

# Workshop

## An introduction to the analysis of population-level kinship structures

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Max Planck Institute for Demographic Research

International Institute for Population Sciences,  
India, November 24, 2025

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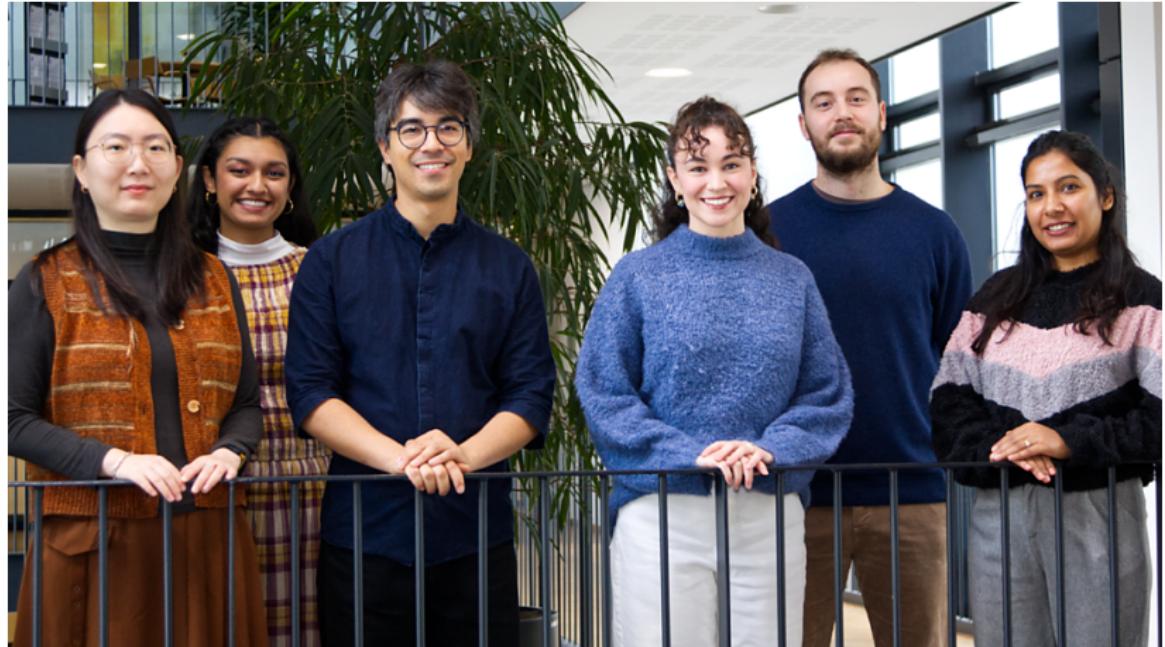
MAX-PLANCK-INSTITUT  
FÜR DEMOGRAFISCHE  
FORSCHUNG



# Who am I?

- ① 2012: BA in Anthropology (Del Valle University, Guatemala)
- ② 2018: PhD in Demography (London School of Economics, UK)
- ③ 2019: Postdoc (Max Planck Institute for Demographic Research)
- ④ 2022: Group Leader: Kinship Inequalities Research Group (MPIDR)

# Kinship Inequalities Research Group, MPIDR



# Research focus

- ① Kinship dynamics
- ② Demography
- ③ Family bereavement
- ④ Armed conflict and mass violence
- ⑤ Collective memory



Rio Negro, Guatemala, 2010

# Introductions

Find someone you don't know and ask:

- ① Their name
- ② Where they study/work
- ③ Favorite food
- ④ What is the demography of kinship?

