
Years of life lived with multiple chronic diseases and associated lifetimes in Denmark

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Background: Multimorbidity prevalence & risks

- Multimorbidity is a growing global public health concern (Skou et al. 2022)
- Its prevalence has increased over the past decades, affecting 37% of adults globally and over half of those aged 60+ (Chowdhury et al., 2023; Nguyen et al., 2019)
- People with multimorbidity face a higher risk of death compared to those without (Nunes et al., 2016)
- Individuals with lower socioeconomic status face a higher risk of developing multimorbidity (Pathirana & Jackson, 2018)

Background: Health expectancy & multimorbidity

- While life expectancy increases, so do the years spent with chronic diseases and multimorbidity (Fabbri et al., 2025; Tetzlaff et al., 2017)
- Research on multimorbidity has focused predominantly on prevalence, mortality risk, and healthcare use while the length of life spent in each health state remains poorly quantified (Skou et al., 2022)
- Mortality risks among individuals with multimorbidity are highly heterogeneous and shaped by the number and combination of conditions (Ukolova & Strozza, 2026). **Yet how long individuals live as they progress through these states is understudied**

How many years between ages 65 and 89 are spent healthy, with one chronic disease, and with multi-morbidity in the general population?

How does this distribution change conditional on already living with one chronic disease or multi-morbidity at age 65?

- **How do these patterns look when isolating specific chronic diseases?**
- **How do these patterns vary over time by sex and socioeconomic status?**

Data: Danish registers

→ Population register

→ Cause of death register

→ Register of chronic diseases

→ Including individuals diagnosed with: asthma, COPD, dementia, diabetes (type 1 and 2), osteoporosis, rheumatoid arthritis, and schizophrenia

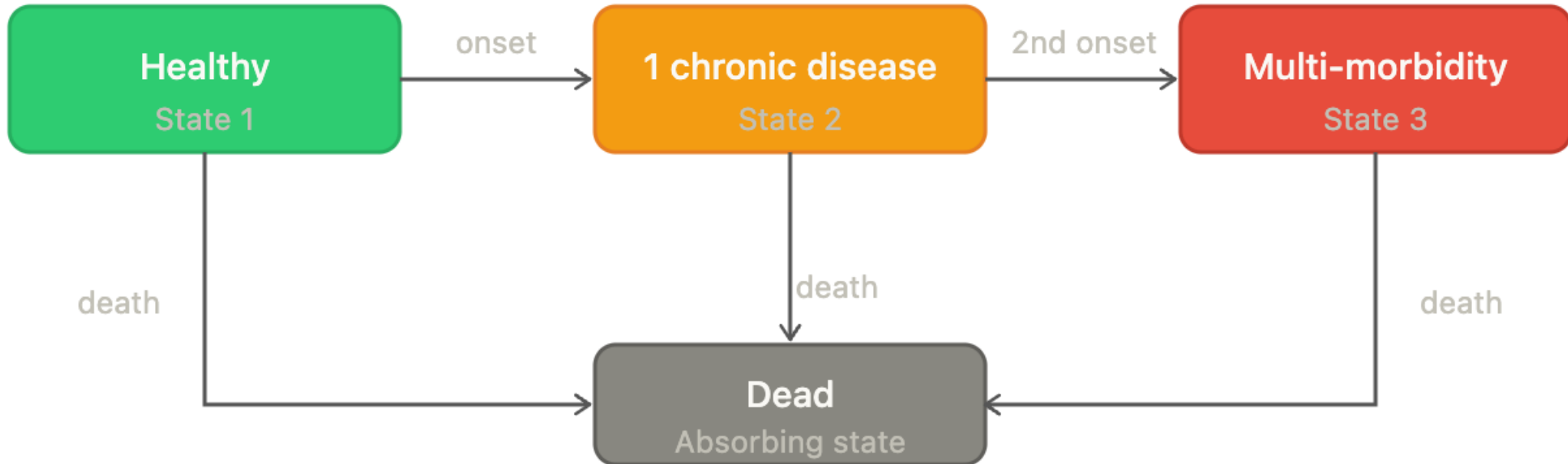
Data: Study population

All Danish residents observed between ages 50 and 89, pooled period 2015–2019 categorised in different health states:

- Healthy (H): no recorded diagnosis among the selected conditions
- One chronic disease (1CD): one recorded diagnosis*
- Multimorbidity (MM): two or more conditions diagnosed

*Either one of the eight chronic diseases of interest *or a specific one*

Methods: Multi-state life table (framework)



Methods: Multi-state life table (construction)

