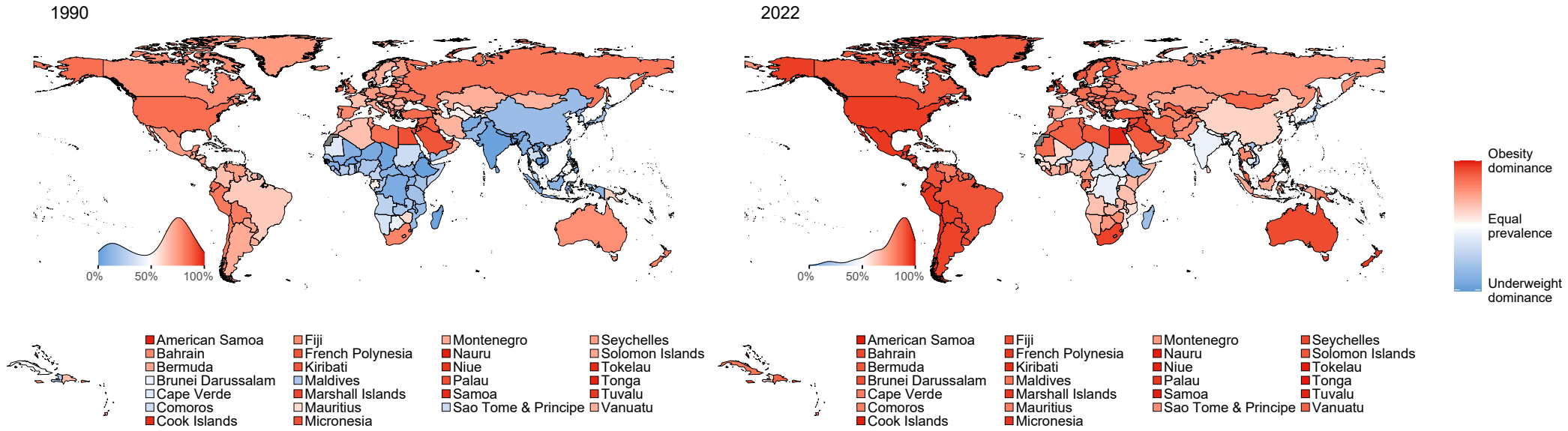
An increase in the double burden of underweight and obesity



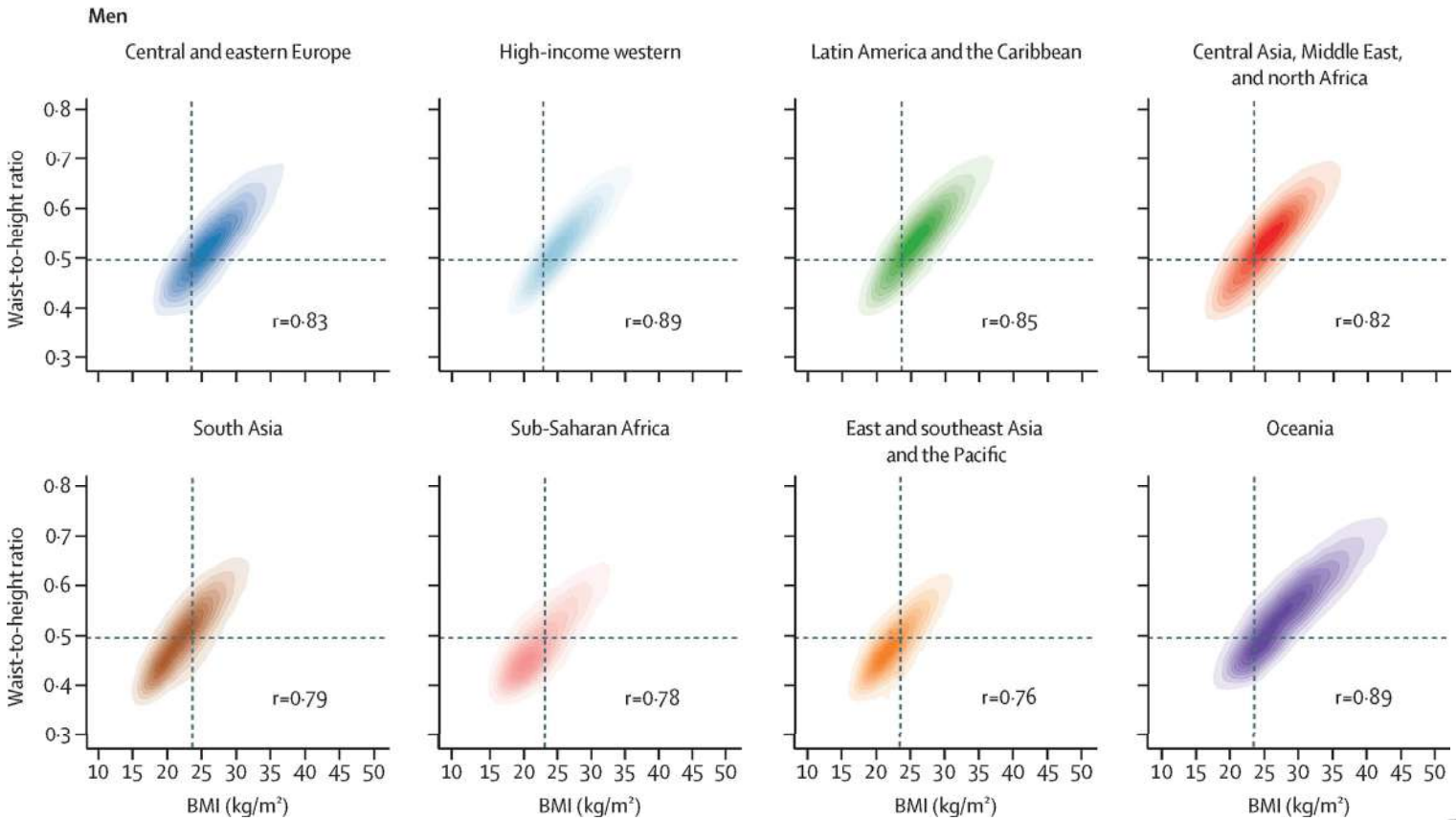
NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2024; www.ncdrisc.org

Increasing obesity dominance of malnutrition in adults



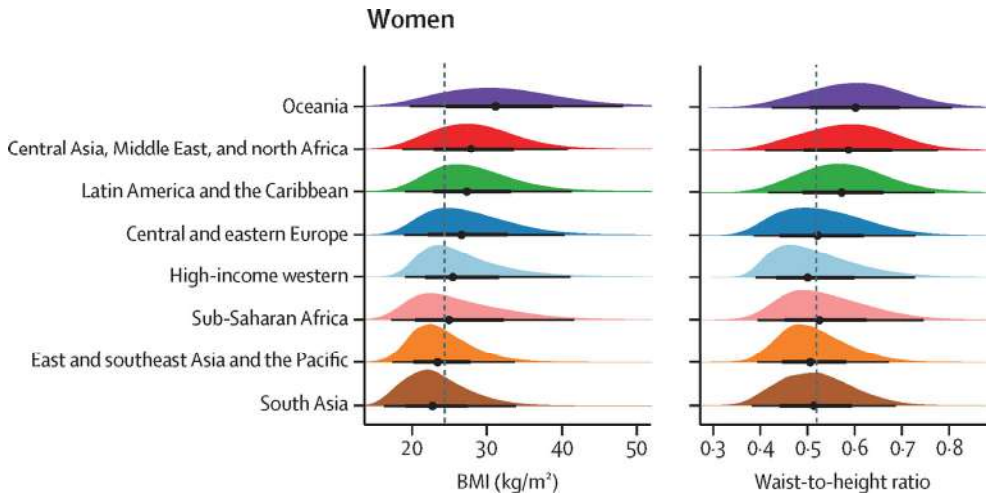
NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2024; www.ncdrisc.org

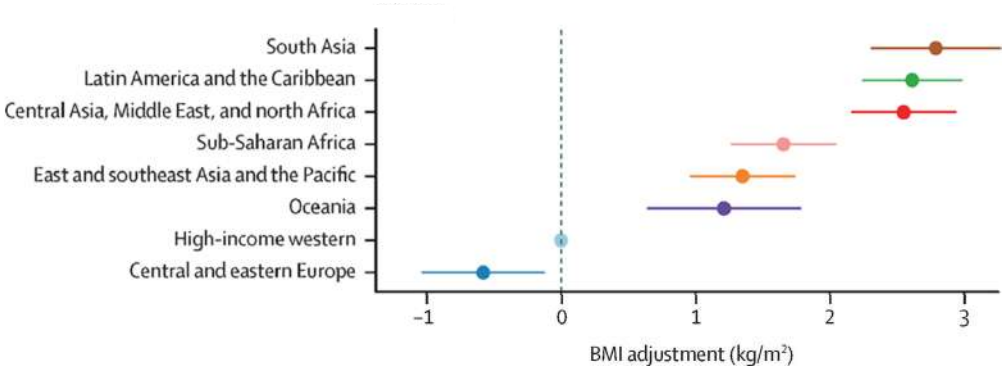
BMI and waist-to-height ratio are correlated within all regions



NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2024

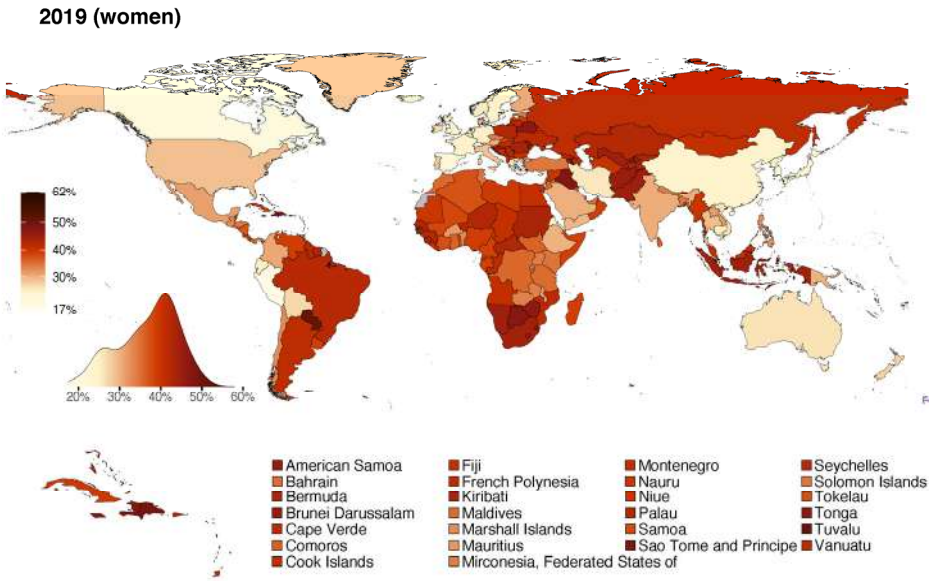
At any BMI level, people in south Asia have a higher waist-to-height ratio