# Our plan for today

09:00 - 09:20 Introductions

09:20 - 10:00 Kinship demographic theory

10:00 - 10:30 Technical setup

*10:30 - 11:00 Coffee break*

11:00 - 12:00 The simple kinship model

*12:00 - 13:30 Lunch*

13:30 - 14:30 Two-sex time-variant kinship models

*14:30 - 15:00 Coffee break*

15:00 - 15:30 Projections of kin by education for Singapore

15:30 - 16:00 Conclusions and closing

# This presentation

1. Introduction to kinship demography
2. Demographic models of kinship
3. Example: projections of kinship
4. Course setup and evaluation

# Introduction to kinship demography

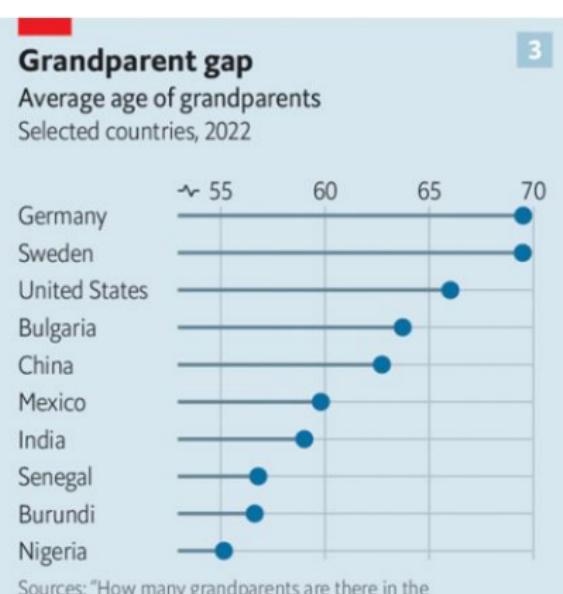
## Consider a baby born in India in 2020...

- ① How old were her grandparents when she was born, on average?
- ② How many living children will she have on her 70th birthday?
- ③ How many grandchildren?

# Kinship structure is a question of societal interest<sup>1</sup>



The Economist



<sup>1</sup>'The age of the grandparent has arrived.' (Jan 2023). The Economist.  
<https://www.economist.com/international/2023/01/12/the-age-of-the-grandparent-has-arrived>

# Definitions (1)<sup>2</sup>

## Kinship

Social relationships that bind individuals together through culturally shared definitions of relatedness on biological, legal, or normative grounds, ultimately constituting family systems.

## Family

More narrow group of kin given special privilege which, among other things, organize the provision of support, socialization, and social placement of its members.

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<sup>2</sup>Alburez-Gutierrez, D., Barban, N., Caswell, H., Kolk, M., Margolis, R., Smith-Greenaway, E., Song, X., Verdery, A., & Zagheni, E. (2022). Kinship, Demography, and Inequality: Review and Key Areas for Future Development. *SocArXiv*. <https://doi.org/10.31235/osf.io/fk7x9>

## Definitions (2)<sup>3</sup>

### Kinship demography

The study of family networks, their structures and dynamics from a demographic perspective and using demographic methods.

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<sup>3</sup> Alburez-Gutierrez, D., Barban, N., Caswell, H., Kolk, M., Margolis, R., Smith-Greenaway, E., Song, X., Verdery, A., & Zagheni, E. (2022). Kinship, Demography, and Inequality: Review and Key Areas for Future Development. *SocArXiv*. <https://doi.org/10.31235/osf.io/fk7x9>

# Kinship as a demographic human universal

- ① All humans are born
- ② All humans die
- ③ All humans are embedded in kinship structures<sup>4</sup>
- ④ No particular family configuration is universal or stable

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<sup>4</sup>Caswell, H. (2019). The formal demography of kinship: A matrix formulation. *Demographic Research*, 41, 679–712

## Demographic models of kinship

## What are kinship models?

- ① Kinship is an *emergent property* of demographic systems
- ② Simplified representation of interaction between reproduction, survival (and more)
- ③ Can be formal (mathematical) or simulation-based (computational)

# Formal models of kinship

Given a set of:

- ▶ age-specific fertility rates
- ▶ survival probabilities
- ▶ simplifying assumptions

The models produce:

- ① Number of (living/dead) kin
- ② Age distribution of relatives
- ③ From the point of view of an average member of the population ('Focal')

