Climate, Disasters, and the Health and Well-Being of Older Populations

Elizabeth Frankenberg
Cary C. Boshamer Distinguished Professor of Sociology
University of North Carolina at Chapel Hill
e.frankenberg@unc.edu

UNC | CAROLINA POPULATION CENTER

Components of climate change and climate shocks

Physical dimensions:

Wind

Rainfall / drought

Humidity

Temperature

Sea level / tides

Ground saturation

Event parameters:

Speed of onset

Predictability

Duration

Scale

Chronic vs acute

Vary across events, and across space and time for specific events

Components of climate change and climate shocks

Physical dimensions:

Wind

Rainfall / drought

Humidity

Temperature

Sea level / tides

Ground saturation

Event parameters:

Speed of onset

Predictability

Duration

Scale

Chronic vs acute

Vary across events, and across space and time for specific events

Impacts:

Property damage

Exposure to physical threats

Change in work opportunities

Disruption to daily activities

Disruption to social networks

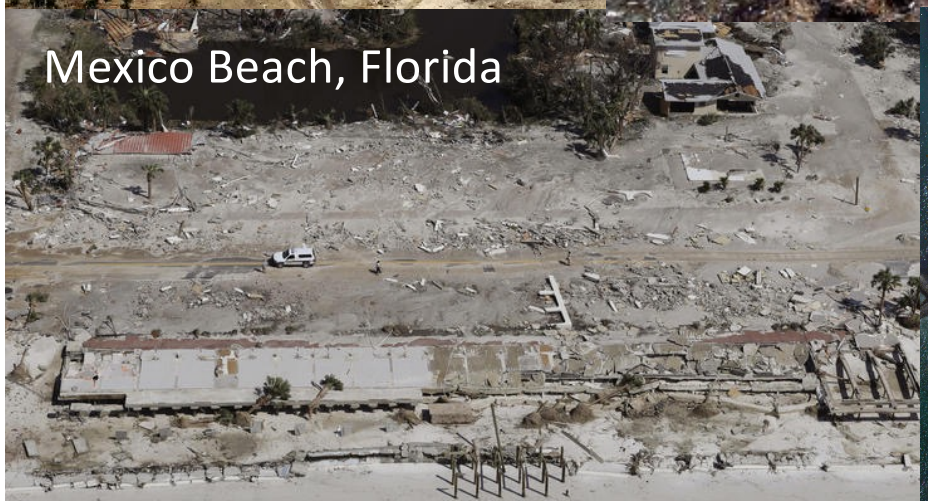
Reduced access to health care

Rising prices

Demographic, economic, social factors shape degree of impact

Adaptation / Recovery efforts matter!

Landscapes illustrating the physical forces accompanying events



Climate change and climate shocks:
increasing frequency and intensity of extreme events against a backdrop of changing baseline conditions (pulse and press)

“New Normal”

More devastating fires, storms, hurricanes

Greater climate variability

More pressure, longer duration, less recovery time between events

Harris et al. 2018. Biological responses to the press and pulse of climate trends and extreme events. *Nature Climate Change*. 8,579-587.

Climate change and climate shocks:
increasing frequency and intensity of extreme events against a backdrop of changing baseline conditions (pulse and press)

"New Normal"

More devastating fires, storms, hurricanes

Greater climate variability

More pressure, longer duration, less recovery time between events

To what extent does an event:

impact health, e.g. raise mortality (immediately or longer-term)
destroy livelihoods, assets, socio-economic well-being

What resources are available to support a post-event recovery phase?
How often do these events occur?

Harris et al. 2018. Biological responses to the press and pulse of climate trends and extreme events. *Nature Climate Change*. 8,579-587.

Does the biology of aging or the evolution of SES that accompanies aging diminish the ability to respond and adapt?

Does the biology of aging or the evolution of SES that accompanies aging diminish the ability to respond and adapt?

Reduced physical mobility

Greater frailty

Cognitive decline

Diminished thermal regulation

Limited economic resources, safety net access, social/family networks

(Perhaps) heightened anxiety induced by uncertainty

(Perhaps) deep attachment to place

Social and Economic Impacts of Climate

Measurement and Methods:

Accurate measurement of climate-related physical forces

evidence from populations observed before and after a climate event longitudinal data is critical

“dose-response” relationships using a natural experiment framework

Economic systems:

Agricultural yields, Labor Productivity, Trade, General equilibrium effects

Carlton, T. and S. Hsiang. 2016. Social and economic impacts of climate. *Science*. 353(6304).