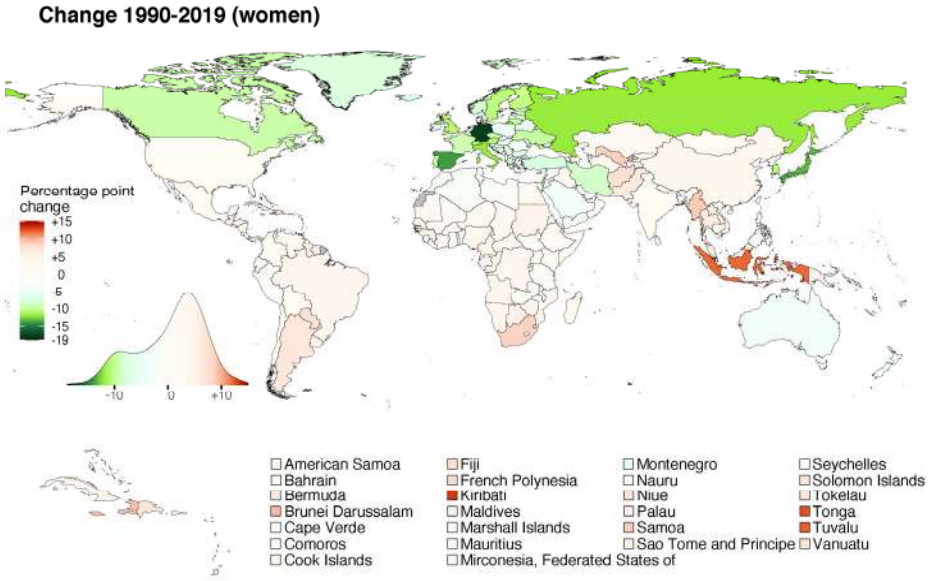




NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2024; www.ncdrisc.org

Heterogeneous trends in hypertension

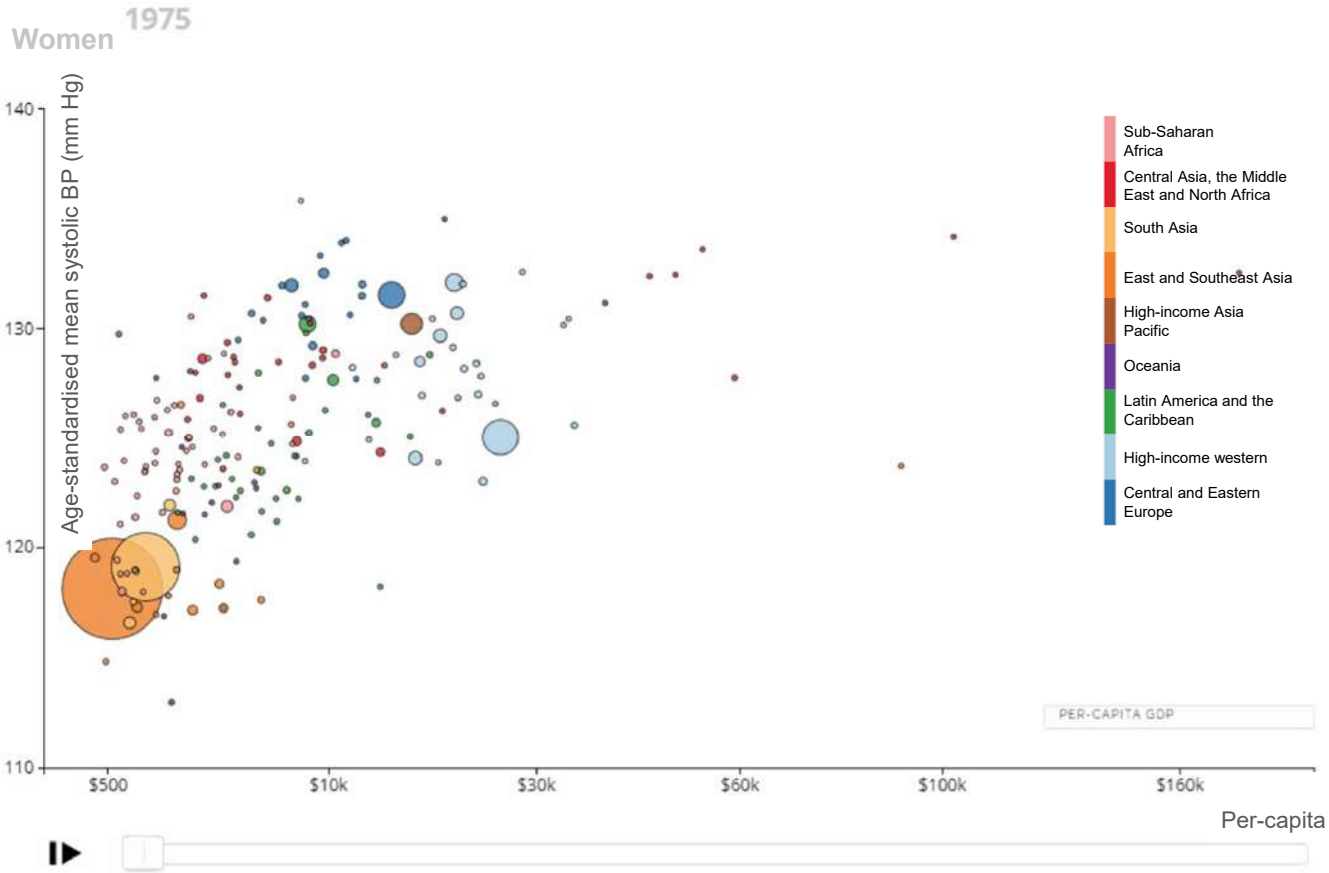




NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2021

NCD·RisC
Risk Factor Collaboration

A repositioning of the epicentre of high blood pressure



Per-capita GDP (2011 international $)

NCD Risk Factor Collaboration *Lancet* 2017; Zhou et al Nature Reviews Cardiology 2021; www.ncdrisc.org

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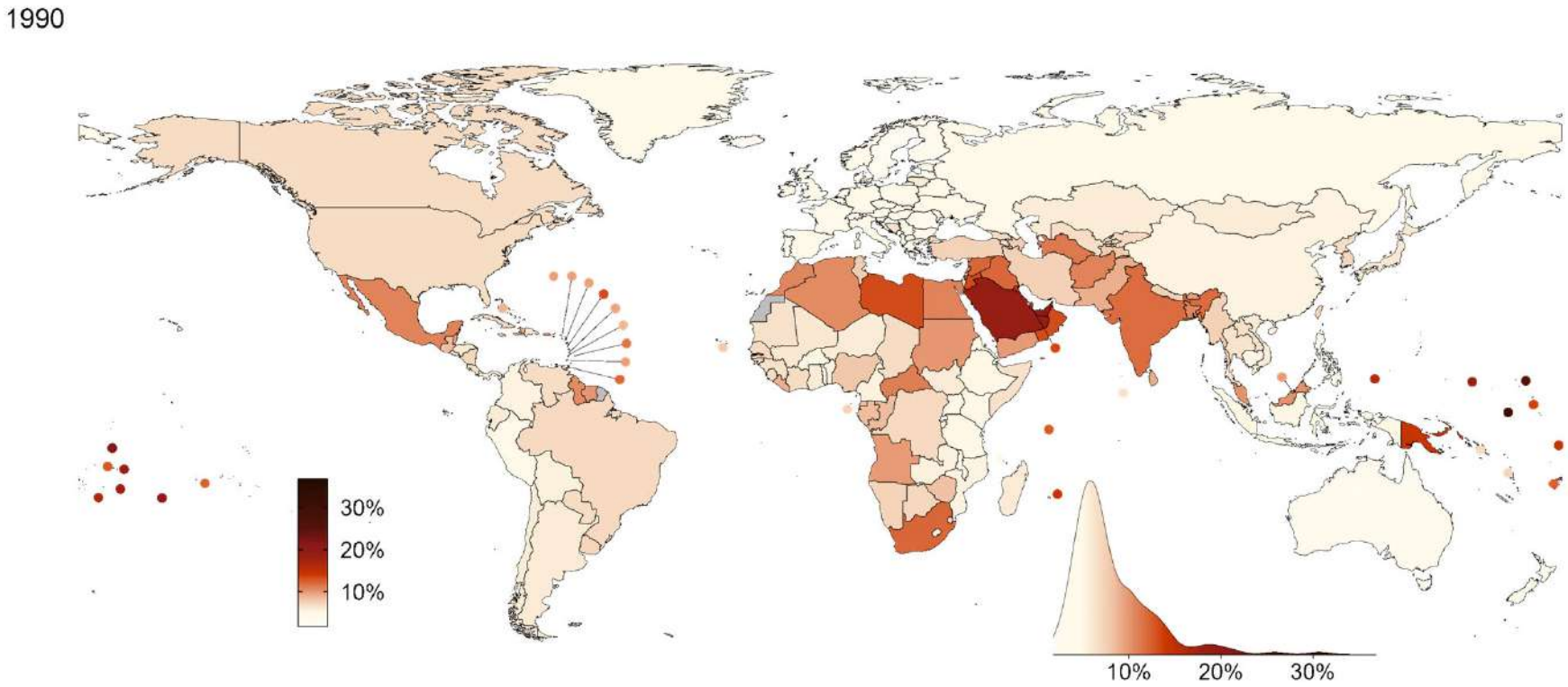
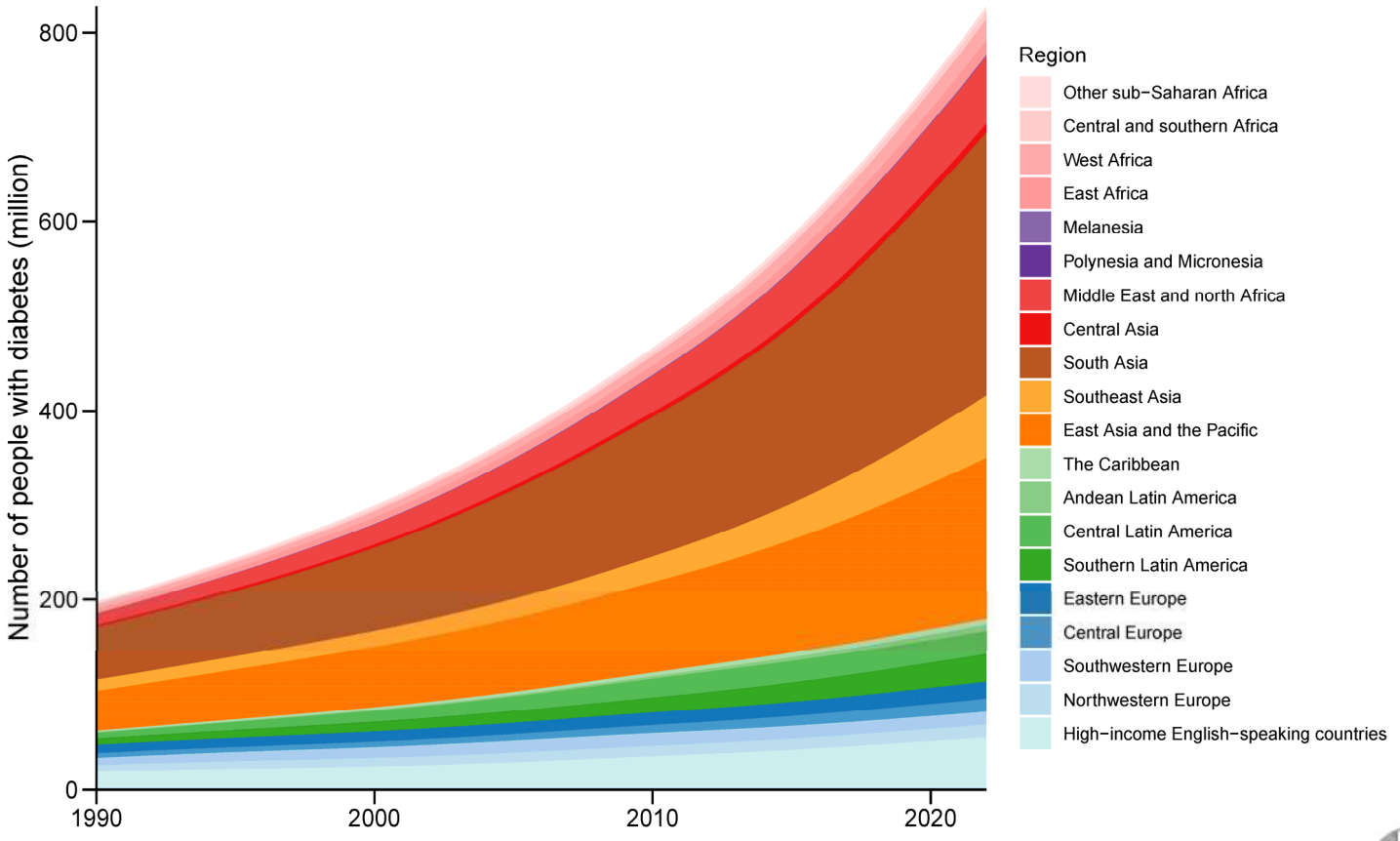
Prevalence of diabetes has increased in most countries, especially in low- and middle-income countries



