



National Institutes of Health (NIH) - *Office of Disease Prevention*

Prevention Scientific Interest Group (SIG) Webinar Series

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# Multi-morbidity in the Rochester Epidemiology Project

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# Outline

1. Description of the Rochester Epidemiology Project (REP)
  - General description
  - Linkage methods
2. Descriptive studies of multi-morbidity (MM)
  - Validation of diagnostic codes (ICD)
  - Incidence and prevalence
  - Area Deprivation Index (ADI)
3. MM and accelerated aging
  - MM as a marker of aging pace
  - Normative data
4. Conclusions

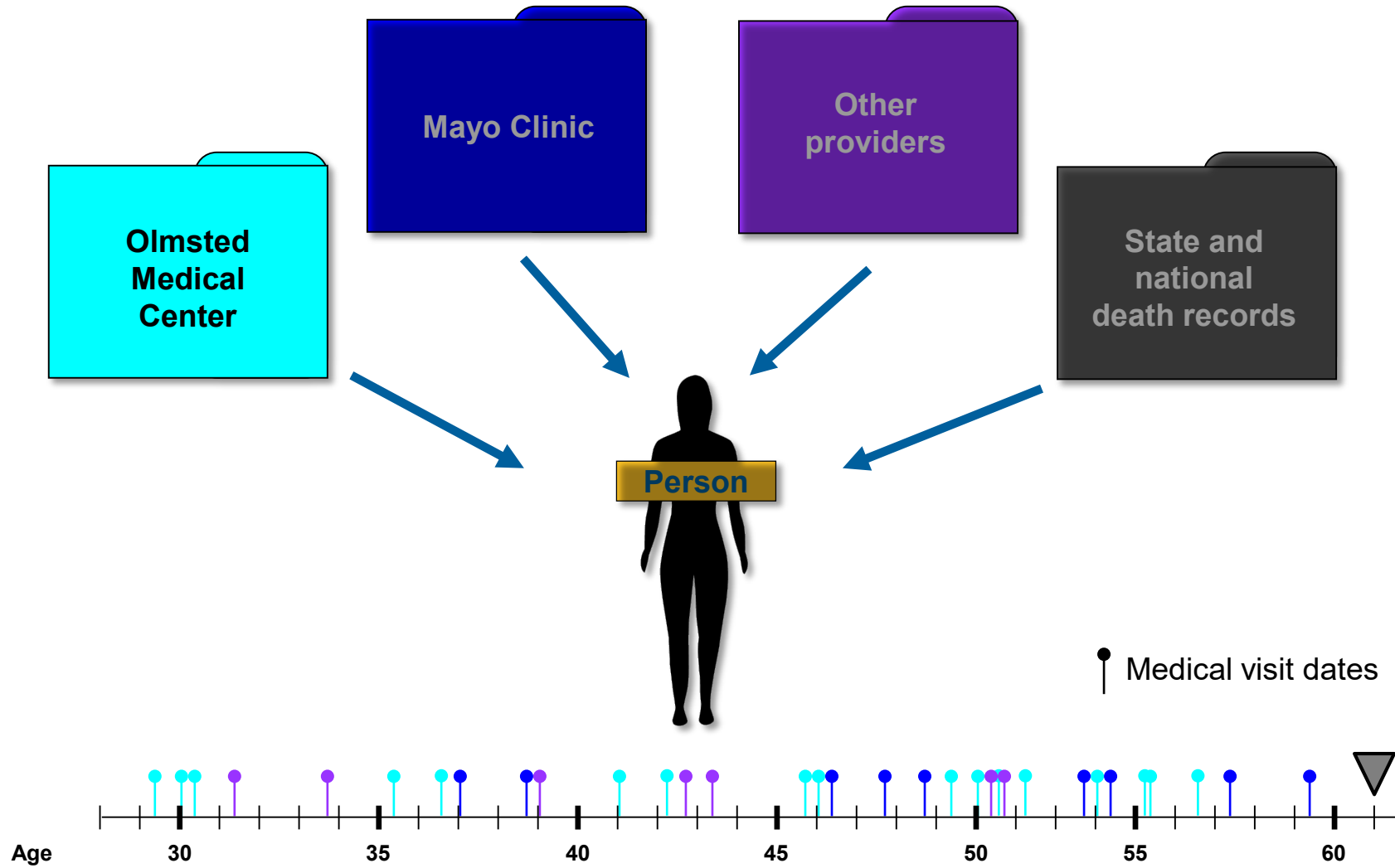
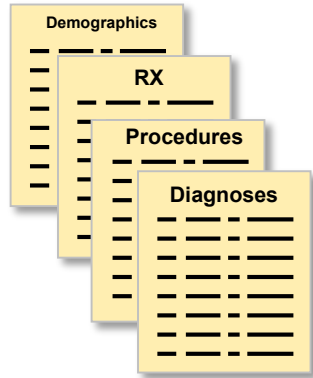


# 1. Description of the Rochester Epidemiology Project (REP)

# General description

- Medical records-linkage system for research
  - Population-based = defined geographic region
  - Initially paper records, then electronic health records (EHR)
  - Within care providers and across care providers – identifiable data
  - Both sexes, all ages, and all race and ethnicity groups
  - Existed for 55 years – > 3,000 papers
- Utility of a health records data system
  - **Size:** How many people? ~150,000 persons in Olmsted County
  - **Depth:** For how many years? Up to 50 years
  - **Type:** What data are stored and retrievable? Diagnoses, drugs, lab tests, etc.
- 2010: Extended to 27 counties in Minnesota and Wisconsin (~700,000 persons)

# Linkage across care-providers



# Life course studies



**Birth**



**Adult life**



**Aging**



**Intra-uterine life**



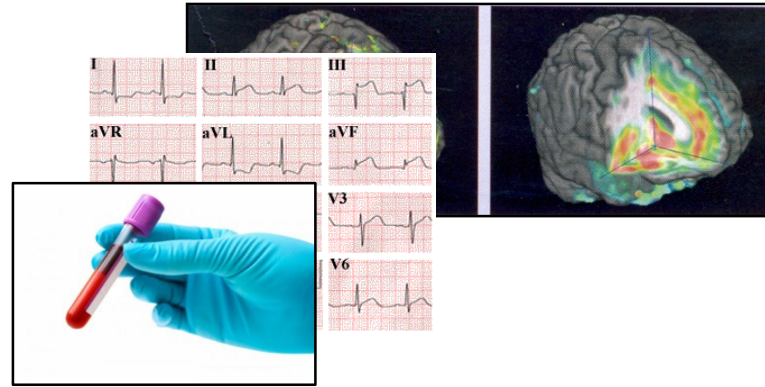
**Medical biography  
“the book of life”**

