The exceptionally high longevity of Nicoya, Costa Rica

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Presentation's content

1. Context: Costa Rica health and the topic of *hot spots* of longevity
2. The measurement of Nicoya longevity
3. Start exploring the "why"

Scientific interest on *hot spots* of high longevity

- May have keys for successful ageing
- Elusive—false past claims in the Andes & Caucasus
- Need of documenting age
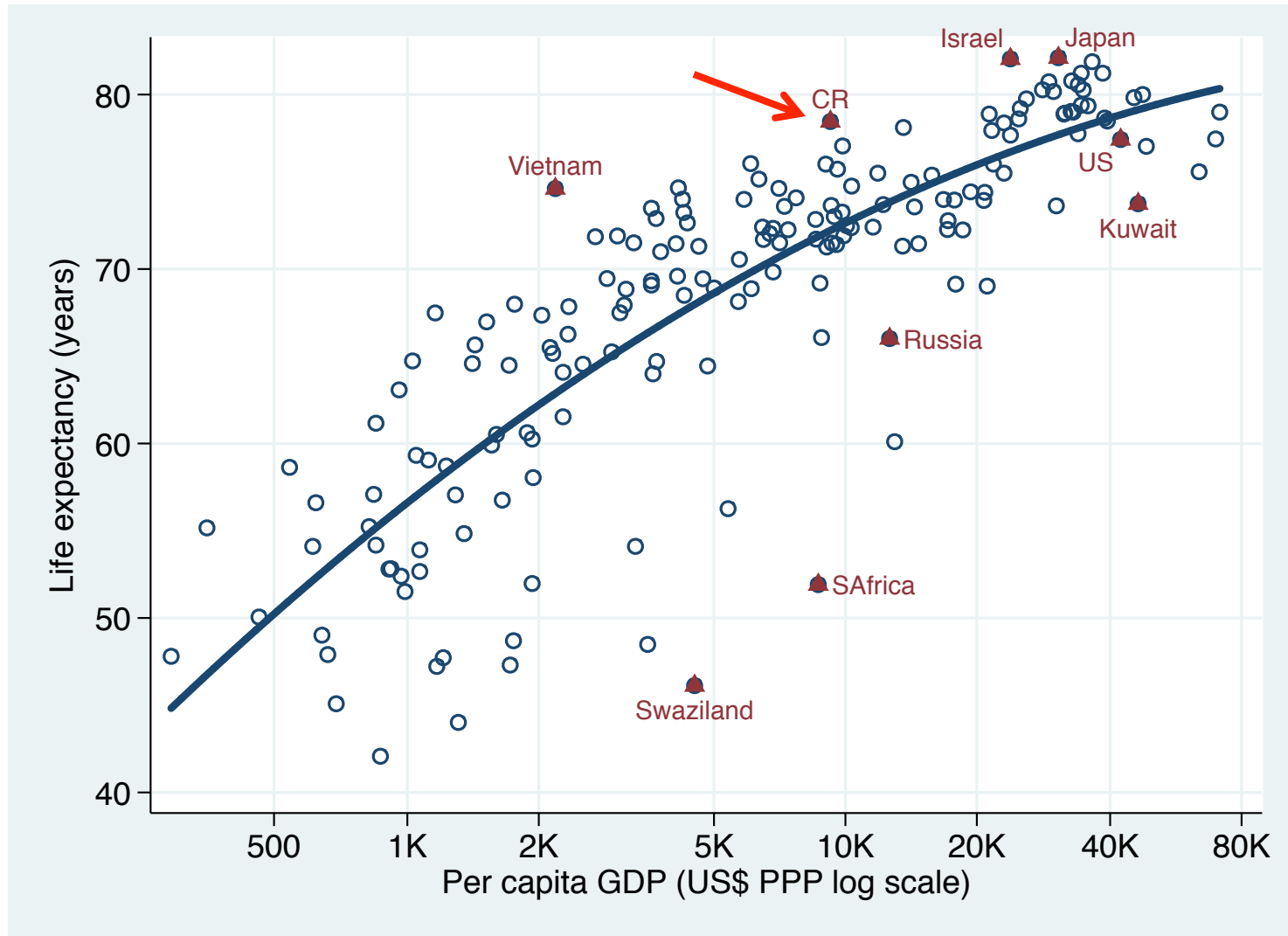- "Blue Zones" of Okinawa y Sardinia

