Estimating life-tables for very small areas in a national context:

An analysis of Israel Statistical Areas

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Rationale

- As mortality reaches minimal levels, important to distinguish young from middle-age mortality
- Mortality varies by age and sex, so just dividing number of deaths by population can give a very distorted picture of the risk of dying
- Standardised rates, which control for the age distribution, are good for comparing the average level of risk, cannot distinguish differences at specific ages
- Life tables look at mortality by age, but fine detail requires a large population and large number of deaths for reliable estimation
- Question:
  - can we estimate local level life tables for very small populations?
  - and if we can, how much do we learn?

Data

- 1125 Statistical Areas (SA) in 189 Israeli municipalities

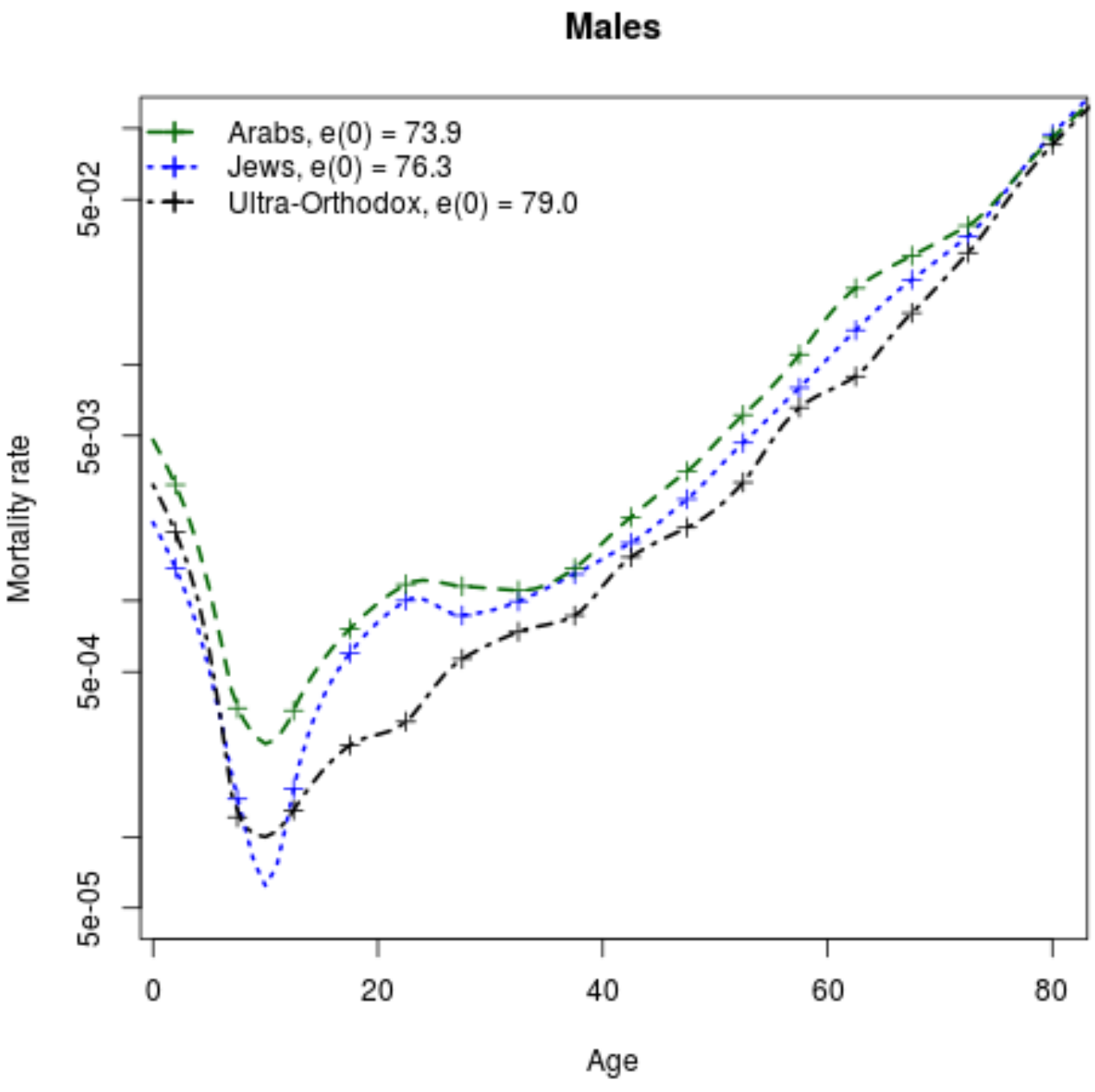
  (includes Israeli settlements in OT, not include Palestinian populations in E. Jerusalem, Golan heights)
- Minimum: 1,000 each, males and females
- Range: 2,000 – 29,000, median = 3,645
- Population Data: Census 1995
- Social Data: Census 1995
- Mortality data: deaths by sex and 5-year age groups, 0 – 75+, 1993 to 1997
- Deaths / SA, 3 – 429, median = 114
- Empty cells: 15403 / 36000 = 43%

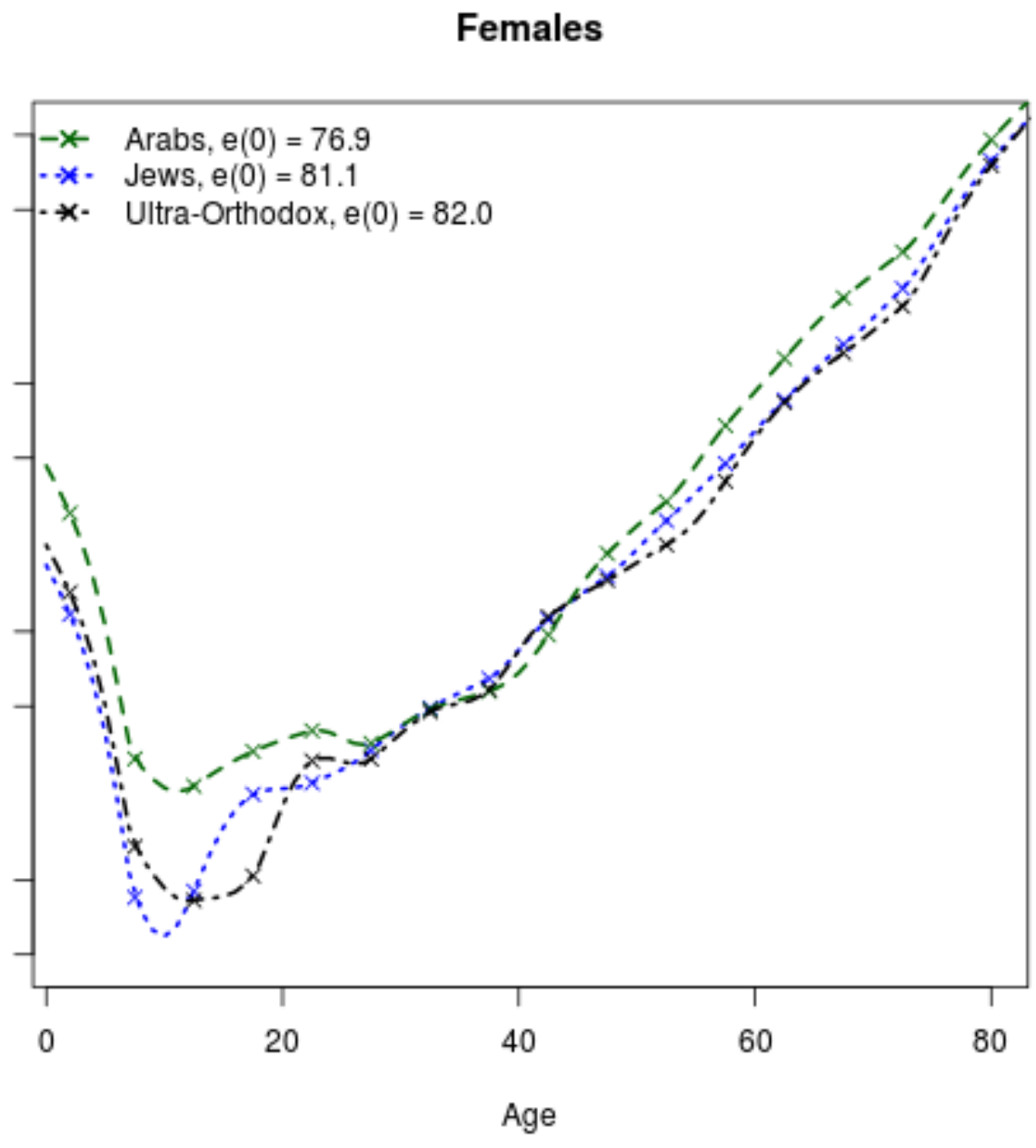
(1 Population cell = 0, set to 0.5)