2004 Sumatran-Andaman EQ and Indian Ocean Tsunami (December 26)

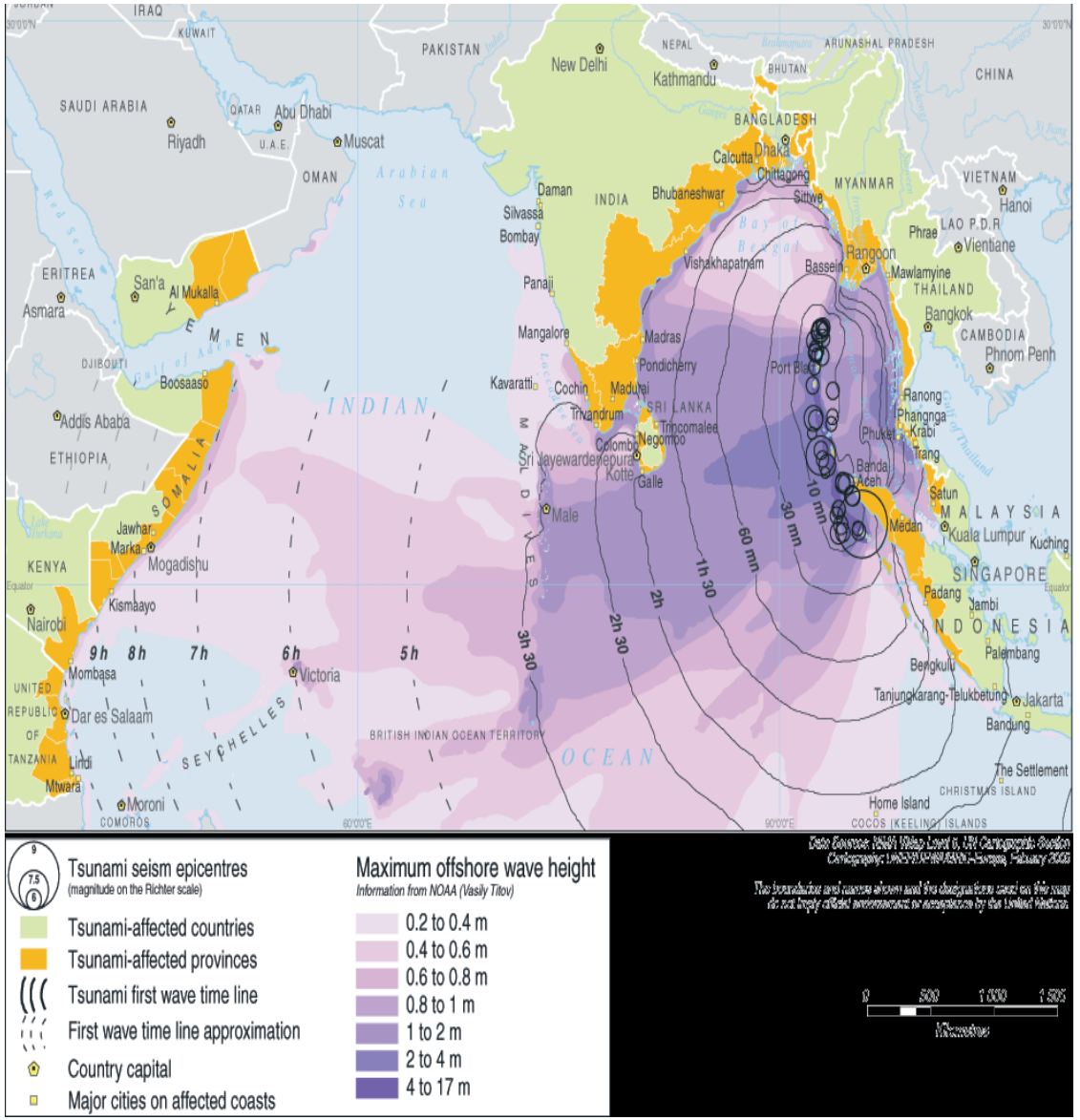
Earthquake. 9.3 on Richter scale
1200 km "unzipping"
Impacts on water movement in every ocean
slammed coastlines of 26 countries

What affects wave force/height?

"consecutive effect of even tiny fluctuations in the profile of the ocean floor can cause unexpectedly strong fluctuations in the wave height of tsunamis, with maxima several times higher than the average wave height"

(Degueldre et al. "Random Focusing of Tsunami Waves." *Nature Physics 2021*)

Aceh, Indonesia: ~200,000 dead, ~750,000 displaced



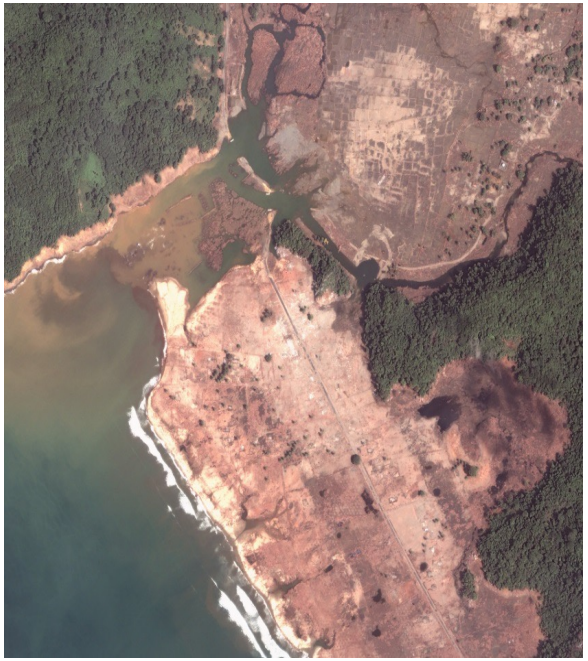
Aceh

Before Tsunami

Aceh

Before Tsunami

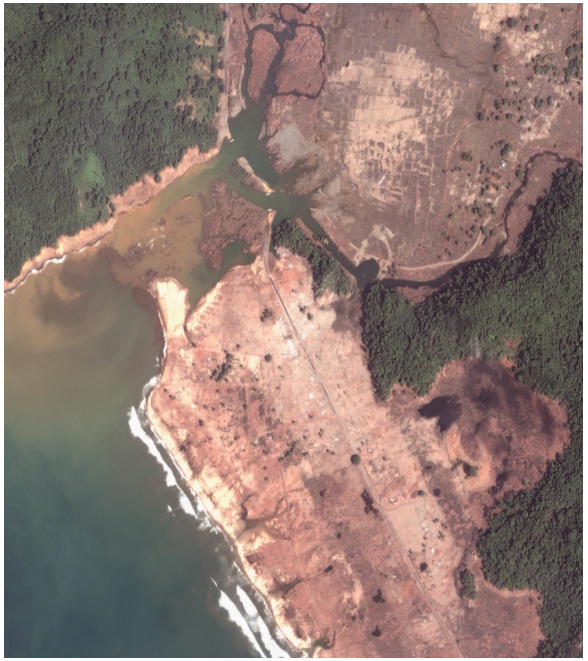
After Tsunami



Aceh

Before Tsunami

After Tsunami



Unexpected:
last tsunami 600 years ago

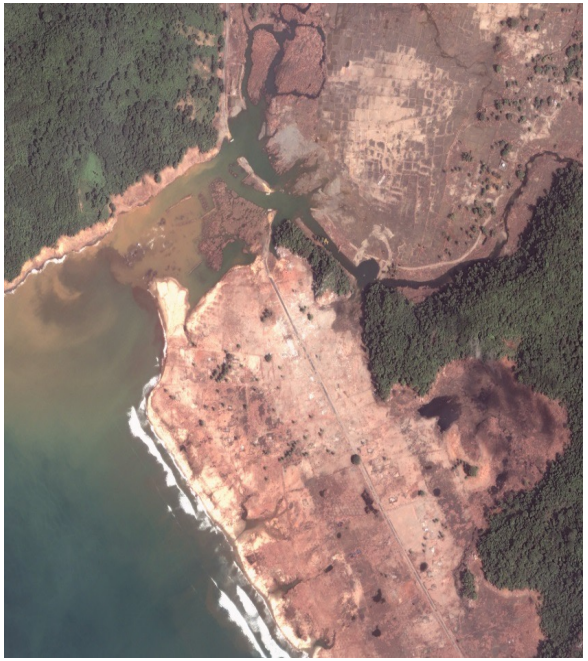
Idiosyncratic:
local variation in impact driven by off-shore topography