# Type of data

Prescriptions of drugs  
RxNorm, VA classes



Laboratory tests  
LOINC codes



Medical diagnoses and surgical procedures  
ICD codes



Services and procedures  
ICD and CPT codes

Immunizations

Life habits

Biological specimens  
on  $\approx 10\%$

Demographic data



## 2. Descriptive studies of multi-morbidity



# List of 20 chronic conditions

Department of Health and Human Services (DHHS) - 2013

## Mental health (5)

- Depression
- Substance abuse disorders
- Dementia and Alzheimer's disease
- Schizophrenia or psychosis
- Autism spectrum disorder

## Other somatic (8)

- Arthritis
- Cancer (all types)
- Asthma
- COPD
- Osteoporosis
- Chronic kidney disease
- Hepatitis
- HIV



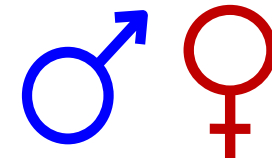
## Cardiovascular or metabolic (7)

- Hyperlipidemia
- Hypertension
- Diabetes
- Cardiac arrhythmias
- Coronary artery disease
- Stroke
- Congestive heart failure

Any multi-morbidity:  $\geq 2$  conditions

Somatic-mental:  $\geq 1$  mental and  $\geq 1$  somatic condition

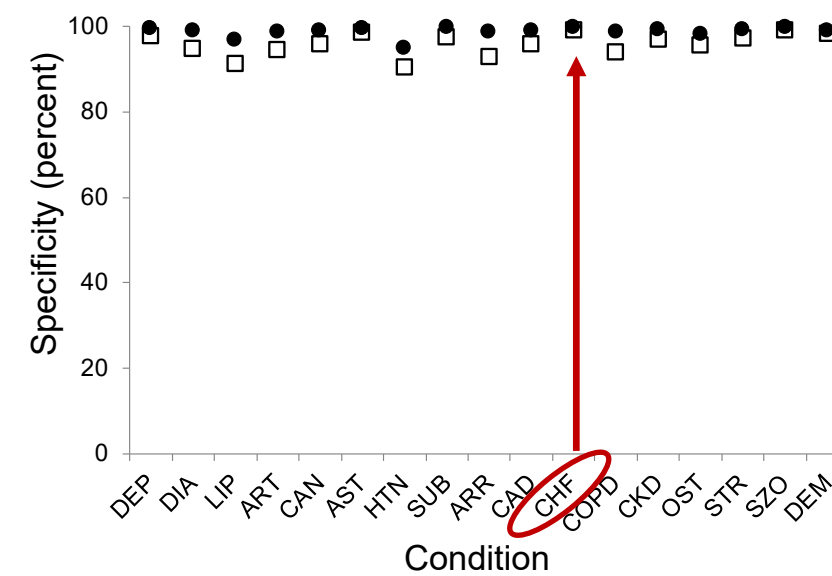
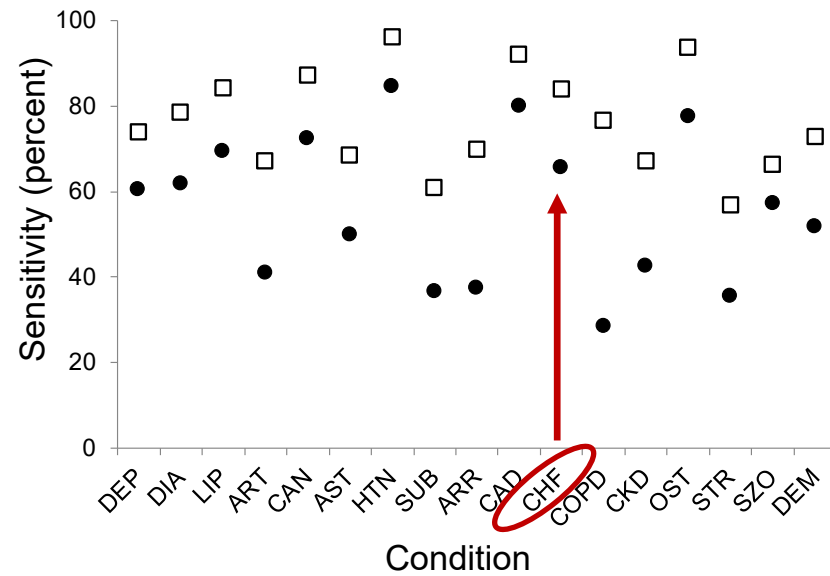
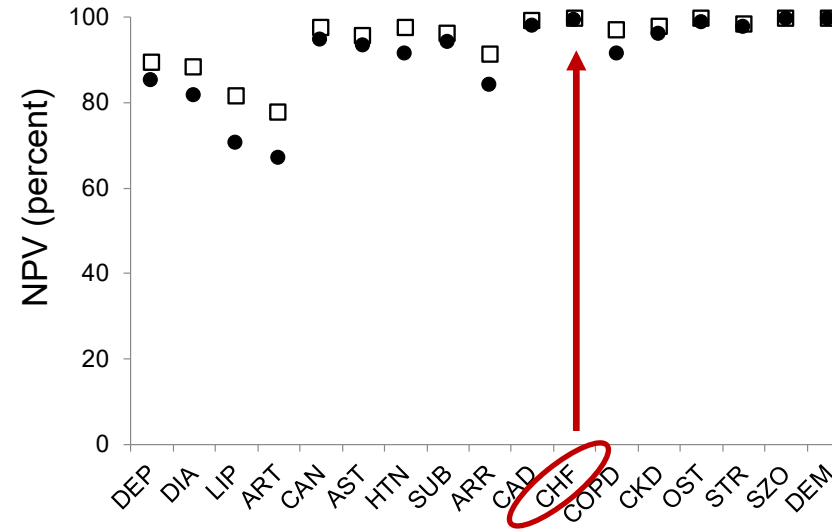
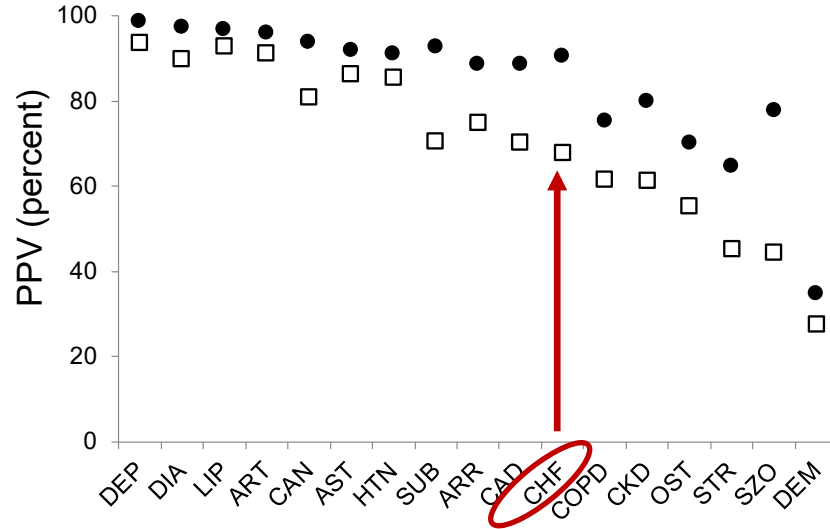
Severe multi-morbidity:  $\geq 5$  conditions