Focal: an average member of the population

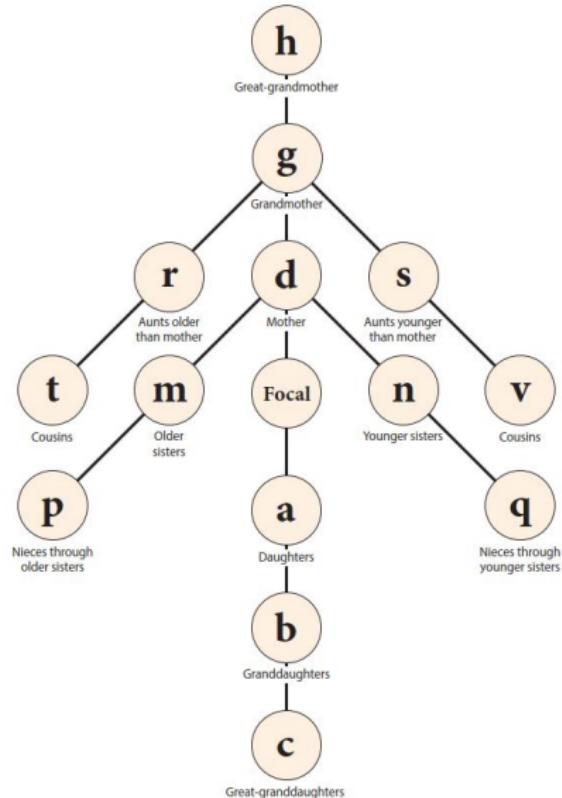


# Matrix kinship models

- ① The relatives of Focal constitute a population
- ② They can be modelled using traditional projection methods
- ③ Matrix operations provide an efficient implementation



# Kinship structure



## Implementation: time-invariant, one-sex models<sup>5</sup>

The models are of the general form:

$$\underbrace{\mathbf{k}(x+1)}_{\substack{\text{age structure of kin} \\ \text{at Focal's age } x+1}} = \underbrace{\mathbf{U} \mathbf{k}(x)}_{\substack{\text{ageing and survival} \\ \text{of existing kin}}} + \underbrace{\begin{cases} \mathbf{0} \\ \mathbf{F} \mathbf{k}^*(x) \end{cases}}_{\substack{\text{new kin members} \\ \text{added to the population}}}.$$

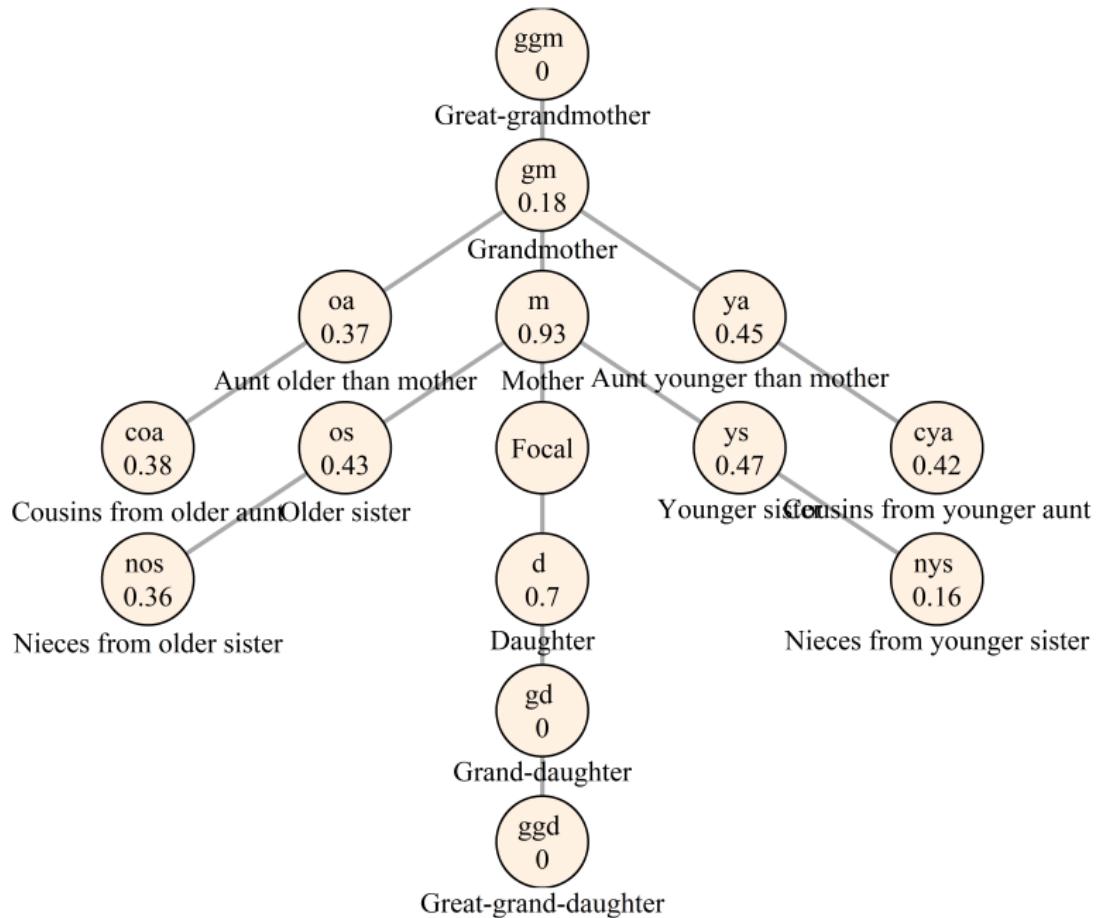
where:

- ▶ **U** a matrix with survival probabilities in the subdiagonal
- ▶ **F** a matrix with fertility rates in the first row

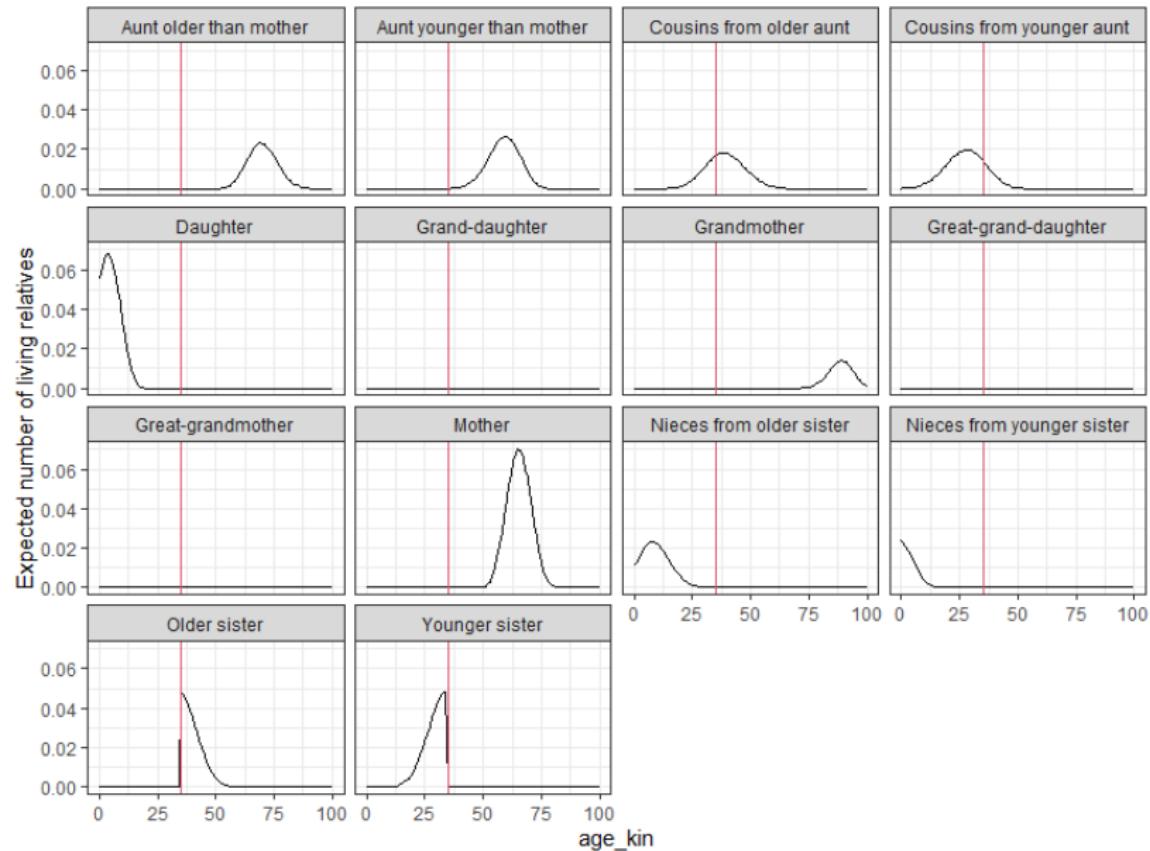
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<sup>5</sup>Caswell, H. (2019). The formal demography of kinship: A matrix formulation. *Demographic Research*, 41, 679–712