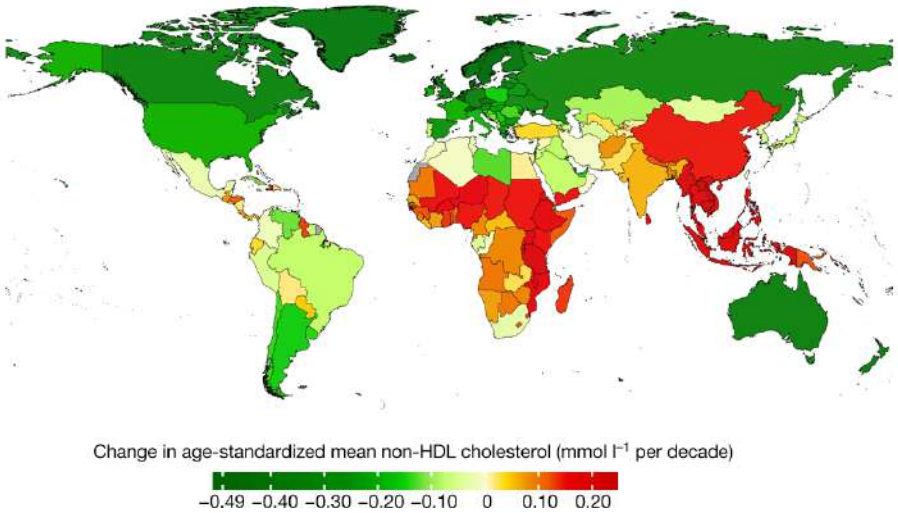
NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2024; www.ncdrisc.org

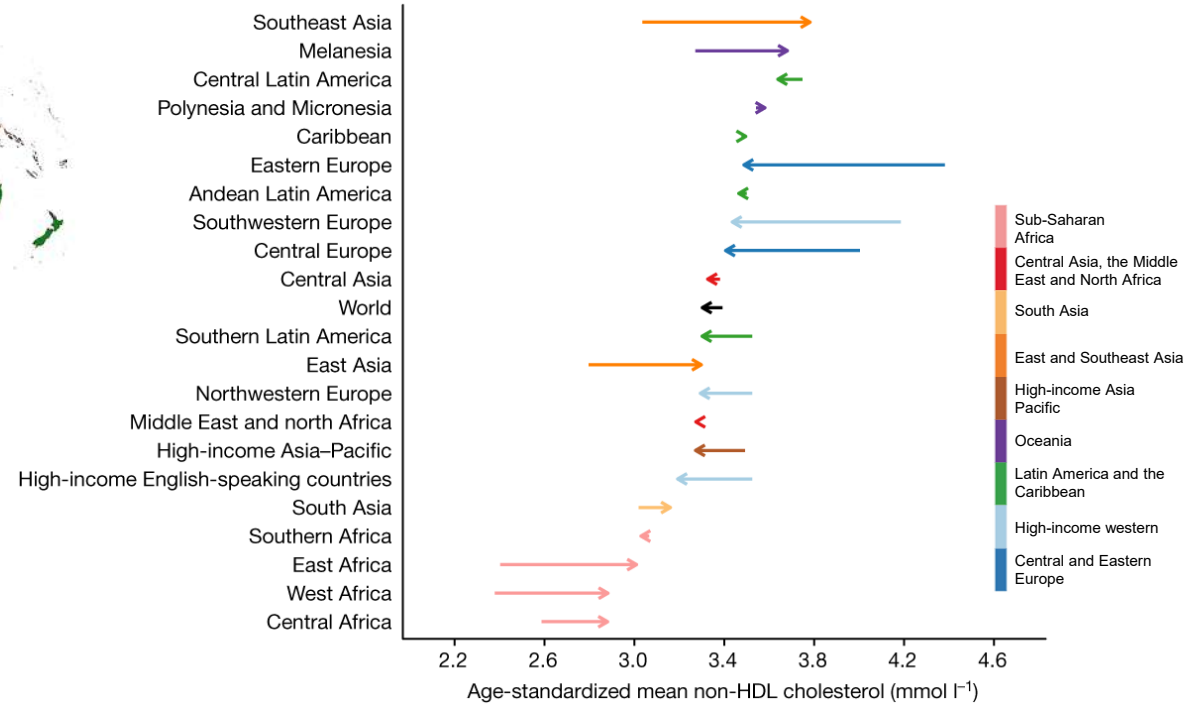
Over 800 million adults lived with diabetes in 2022



NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2024

A global convergence, and increasingly repositioning, of non-optimal cholesterol





NCD·RisC Risk Factor Collaboration

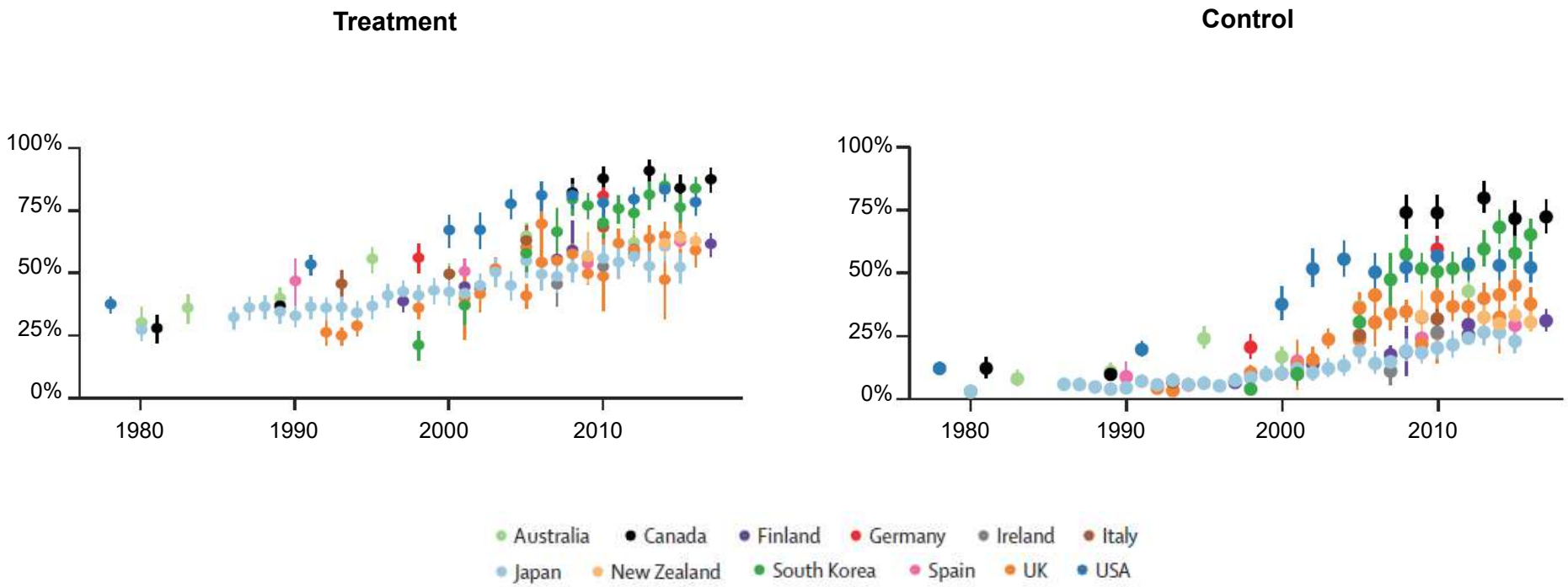
NCD Risk Factor Collaboration *Nature* 2020

NCD-RisC data potential and directions

- How do countries compare in use of effective treatments and control?
  - Hypertension, diabetes, risk-based multi-drug treatment, etc.