Starting from the **transition rates** estimated directly from observed person-time and event counts within each age-year-state cell:

$$M_x^{ij} = \frac{D_x^{ij}}{N_x^i}$$

D_x^{ij} : transition from state i to j at age x

N_x^i : mid-year population in state i at age x

We can derive:

→ **Transition probabilities:** $q_x^{ij} = \frac{M_x^{ij}}{1 + 0.5 * M_x^{ij}}$

→ **Survivors:** $l_{x+1}^i = l_x^i * (1 - q_x^{i\cdot}) + \sum_{k \neq i} l_x^k * q_x^{ki}$

→ **Person-years:** $L_x^i = 1/2 (l_x^i + l_{x+1}^i)$

Methods: Multi-state life table (outcomes)

→ **Partial health-adjusted life expectancy 65-89, both sexes combined:**

$$e_{65}^i = \sum_{x=65}^{89} L_x^i / l_{65}$$

→ General population (H, 1CD, MM):

→ H = 1000 * % healthy; 1CD = 1000 * % 1 chronic disease; MM = 1000 * % multi-morbid

→ Conditional on being healthy at age 65 (H, 1CD, MM)

→ H = 1000; 1CD = 0; MM = 0

→ Conditional on having one chronic disease at age 65 (1CD, MM)

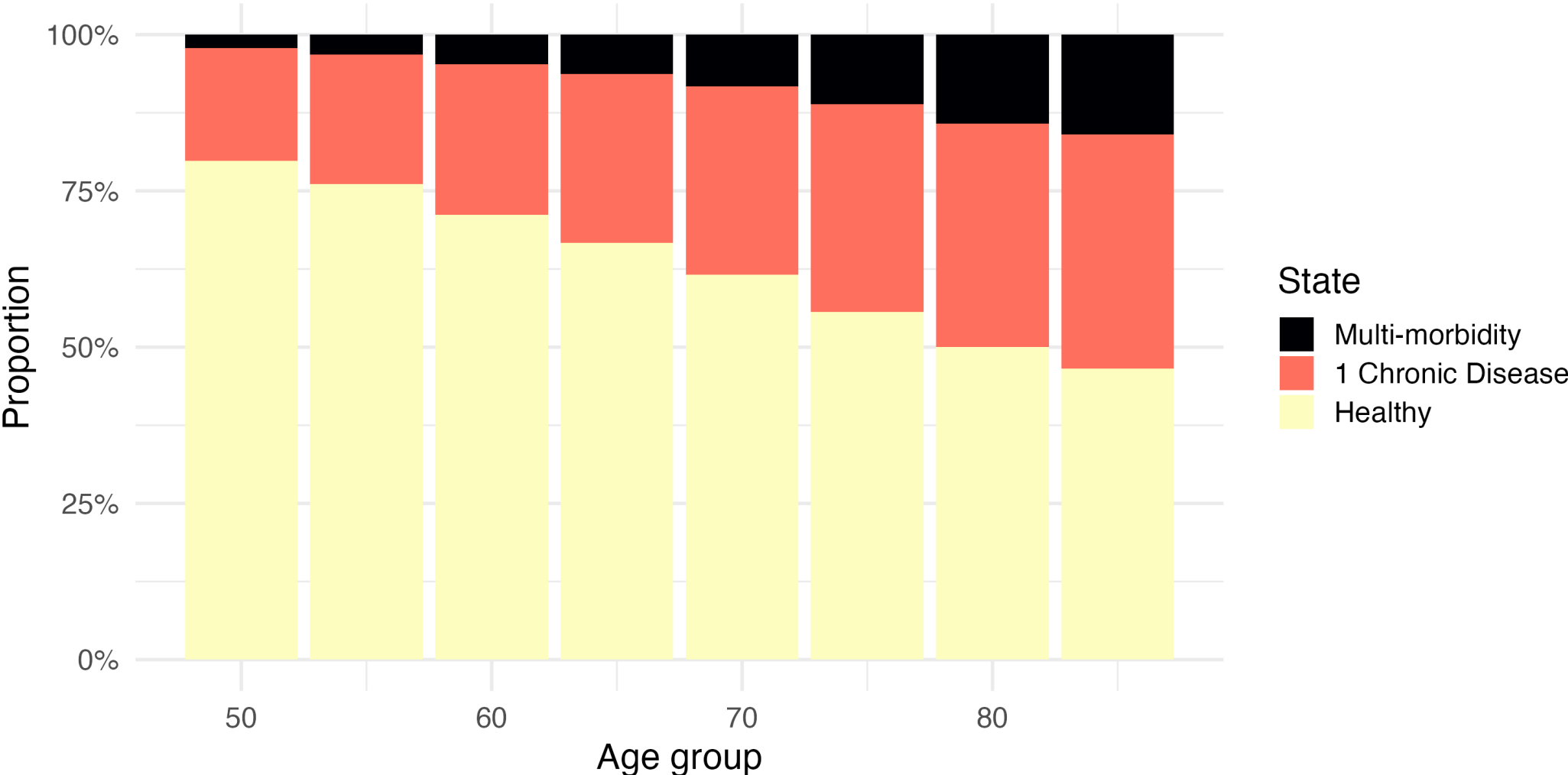
→ H = 0; 1CD = 1000; MM = 0

→ Conditional on having multiple chronic diseases at age 65 (MM)