Population Groups

- 3 Population Groups:
  - Palestinian – Arab: SA's with at least 50 % of population Arab. 106 SA's
    - Total Population: 654,308
    - Total deaths: 10,879, CDR = 3.32
  - Ultra Orthodox: SA's with predominantly ultra-orthodox population (voting patterns). 66 SA's
    - Total Population: 275,461
    - Total deaths: 5,594, CDR = 4.06
  - Jewish population: All the rest, 953 SA's
    - Total Population: 3,550,339
    - Total deaths: 123,309, CDR = 6.95

Group Mortality Curves





Local mortality curves (raw)
Problematic!

- 2250 mortality curves,
  - 43% empty cells – replace with age / sex / group specific rates
- Anticipate: at age 5 to 10, differential negative
  - 2% of female, 3% of male values positive
- Anticipate: from age 15-20 and up, differentials positive
  - 19% female, 25% male values not positive
- Anticipate: No (or very few) life expectancies more than 10 years above or below group life expectancy
  - 3 female, 0 male above; 6 female, 8 male below
  - No LE > 95, 4 (2M, 2F) < 60
- Errors in rates, cancel out in life expectancies?

Note: LE's calculated by integration of mortality rates, set max = 0.5 at age 110

Solution

- Age – sex specific mortality rate as function of:
  - Age
  - Sex
  - Group
  - Social conditions
  - Local peculiarities
- Multilevel model (Poisson):
  - Deaths = f((sex / group) * social conditions [FIXED (Nested)]
  - + sex/group * Age [RANDOM (Shape)]
  - + social conditions * Age [RANDOM (Shape)]
  - + statistical area [RANDOM]
    - Offset = log(population)
    - Weight by number of Deaths in each cell

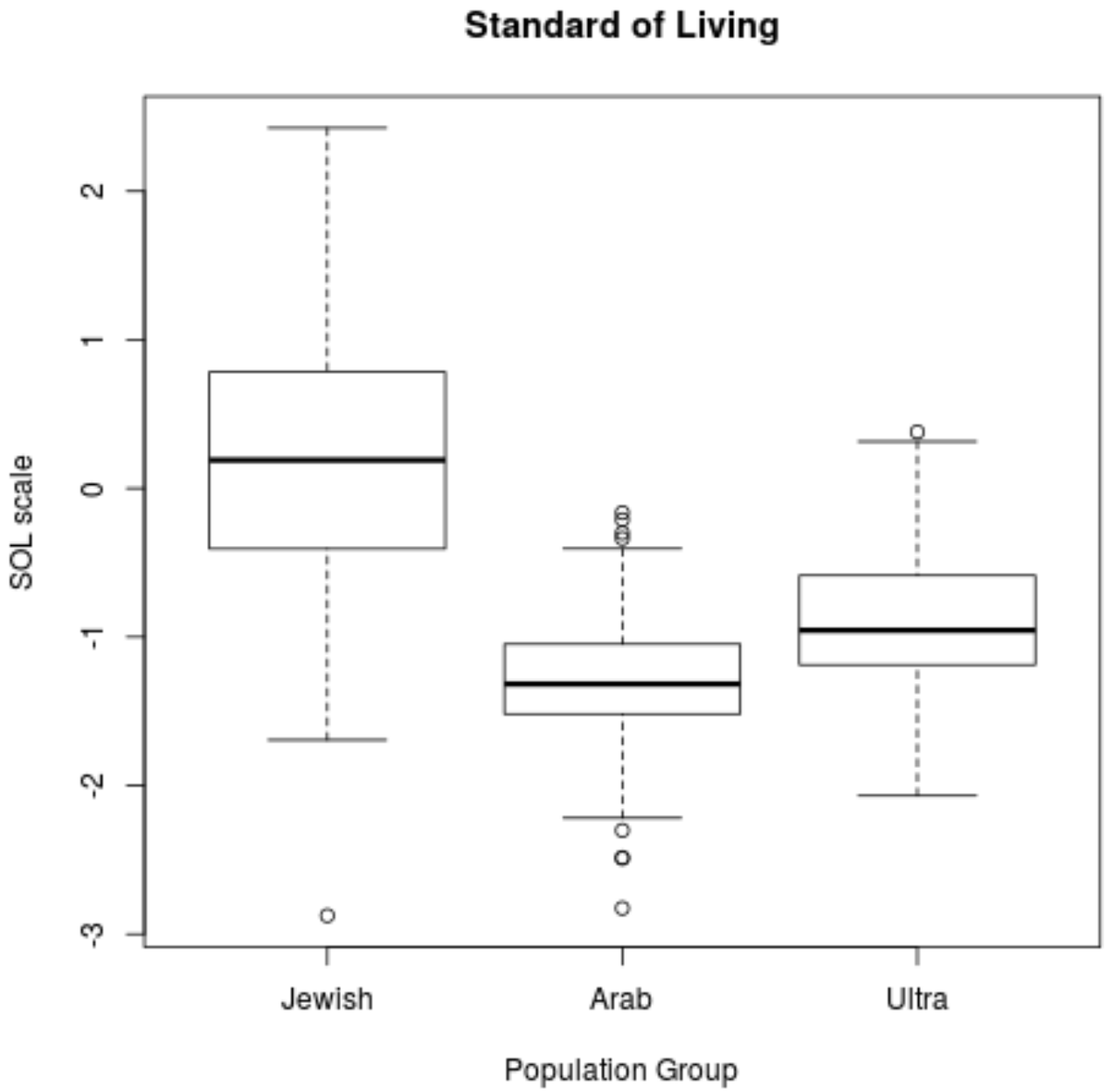
Social Conditions (1)