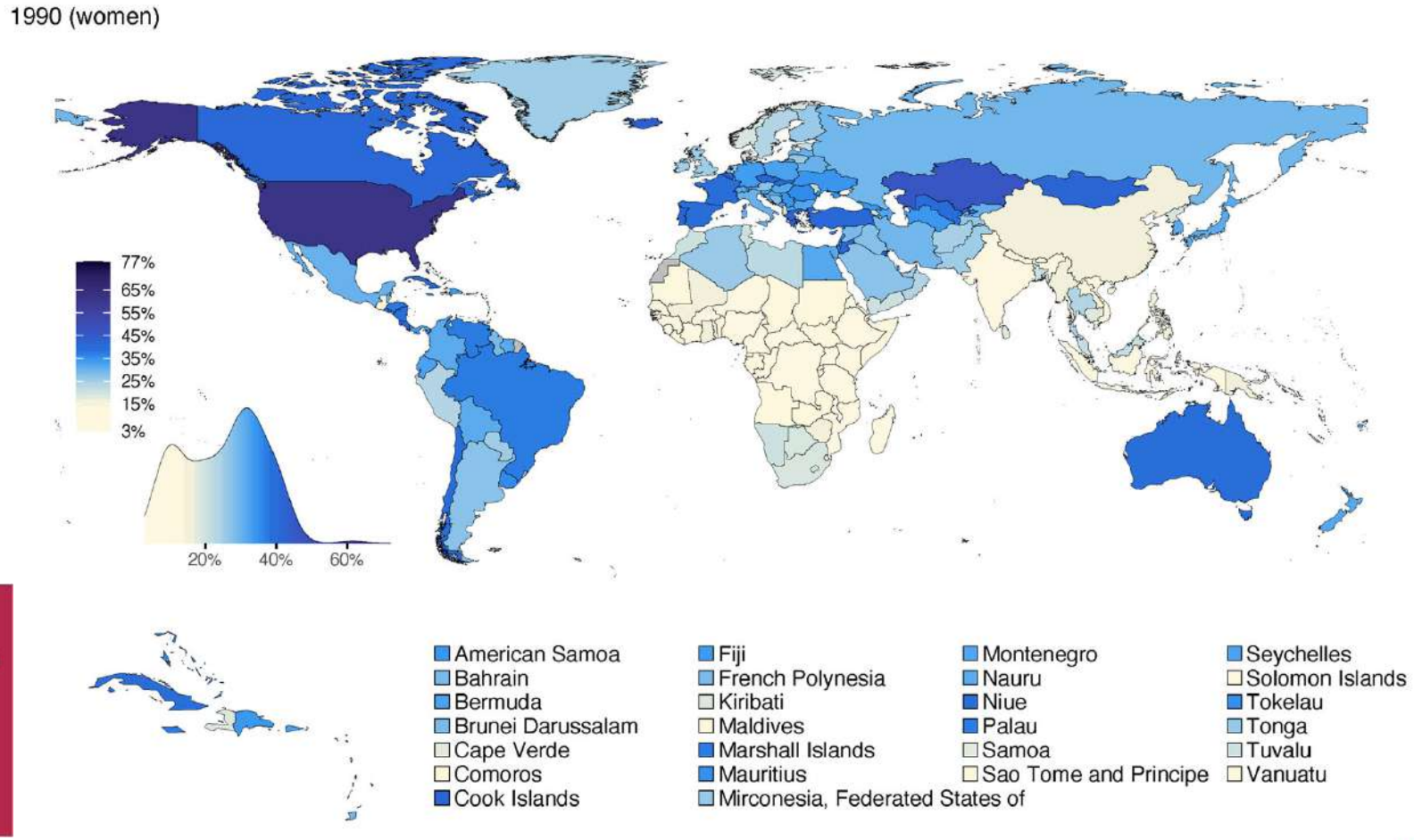
NCD·RisC
Risk Factor Collaboration

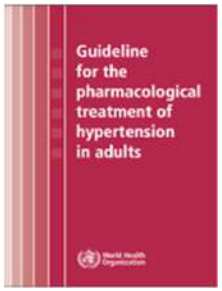
Hypertension treatment and control in 12 high-income countries (results for 60-69 year-old women)



NCD Risk Factor Collaboration *Lancet* 2019

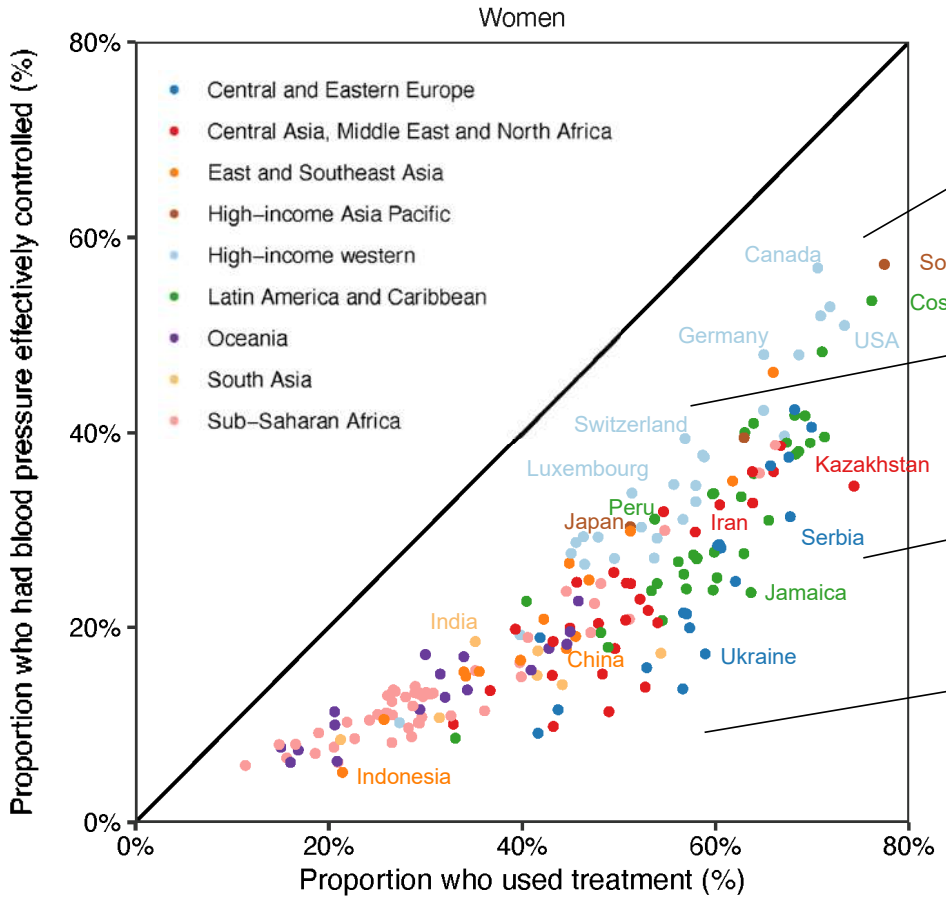
Highly variable rates of hypertension treatment across the world





NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2021

Varying degree of control among those treated



High treatment with good control among treated

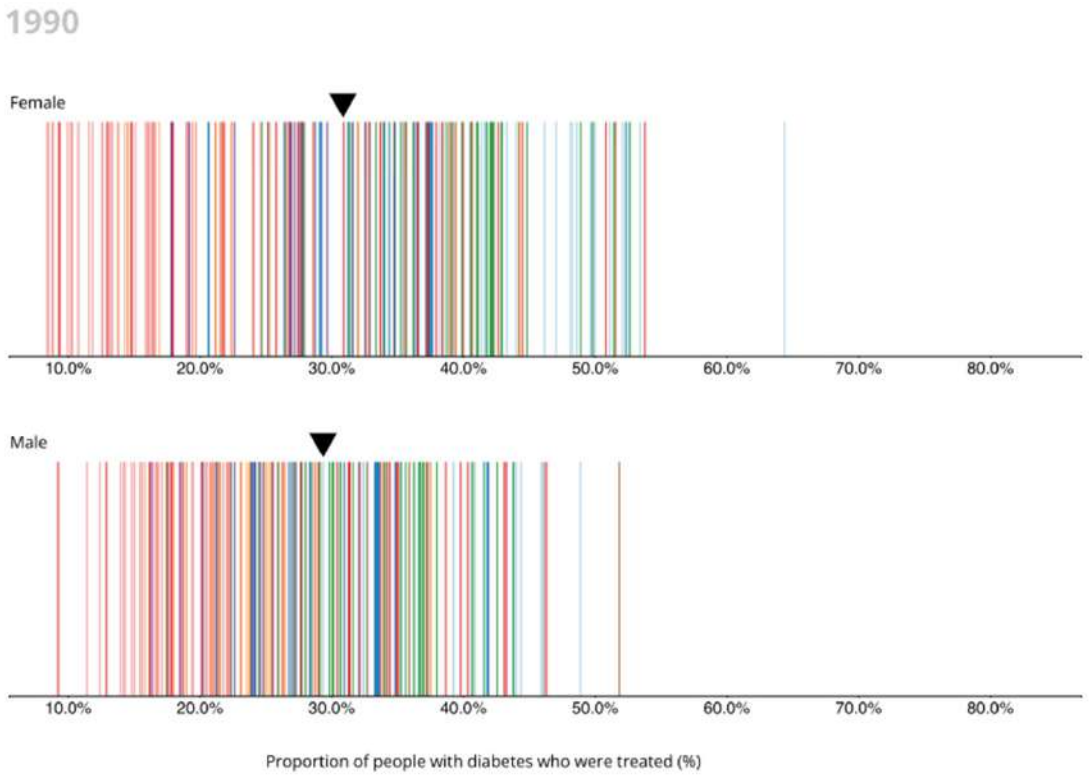
Medium treatment with good control among treated

Medium treatment with poor control among treated

Poor treatment and poor control

NCD Risk Factor Collaboration (NCD-RisC) *Lancet* 2021

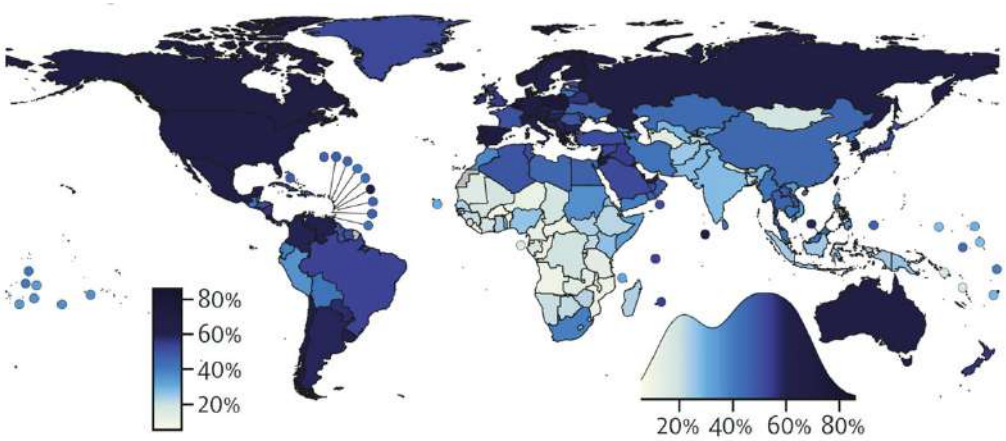
Rates of diabetes treatment have improved unevenly across the world, stagnating in many low- and middle-income countries



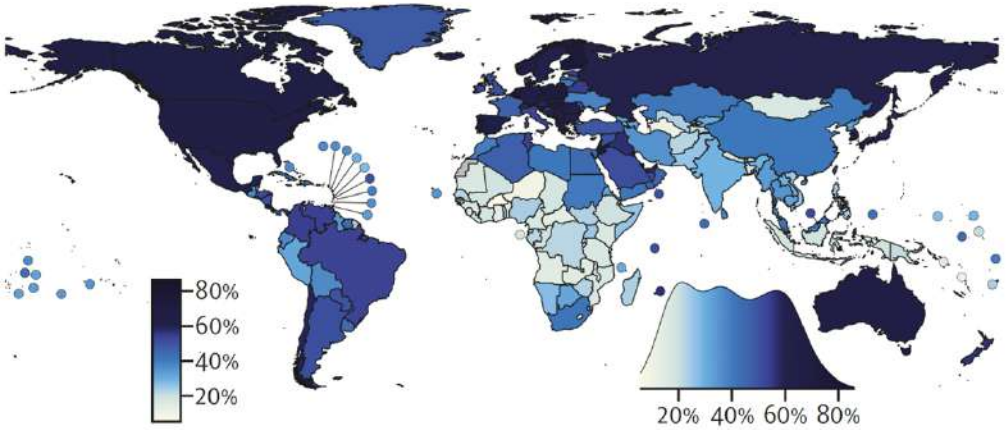
NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2024; www.ncdrisc.org