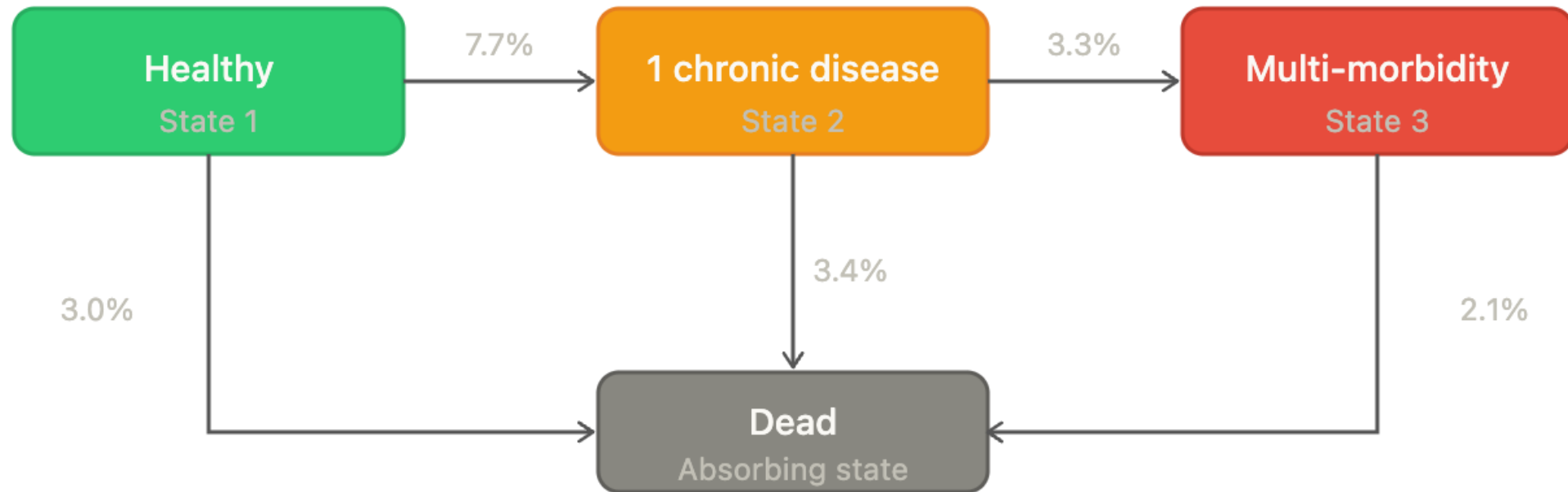
→ H = 0; 1CD = 0; MM = 1000

RESULTS: CHRONIC DISEASES

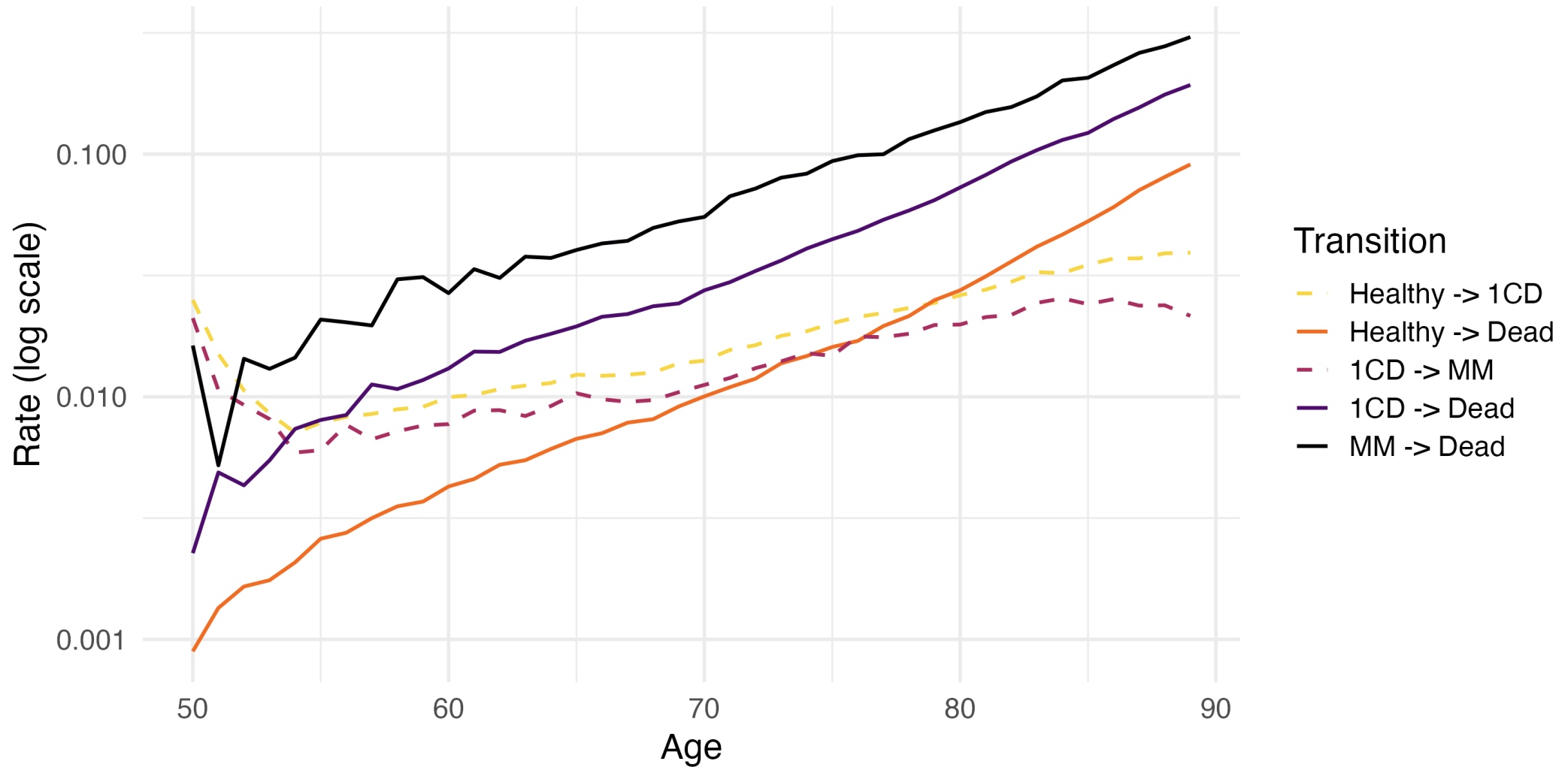