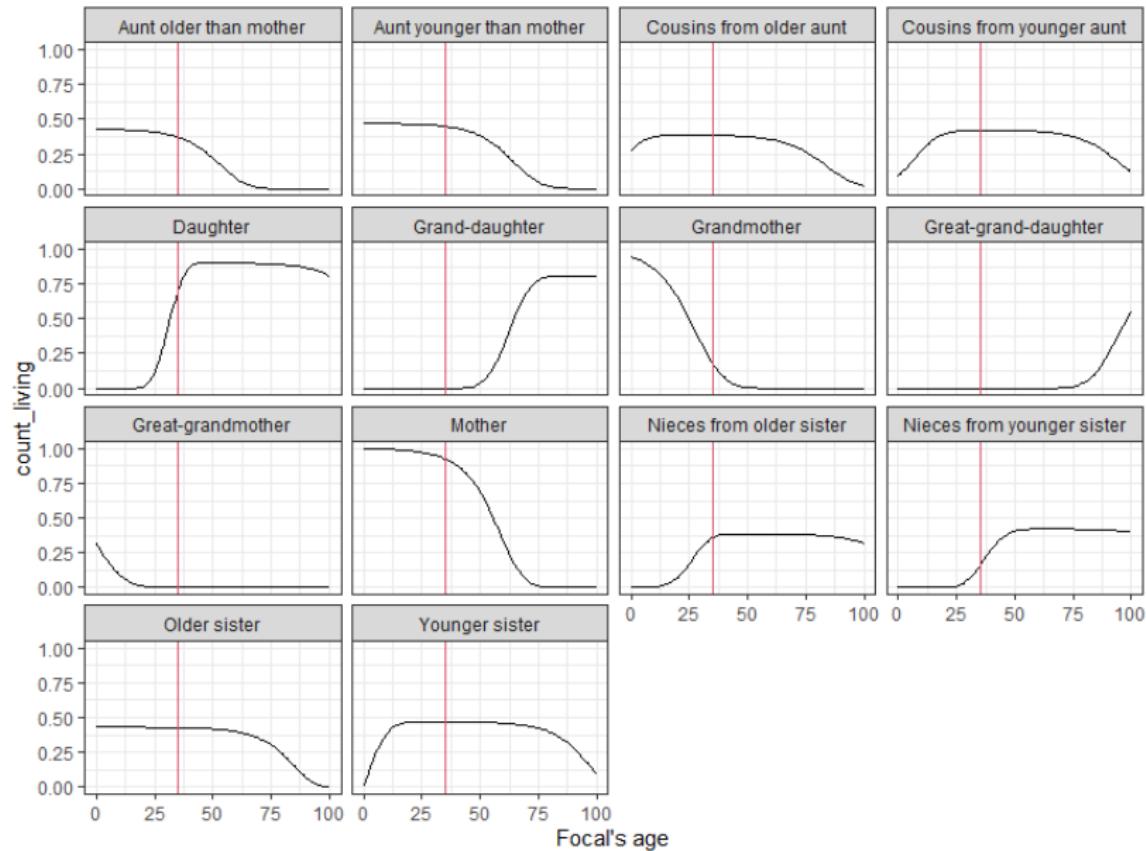
# Kinship structure



# Age distributions of kin



# Expected number of kin



# Daughters

Daughters (**a**) are the result of the reproduction of Focal:

$$\underbrace{\mathbf{a}(x+1)}_{\substack{\text{age structure of daughters} \\ \text{at Focal's age } x+1}} = \underbrace{\mathbf{U} \mathbf{a}(x)}_{\substack{\text{ageing and survival} \\ \text{of existing daughters}}} + \underbrace{\mathbf{F} \mathbf{e}_x}_{\substack{\text{new daughters} \\ \text{(subsidy)}}}. \quad (1)$$

$$\mathbf{a}(0) = \mathbf{0}.$$

where:

- ▶ **U** is a matrix with survival probabilities in the subdiagonal
- ▶ **F** is a matrix with fertility rates in the first row
- ▶ **F e<sub>x</sub>** is the subsidy vector
- ▶  $e_x$  is the unit vector for age  $x$
- ▶  $\mathbf{a}(0)$  is the distribution of daughters at Focal's birth

# Mothers

The population of mothers (**d**) of Focal consists of at most a single individual:

$$\underbrace{\mathbf{d}(x+1)}_{\text{age structure of mothers at Focal's age } x+1} = \underbrace{\mathbf{U d}(x)}_{\text{ageing and survival of existing mothers}} + \underbrace{0.}_{\text{new mothers (subsidy)}} \quad (2)$$

$$d(0) = \pi.$$

where:

- ▶  $b(0)$  is the distribution of mothers at Focal's birth
- ▶  $\pi$  is the distribution of ages of mothers in the population