Background

- High life expectancy in Costa Rica, especially adult males
- Nicoya in the spot light of news media as a "Blue Zone" since 2007
- Rich longitudinal data recently assembled for elderly Costa Ricans.
- Good vital registries and population stats
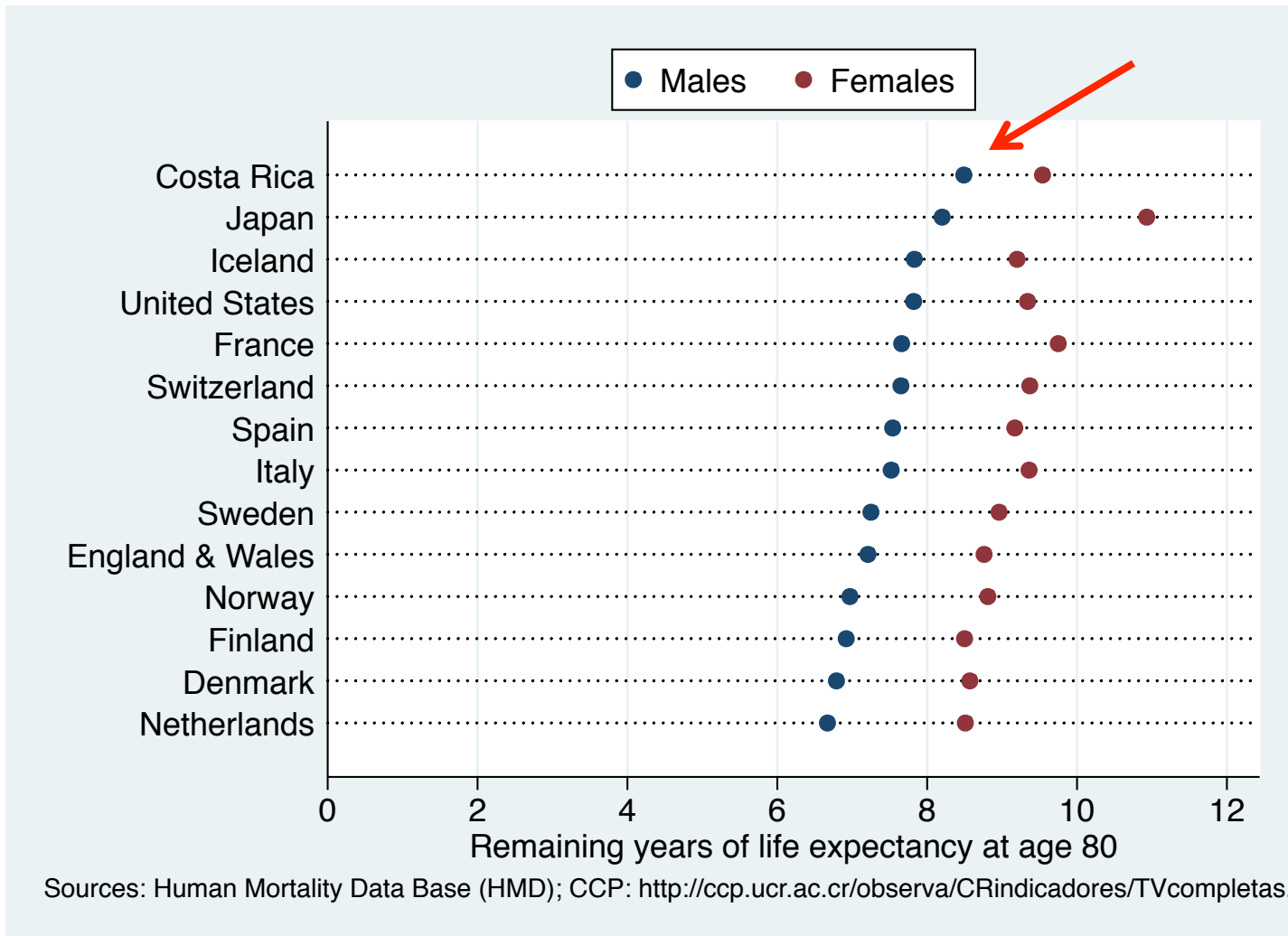- All Costa Ricans have an ID number linked to birth ledger: well documented DoB

Good health of Costa Ricans

- 1985 Rockefeller Foundation conference and book: "*Good Health at Low Cost*" (CR, Kerala, Sri Lanka, China, and Cuba)

- Costa Rica has the second highest life expectancy in the Americas

- 2009 article in *Demography* suggests that elderly men in Costa Rica may have the highest life expectancy in the world

- Costa Rica is 14th in age 60 life expectancy in the world according to the UNPD

Life expectancy and GDP by 2005

Life expectancy at old age

Sources: Human Mortality Data Base (HMD); CCP: http://ccp.ucr.ac.cr/observa/CRindicadores/TVcompletas.

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ZONE 2: COSTA RICA

Daily Dispatch

In 2005, Dr. Luis Rosero, a Costa Rican demographer trained in the U.S, presented a paper at an international conference claiming to have discovered that 60 year-old Costa Ricans have the longest life expectancy of anyone in the world. In other words, if you are middle aged and live in Costa Rica, you are more likely to reach, say, a healthy age 90 than your counterparts worldwide. The academics at the conference did not believe Dr. Rosero. After all, Central America is still considered "Third World," a place of poverty, tropical disease, and, during the 1990's, terrible wars. How could the people here live longer than "First World" countries like those in Europe and the U.S?

Read more...

Video

Day 1 Video
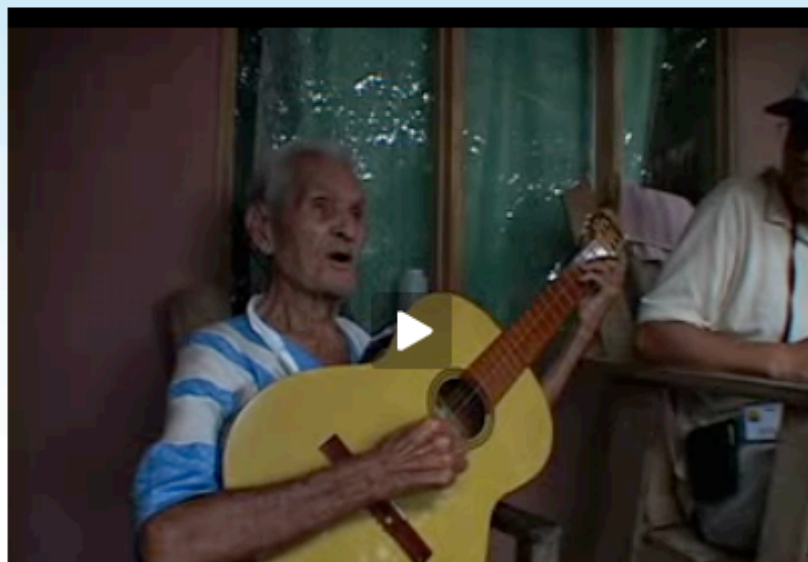
The Bottom Line

What longevity clues did we find today?

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Direct the Team

Vote to tell the team what to do next

Read more...

Image Gallery

Pictures shot on location.

Read more...

Daily Data

Fun facts and figures from the team.

Read more...

Dan's Dilemma

Lead the team leader!

Read more...

Mystery Photo

Take a guess, learn something new.

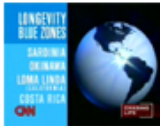Read more...

Nicoya in the news media since 2007

ABC 20/20 Denmark segment

View Blue Zones' happiness research on Denmark on ABC 20/20.

ABC 20/20 Singapore segment

View Blue Zones' happiness research on Singapore on ABC 20/20.

CNN Special: Chasing Life

View Blue Zones in Dr. Sanjay Gupta's special report on CNN.

Anderson Cooper 360

View the Anderson Cooper segment featuring Blue Zones founder Dan Buettner.

Good Morning America

Dan Buettner speaks on Good Morning America.