State distribution by age-group, years 2015-19



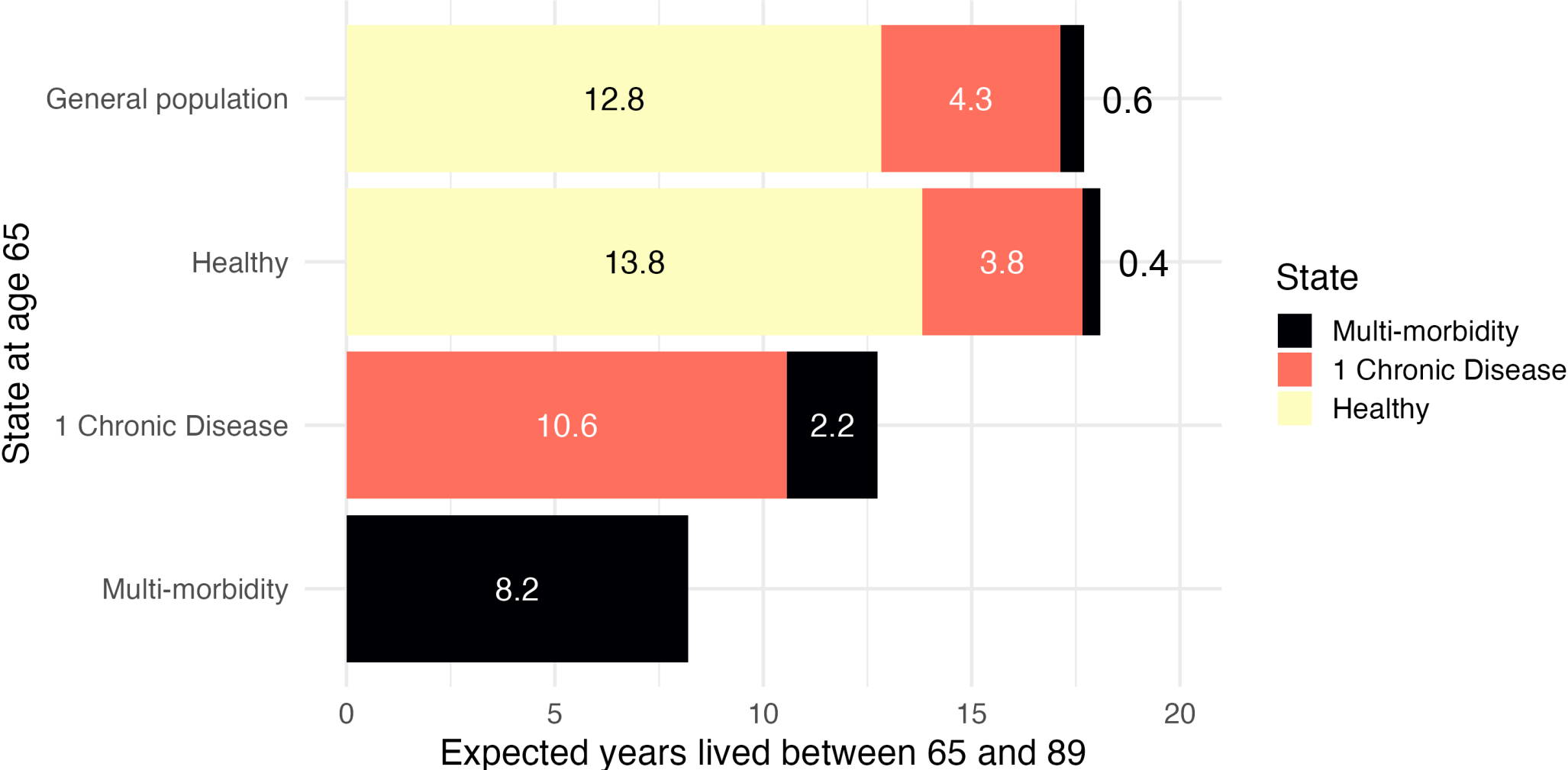
Transitions between states by age, years 2015-19