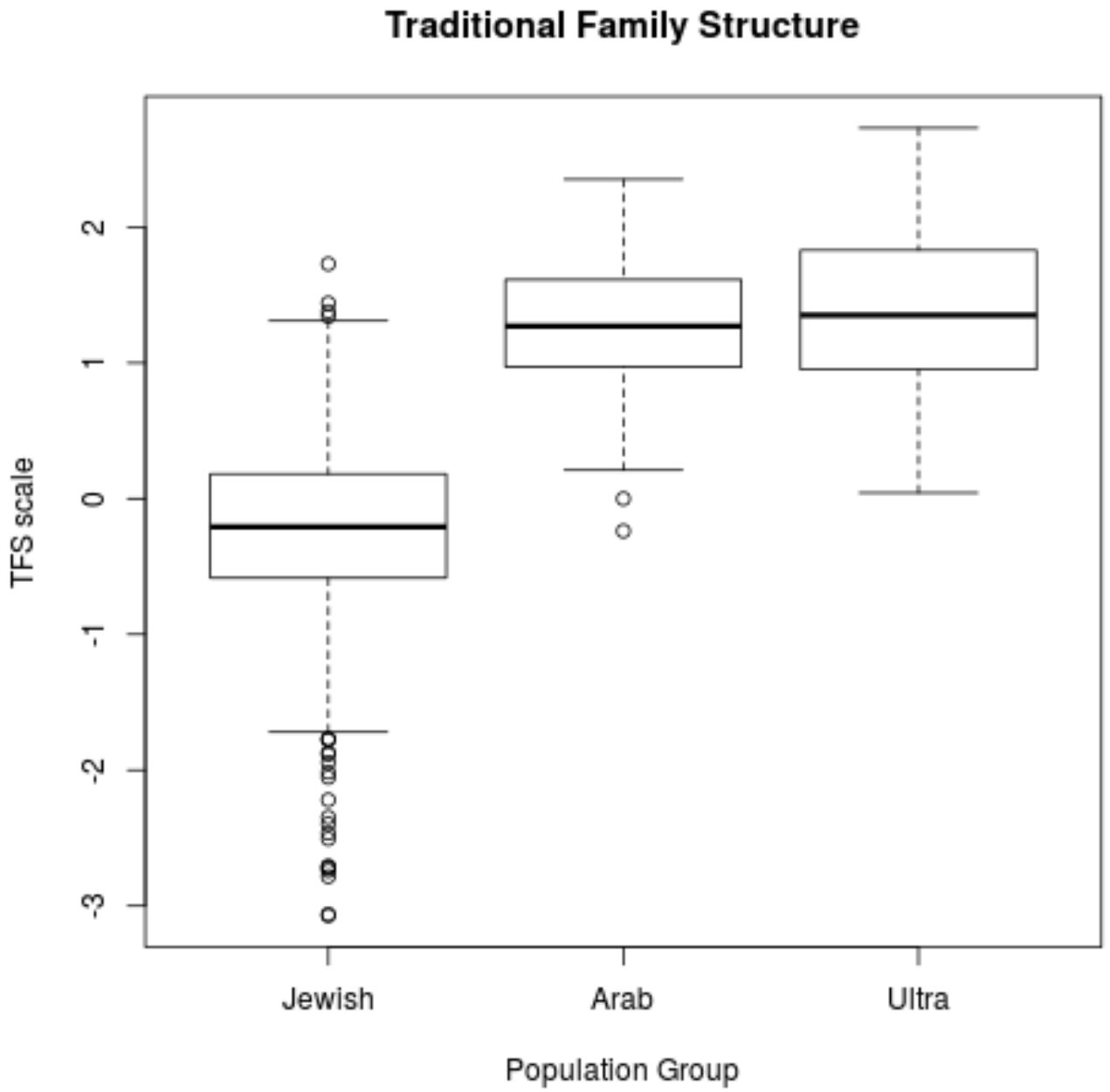
1. **Standard of Living Scale (SOL)**
   - Household goods average number in HH of:
     - video, microwave, dishwasher, computer, AC, dryer, cars)
   - Mean HH income per person (income/persons^0.5)
   - Proportion aged 25-60 with HS matriculation (logit)
   - Proportion aged 25-60 working (logit)
   - Proportion of those working in professional or managerial positions (logit)
   - Scale = sum(z-scores), $\alpha = 0.937$, $\lambda = 4.0$ (80%)
   - $\text{Mean} = 0$, $\text{sd} = 0.894$

Social Conditions (2)

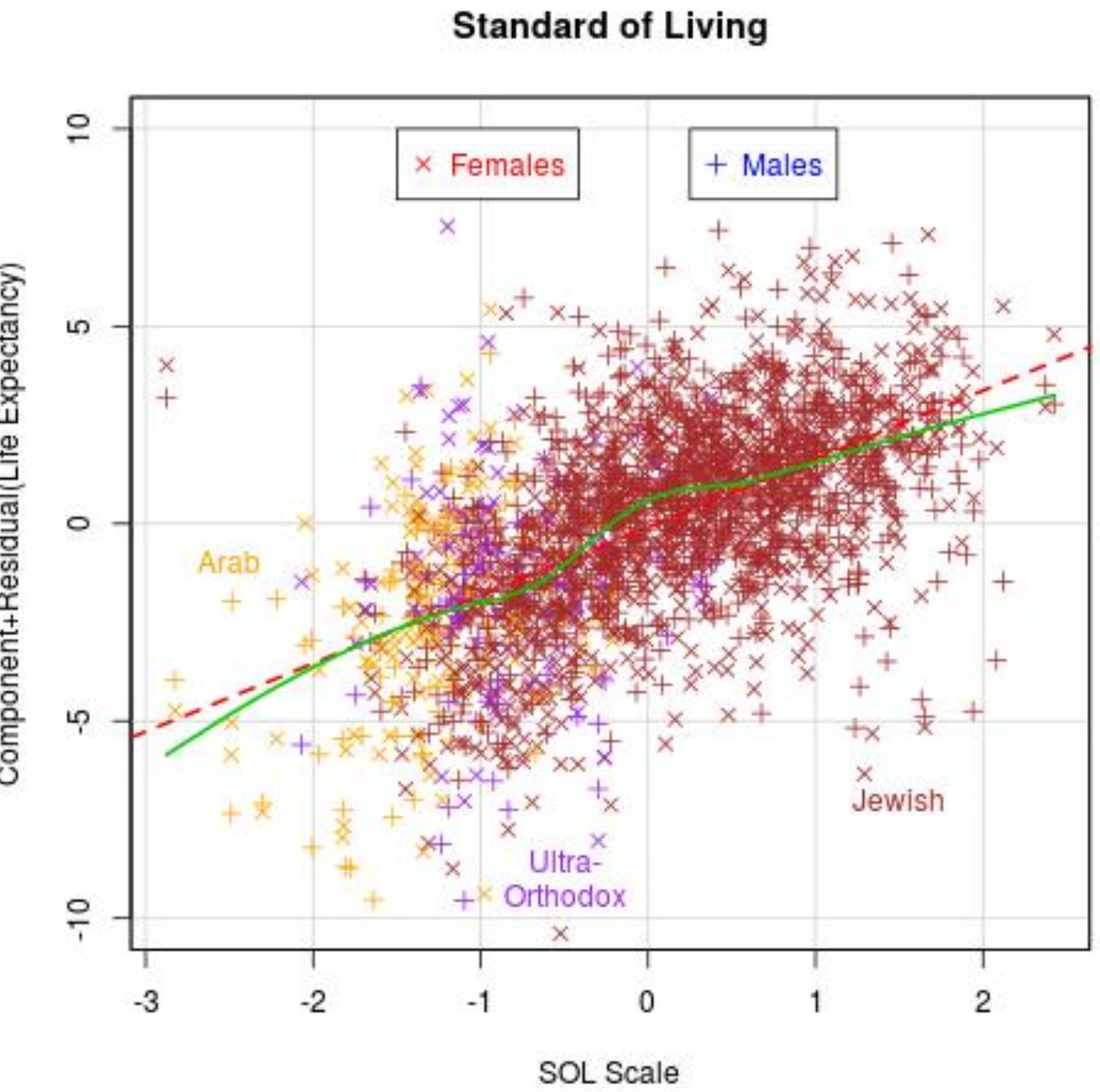
1. **Traditional family structure (TFS)**
   - Average N children ever born, women aged 35-60
   - Average household size
   - Child-women ratio (current fertility) (logged)
   - Proportion households > 6 persons (logit)
   - I_m (proportion married) (logged)
   - SMAM (average age at marriage)
- Scale = sum(z-scores), $\alpha = 0.911, \lambda = 4.4\ (70\%)$
- $\text{Mean} = 0, \text{sd} = 0.835$