# Validation of ICD codes vs. medical records

- Validation of 2 code-based algorithms vs. standard for comparison
- 2 algorithms:  $\geq 1$  ICD code or 2 ICD codes separated by  $> 30$  days
- Standard: Medical record abstraction (full text) by a nurse
  
- Random sample of men 40-64 and 65-84, and women 40-64 and 65-84
- Prevalent chronic conditions on 31 Dec 2010
  - 5 years of diagnoses from 1 Jan 2006 to 31 Dec 2010
- 17 chronic conditions from DHHS
  
- Sensitivity, specificity, PPV, and NPV

# Validation of ICD codes



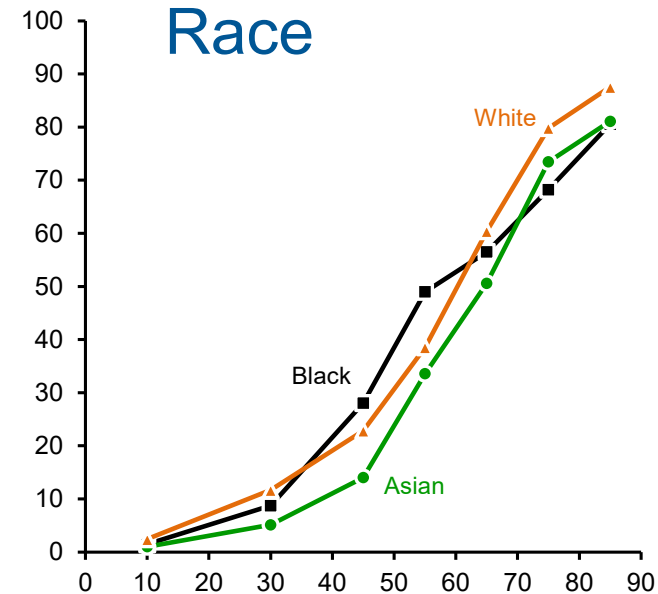
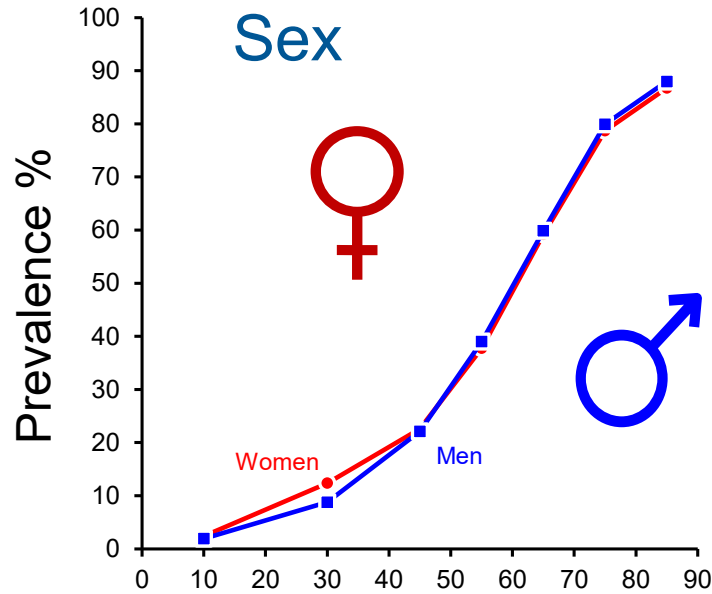
● Two codes separated by 30 days    □ One code

# Prevalence and incidence of multi-morbidity (MM)

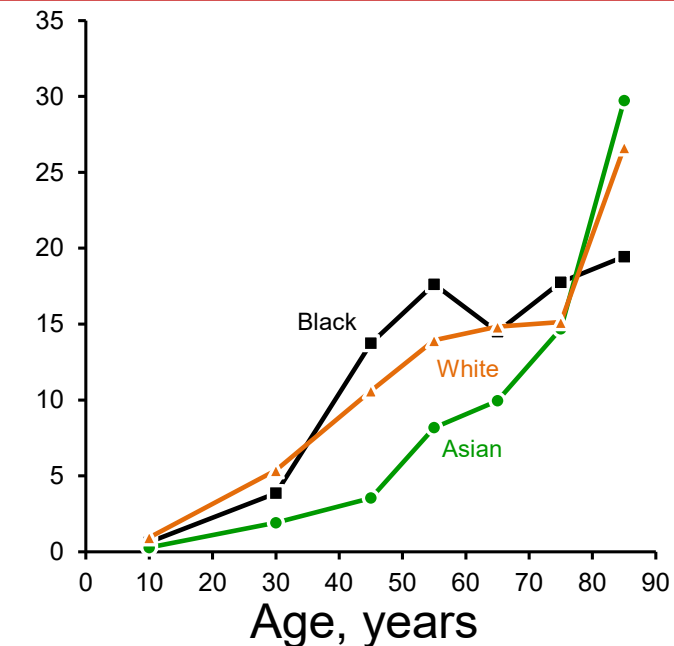
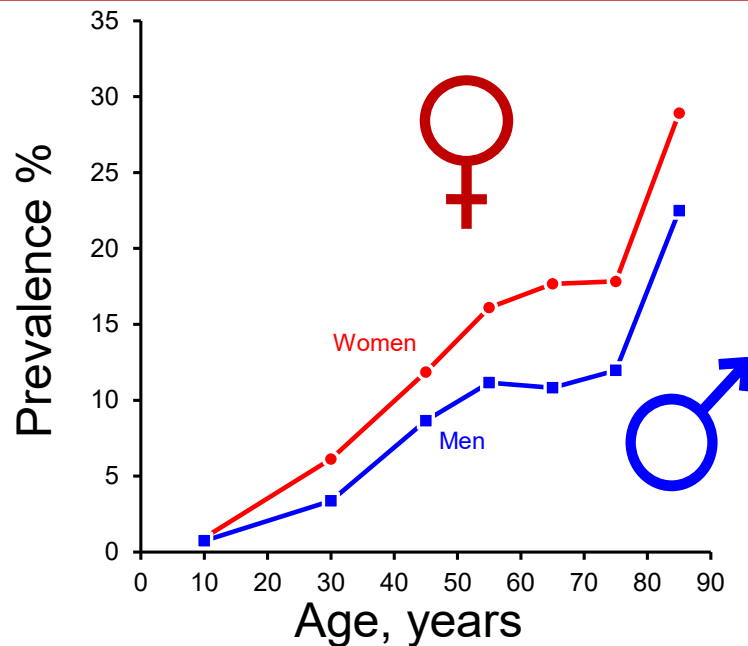
- Using 20 chronic conditions from the DHHS; 2 codes, >30 days
- Prevalence and incidence of MM
  - Increases steeply with older age
  - Same magnitude but different patterns in men and women (dyads and triads)
  - Differ by race (Blacks > Whites > Asians)
- Prevalence of somatic and mental MM
  - Increases steeply with older age
  - Higher in women at all ages plus different patterns (dyads and triads)
  - Differ by race (Blacks > Whites > Asians)
- Area Deprivation Index (ADI) and MM prevalence
  - Association stronger in younger, in women, and in less educated