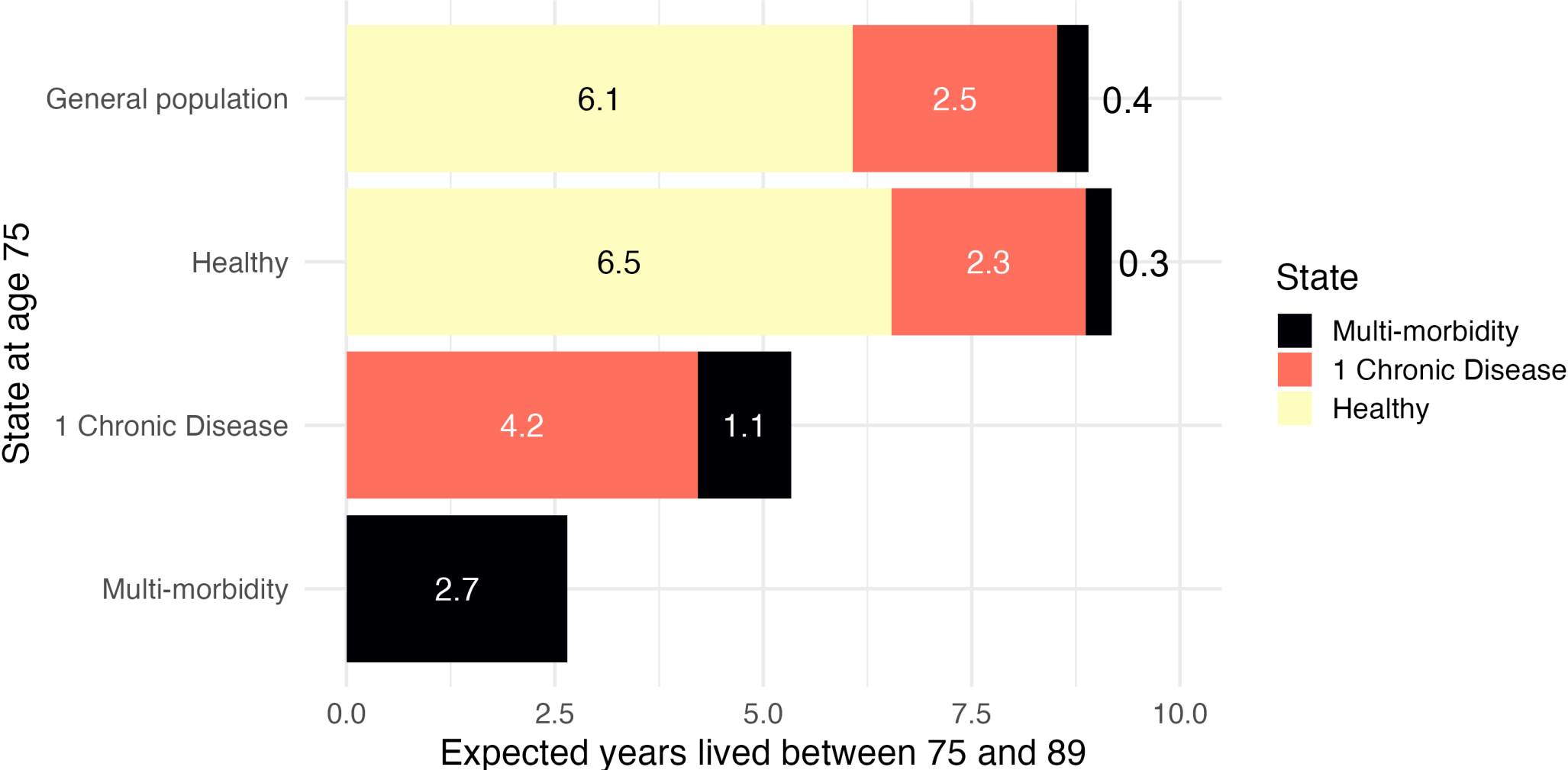
Transition rates over ages 50-89, years 2015-19