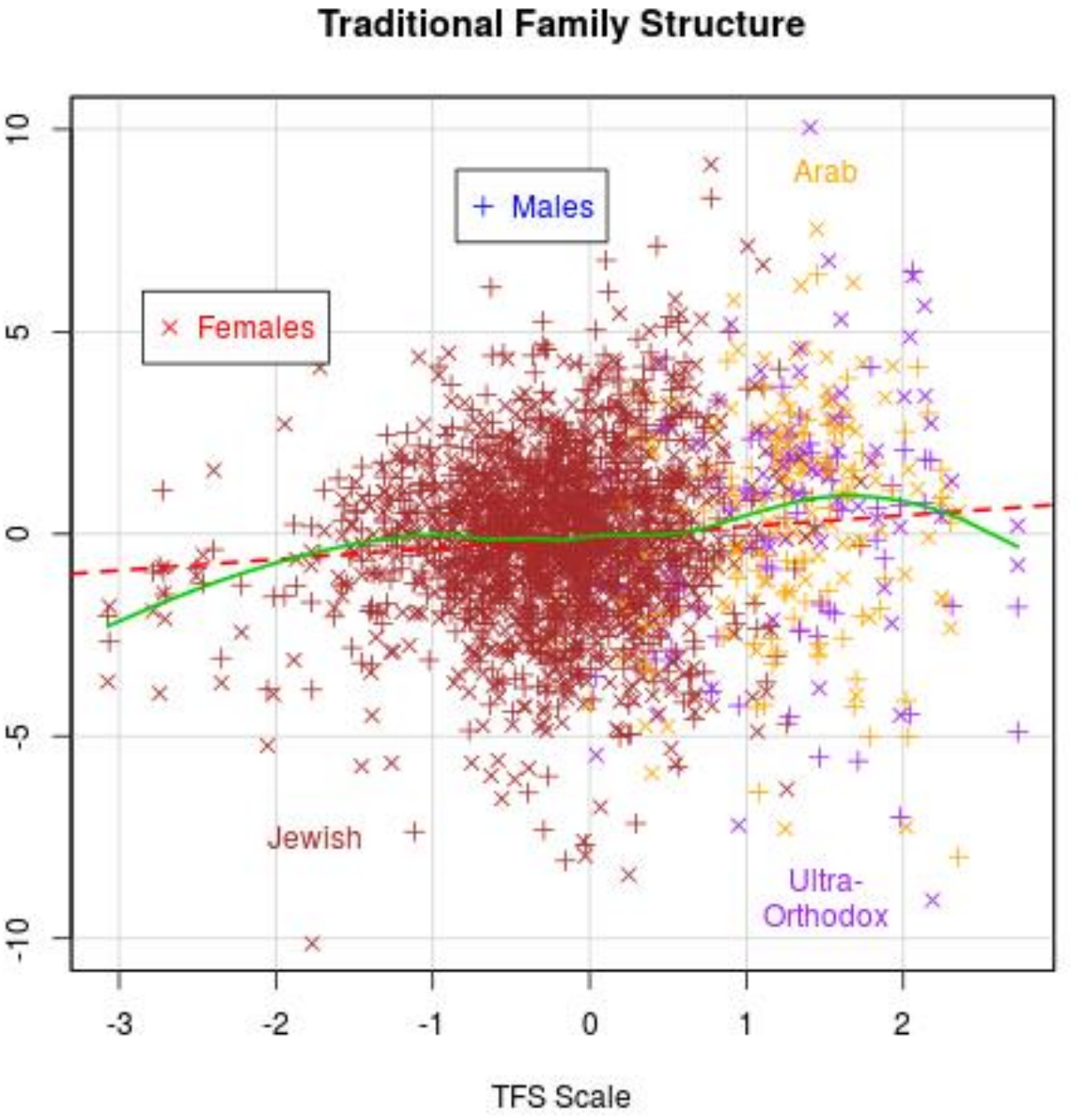
Social Conditions, by Group





Reproducing e_0 (raw) by social conditions





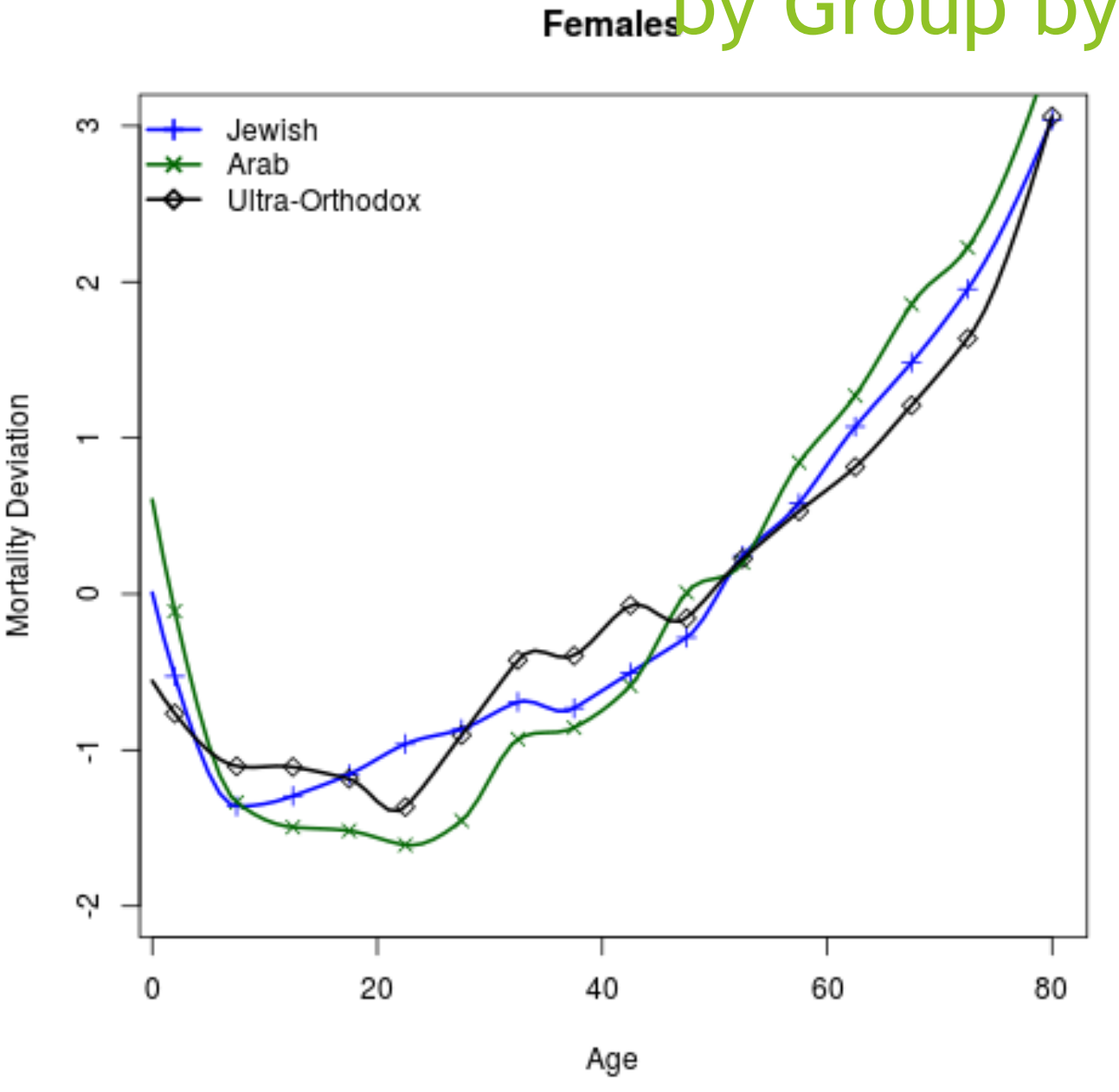
Multilevel models, reproducing number of deaths, by age and sex, in each SA