Rocca et al., *Mayo Clin Proc* 2014; St. Sauver et al., *BMJ Open* 2015; Bobo et al., *J Gerontol* 2016; Chamberlain et al., *BMC Public Health* 2020

# Prevalence of multi-morbidity (MM)



Any  
multi-morbidity  
 $\geq 2$  conditions



Somatic-mental  
multi-morbidity  
 $\geq 2$  conditions

# Sex differences by type of dyad, ages 50-59 years

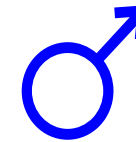
## Somatic health condition

Mental health condition

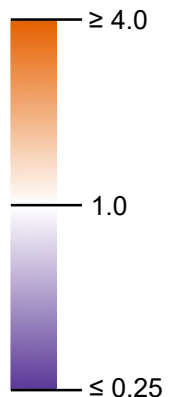
	LIP	HTN	DIA	ART	CAN	ARR	AST	CAD	COPD	OST	CKD	STR	CHF	HEP
DEP	1.4	1.5	1.5	1.8	1.3	2.1	2.2	2.0	2.9	3.1	2.6	2.6	2.3	2.8
ANX	1.5	1.4	1.3	1.8	ns	3.2	1.9	2.1	2.8	3.7	ns	ns	2.7	3.4
SUB	ns	1.9	1.5	1.9	ns	3.2	2.1	2.4	4.9	ns	3.0	4.2	2.9	8.9
DEM	ns	ns	ns	2.0	2.5	2.9	n<5	2.5	4.4	n<5	n<5	15.7	n<5	n<5
SZO	ns	1.8	2.5	ns	n<5	4.4	n<5	3.0	5.6	10.4	4.7	7.2	n<5	n<5

---

DEP	1.4	1.4	1.5	1.8	1.2	1.7	2.0	2.1	2.3	1.6	1.9	2.2	2.4	2.8
ANX	1.4	1.5	1.4	1.8	1.3	2.1	1.9	2.1	2.6	1.6	2.2	2.6	4.5	2.6
SUB	ns	1.9	1.5	2.0	ns	2.3	2.1	2.8	4.3	ns	ns	3.5	6.8	14.0
DEM	ns	1.8	ns	ns	n<5	3.8	n<5	n<5	3.8	5.5	6.5	n<5	n<5	n<5
SZO	1.7	1.9	2.0	1.8	ns	3.5	ns	4.1	4.5	n<5	5.2	n<5	n<5	n<5



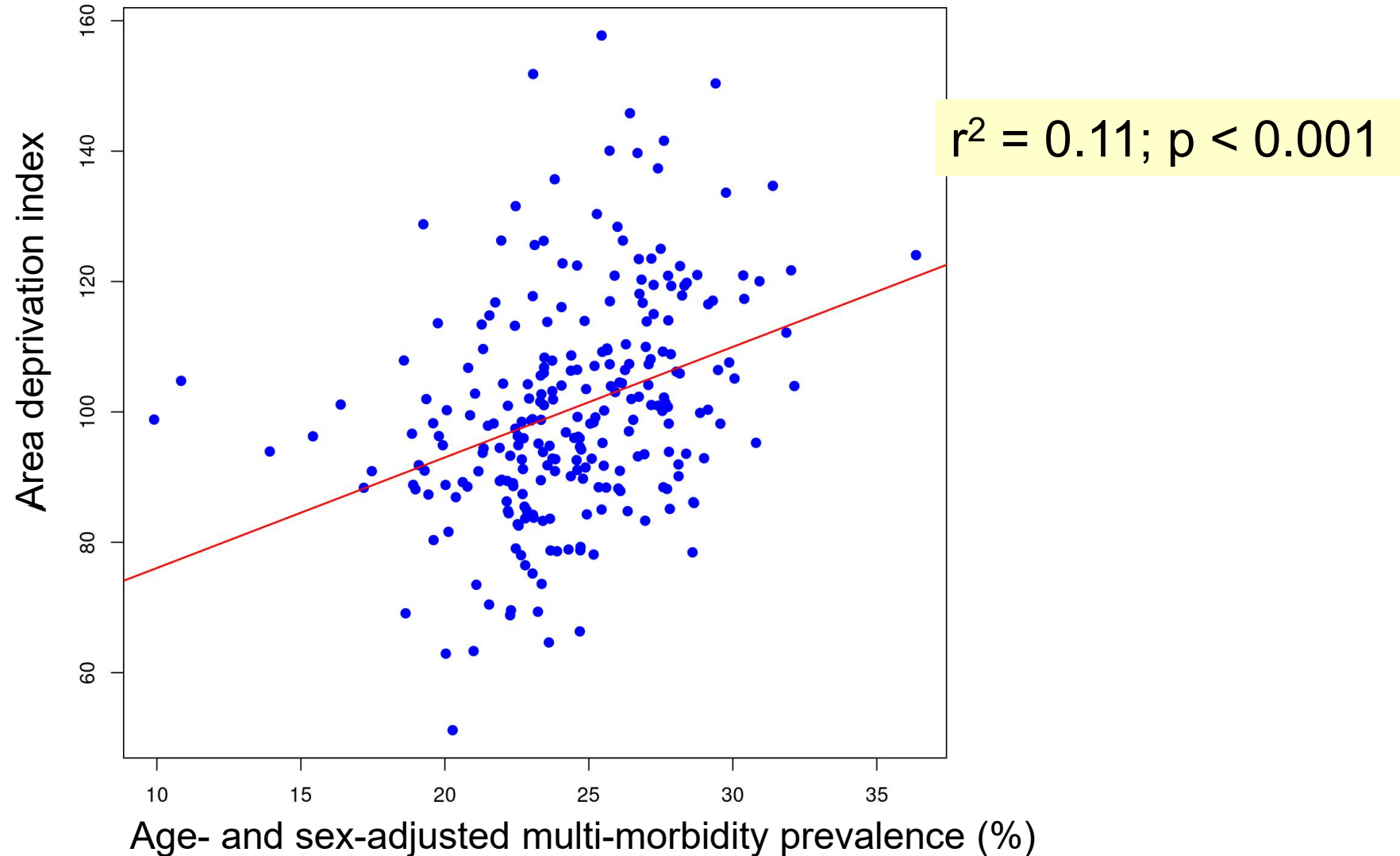
Observed to expected ratio (OER)



# Area Deprivation Index (ADI) and MM prevalence

- The ADI is a composite measure of neighborhood socioeconomic disadvantage at the census block group level
- 17 census measures capturing education, employment, income, poverty, and housing characteristics
- REP 7-county region in Minnesota
- Geocoded patient addresses (N = 198,941; 96%) and linked to census block groups (N = 251)
- 5-year estimates (2011-2015) from the American Community Survey or 2010 Census to calculate ADI
- ADI was stratified into quintiles