Substantial inequality in contemporary diabetes treatment coverage

Women



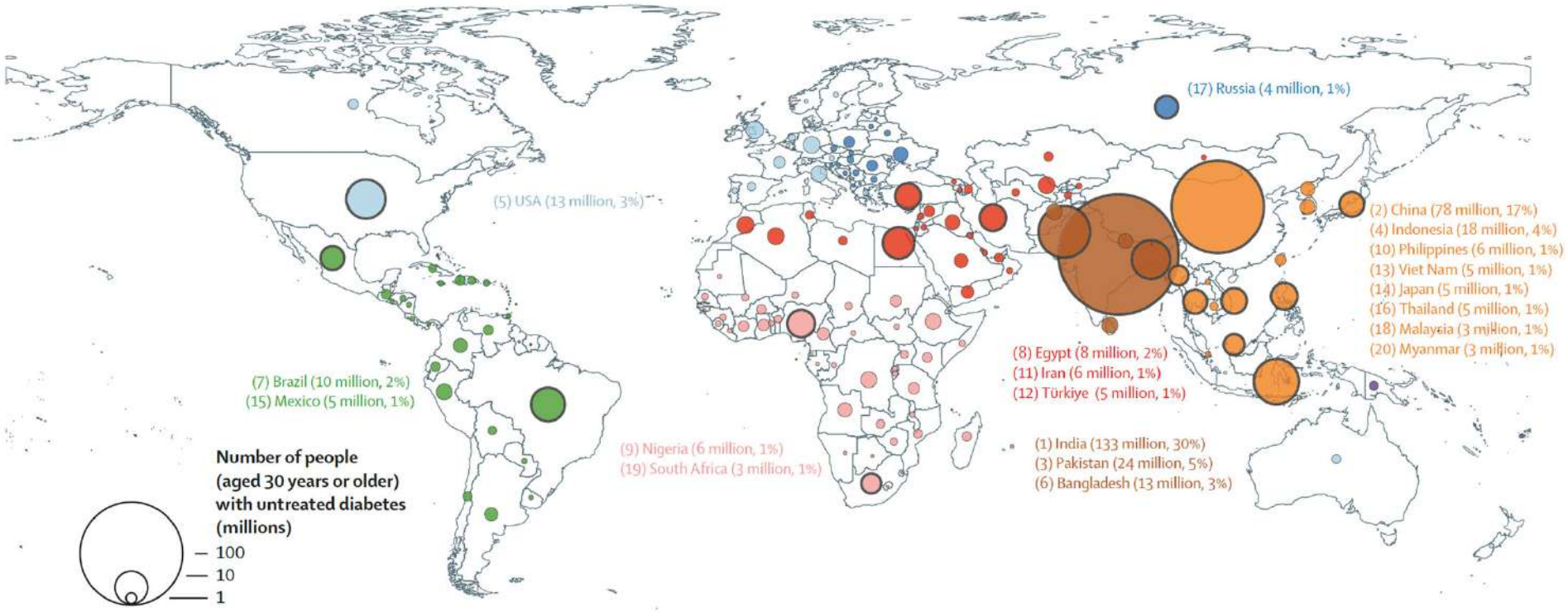
Men



NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2024

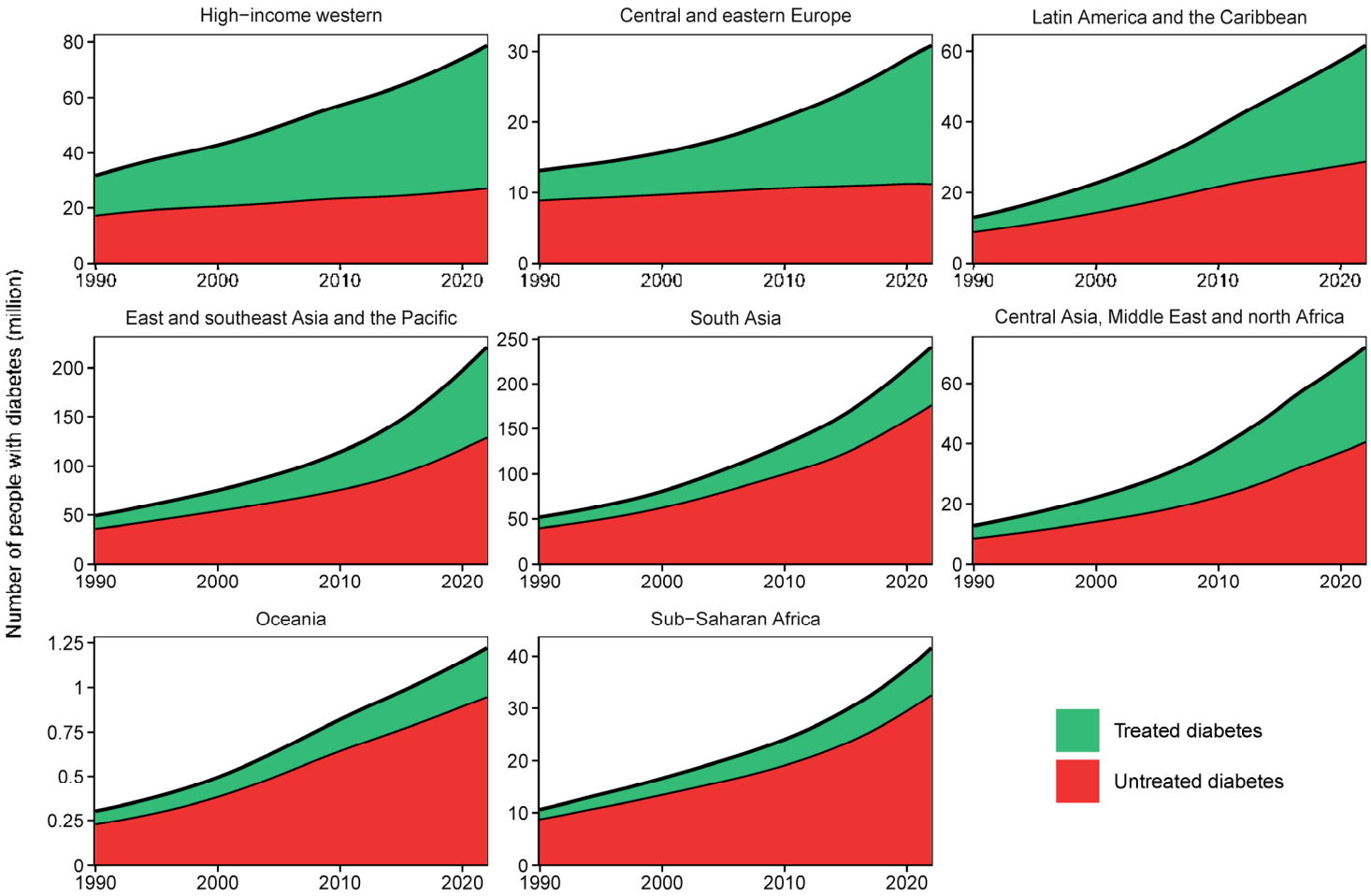
NCD·RisC
Risk Factor Collaboration

The majority of people with untreated diabetes live in low- and middle-income countries



NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2024

Nearly 450 million were not treated for their diabetes



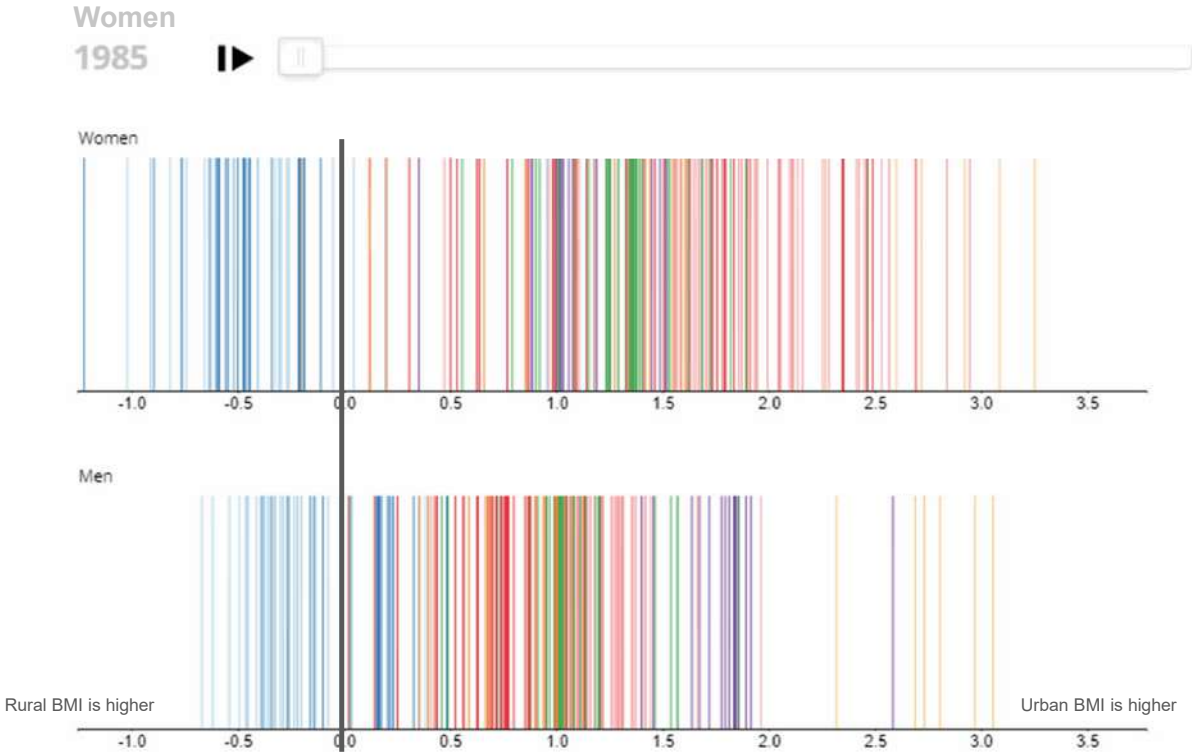
NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2024

NCD-RisC data potential and directions – population subgroups

- How do risk factor levels and trends vary in population subgroups?
  - Women and men
  - Adolescents and young adults, middle-ages, and older adults
  - By education or economic status, or rural and urban place of residence

NCD·RisC
Risk Factor Collaboration

Rising rural BMI is driving global obesity epidemic in adults



NCD Risk Factor Collaboration *Nature* 2019; www.ncdrisc.org

NCD·RisC
Risk Factor Collaboration

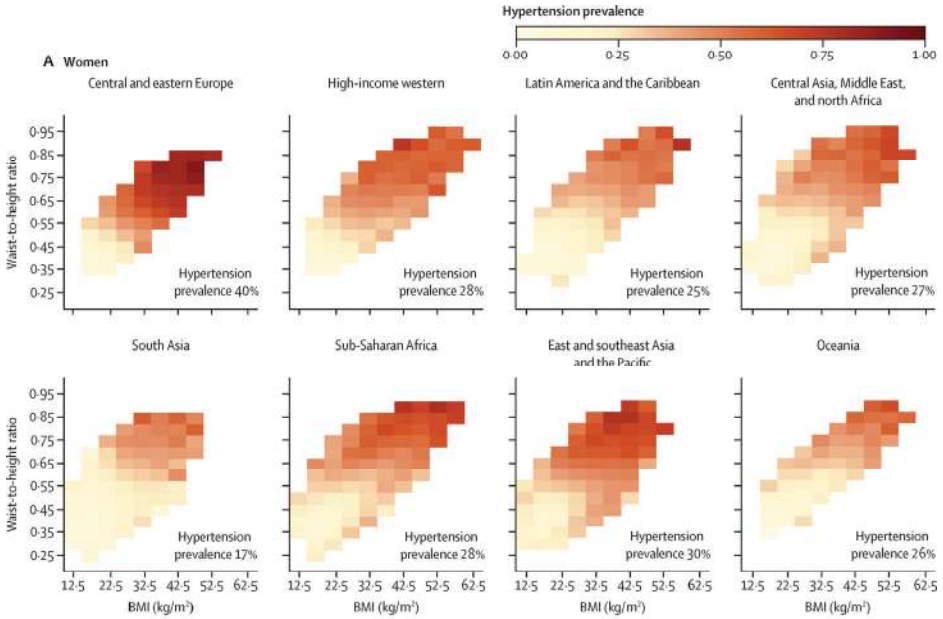
NCD-RisC data potential and directions – population subgroups