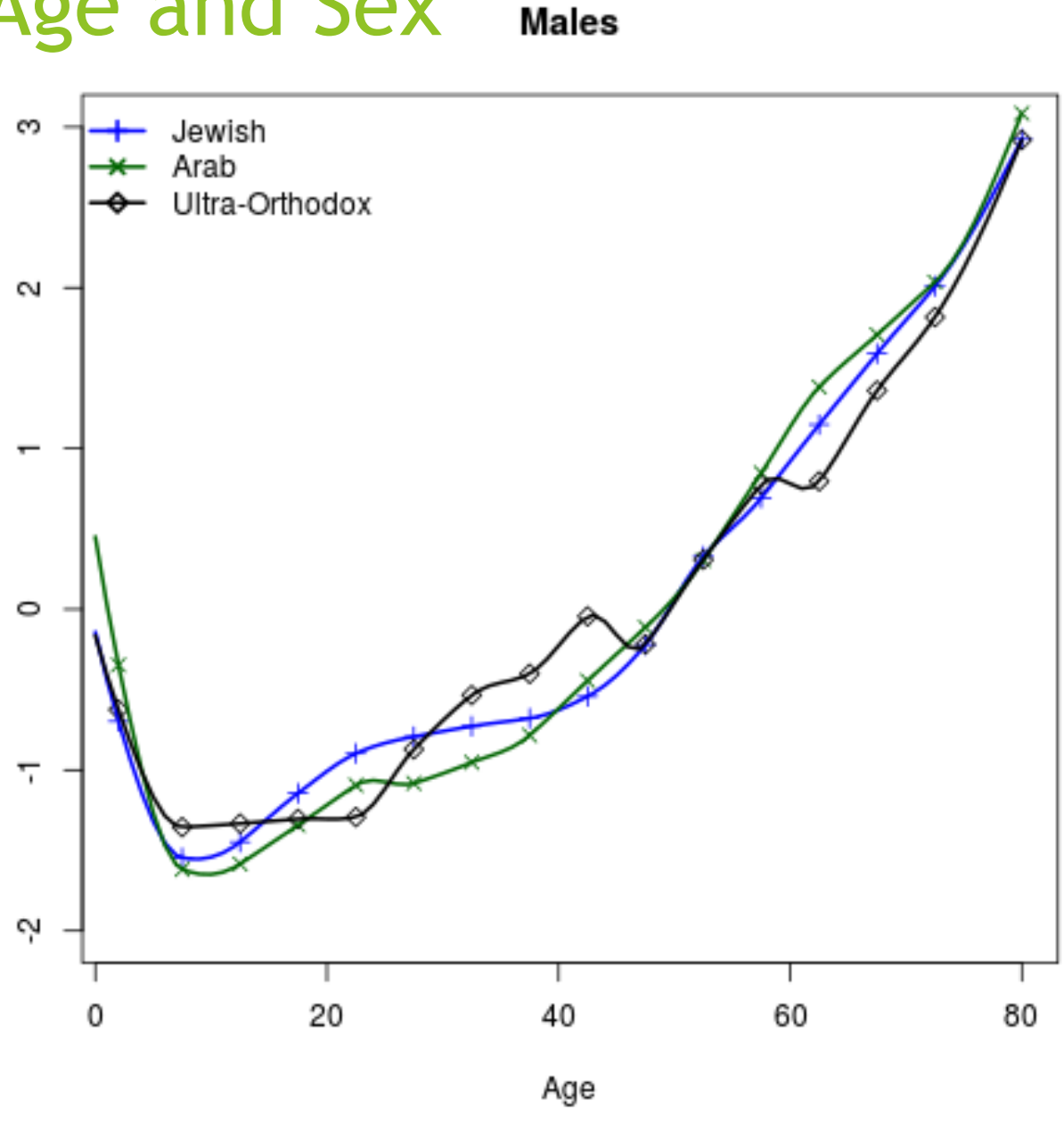
Fixed	Model 1: No Social Conditions		Model 2: Nested Curves		Model 2: Shape Adjusted	
Variable	e^b		e^b		e^b	
	Males	Females	Males	Females	Males	
Intercept	0.0192*	0.0263*	0.0195*	0.0267*	0.0196*	0.02638
Group: Arab	0.863	0.901	0.773*	0.779*	0.762*	0.809*
Group: Ultra	0.939	0.843*	0.882	0.773*	0.904	0.822*
SOL			0.897*	0.875*	0.851*	0.793*
TFS			0.966*	0.967*	0.925*	0.863

Multilevel models, reproducing number of deaths, by age and sex, in each SA

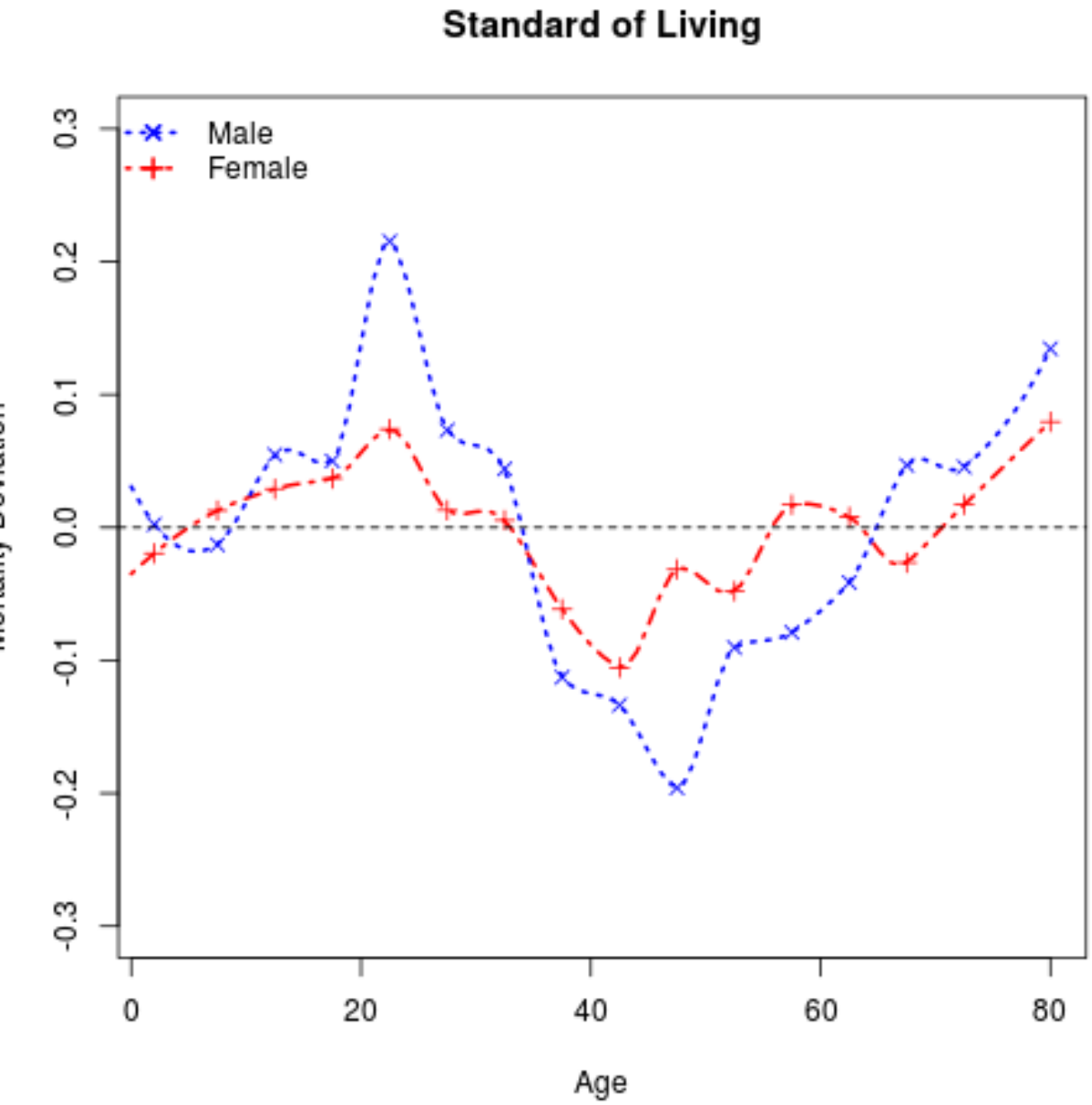
Random	Model 1: No Social Conditions		Model 2: Nested Curves		Model 2: Shape Adjusted	
Source	Variance		Variance		Variance	
	Males	Females	Males	Females	Males	Females
Age	1.54	1.61	1.54	1.61	1.55	1.61
Age:Arab	0.194	0.0880	0.193	0.0884	0.118	0.0343
Age:Ultra	0.0269	0.0300	0.0272	0.0302	0.0663	0.0613
Age:SOL					0.00282	0.0115
Age:TFS					0.0209	0.0178
SA	0.0807		0.0740		0.0740	
Δ Deviance (df)	785383		493(4)		4923 (34)	