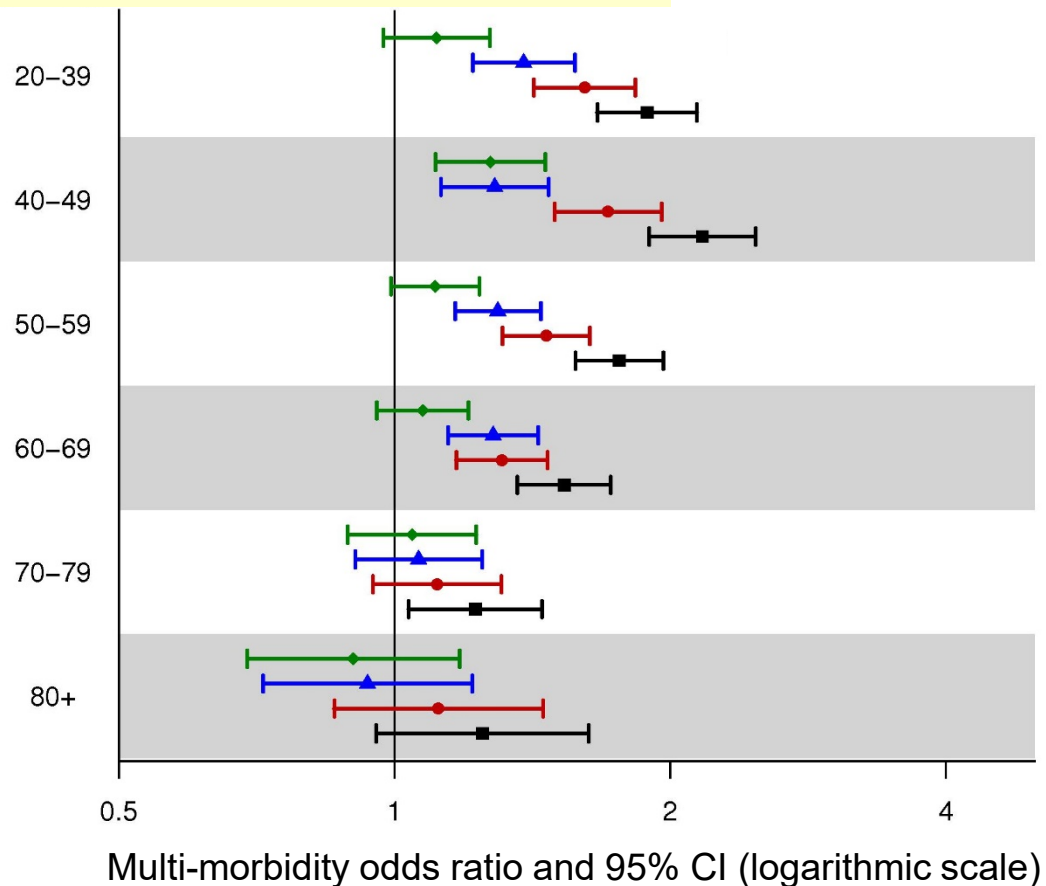
# Area Deprivation Index and MM prevalence