# Typology of formal kinship models

No	time	sex	state	reference
1	<b>invariant</b>	<b>female</b>	<b>age</b>	6
2	variant	female	age	7
3	invariant	two	age	8
4	invariant	female	multiple	9
5	variant	two	multiple	10

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<sup>6</sup>Caswell, H. (2019). The formal demography of kinship: A matrix formulation. *Demographic Research*, 41, 679–712

<sup>7</sup>Caswell, H., & Song, X. (2021). The formal demography of kinship. III. kinship dynamics with time-varying demographic rates. *Demographic Research*, 45, 517–546

<sup>8</sup>Caswell, H. (2022). The formal demography of kinship IV: Two-sex models and their approximations. *Demographic Research*, 47, 359–396

<sup>9</sup>Caswell, H. (2020). The formal demography of kinship II: Multistate models, parity, and sibship. *Demographic Research*, 42, 1097–1146

<sup>10</sup>Williams, I., Alburez-Gutierrez, D., Caswell, H., & Song, X. (2023). *DemoKin*: 1.0.3. <https://CRAN.R-project.org/package=DemoKin>

Consider a baby born in India in 2020...

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# DemoKin: matrix kinship models in R<sup>11</sup>

- ▶ Time-(in)variant models
- ▶ One/two-sex models
- ▶ Multistate models
- ▶ Kin loss by cause of death
- ▶ More in the lab session...