$US 7 billion in assistance 2005-2012

Aceh

Before Tsunami

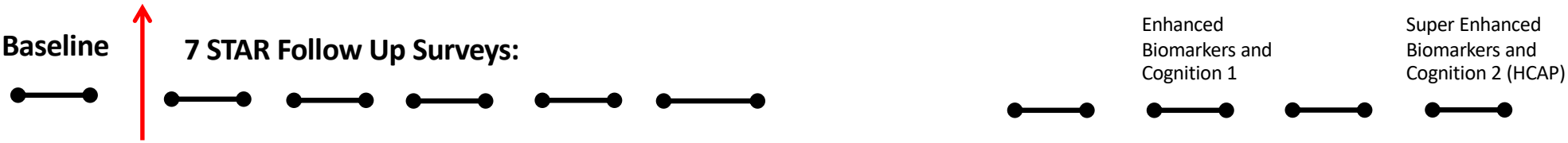
After Tsunami



5 years later

Study of the Tsunami Aftermath and Recovery (STAR)

Longitudinal survey of individuals, families, and communities
Indonesia: before and after the 2004 Indian Ocean tsunami

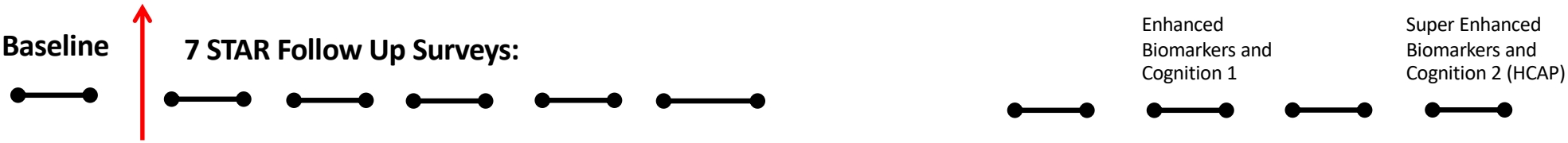


Baseline: N~26,000, ages 0-80+ span a continuum of destruction

96% of survivors interviewed at least once movers tracked

Study of the Tsunami Aftermath and Recovery (STAR)

Longitudinal survey of individuals, families, and communities
Indonesia: before and after the 2004 Indian Ocean tsunami



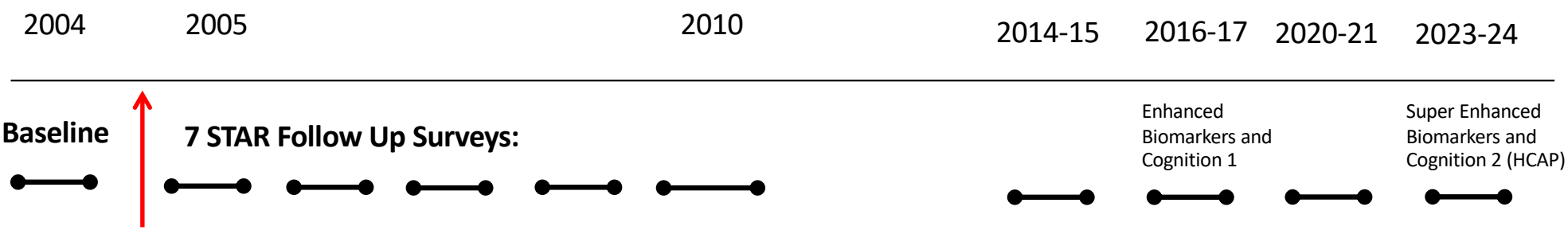
Baseline: N~26,000, ages 0-80+

96% of survivors interviewed at least once

Biological components: height, weight, hip & waist circumference, blood pressure, Hb, dried blood spots (hsCRP)
subsample: venous blood, HbA1c (POCT), lipid panel, Thyroid function

Study of the Tsunami Aftermath and Recovery (STAR)

Longitudinal survey of individuals, families, and communities
Indonesia: before and after the 2004 Indian Ocean tsunami



Baseline: N~26,000, ages 0-80+

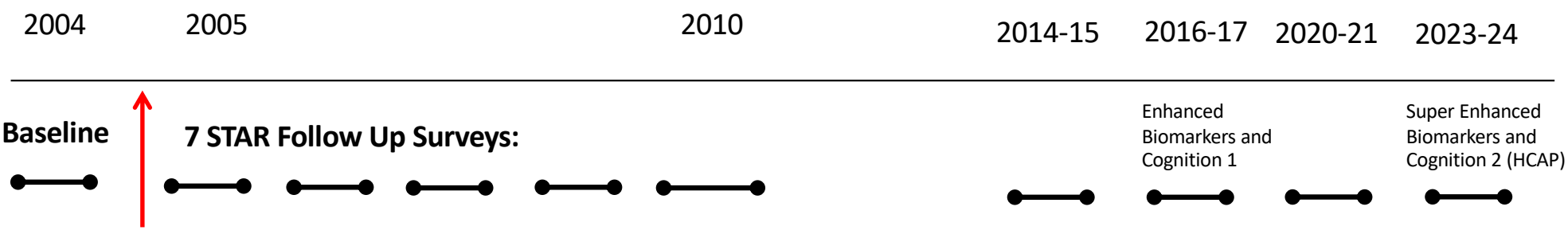
96% of survivors interviewed at least once

Biological components: height, weight, hip & waist circumference, blood pressure, Hb, dried blood spots (hsCRP)
subsample: venous blood, HbA1c (POCT), lipid panel, Thyroid function

Cognitive components: adapted MMSE, Ravens, Word Recall
subsample: executive function (tablet-based) HCAP, olfactory function, caretaker assessments

Study of the Tsunami Aftermath and Recovery (STAR)

Longitudinal survey of individuals, families, and communities
Indonesia: before and after the 2004 Indian Ocean tsunami



Baseline: N~26,000, ages 0-80+

96% of survivors interviewed at least once

Biological components: height, weight, hip & waist circumference, blood pressure, Hb, dried blood spots (hsCRP)
subsample: venous blood, HbA1c (POCT), lipid panel, Thyroid function

Cognitive components: adapted MMSE, Ravens, Word Recall
subsample: executive function (tablet-based) HCAP, olfactory function, caretaker assessments

Survey domains: hh composition, economic resources, education, migration, work, fertility, psychosocial health
tsunami shocks, loneliness, sleep, frailty, memory, social support and networks

Mortality

At the time of the tsunami

Among survivors 5, 10, and 15 years after the tsunami

For survivors:

Psychosocial Health

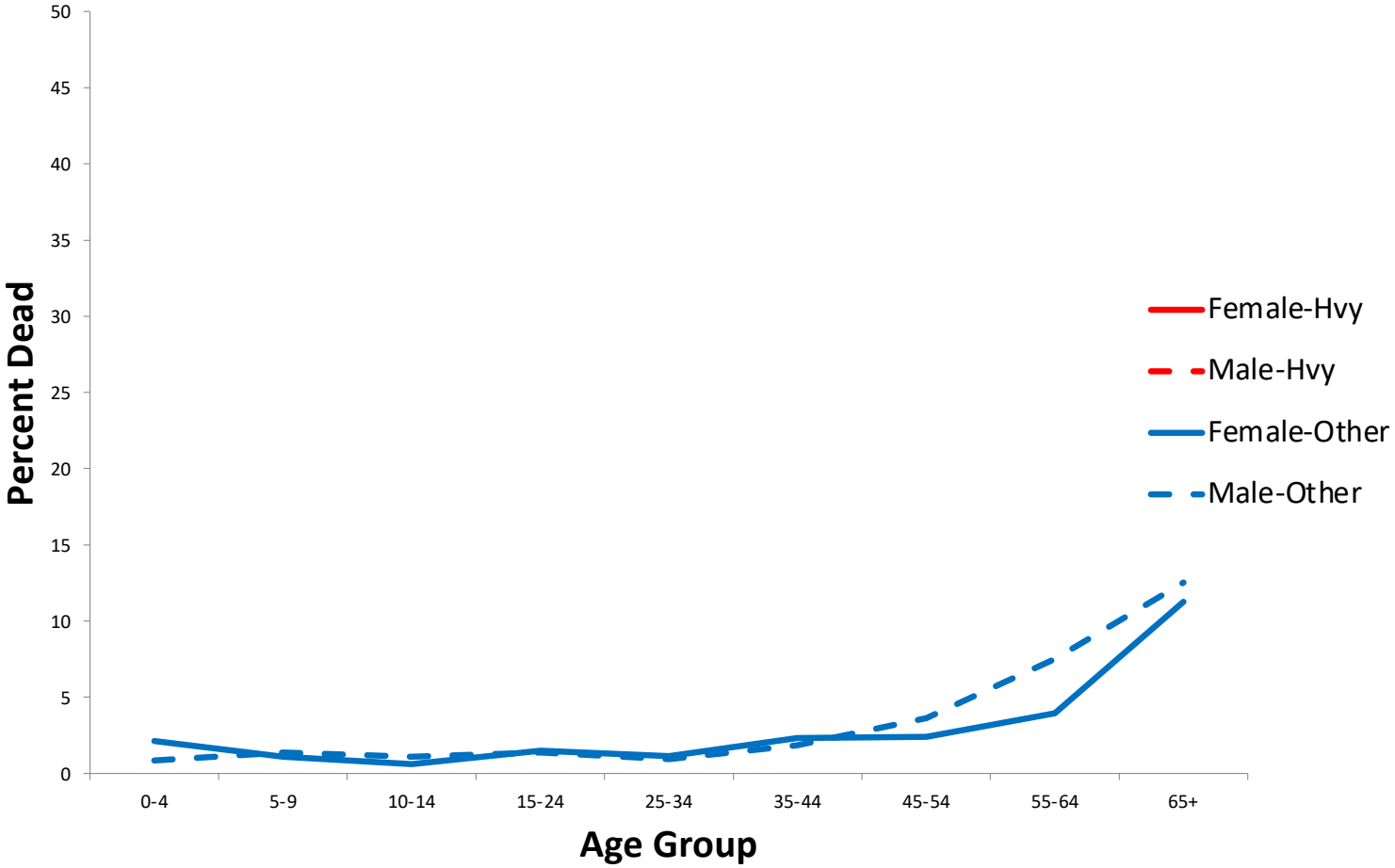
Cognition

Biomarkers

Economic Impacts

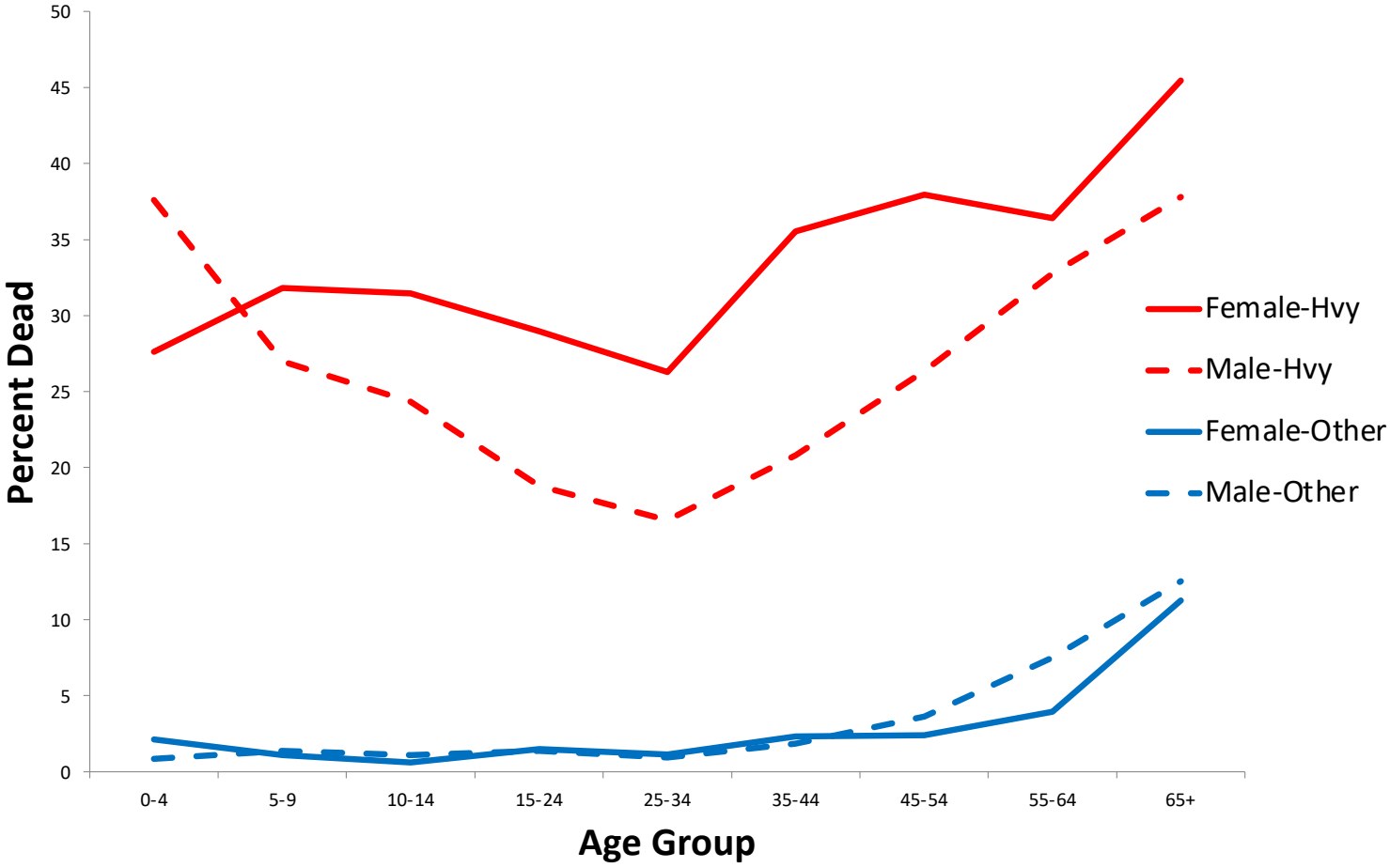
Role of assistance

Mortality between 2004 and 2005



Frankenberg, E, T Gillespie, S Preston, B Sikoki, D Thomas. 2011. "Mortality, the Family, and the Indian Ocean Tsunami." *The Economic Journal*. 121: F162-182.

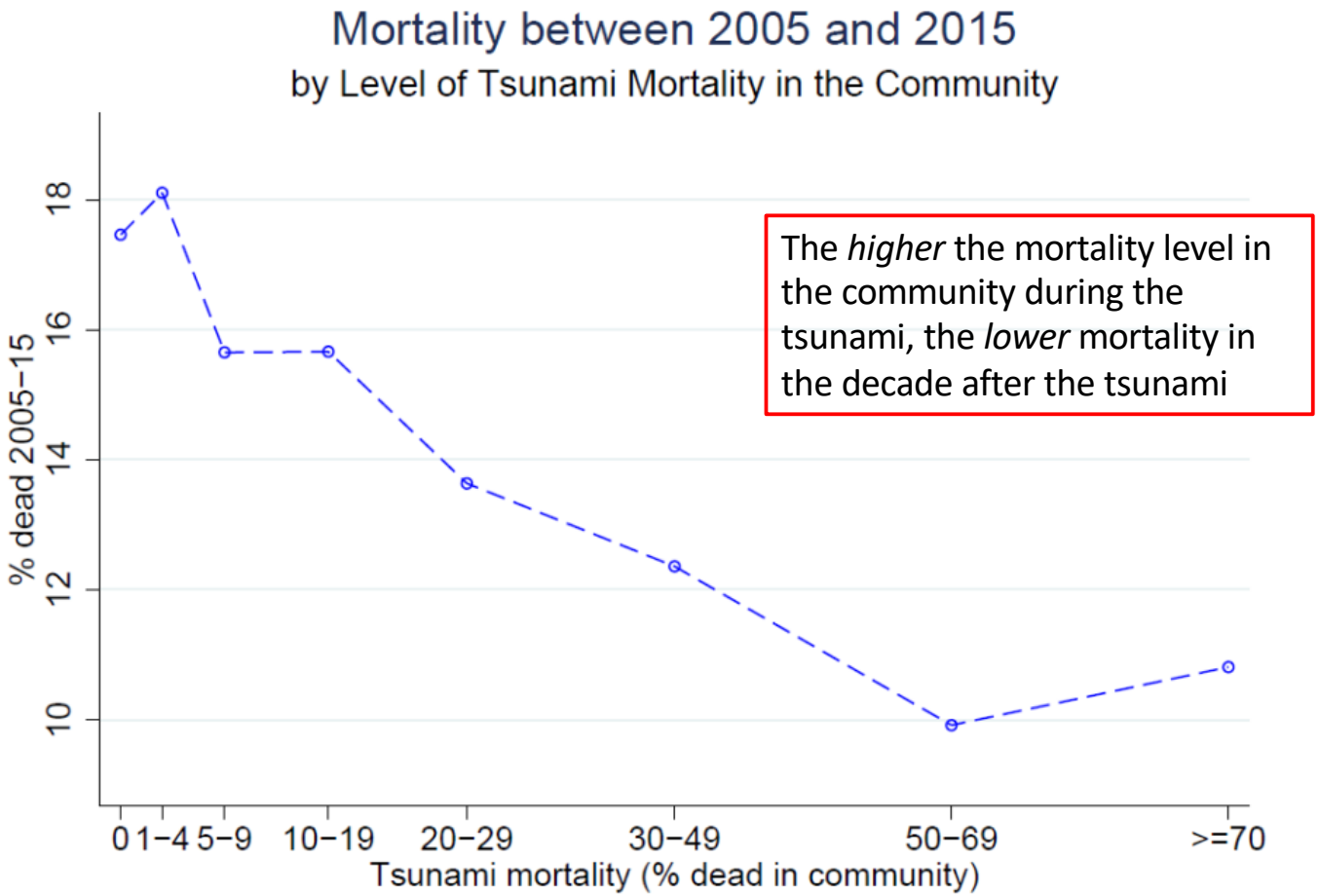
Mortality between 2004 and 2005



Frankenberg, E, T Gillespie, S Preston, B Sikoki, D Thomas. 2011. "Mortality, the Family, and the Indian Ocean Tsunami." *The Economic Journal*. 121: F162-182.

Frankenberg, E, C Sumantri, D Thomas. 2020. “Effects of a natural disaster on mortality risks over the longer term.” *Nature Sustainability*.

Frankenberg, E, C Sumantri, D Thomas. 2020. “Effects of a natural disaster on mortality risks over the longer term.” *Nature Sustainability*.



Frankenberg, E, C Sumantri, D Thomas. 2020. "Effects of a natural disaster on mortality risks over the longer term." *Nature Sustainability*.

Among those 50 and older at the disaster, survivors from badly damaged communities have ***better survival prospects*** over the next five, ten, and fifteen years

Do particular tsunami experiences leave scars that reduce survival prospects?