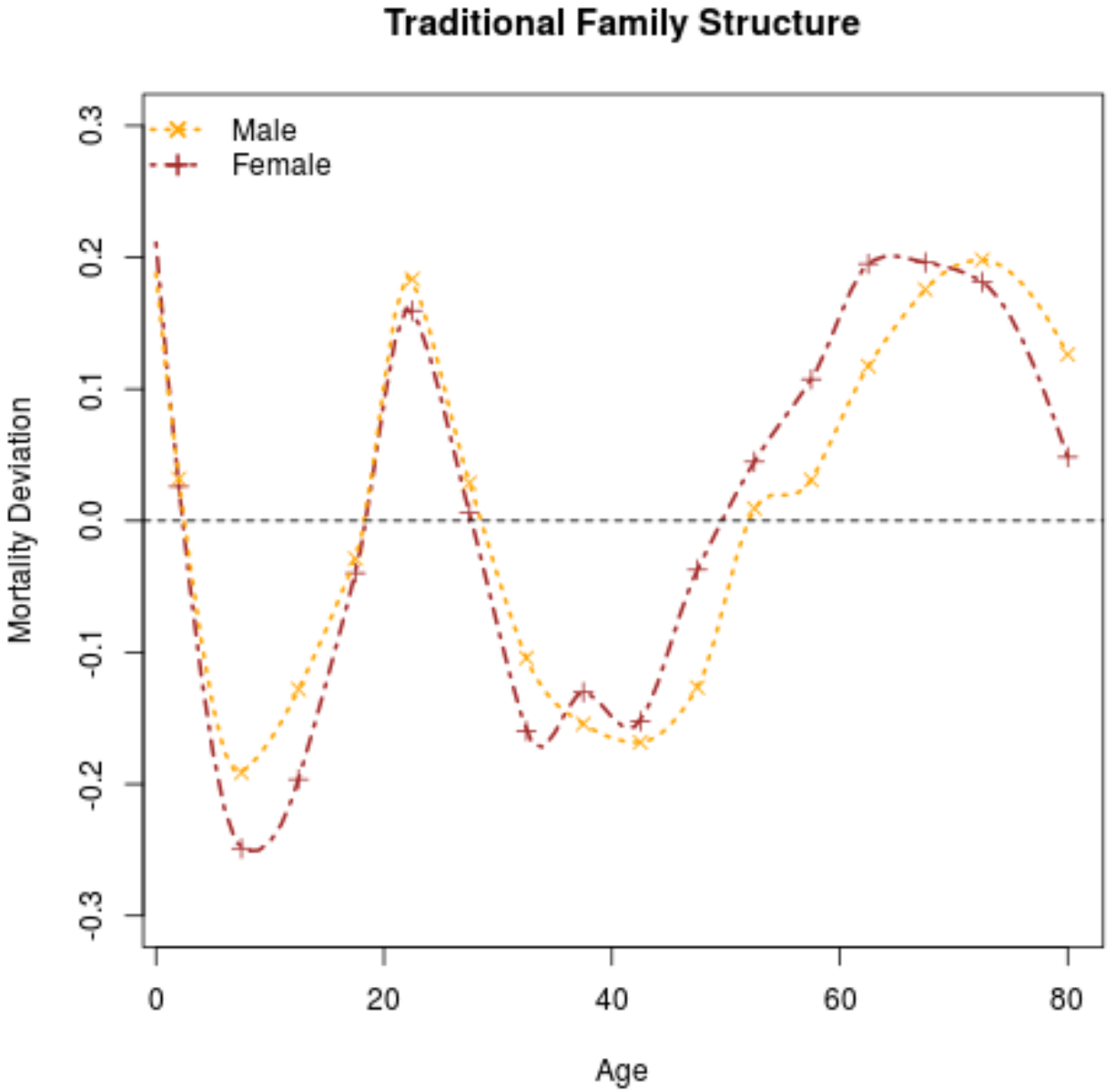
Random mortality variations: by Group by Age and Sex