ABC World News Tonight

Dan Buettner speaks with Ned Potter about Blue Zones and the longevity clues that his Quest Network have discovered. >>

Good Morning America

Dan Buettner speaks with ABC's Charlie Gibson about Blue Zones Quests, his National Geographic

Objectives and strategy

1. **To determine if Nicoya really has a survival advantage and its magnitude (Is it a longevity hot spot?):**

   - Spatial analysis of death risk in elderly Costa Ricans

   - Follow up of about 16K elderly Costa Ricans, 1990-2011 using proportional hazard modeling

   - Inter-census survival ratios

2. **To explore/discard possible explanations:**

   - Migration and SES and the Nicoya advantage

   - Cause of death mortality

   - Data from a survey of ~3,000 elderly Costa Ricans:
     - Some health risk factors
     - 18 biomarkers and health conditions
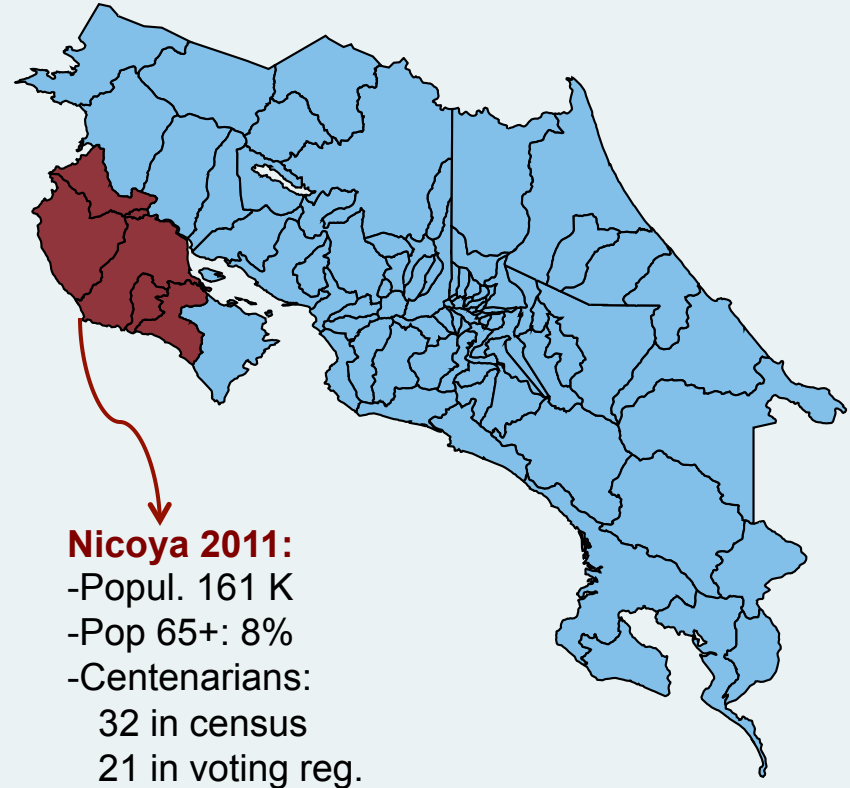   - Diet

Data and methods– 4 studies

1. Death registry of quasi-extinct cohorts. Spatial analysis using "satscan"

2. The longitudinal mortality study from 1990 to 2011, N=16.000

3. The 1984, 2000 and 2011census

4. CRELES panel N=3.000: diet, biomarkers and risk factors
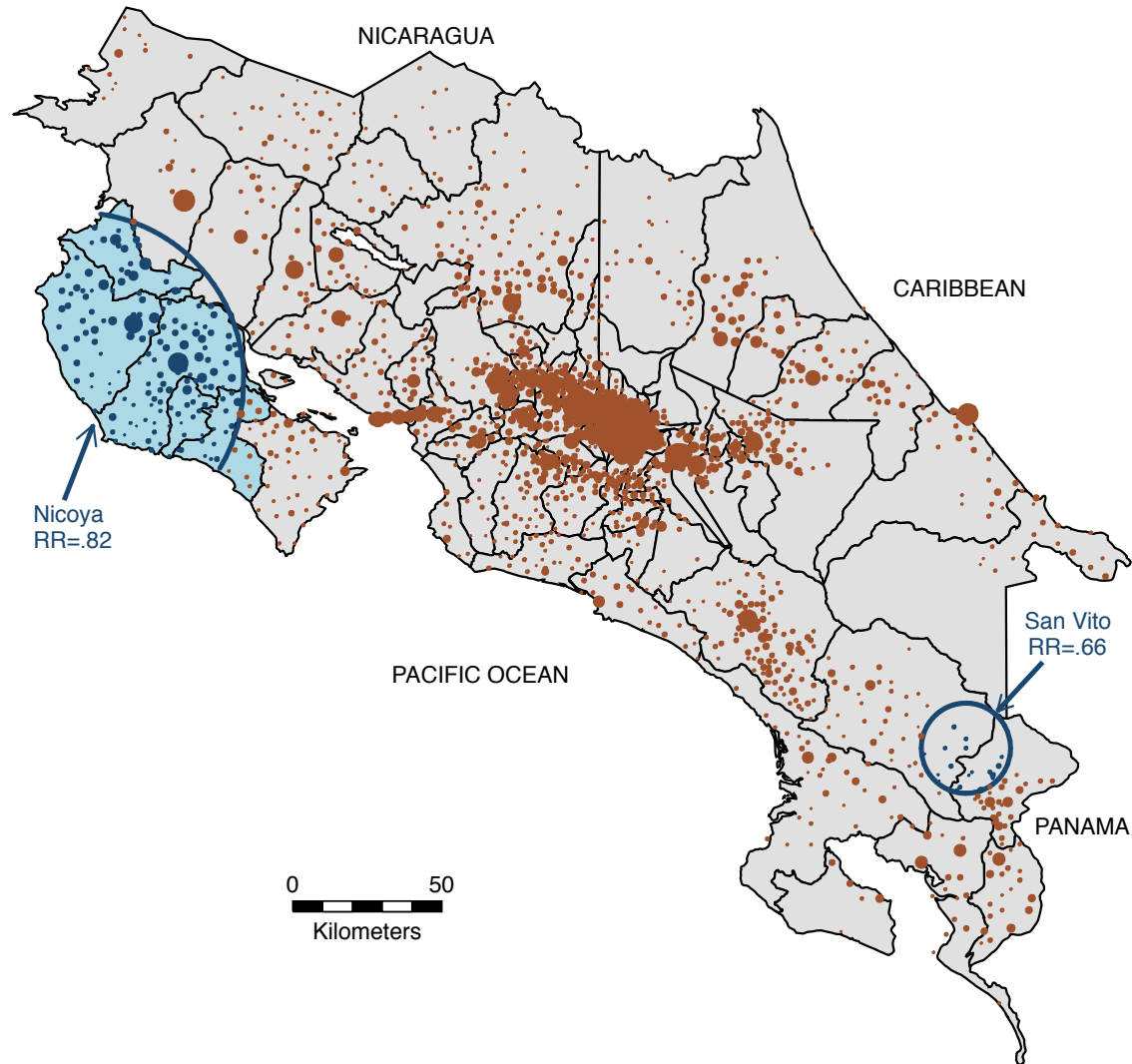
Costa Rica & Nicoya

Latin America countries

Costa Rica 2011:
-Popul. 4.4 M
-Pop 65+: 7%
-Centenarians: 509
-Life Exp.: 79.3 yrs
-GNP: $ 11K PPP

Costa Rica cantons

Nicoya 2011:
-Popul. 161 K
-Pop 65+: 8%
-Centenarians:
   32 in census
   21 in voting reg.