- How do risk factor levels and trends vary in population subgroups?
  - Women and men
  - Adolescents and young adults, middle-ages, and older adults
  - By education or economic status, or rural and urban place of residence
  - In people at different BMI ranges

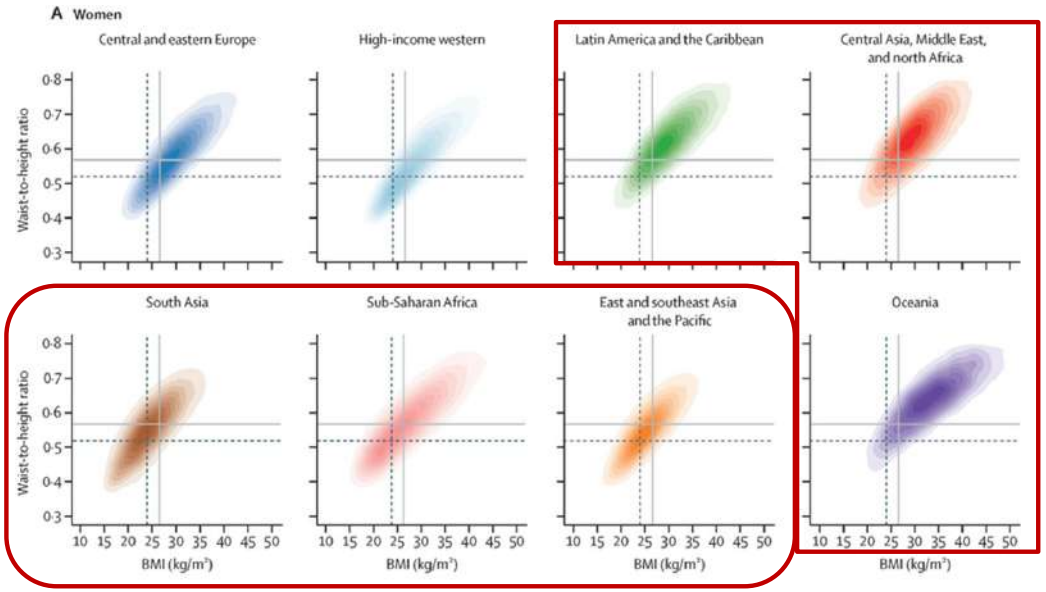
NCD·RisC
Risk Factor Collaboration

Hypertension in relation to body-mass index and waist-to-height ratio

Prevalence of hypertension



Density of people with hypertension



NCD-Risk Factor Collaboration (NCD-RisC) *Lancet* 2024

NCD-RisC data potential and directions - multiple conditions

- The question: How are multiple conditions distributed and patterned?
  - How do cardiometabolic and renal overlap with liver, neuropsychiatric and musculoskeletal conditions, cancers and infections?
  - Do different phenotypes emerge in different regions/times? do we see compression or expansion of morbidity as mortality declines?
  - How do they vary among population subgroups? What are the implications for risk and care?

- The task: Identify phenotypes (or clusters) that collectively characterize a population beyond single clinical definitions such as the metabolic syndrome
  - Emphasis on epidemiological, clinical and health system relevance

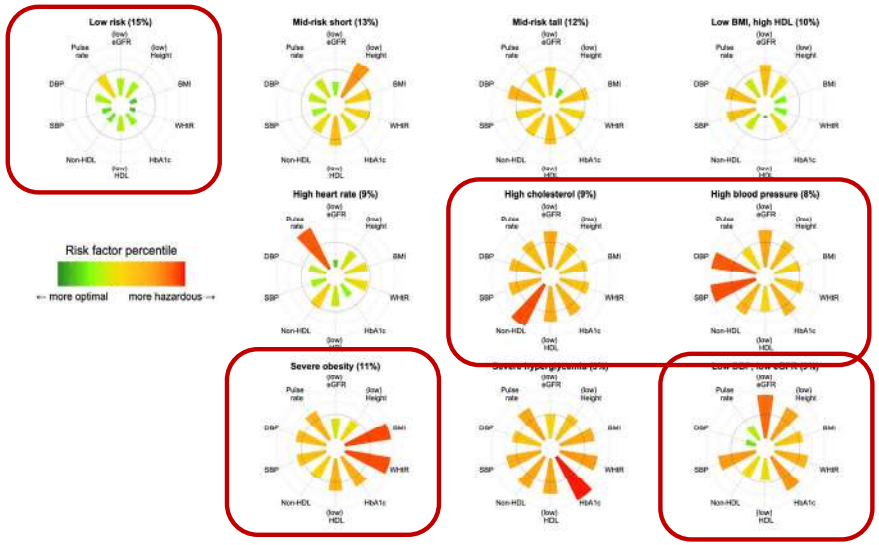
NCD·RisC
Risk Factor Collaboration

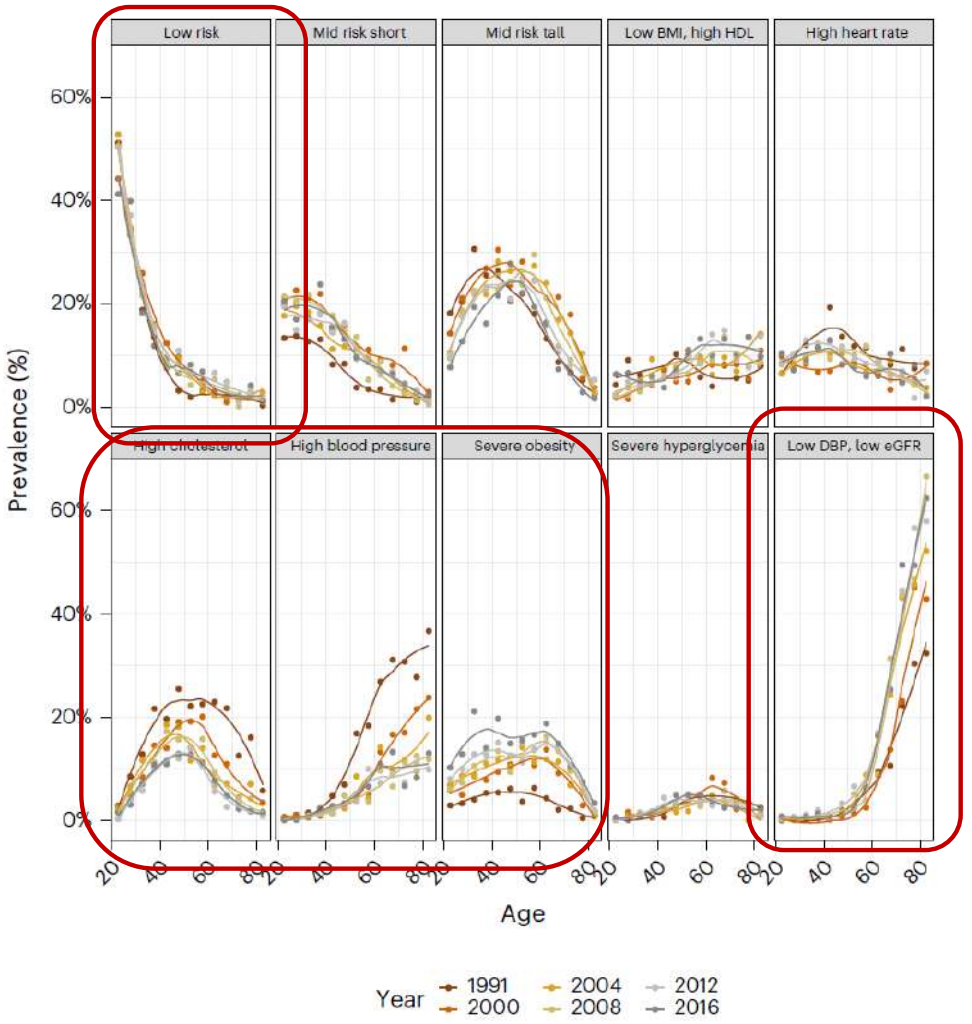
Relationship of cardiometabolic-renal phenotypes with age

nature cardiovascular research

Article

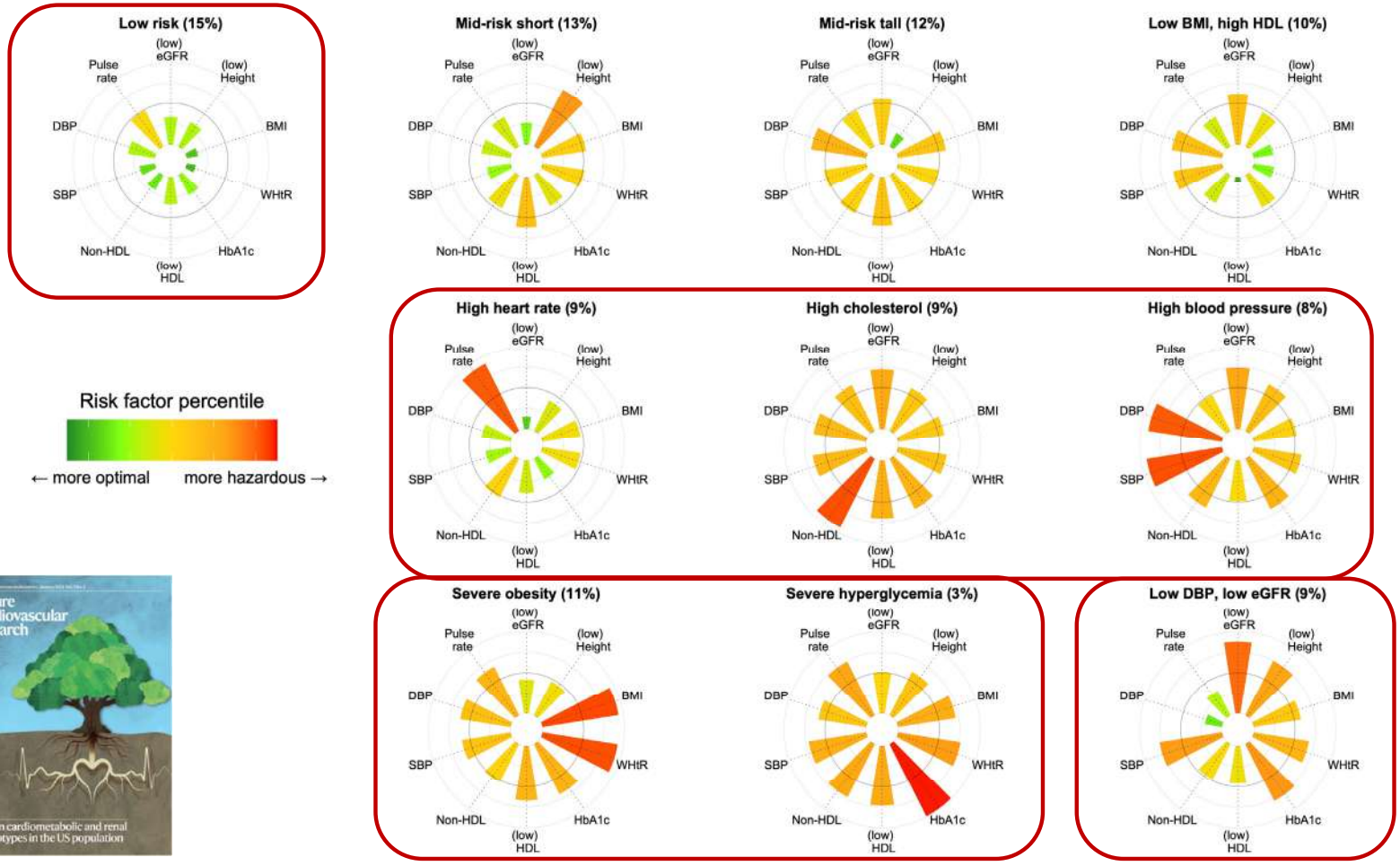
Cardiometabolic and renal phenotypes and transitions in the United States population