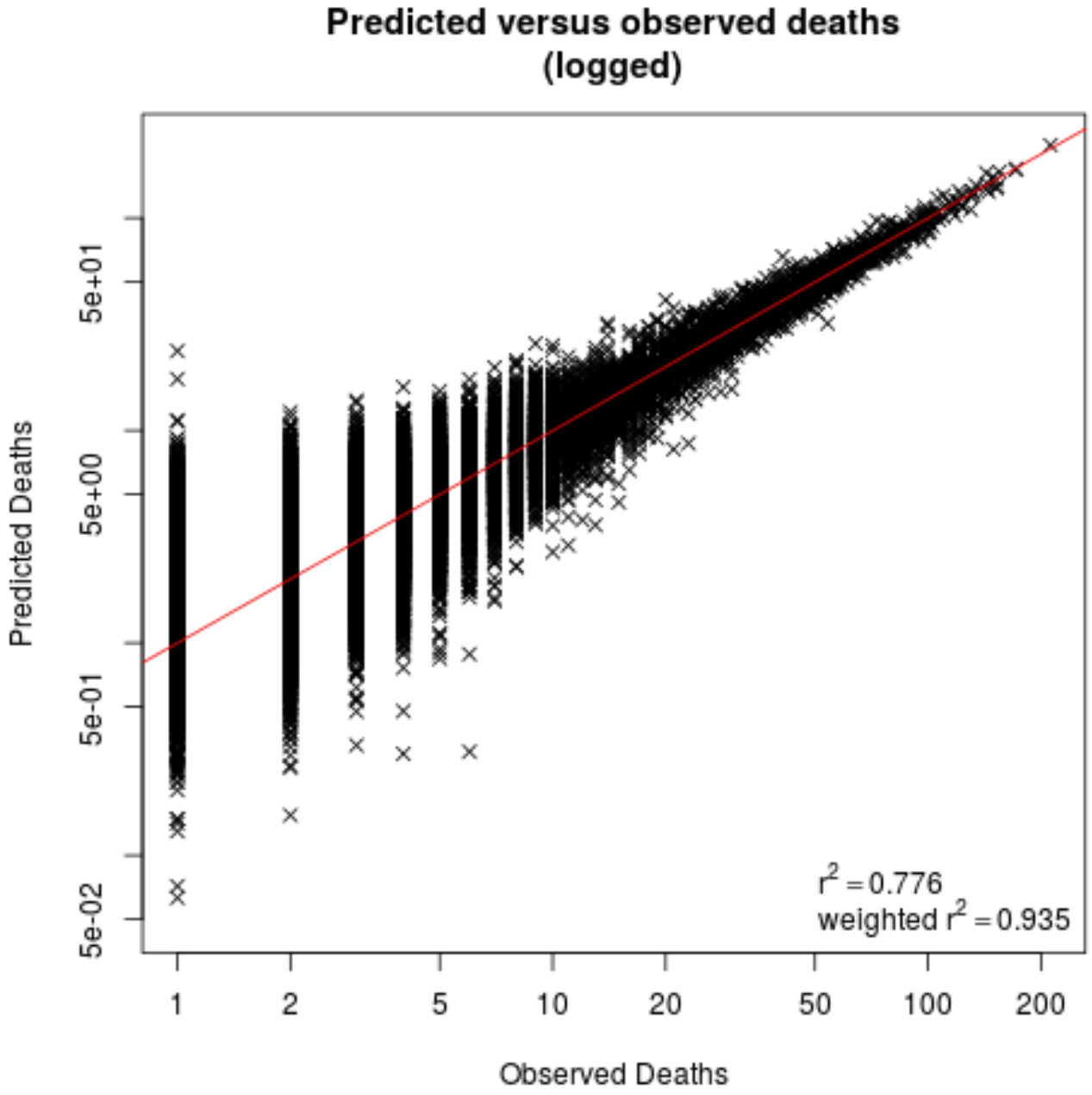
Random variations: SOL and TFS by Age and Sex



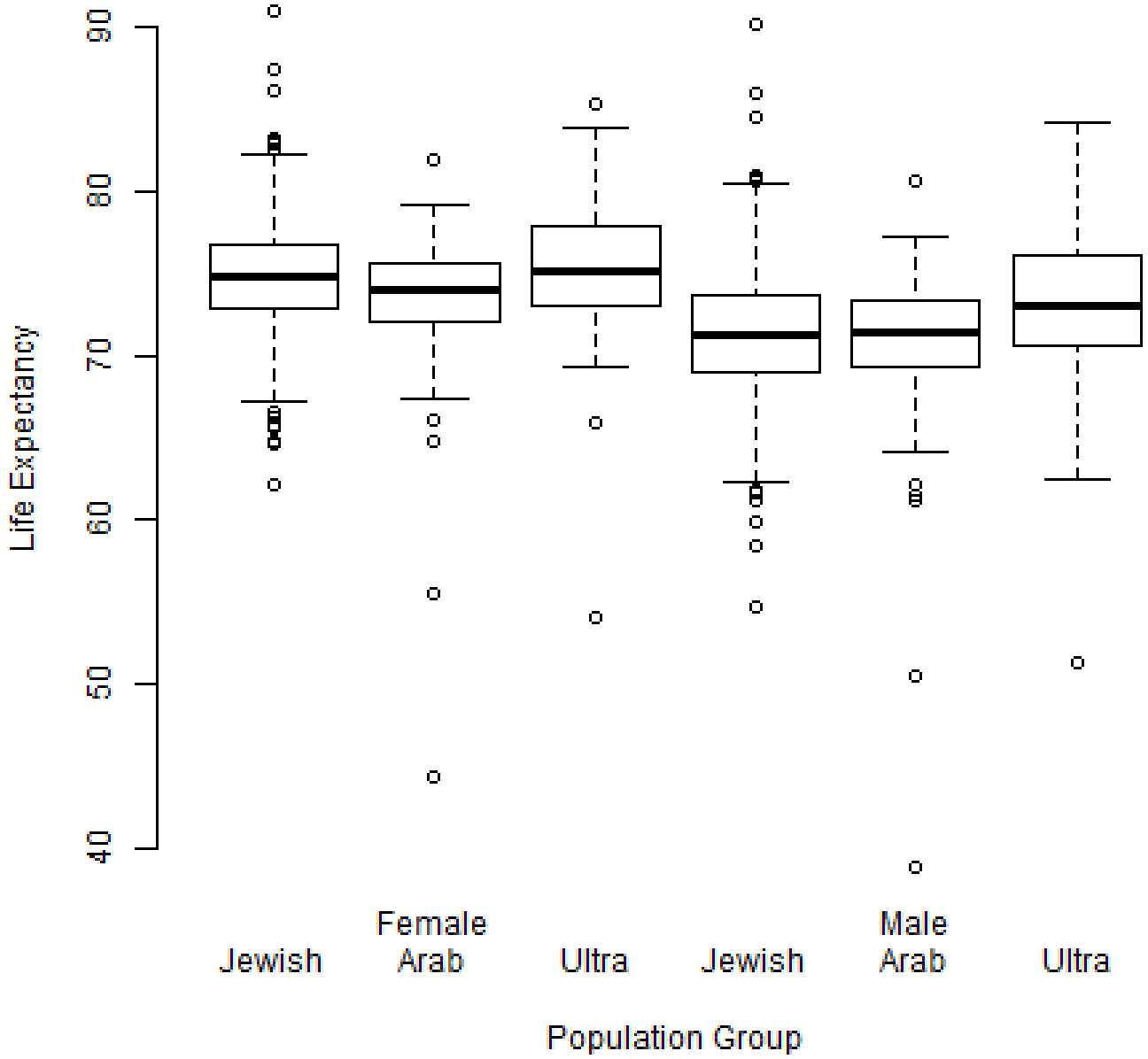


Quality of fit

- 2250 mortality curves,
- 36000 cells (age * sex)
- No empty cells
- At age 5 to 10, 2 differentials positive
- from age 15-20 and up 8.1% female, 6.1% male differentials negative
- No life expectancies more than 10 years above or below group life expectancy
- No LE > 95, 4 (2M, 2F) < 60
- Fixed (most) errors in rates, life expectancies credible