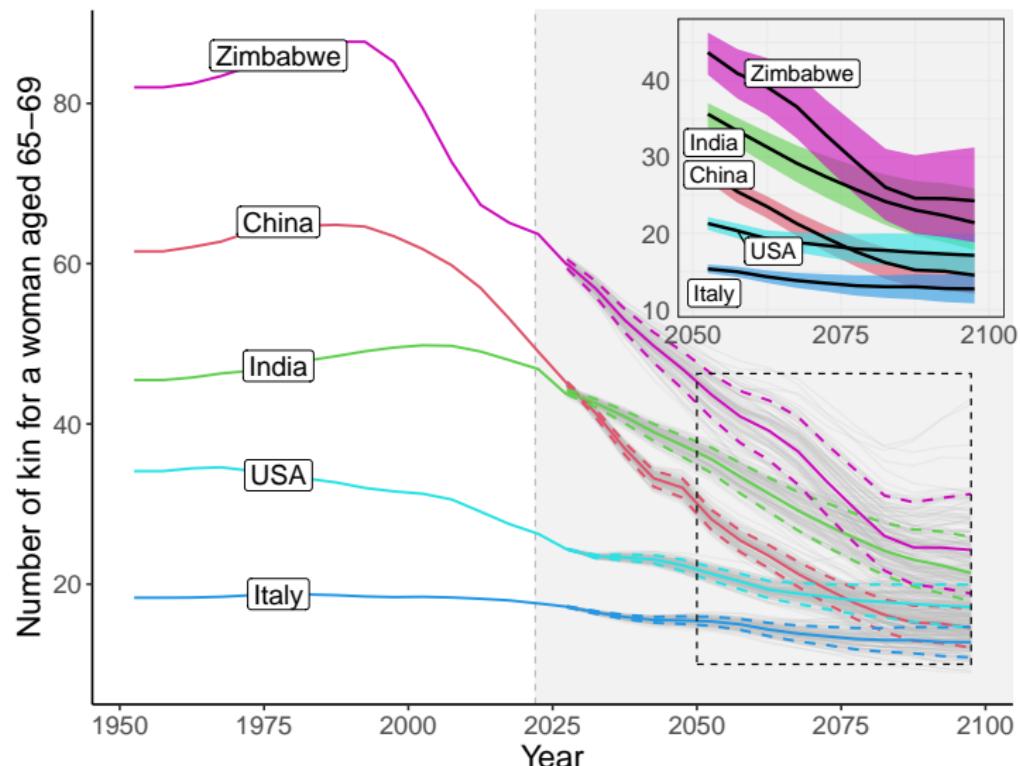


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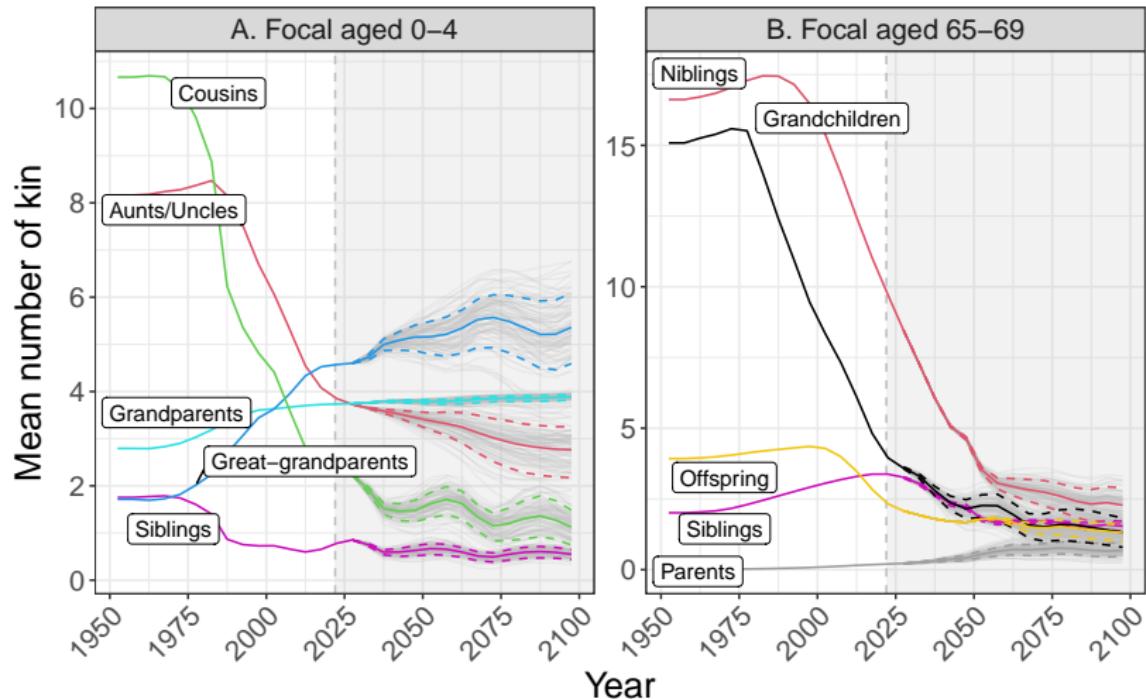
## Example: projections of kinship