1. Spatial analysis of extinct cohorts mortality

- Born before 1920: N=78K deaths in 1990-2011 plus 2K alive in 2011

- Excluding: foreign born and late birth registrations (Id card number)

- Geo-coordinates of voting place in 1990 (1700 points)

- SATSCAN: sims. all possible circles for each point, compares observed with expected deaths (Poisson distribution).
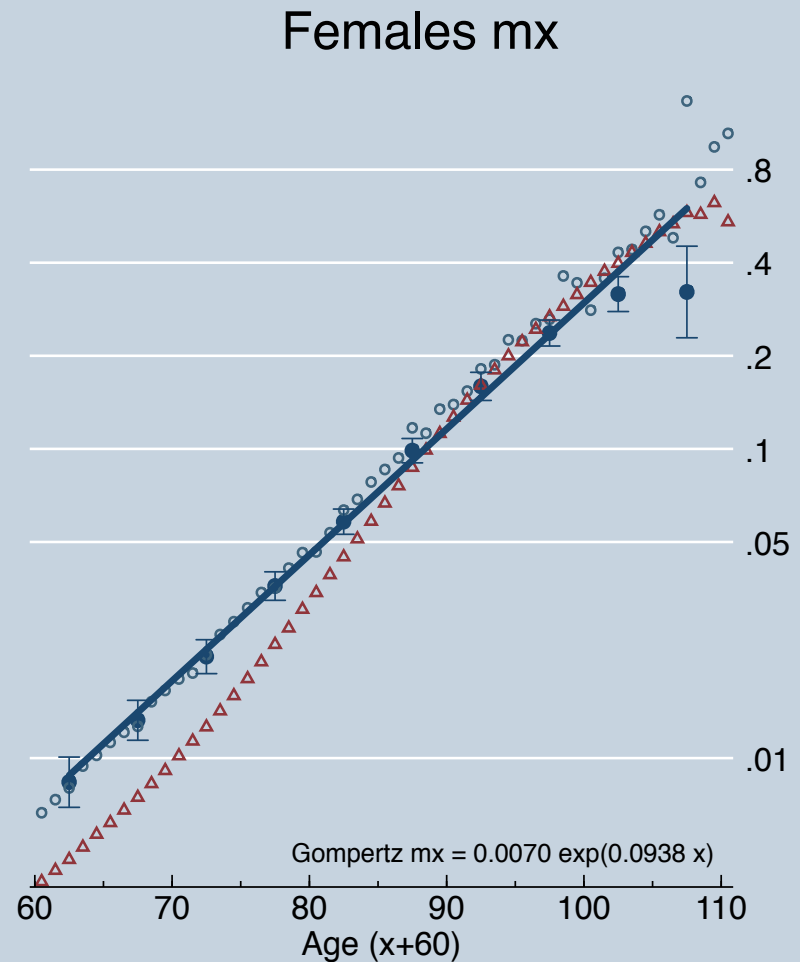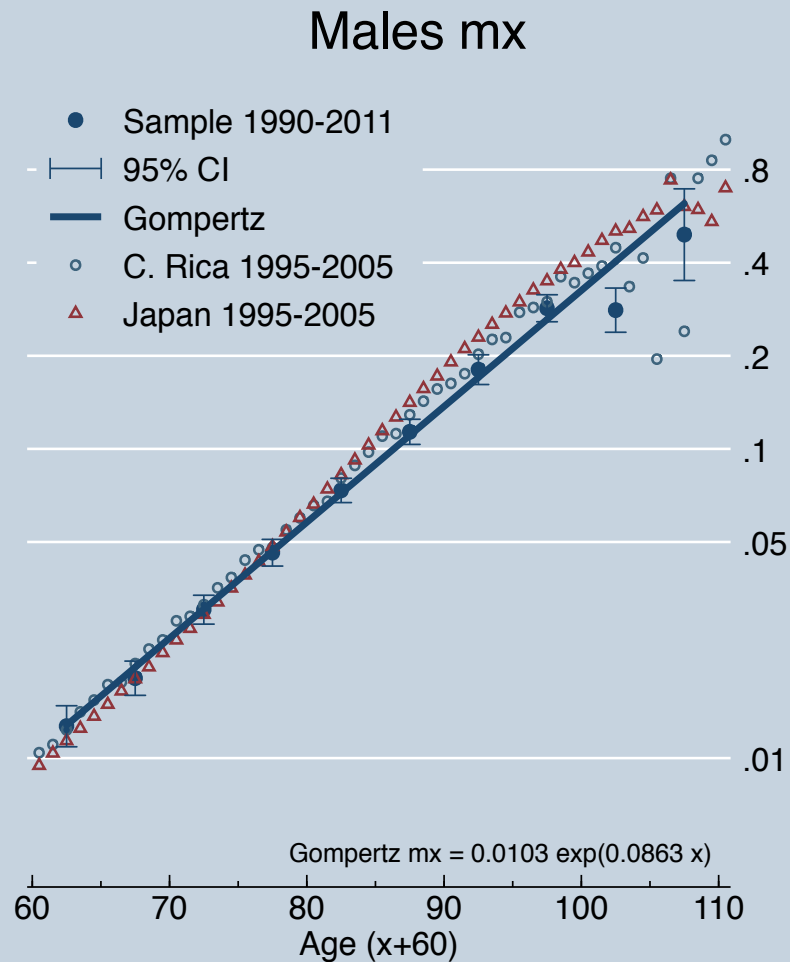
Two "islands" of low mortality

NOTES: Each point is a voting location. Points are proportional to population size. Canton limits shown.