Partial health-adjusted life expectancy (65-89)

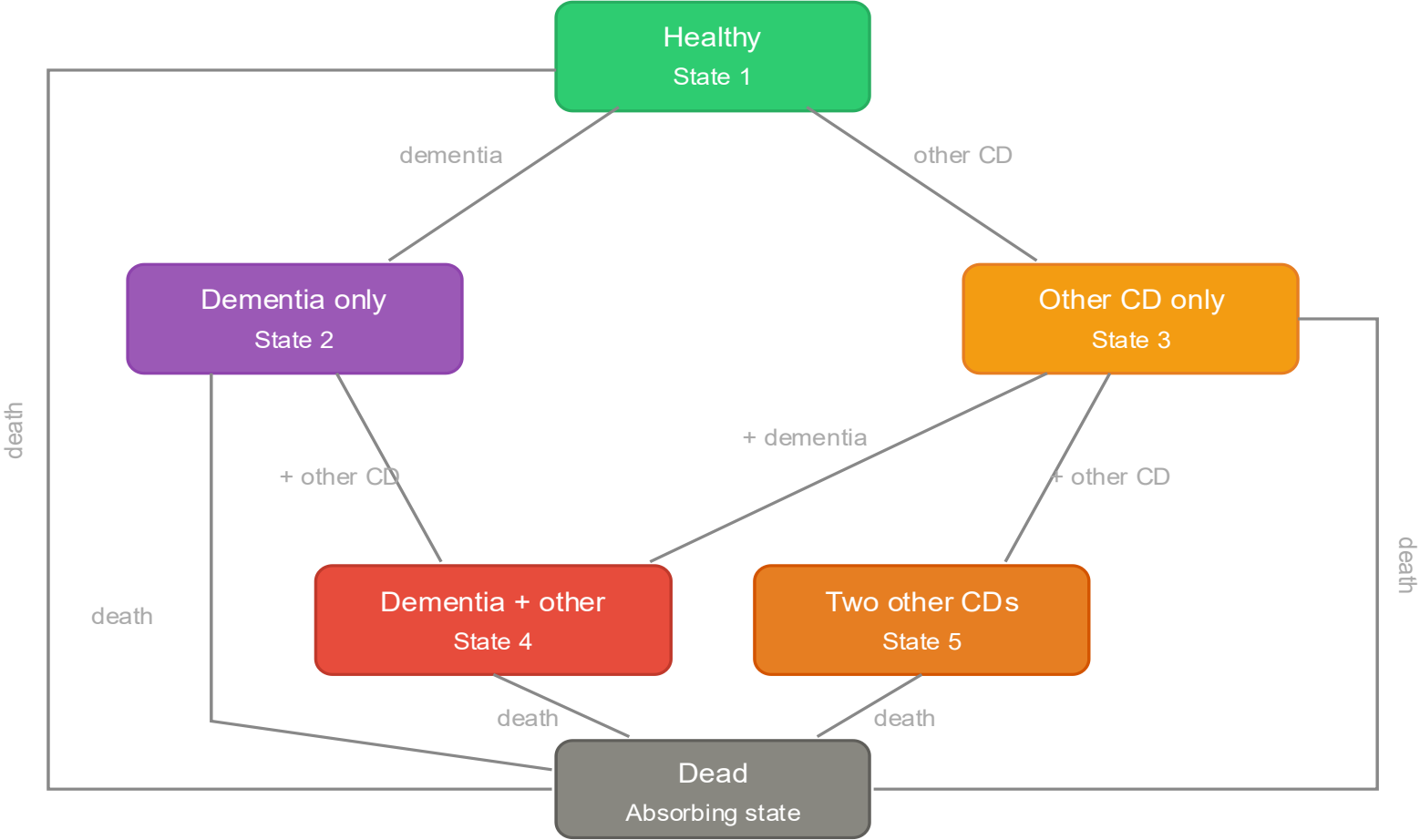


Partial health-adjusted life expectancy (75-89)