Lhoste et al *Nature Cardiovascular Research* 2024

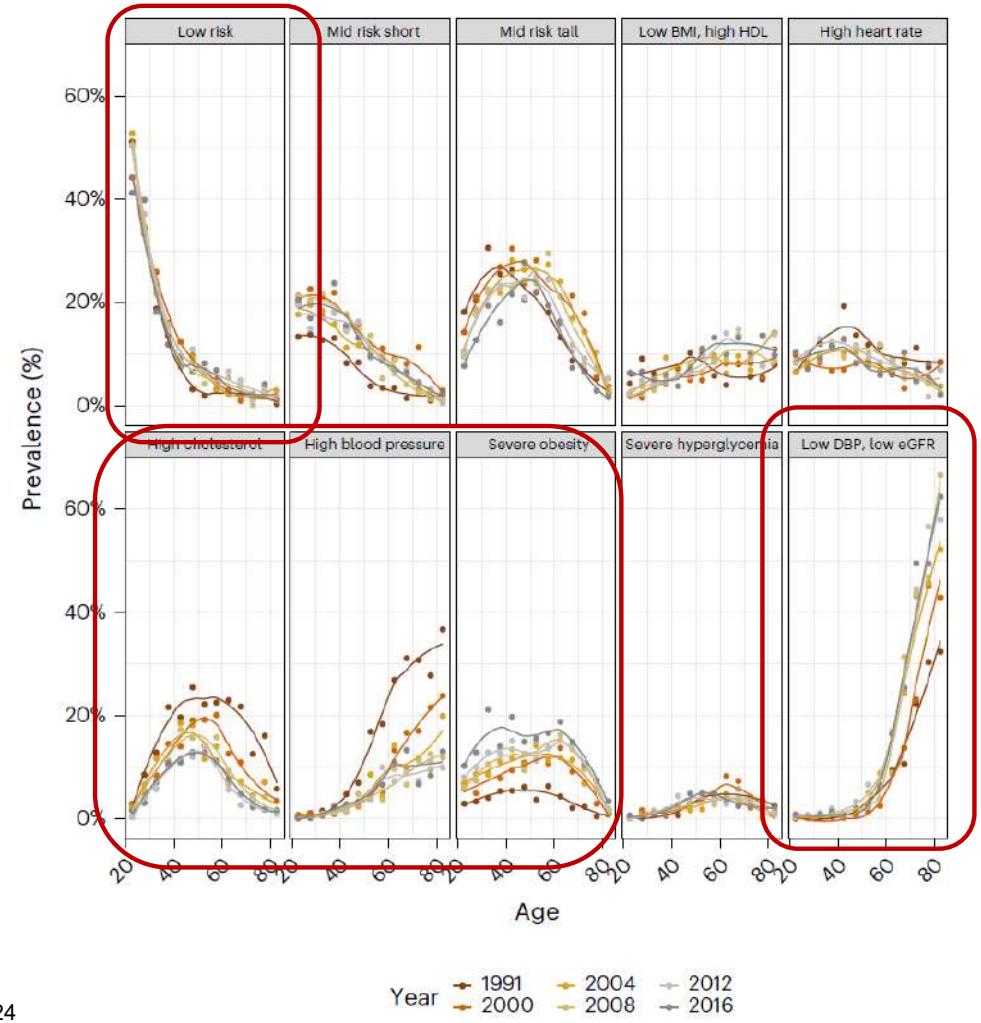
Ten cardiometabolic and renal phenotypes in the US population



Lhoste et al *Nature Cardiovascular Research* 2024

NCD·RisC Risk Factor Collaboration

Relationship of the identified phenotypes with age



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Demographic features and medication use of the clusters

Men	Age distribution				Medication use[a]			
	Median (years)	20–39 years	40–59 years	60+ years	Antihypertensive	Statins	Oral hypoglycemic	Insulin
Low risk *n*=3,730	28 (23–38)	77% *n*=2,875	16% *n*=615	6% *n*=240	2.7% (2.1–3.1) *n*=100	2.5% (2.2–3.2) *n*=95	0.7% (0.5–11) *n*=27	0.5% (0.4–0.8) *n*=20
Mid risk short *n*=3,981	38 (28–50)	54% *n*=2,133	33% *n*=1,313	13% *n*=535	6.9% (6.2–7.8) *n*=274	6.8% (6.1–7.7) *n*=272	2.6% (2.1–3.1) *n*=102	0.5% (0.3–0.7) *n*=18
Mid risk tall *n*=4,028	44 (33–56)	39% *n*=1,586	41% *n*=1,650	20% *n*=792	14.2% (13.2–15.3) *n*=572	11.0% (10.1–12.0) *n*=442	2.0% (1.6–2.5) *n*=81	0.6% (0.4–0.9) *n*=26
Low BMI, high HDL *n*=2,174	54 (39–67)	25% *n*=544	34% *n*=747	41% *n*=883	19.9% (18.3–21.6) *n*=431	11.7% (10.4–13.1) *n*=254	3.2% (2.5–4.0) *n*=69	1.1% (0.7–1.6) *n*=23
High heart rate *n*=2,401	45 (34–60)	37% *n*=889	37% *n*=899	26% *n*=613	17.9% (16.4–19.5) *n*=428	11.6% (10.4–13.0) *n*=279	6.0% (5.1–7.0) *n*=144	1.6% (1.2–2.2) *n*=38
High cholesterol *n*=2,887	48 (39–60)	26% *n*=755	48% *n*=1,378	26% *n*=754	15.8% (14.5–17.2) *n*=455	8.2% (7.2–9.3) *n*=236	2.8% (2.3–3.5) *n*=82	0.4% (0.2–0.7) *n*=12
High blood pressure *n*=2,396	66 (56–74)	5% *n*=112	25% *n*=602	70% *n*=1,682	43.1% (41.2–45.1) *n*=1,030	16.0% (14.6–17.6) *n*=383	7.5% (6.5–8.7) *n*=180	2.9% (2.2–3.7) *n*=70
Severe obesity *n*=2,613	48 (35–60)	33% *n*=868	39% *n*=1,020	28% *n*=725	36.5% (34.6–38.3) *n*=951	20.3% (18.8–21.9) *n*=530	14.2% (12.9–15.6) *n*=370	4.4% (3.7–5.2) *n*=114
Severe hyperglycemia *n*=976	57 (48–65)	11% *n*=105	42% *n*=413	47% *n*=458	36.8% (33.8–39.9) *n*=358	31.8% (29.0–34.8) *n*=309	54.8% (51.6–57.9) *n*=533	30.6% (27.8–33.5) *n*=298
Low DBP, low eGFR *n*=3,086	73 (66–80)	2% *n*=63	8% *n*=248	90% *n*=2,775	51.1% (49.3–52.9) *n*=1,571	40.5% (38.8–42.3) *n*=1,244	20.2% (18.8–21.7) *n*=623	6.7% (5.9–7.7) *n*=207
All *n*=28,272	48 (34–64)	35% *n*=9,930	31% *n*=8,885	34% *n*=9,457	21.9% (21.4–22.4) *n*=6,171	14.3% (13.9–14.7) *n*=4,044	7.8% (7.5–8.2) *n*=2,211	2.9% (2.7–3.1) *n*=826

Lhoste et al *Nature Cardiovascular Research* 2024

Clinical features of the clusters

Men	Hypertension[a]	Diabetes[b]	Obesity[c]	History of Myocardial Infarction	History of Stroke	History of Congestive Heart Failure
Low risk n=3,730	4.3% (3.7-5.0) n=159	1.5% (1.2-1.9) n=56	0.% (0.4-0.9) n=21	1.4% (1.1-1.8) n=51	0.7% (0.5-1.0) n=25	0.7% (0.5-1.1) n=27
Mid-risk short n=3,981	9.0% (8.2-10.0) n=359	4.9% (4.3-5.6) n=194	20.1% (18.9-21.4) n=801	2.0% (1.7-2.5) n=81	1.2% (0.9-1.6) n=48	1.0% (0.7-1.4) n=40
Mid-risk tall n=4,028	21.2% (20.0.9-22.5) n=852	4.0% (3.5-4.7) n=163	23.0% (21.7-24.3) n=925	2.7% (2.2-3.2) n=107	1.4% (1.1-1.8) n=57	1.6% (1.3-2.1) n=65
Low BMI, high HDL n=2,174	38.8% (36.8-40.9) n=842	5.7% (4.8-6.8) n=124	4.9% (4.1-5.9) n=106	4.4% (3.6-5.3) n=95	2.8% (2.2-3.5) n=60	2.4% (1.8-3.1) n=52
High heart rate n=2,401	33.5% (31.6-35.4) n=803	10.4% (9.2-11.6) n=248	27.2% (25.4-29.0) n=652	3.9% (3.2-4.8) n=94	2.5% (2.0-3.3) n=61	2.6% (2.0-3.3) n=62
High cholesterol n=2,887	34.9% (33.2-36.7) n=1,008	8.2% (7.3-9.3) n=237	38.9% (37.1-40.7) n=1,123	4.7% (4.0-5.5) n=135	1.7% (1.3-2.2) n=49	2.2% (1.7-2.8) n=64
High blood pressure n=2,396	97.9% (97.3-98.4) n=2,346	17.7% (16.2-19.3) n=423	26.4% (24.7-28.2) =632	10.5% (9.3-11.8) n=250	7.4% (6.5-8.6) n=178	6.5% (5.6-7.5) n=154
Severe obesity n=2,613	51.7% (49.8-53.7) n=1,350	25.1% (23.5-26.8) n=655	100.0% (--)[d] n=2,613	6.4% (5.5-7.4) n=166	3.1% (2.5-3.9) n=82	4.9% (4.2-5.9) n=129
Severe hyperglycemia n=976	53.7% (50.6-56.9) n=524	100.0% (--)[d] n=976	47.6% (44.5-50.8) n=465	10.6% (8.8-12.7) n=103	5.9% (4.6-7.5) n=57	6.8% (5.4-8.6) n=66
Low DBP, low eGFR n=3,086	59.5% (57.8-61.2) n=1,830	31.2% (29.6-32.9) n=964	34.6% (33.0-36.3) n=1,068	18.7% (17.4-20.1) n=575	9.3% (8.3-10.4) n=286	11.5% (10.5-12.7) n=353
All n=28,272	35.7% (35.1-36.3) n=10,073	14.3% (13.9-14.7) n=4,040	29.7% (29.2-30.3) n=8,406	5.9% (5.6-6.2) n=1,657	3.2% (3.0-3.4) n=903	3.6% (3.4-3.8) n=1,012