Yes, for adults 50 and older at the tsunami

Females: Losing a spouse reduces survival

Males: High levels of post-traumatic stress reactivity and residence in in temporary housing reduce longer term survival prospects

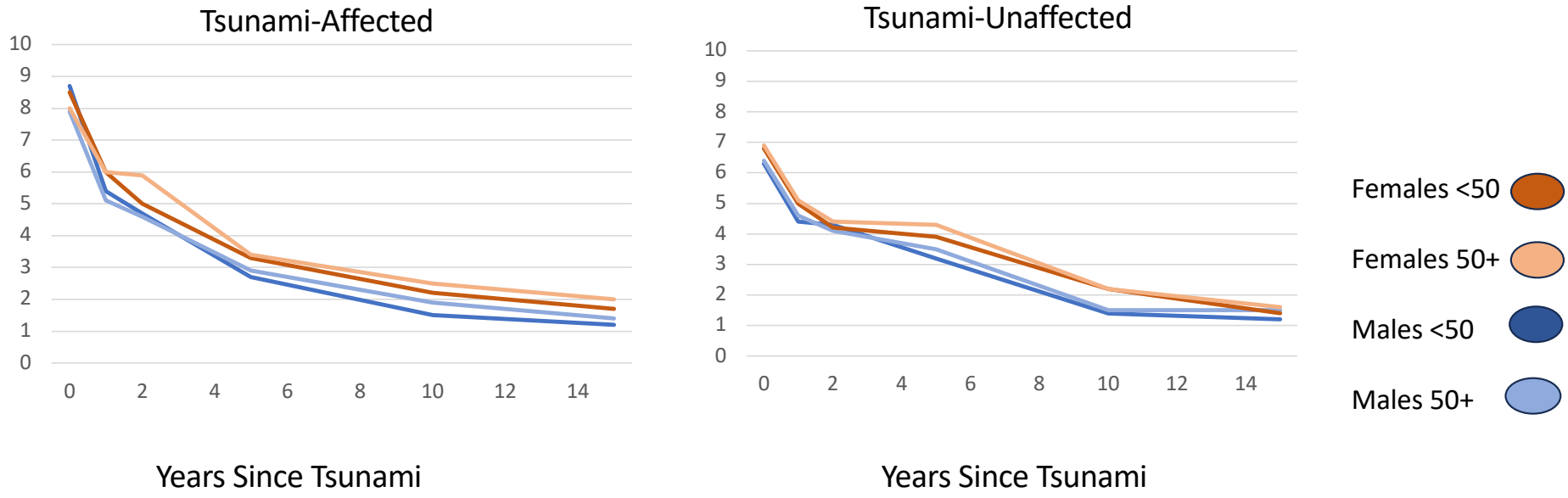
Losing a spouse increases survival

No evidence of scarring for younger adults

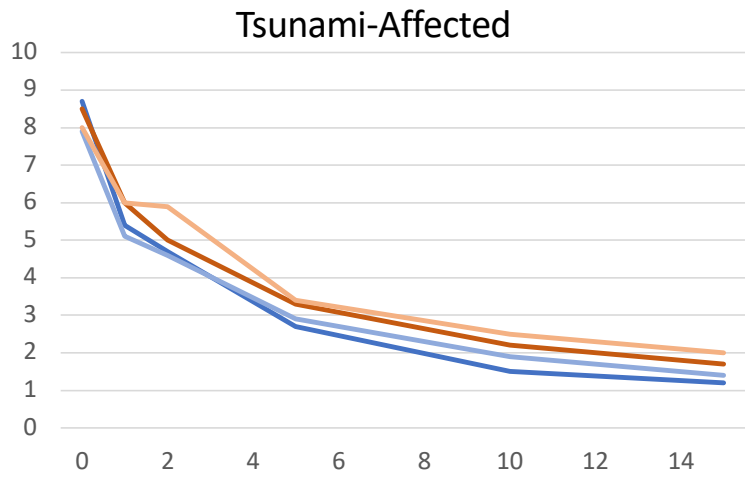
Frankenberg, E., N Ingwersen, R Iwo, C Sumantri, D Thomas. 2022. "Impacts of Disaster-Induced Death and Destruction on Health and Mortality over the Longer-Term." Chapter 1 in Environmental Impacts on Families: Change, Challenge, and Adaptation. McHale, Susan, Valarie King, and Jennifer E. Glick (eds). National Symposium on Family Issues. Springer.

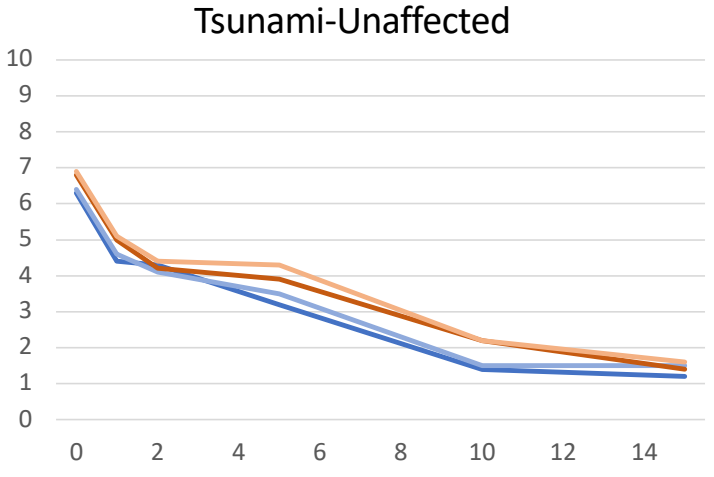
Psychosocial Health:
post-traumatic stress reactivity and depression levels over 15 years

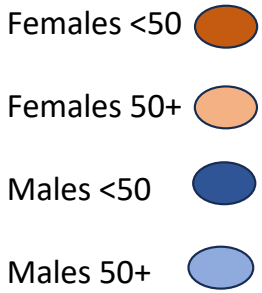
Post Traumatic Stress Reactivity (PCL-C, 21 points)



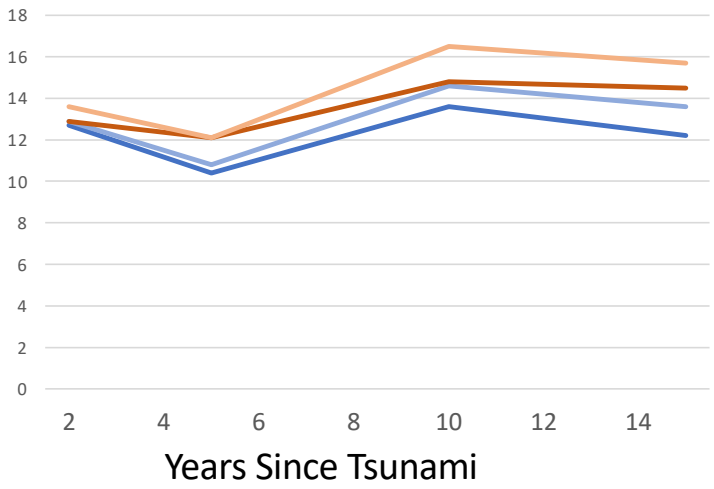
Post Traumatic Stress Reactivity (PCL-C, 21 points)