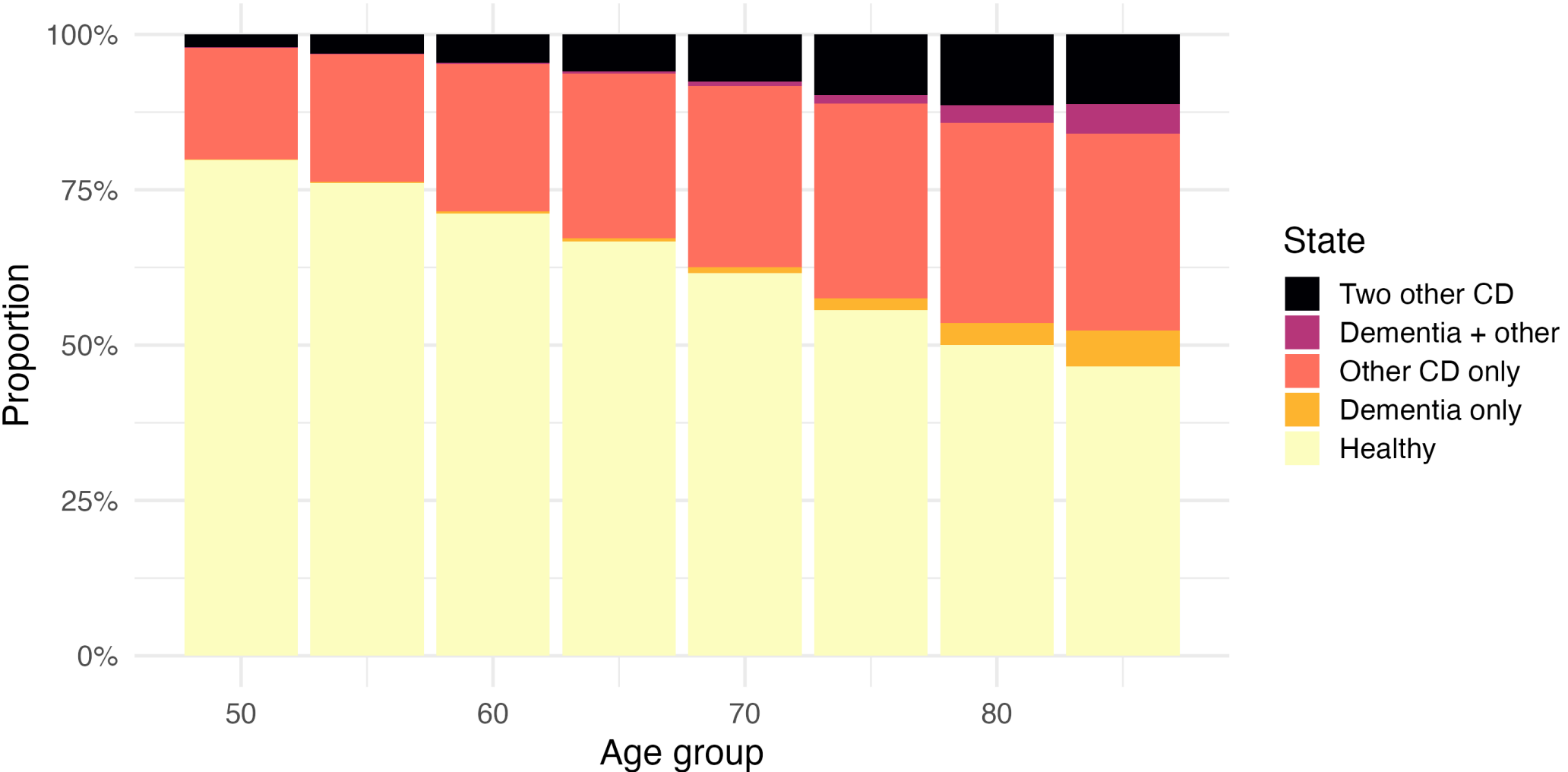


RESULTS: DEMENTIA + CHRONIC DISEASES

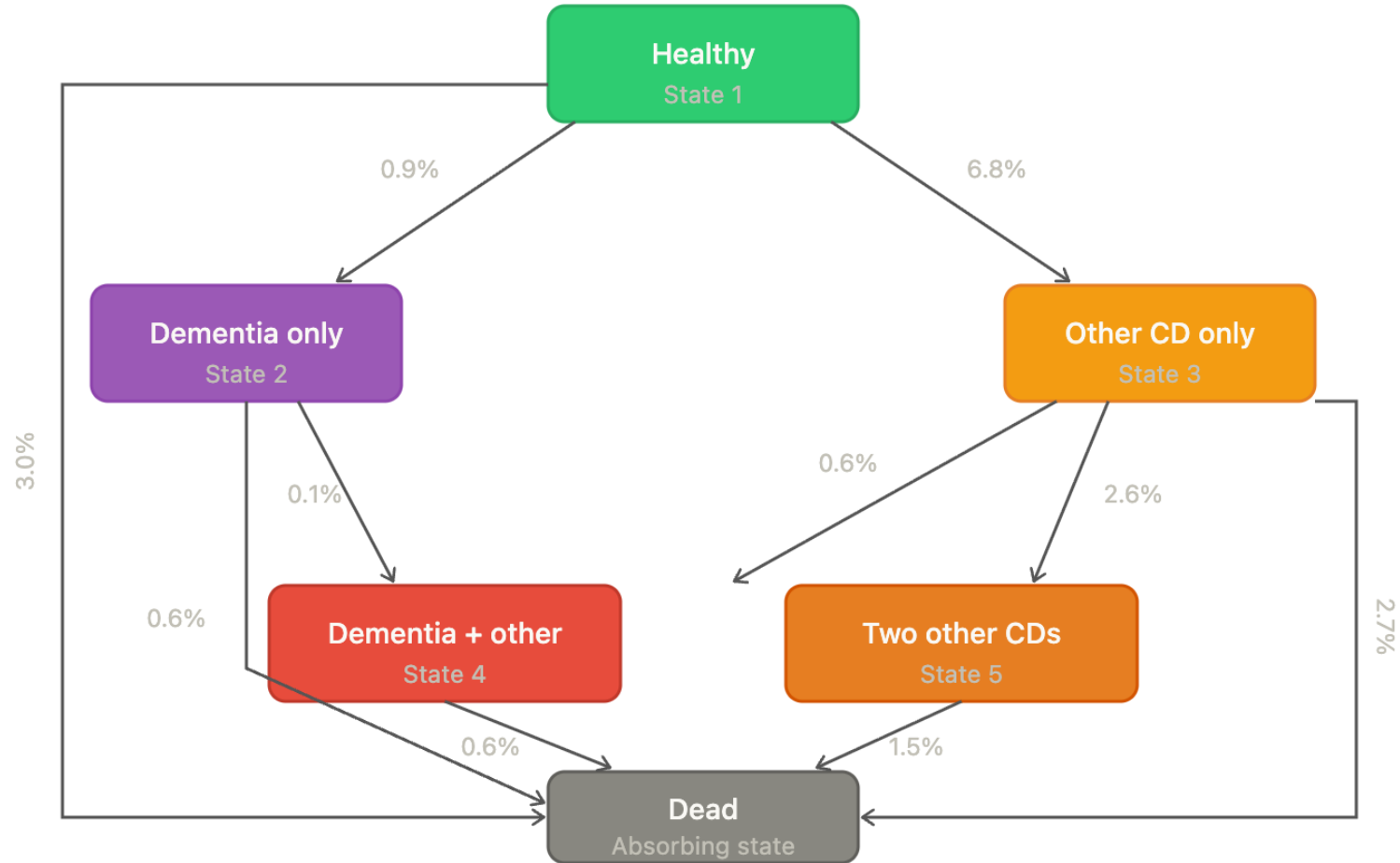
Methods: Multi-state life table (framework)



State distribution by age-group



Transitions between states by age



WRAPPING UP

Preliminary discussion:

- Among the general population at 65, a good portion of remaining years are spent *healthy*:
 - Those healthy at 65 spend one additional year in good health compared to ...
 - Those with one chronic disease at 65 live as long as the healthy years of ...
 - Those with multimorbidity live less than half the years of ...
the general population
- Heterogeneity within multimorbidity matters: the gap narrows at older ages, but the disease profile at 75 differs markedly from that at 65
- The time spent in successive health states conditional on starting condition directly relevant for insurance pricing, long-term care planning, and public health resource allocation

Next steps:

- Stratify results by specific chronic disease (COPD, dementia, diabetes)
- Perform the analysis by sex
- Extend to multiple periods to capture time trends
- ...

Thank you for attention!

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