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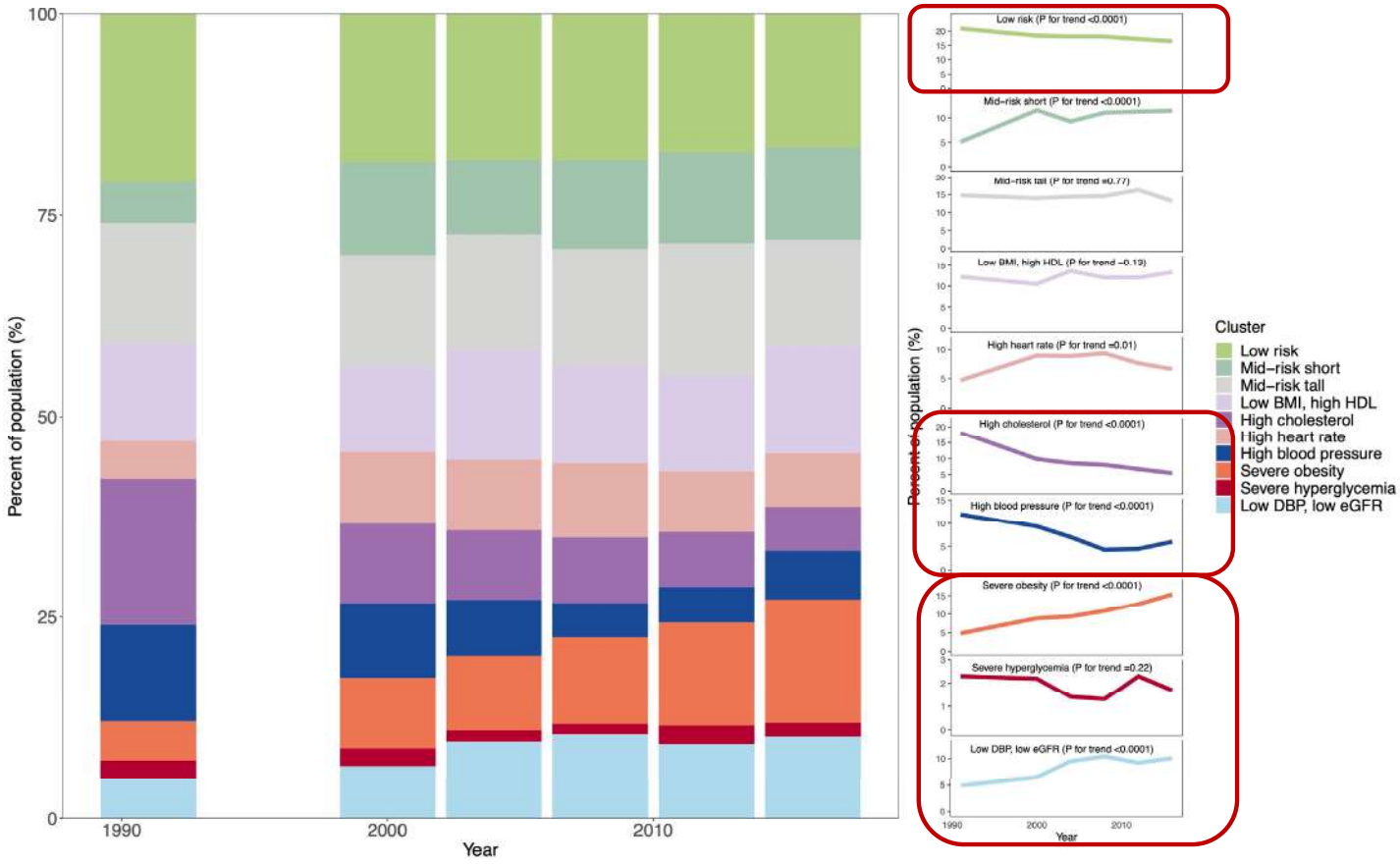
Risk Factor Collaboration

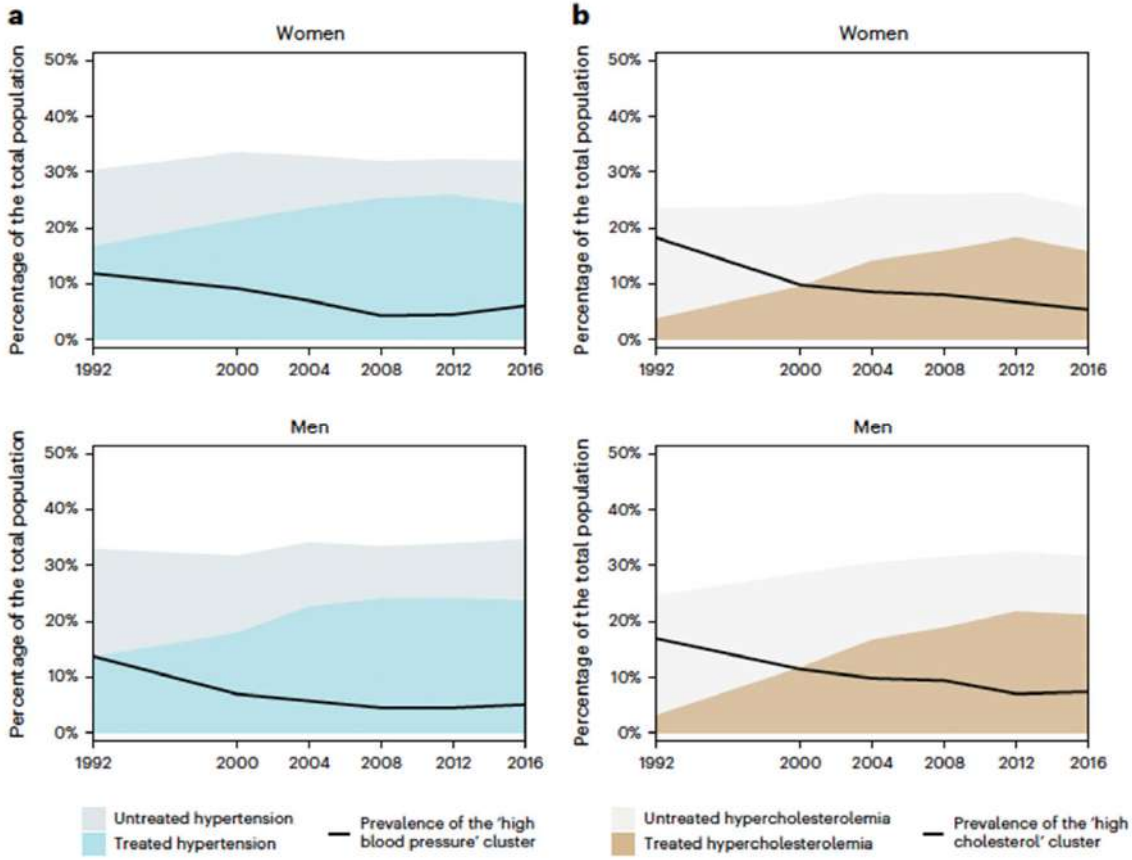
Time trends of cardiometabolic and renal phenotypes



Lhoste et al *Nature Cardiovascular Research* 2024

NCD·RisC
Risk Factor Collaboration

Trends in the use of antihypertensive medicines and statins



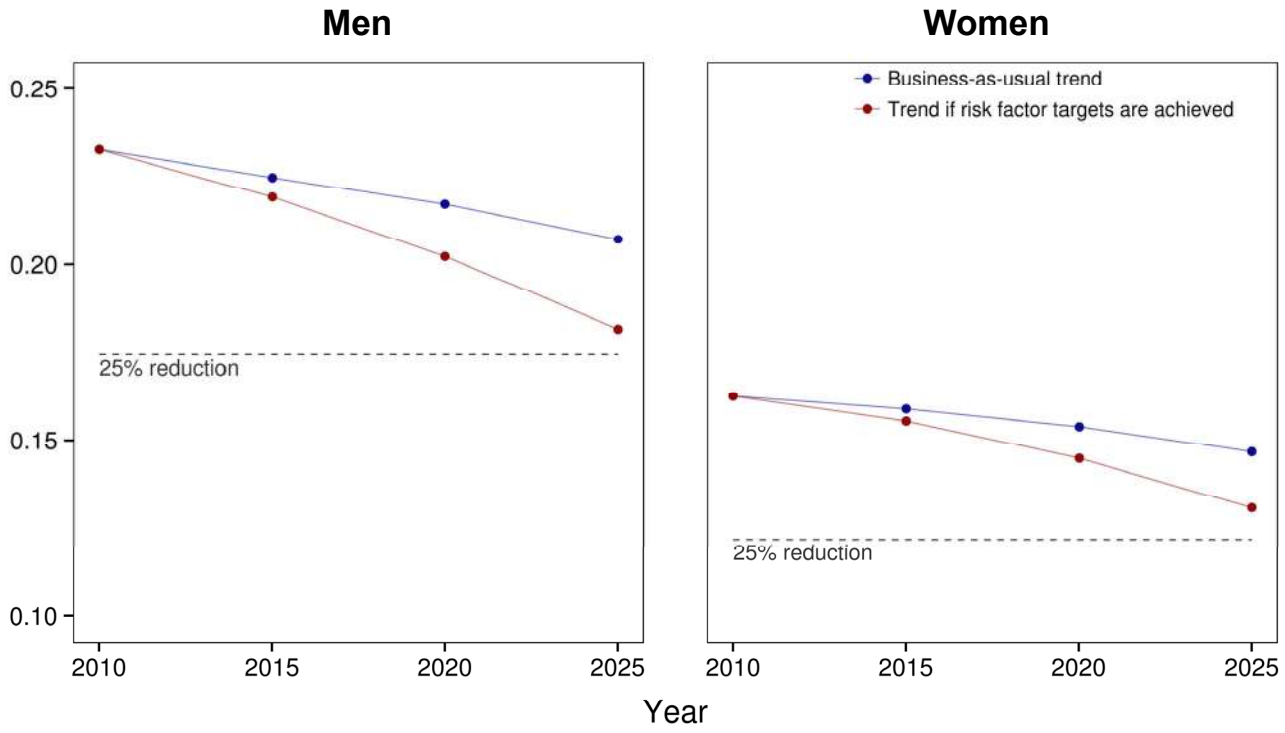
Lhoste et al *Nature Cardiovascular Research* 2024

NCD·RisC
Risk Factor Collaboration

Modelling risk factor interventions and the decline in NCDs

Contribution of six risk factors to achieving the 25×25 non-communicable disease mortality reduction target: a modelling study

Vasilis Kontis, Colin D Mathers, Jürgen Rehm, Gretchen A Stevens, Kevin D Shield, Ruth Bonita, Leanne M Riley, Vladimir Poznyak, Robert Beaglehole*, Majid Ezzati*



Kontis et al *Lancet* 2014

NCD·RisC Risk Factor Collaboration

Acknowledgements

- Worldwide NCD-RisC collaborators
- NCD-RisC core team

Funders

- Wellcome Trust for the creation of initial NCD-RisC database
- UKRI, UK MRC, EU, WHO, AstraZeneca Young Health Programme

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Risk Factor Collaboration