2. Longitudinal mortality sample (LMS) 1990-2011, ages 60+

Variable	Costa Rica	No Nicoya	Nicoya
Individuals	16,315	15,389	926
Quasi-centenarians (95+)	1,115	949	166
Deaths	5,689	5,323	366
Person-years	123k	117k	7k
Mean age	73.3	73.1	75.6
Mean education yrs	4.3	4.4	3.2
Health insurance			
None	15%	15%	17%
Government paid	14%	14%	25%

Age specific death rates in the LMS

Males mx

Females mx

- ● Sample 1990-2011
- ⊢—⊣ 95% CI
- ▬ Gompertz
- ○ C. Rica 1995-2005
- △ Japan 1995-2005

Gompertz mx = 0.0103 exp(0.0863 x)

Gompertz mx = 0.0070 exp(0.0938 x)

Age (x+60)

Age (x+60)

Death rate ratios (DRR)

| Explanatory variable	Base model DRR		SES adjusted	
	Males	Females	Males	Females
Nicoya	0.800 **	0.978	0.814 **	0.941
Year (2000 is 0)	0.991 **	0.984 **	0.990 **	0.984 **
Age (Gamma exp.)	1.092 **	1.101 **	1.093 **	1.101 **
Education (years)			1.010 *	0.984 **
Public health insurance				
None			0.938	0.945
Free from governm.			1.007	1.075
Paid from job			1 Ref.	1 Ref.
Constant (m60)	0.0101 **	0.0067 **	0.0097 **	0.0071 **

Significant at: **P < .01, *P<.05
DRR estimated with Gompertz proportional hazard regression models

Metrics of Nicoya advantage at age 60

| Population	Life expectancy		Centenarians %*	
	Males	Females	Males	Females
Nicoya	23.6	24.2	4.8	4.3
(95% CI)	(22.5-25.2)	(23.3-25.5)	(2.9-7.5)	(2.5-6.8)
Sardinia	20.7	25.1	0.7	1.4
Okinawa	22.4	28.5	2.1	9.3
Costa Rica	21.1	23.7	1.2	2.3
Japan	21.4	26.7	0.7	3.7
U.S.A.	19.7	23.2	0.5	1.8

*Life table probability of reaching age 100 (per 100)

Migration and Nicoya DRR
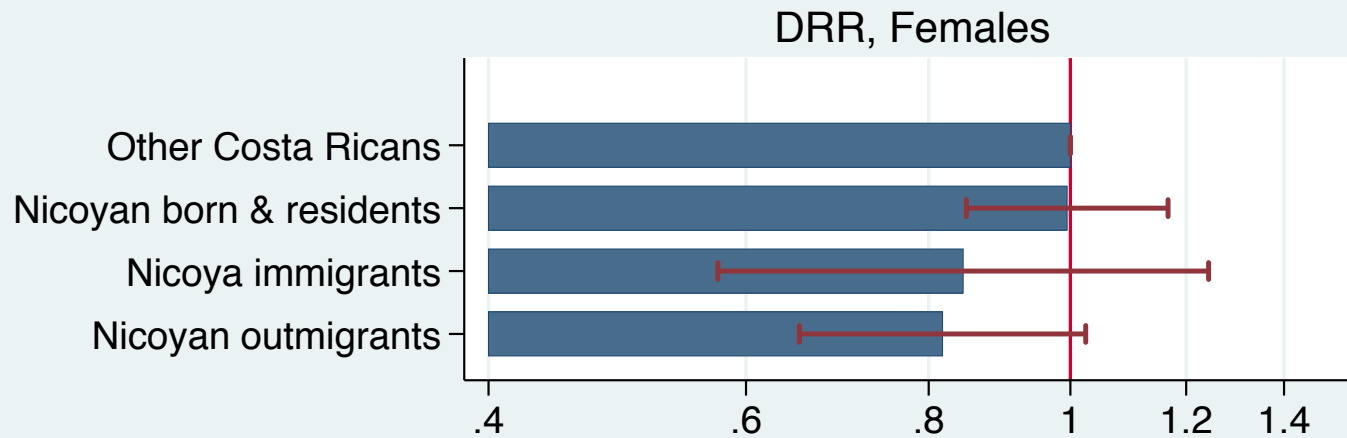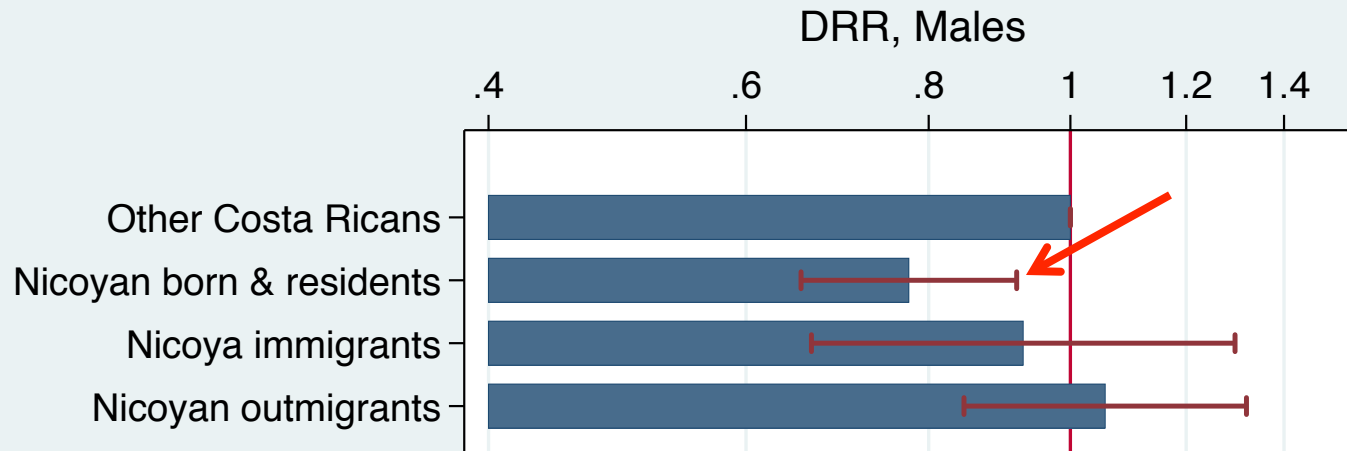
DRR estimated with Gompertz proportional hazard regression models adjusted for time