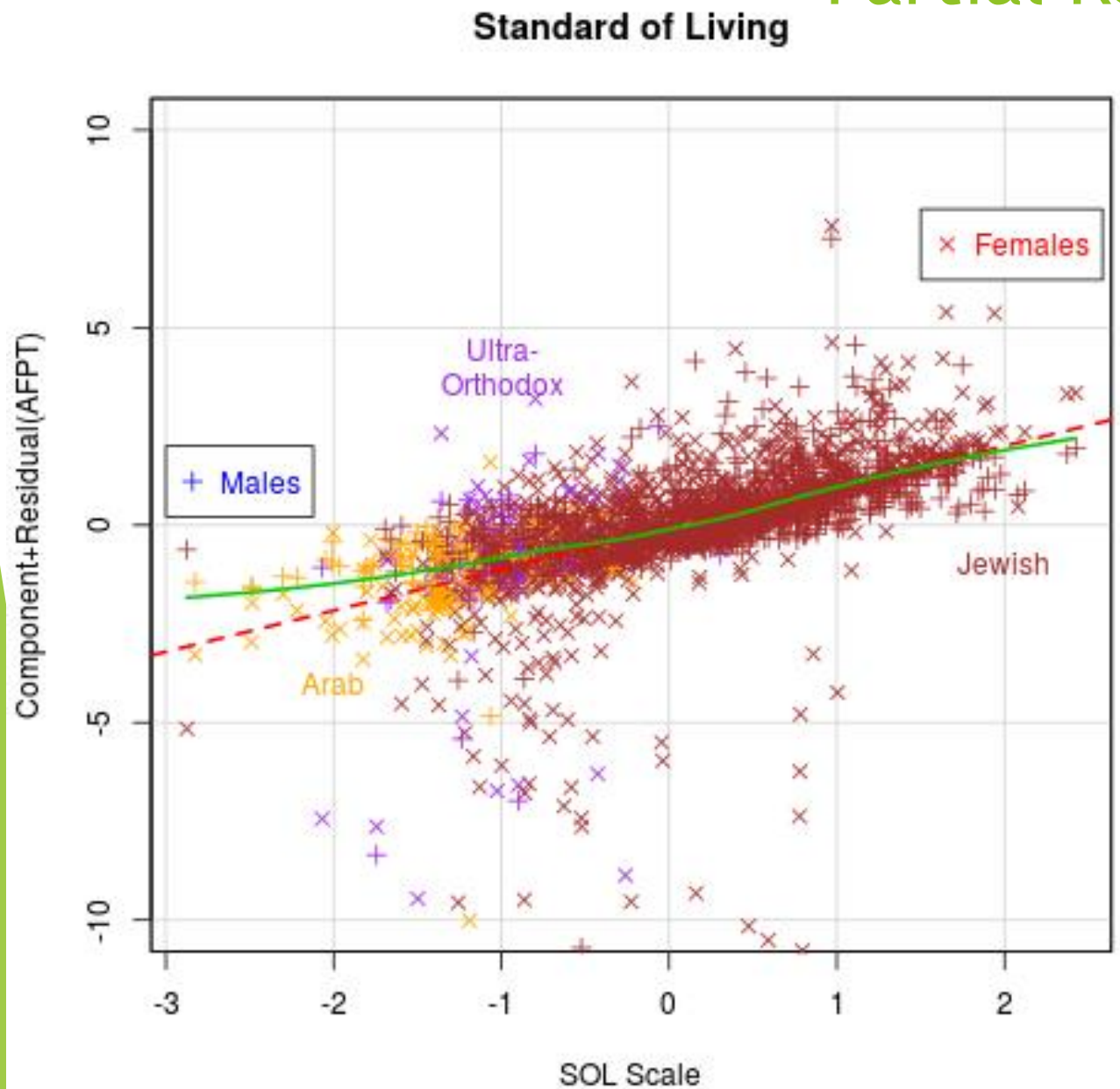


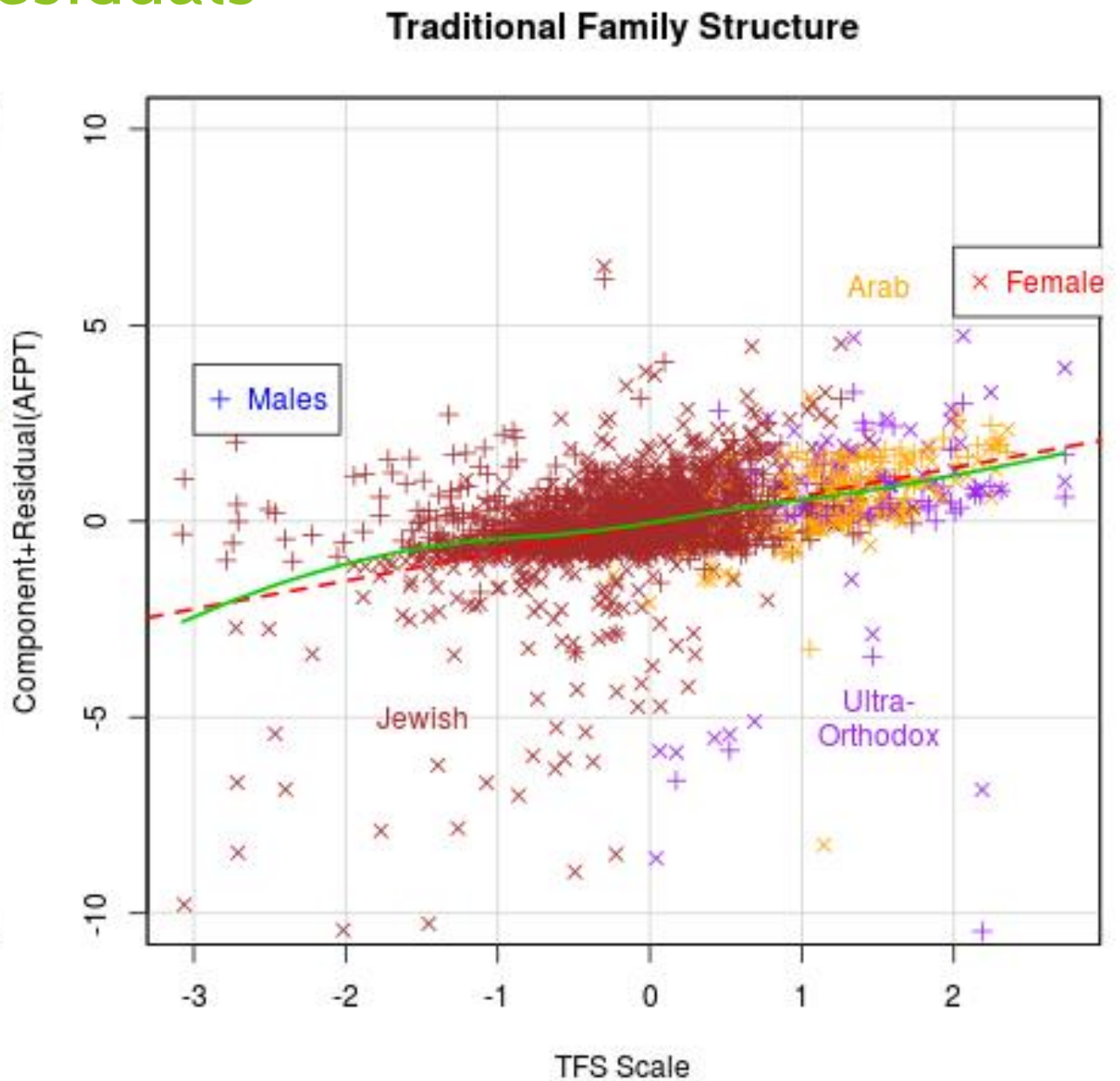
Predicted life expectancies



AFPT by SOL and TFS

Partial Residuals





Summary

- Life tables contain information on the distribution of mortality, inaccessible from summary measures, e.g. SMR
- Small area data insufficient to compute reliable life tables: too much missing data
- Pool data from small areas, together with social information, to estimate local age-sex specific mortality rates

Conclusions

- Model produces credible, local-area mortality curves
- Favourable, Salutogenetic conditions, reduce mortality at all ages, stretch out period of minimum rates, delay senescent increase, AFPT
- Population groups have different shapes to mortality curves, largely as result of conditional conditions
- Traditional family structure important part of social conditions, not just standard of living

Thank You