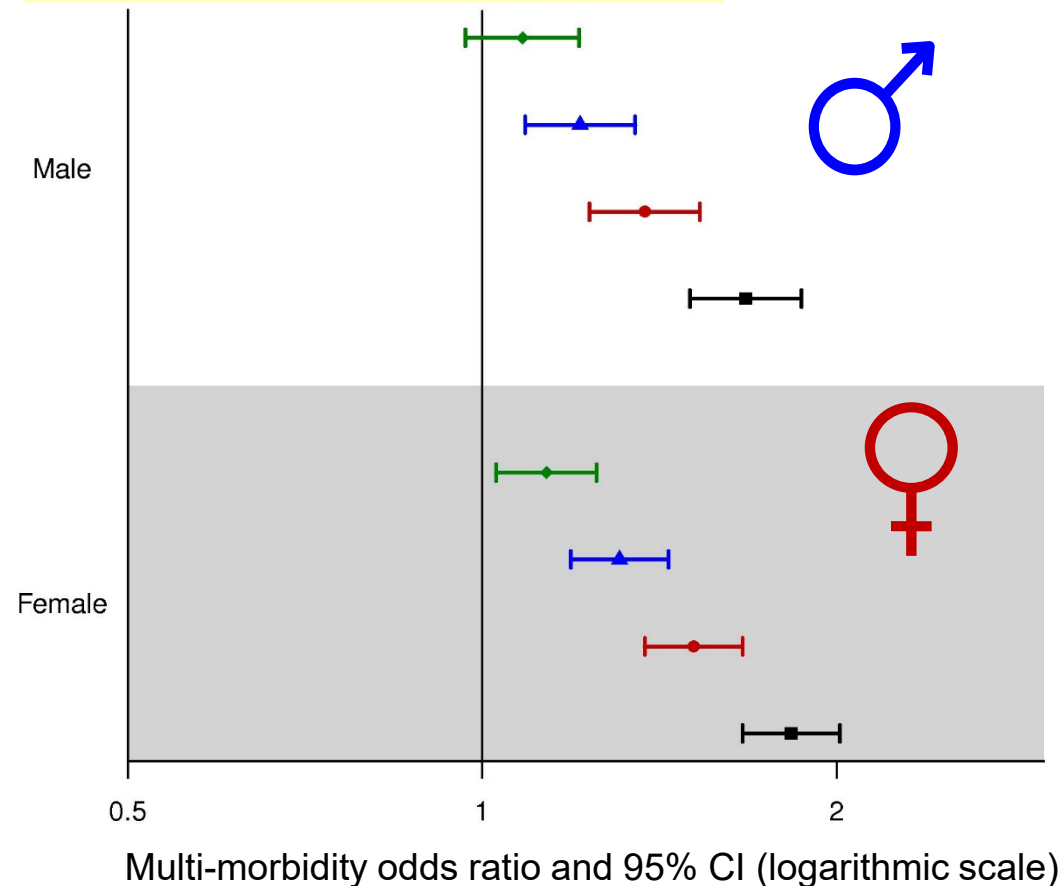


# Area Deprivation Index and MM prevalence

Age: p for interaction < 0.0001



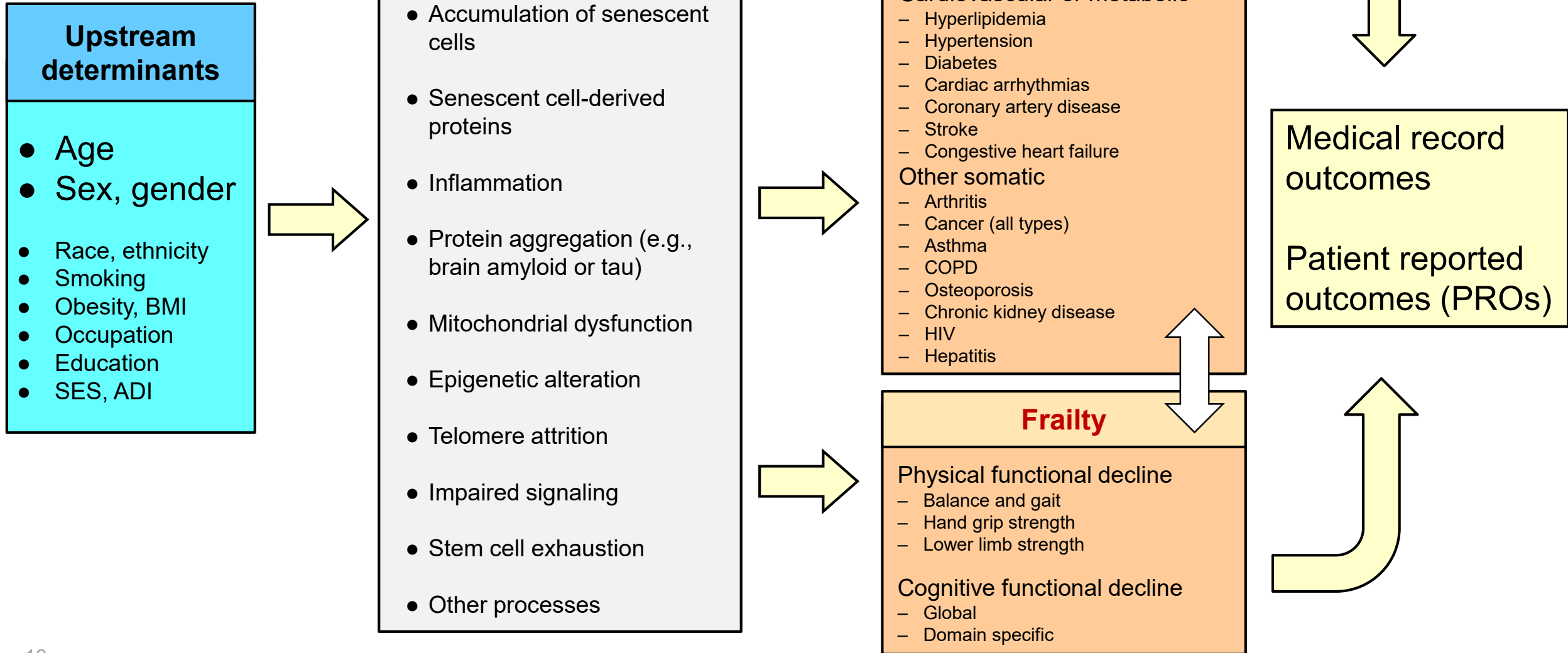
Sex: p for interaction < 0.0001



Deprivation quintiles: ◆ 20-39% ▲ 40-59% ● 60-79% ■ 80-100%

# 3. Multi-morbidity and accelerated aging

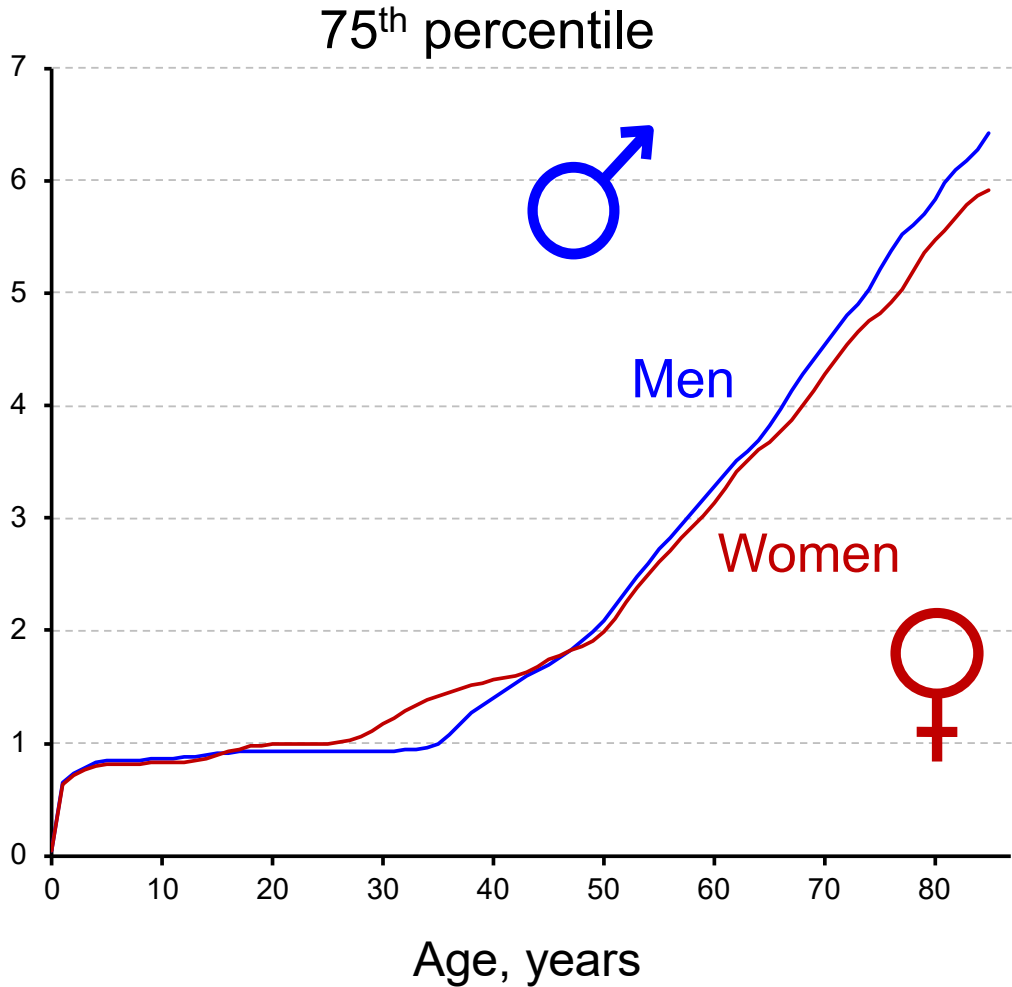
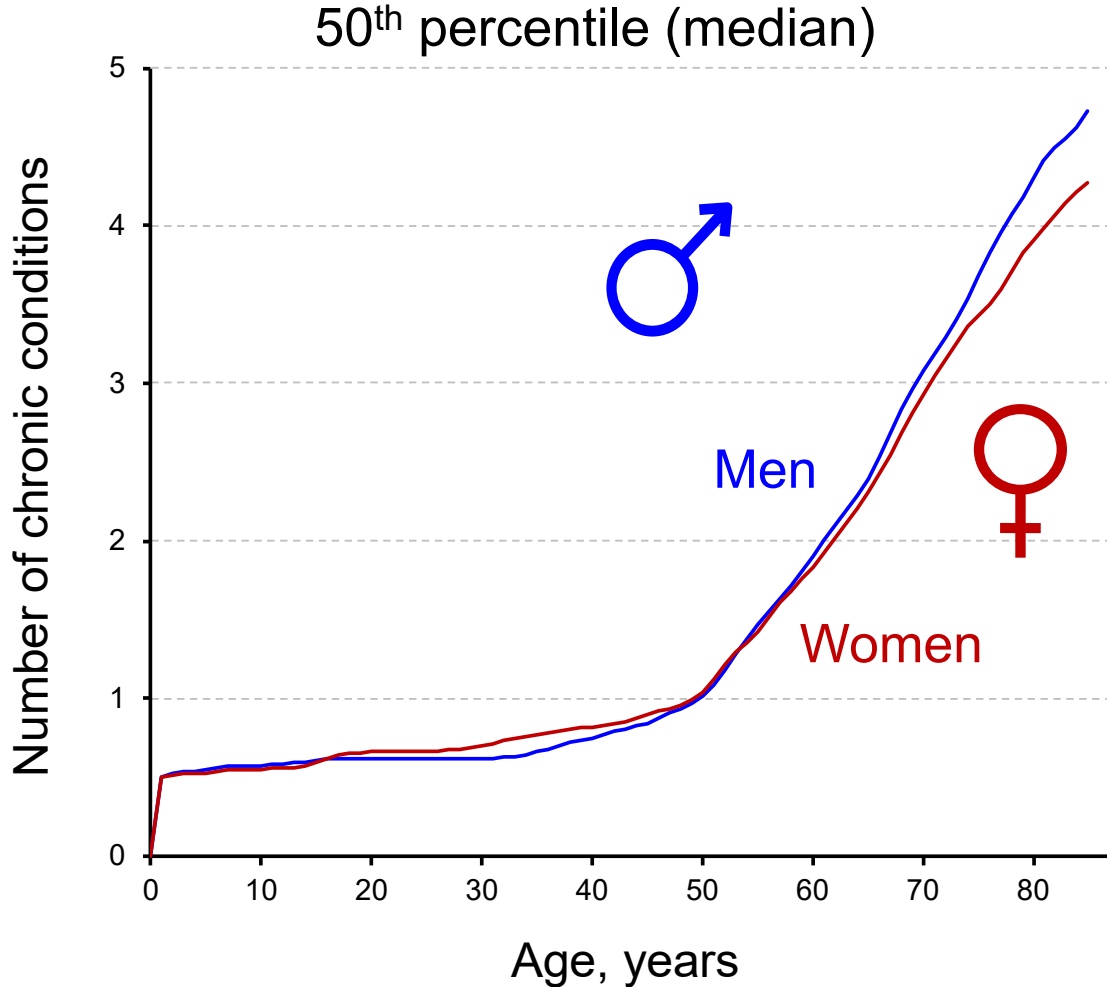
# General conceptual frame