# Total number of kin (all kin combined) for a 5yo woman<sup>12</sup>

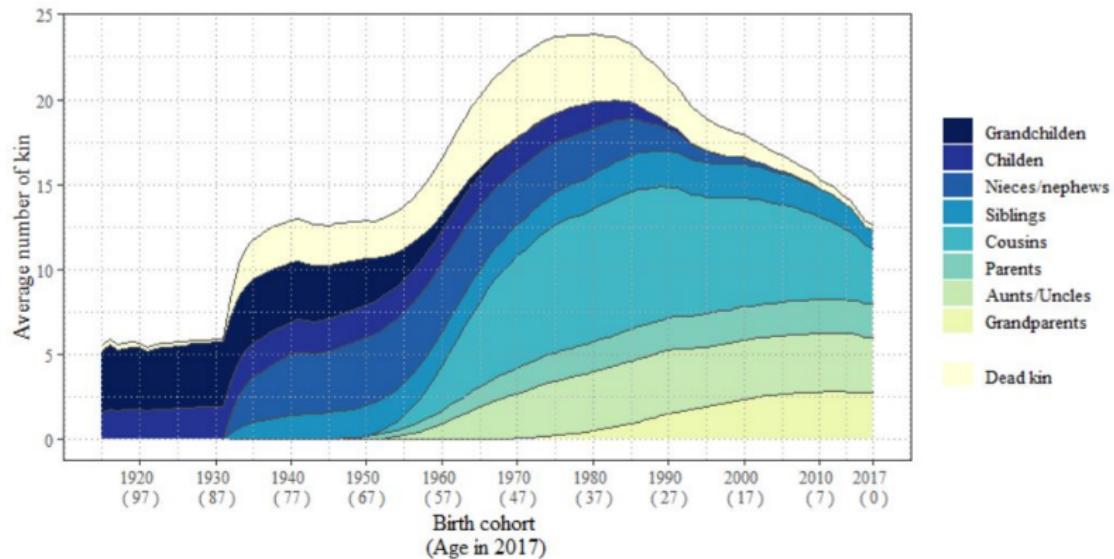


<sup>12</sup>Alburez-Gutierrez, D., Williams, I., & Caswell, H. (2023). Projections of human kinship for all countries. *Proceedings of the National Academy of Sciences*, 120(52), e2315720120. <https://doi.org/10.1073/pnas.2315720120>

# Number of living kin in China



Note: Kinship structure also can be studied empirically<sup>13</sup>



<sup>13</sup> Kolk, M., Andersson, L., Pettersson, E., & Drefahl, S. (2021). The Swedish Kinship Universe – A demographic account of the number of children, parents, siblings, grandchildren, grandparents, aunts/uncles, nieces/nephews, and cousins using national population registers. *Stockholm Research Reports in Demography*, 28. <https://doi.org/10.17045/sthlmuni.17704988.v1>

## Course setup and evaluation

# Course overview

- ① Mon - “Introduction and one-sex time-invariant models”
- ② Tue - “Two-sex time-variant models”
- ③ Wed - “Multistate kinship models”
- ④ Thu - Group Work

Course website: [https://alburez.me/kinship\\_workshop\\_iips/](https://alburez.me/kinship_workshop_iips/)

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