Nicoya DRR by cause of death
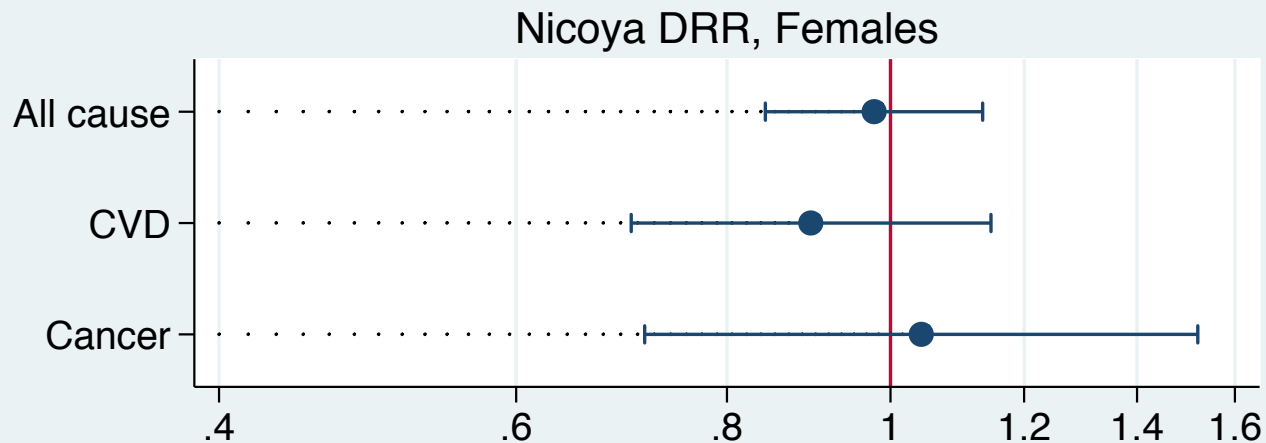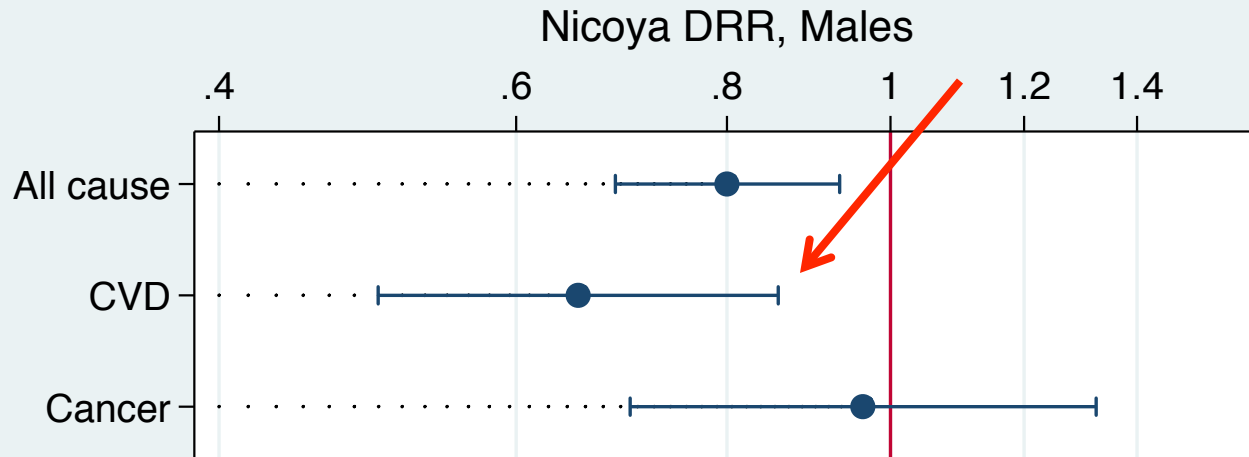
DRR estimated with Gompertz proportional hazard regression models adjusted for time

3. Census survival ratios. Population 60+ yrs

| Survival ratio by birth place	Survival ratio		N denominators	
	Males	Females	Males	Females
1984-2000: N(76+)/N(60+)				
Nicoya	0.499	0.521	4,782	4,999
Other Costa Rica	0.434	0.492	65,325	70,988
Ratio Nicoya /other CR	1.150	1.058		
1984-2011, N(87+)/N(60+)				
Nicoya	0.155	0.199		
Other Costa Rica	0.118	0.164		
Ratio Nicoya /other CR	1.316	1.209		

4. The CRELES panel

- National sample ages 60+, N=2,900
- Oversampling of oldest ages and oldest Nicoyans (350)
- Two waves of visits: 2005 and 2007
- Biomarkers in venous fasting blood (95% response) plus other exams. At homes.
- Wellcome Trust funded