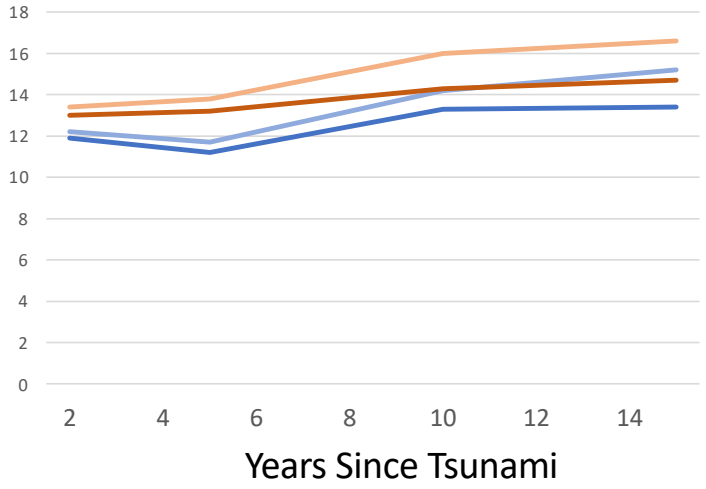






Depression Index (CESD, 60 points)





Cognition:

Does exposure affect cognitive function in the years after the event

Adjusted Mini Mental State Exam
8-item MiniCog

Administered to a random subsample of STAR respondents (age 45 and above) in 2016-17

Summary Statistics (N=1732)

	All	Males	Females
AD/RD Screeners			
Adapted Mini Mental State Exam (max=30)	23.0 (0.13)	24.3 (0.16)	21.8 (0.19)
Demographics			
Years of education	7.8	8.8	7.0
Age	56.8	56.4	57.2
% male	47		

AMMSE: Exposure to the Tsunami

	All	Male	Female	All	Male	Female
Tsunami exposure						
Damaged community	-1.71	-2.54	-0.83	-1.32	-2.33	-0.045
	[1.9]	[3.0]	[0.6]	[1.4]	[2.5]	[0.0]
Saw/heard water	.	.	.	-0.84	0.64	-2.42
				[1.1]	[0.6]	[2.4]
Lost at least half assets	.	.	.	-0.63	-1.48	0.031
				[0.8]	[1.6]	[0.0]

Age and education controlled

Tsunami exposures are associated with reduced performance on AMMSE (and MiniCog) for males and females

Biomarkers: C-Reactive Protein and Adiposity

Effect of exposure to tsunami on inflammation and adiposity 12 years later

	Females			Males		
Respondent age at time biomarker measured:	>=20y	<40y	>=40y	>=20y	<40y	>=40y
% elevated CRP						
Community heavily damaged	4.94	5.15	4.68	1.54	-1.63	7.82
	[2.91]	[2.61]	[1.35]	[0.94]	[0.87]	[2.37]
Overall mean	24.87	22.47	30.00	18.20	15.07	24.46
Waist circumference (cms)						
Heavily damaged	2.18	2.22	2.04	1.34	1.08	1.57
	[3.22]	[2.82]	[2.32]	[2.00]	[1.38]	[1.90]
Overall mean	85.53	83.26	89.26	82.54	80.44	85.73
Sample size	3,555	2,425	1,130	3,352	2,236	1,116

Notes: [t statistics] take into account clustering and heteroskedasticity.

Community of residence at time of tsunami. Relative to living in undamaged community.
Models adjust for age, education and some damage to community.

Elevated CRP is CRP>=3 conditional on CRP<10 mg/dL

Effect of exposure to tsunami on inflammation and adiposity 12 years later

	Females			Males		
Respondent age at time biomarker measured:	>=20y	<40y	>=40y	>=20y	<40y	>=40y
% elevated CRP						
Community heavily damaged	4.94	5.15	4.68	1.54	-1.63	7.82
	[2.91]	[2.61]	[1.35]	[0.94]	[0.87]	[2.37]
Overall mean	24.87	22.47	30.00	18.20	15.07	24.46
Waist circumference (cms)						
Heavily damaged	2.18	2.22	2.04	1.34	1.08	1.57
	[3.22]	[2.82]	[2.32]	[2.00]	[1.38]	[1.90]
Overall mean	85.53	83.26	89.26	82.54	80.44	85.73
Sample size	3,555	2,425	1,130	3,352	2,236	1,116

Notes: [t statistics] take into account clustering and heteroskedasticity.

Community of residence at time of tsunami. Relative to living in undamaged community.
Models adjust for age, education and some damage to community.

Elevated CRP is CRP>=3 conditional on CRP<10 mg/dL

Stressful exposures affect two dimensions of health known to be associated with stroke and CVD

Economic Impacts

Men age 40-60 at the tsunami and directly exposed:

- ten years later earnings are still 30% lower than before the tsunami and 30% lower than for same age men not directly exposed

Men 20-29:

- earnings recover over time, though still 12% lower for the directly exposed relative to not directly exposed

Economic Impacts

Men age 40-60 at the tsunami and directly exposed:

- ten years later earnings are still 30% lower than before the tsunami and 30% lower than for same age men not directly exposed

Men 20-29:

- earnings recover over time, though still 12% lower for the directly exposed relative to not directly exposed

Much of earnings recovery is driven by reconstruction

Spending levels fall 13% in the year after the tsunami

Directly affected still spending 8% less 10 years later (others recover)

Short term increase in willingness to take on financial risk among the exposed, concentrated in younger individuals

Economic Impacts

Men age 40-60 at the tsunami and directly exposed:

- ten years later earnings are still 30% lower than before the tsunami and 30% lower than for same age men not directly exposed

Men 20-29:

- earnings recover over time, though still 12% lower for the directly exposed relative to not directly exposed

Much of earnings recovery is driven by reconstruction

Spending levels fall 13% in the year after the tsunami

Directly affected still spending 8% less 10 years later (others recover)