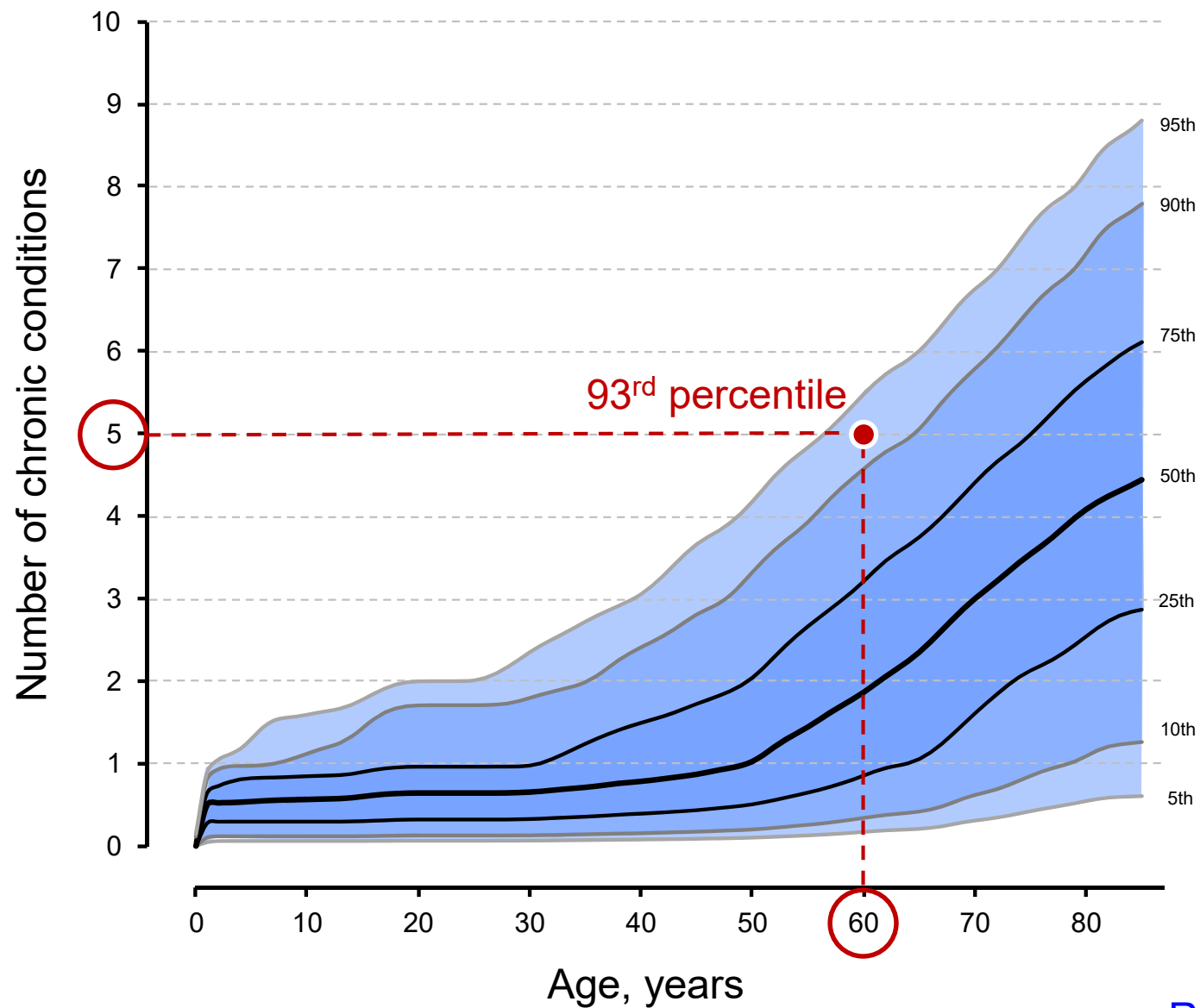
# Normative data – risk of death

- Normative data
  - All residents of Olmsted County, MN
  - Reached  $\geq 1$  birthday from 2005 to 2014 (10 years)
  - Count of chronic conditions at birthday (within 5 years before)
  - Counts transformed to percentile ranks among persons of same age
  - Distribution by sex, race, and ethnicity
- Percentile rank and risk of death
  - At 1 year, 5 years, and end of follow-up (31 Dec 2017)
  - HR for quintiles 1, 2, 4, and 5 vs. 3 (reference)