18 Biomarkers

- *Metabolic indicators:* Fasting Glucose; HbA1c
- *Cardio Vascular:* Diastolic BP; Systolic BP
- *Lipids:* Triglycerides; Total/HDL Cholesterol ratio
- *Stress:* urine Cortisol; DHEAS; Telomere length
- *Inflammation:* CRP
- *Organ specific function reserve*: creatinine; handgrip
- *Nutrition:* Knee height; BMI; waist
- *Functionality*: ADL disability scale
- *Mental health scales*: cognitive MMS, geriatric depression test
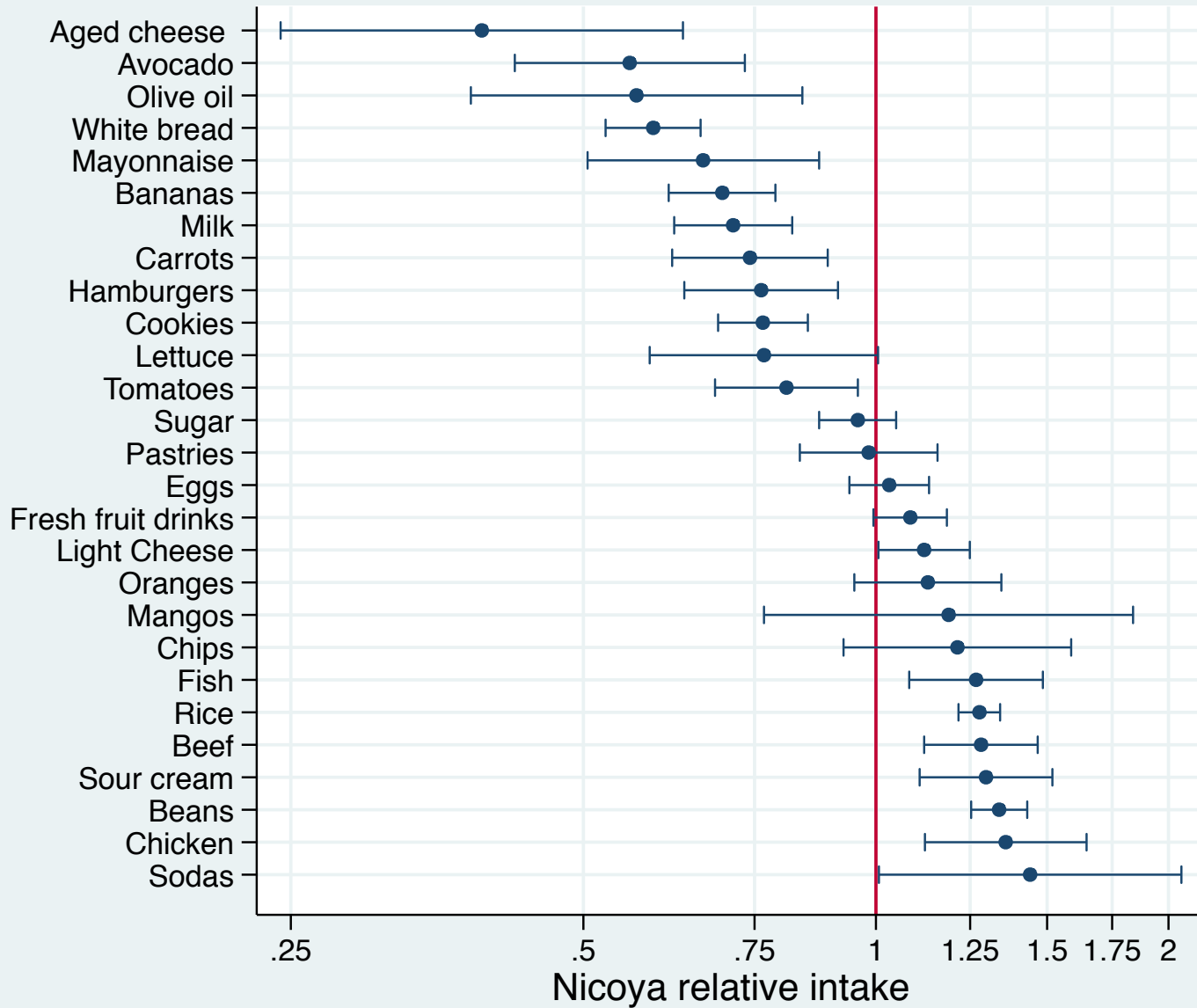
Nicoya effect on normalized biomarkers
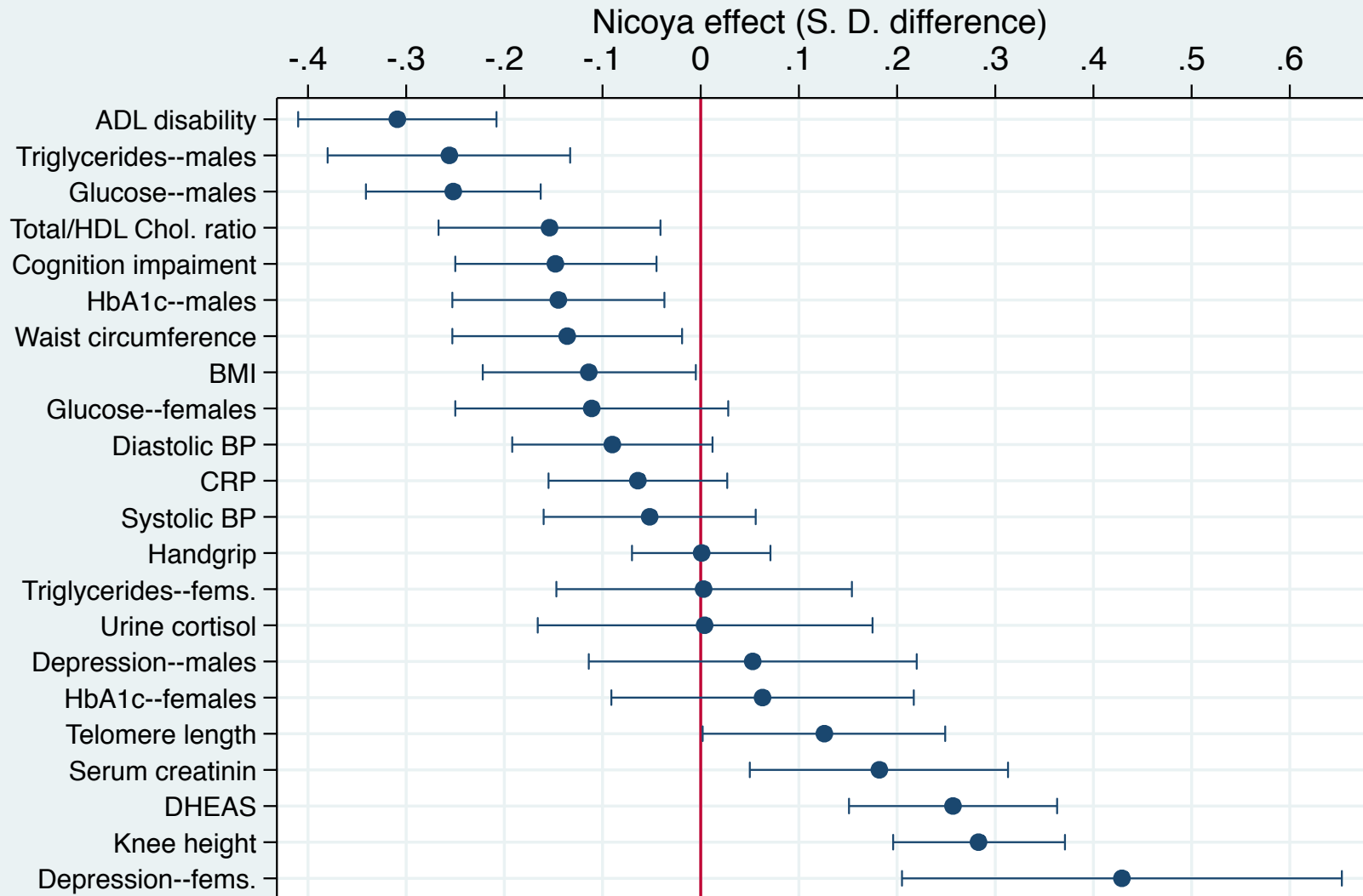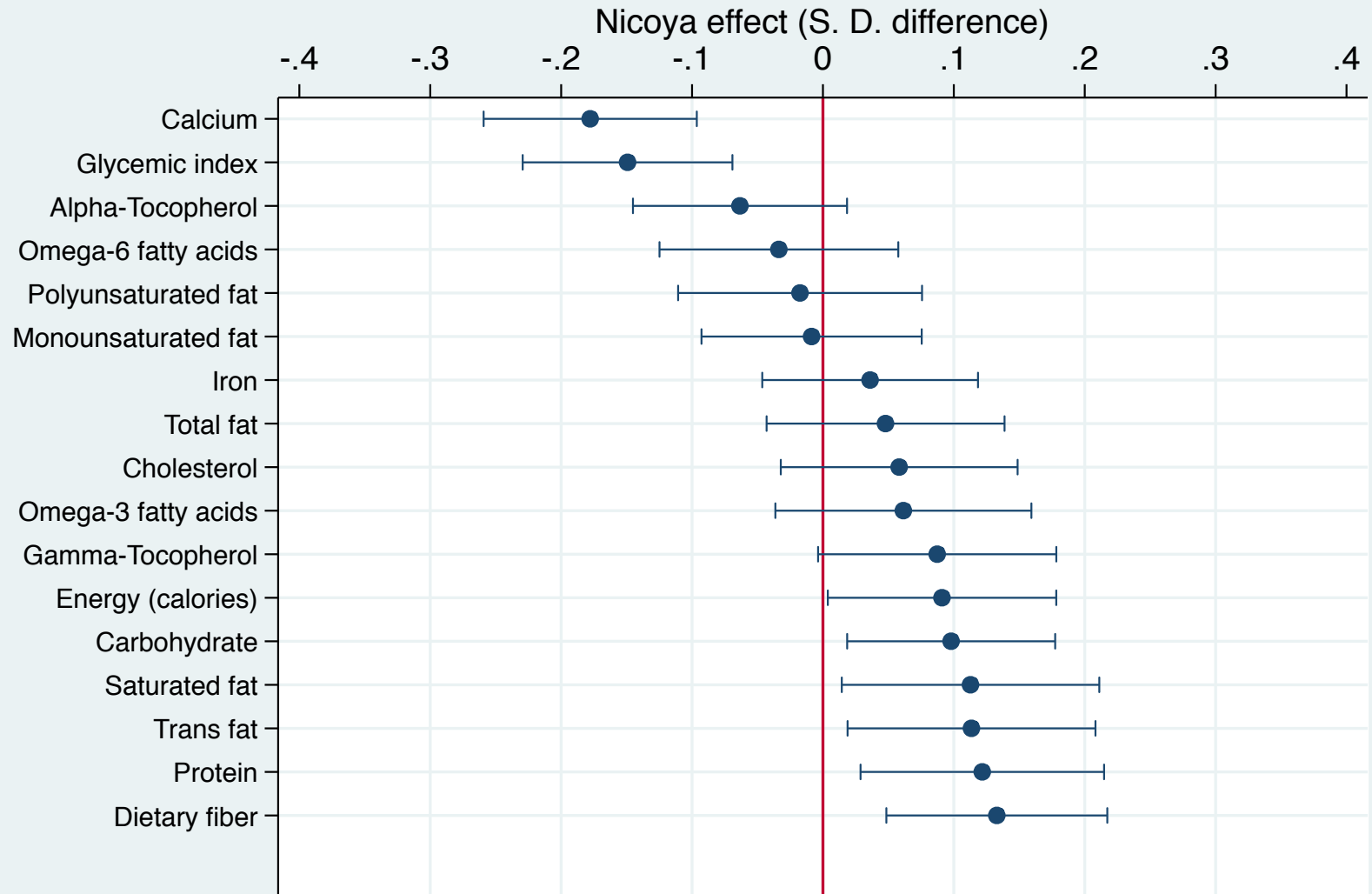
Some health tisk factors