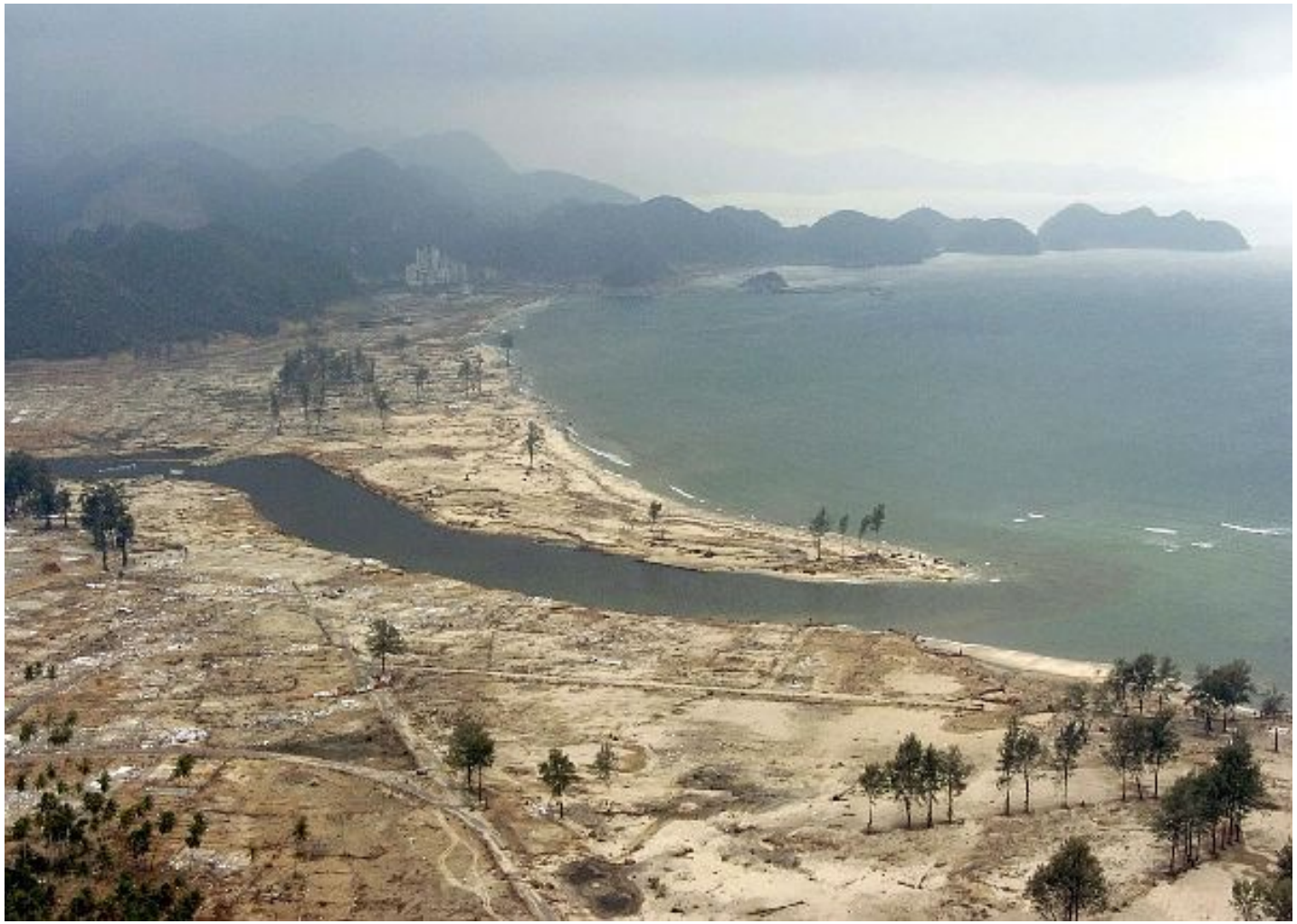
Short term increase in willingness to take on financial risk among the exposed, concentrated in younger individuals

Mechanisms:

- women enter the labor force, households start new businesses, assets are sold (and wealth goes down)

R. Lawton, E. Frankenberg, J. Friedman, D. Thomas. 2021. Long-term economic well-being after the 2004 Indian Ocean tsunami. Ingwersen, N., E. Frankenberg, D. Thomas. 2023. Evolution of risk aversion over 5 years after a major natural disaster. *Journal of Development Economics.*

Gradual restoration to places that look normal



Gradual restoration to places that look normal

Gradual restoration to places that look normal

ASSISTANCE HELPS!

- 21% of STAR respondents received an assistance home (~80% of those whose homes were destroyed)
- Receipt ***less likely*** among those with more resources before the disaster
- Among those who received a home:

  Levels of Post Traumatic Stress Reactivity (PTSR) ***decline significantly*** after receipt of that home

  Effect is concentrated among those whose home was destroyed

Laurito, Maria, Elizabeth Frankenberg, and Duncan Thomas. 2022. "Effects of Housing Aid on Psychosocial Health after a Disaster." *Int. J. Environ. Res. Public Health*, *19*(12), 7302

Discussion

- Exposure to climate change creates stressors that affect physical, psychosocial, and cognitive health over the short and longer-term
- The financial, social, and human resources with which people enter mid-life are likely critical for how old-age unfolds with respect to the implications of climate change for health and economics
- Institutions matter: they can reduce exposures and their consequence, these vary hugely across LMICs
- Housing and psychosocial health emerge as critical
- **Key questions:**
  - Cost-effective strategies for preventing / facilitating recovery from large negative climate shocks and/or less severe but more frequent “press” events
  - general equilibrium effects on economic and social systems
  - How these dynamics intersect with the aging process to generate differential vulnerability

Research Infrastructure

- Pre-event data, population representation and attention to tracking matter
- Efforts to conceptualize and measure exposure and assess its exogeneity also matter
- Important to capture variation in exposure
- National representation isn't always the right priority for studies of environmental exposures
- Scientific opportunity in building networks of studies using a natural experiment "dose of exposure" framework
- Comparisons across studies of different events and populations will be fruitful
- Adding (and assessing) interventions is key to reduce consequences for population health

Collaborators

Eileen Crimmins
Tom Gillespie
Maria Laurito
Ralph Lawton
Peter Katz
Jenna Nobles
Eric Peshkin
Sam Preston
Iip Rifai
Teresa Seeman
Bondan Sikoki
Cecep Sumantri
Wayan Suriastini
Duncan Thomas

Funding is gratefully acknowledged from:
National Institute on Aging at the National Institutes of Health [grant numbers R01 AG031266, R01 AG065395]; Eunice Kennedy Shriver National Institute of Child Health and Development at the National Institutes of Health [grant numbers R01 HD052762, R21 HD051970], the National Science Foundation [grant number CMS-0527763], the World Bank, the Hewlett Foundation, the MacArthur Foundation [grant number 05-85158-000] and the Wellcome Trust [106853/A/15/Z];