# Normative data (men and women separately)



# Normative data (men and women combined)



# Percentile rank look-up table (partial)

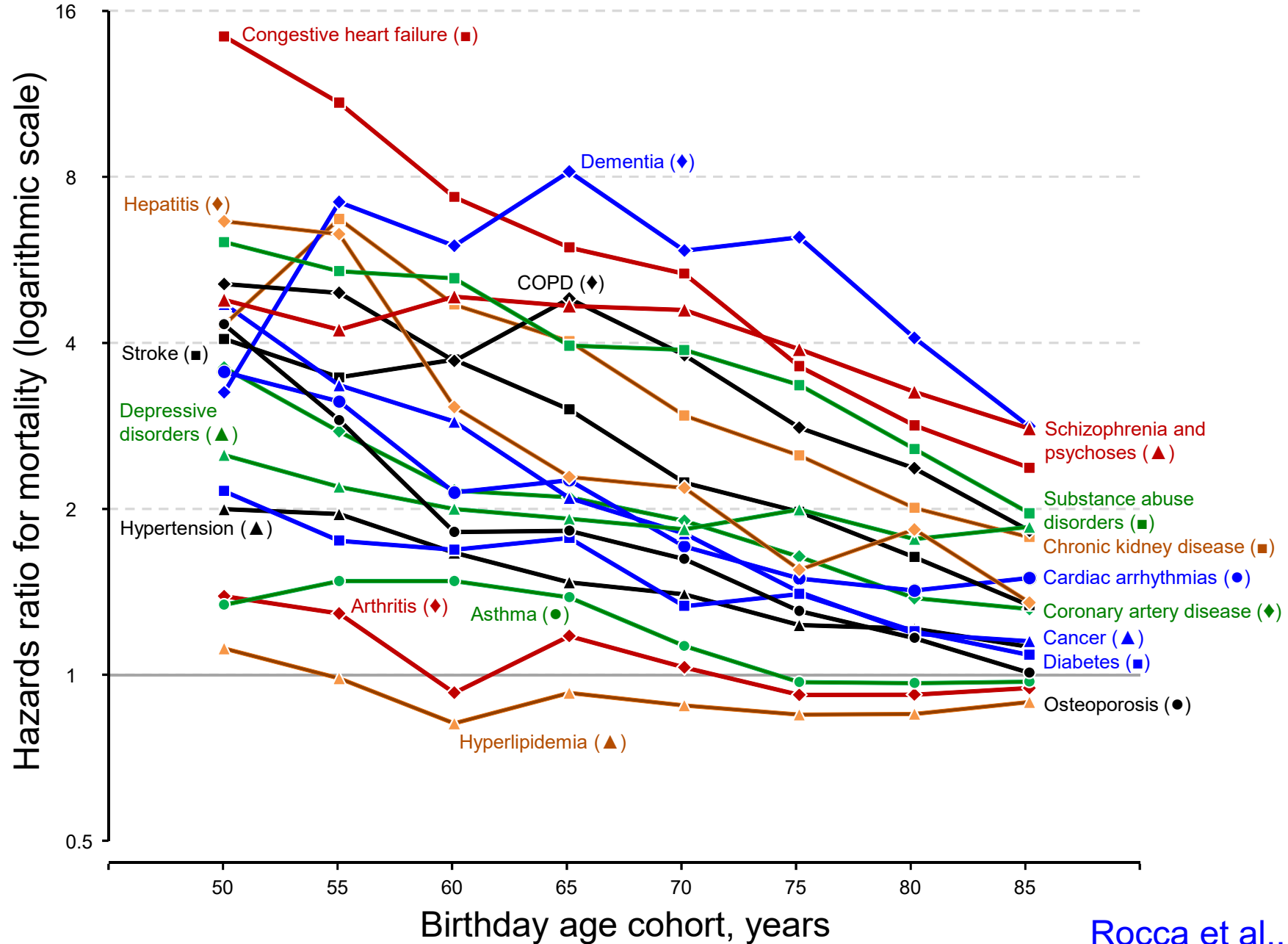
Number of DHHS-defined chronic conditions											
Age, yrs	1	2	3	4	5	6	7	8	9	10	<11
50	49	74	87	94	97	98	99	---	---	---	---
51	46	72	86	93	97	98	99	---	---	---	---
52	44	70	85	93	96	98	99	---	---	---	---
53	42	68	83	92	96	98	99	---	---	---	---
54	40	66	81	91	96	98	99	---	---	---	---
55	38	64	80	90	95	98	99	---	---	---	---
56	36	61	78	89	95	97	98	99	---	---	---
57	34	59	76	88	94	97	98	99	---	---	---
58	32	57	75	87	94	97	98	99	---	---	---
59	30	55	73	86	93	97	98	99	---	---	---
60	29	53	71	85	93	96	98	99	---	---	---
61	27	50	69	84	92	96	98	99	---	---	---
62	26	48	67	83	91	96	98	99	---	---	---
63	25	46	66	81	91	95	98	99	---	---	---
64	24	45	64	80	90	95	97	98	99	---	---
65	23	43	62	79	89	95	97	98	99	---	---
66	22	41	59	77	88	94	97	98	99	---	---
67	20	38	57	75	87	93	97	98	99	---	---
68	19	35	54	73	86	93	96	98	99	---	---
69	17	33	52	71	84	92	96	98	99	---	---

# Percentile of MM and risk of death

- The percentile rank is associated with mortality
  - 1 year
  - 5 years
  - End of follow-up (from 4.7 to 7.4 years)
- Associations stronger in women
- Associations stronger in younger persons



# Risk of death for single chronic conditions



# Percentile of MM and risk of death (end of follow-up)

- Age 65
  - Quintile 1 vs. 3: HR = 1.08
  - Quintile 2 vs. 3: HR = 0.93
  - Quintile 3, ref.: HR = 1.00
  - Quintile 4 vs. 3: HR = 1.47
  - Quintile 5 vs. 3: HR = 4.23
- Age 80
  - Quintile 1 vs. 3: HR = 0.81
  - Quintile 2 vs. 3: HR = 0.79
  - Quintile 3, ref.: HR = 1.00
  - Quintile 4 vs. 3: HR = 1.30
  - Quintile 5 vs. 3: HR = 2.76

The size of the HRs decreases with older age

# 4. Conclusions

# Conclusions

- The REP is a unique resource to study MM locally
  - Olmsted County, MN
  - 27-counties in MN and WI
- Descriptive studies
  - Validation of diagnostic codes
  - Incidence, prevalence, and type of MM (dyads and triads)
  - Studies of somatic-mental MM
  - Area Deprivation Index and MM
  - Focus on age, sex, and race
  - Dimorphic aging
- Accelerated aging
  - Normative data and percentile ranks
  - Risk of death





Improving health globally by studying health locally  
**A Minnesota and Wisconsin Collaboration**

Thank you