Health factor	Nicoya	No Nicoya	Sig.
Smoker current	8%	7%	
Physically active	30%	27%	
Visited at home by health worker in previous year	45%	41%	+
Flu shot previous year	64%	59%	*
Lipid lowering medicine	14%	27%	**
High BP medicine	46%	51%	+

Proportions adjusted by age and sex with logistic regression

Foods in Nicoya diet

Nutrients in Nicoya diet

Conclusions

- Yes, Nicoya is a *hot spot* of high longevity
- Significant survival advantage for elderly Nicoya men: 7 times the prob. of reaching 100 compared to Japan or Sardinia, twice that of Okinawa
- Nicoya out-migrants loose the advantage
- The advantage comes from CVD mortality

Conclusions - 2

- Elderly Nicoyans show a metabolic advantage
- They are also taller and leaner,
- with higher levels of DEHAS
- lower cognitive and physical disabilities
- Nicoyans have longer telomeres
- Public health programs are stronger in Nicoya
- Diet: no evidence of "healthy diet". Based on rice, beans, beef and chicken, slightly higher in calories, proteins and fiver, and lower glicemic index and cow milk.

Discusion: validity of mortality data

- Unlikely age exaggeration:
  - No self-reported age from census or surveys but DoB from registry
  - Late registrations and foreign-born excluded
  - Why just CV diseases, Nicoya and men?
  - Census confirms higher survival of Nicoyans

validity of mortality data - 2

- Unlikely under-registration of deaths:
  - Out of 600 deaths in CRELES panel, only 5 (< 1%) not found in the registry
  - Survivorship double checked against the voting registry every 4 years in the LMS
- Coherence of mortality and biomarkers

Research needed

- Genotyping

- In depth panel of Nicoya adults with proper statistical power and control group.

- Exploratory study of San Vito region.

Abuela Panchita

In a America, only 1 in 7 women over 100 can even take care of themselves. Panchita, freshly 100 years old, not only lives alone, she splits logs, sweeps the courtyard and clears brush with a machete almost as tall as she is.

In the news: Panchita 107 years old, 6th generation great-daughter

Gracias!