



University of Hawai'i



UHERO

THE ECONOMIC RESEARCH ORGANIZATION
AT THE UNIVERSITY OF HAWAII

From Disaster Recovery to Recovery Intelligence: Maui as a Sentinel Model for National Wildfire Health Recovery

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MauiWES.org

State of Hawaii, Kaiser Permanente, HCF
NIH R61MD019793, AirHEALTH (P01HL152953)

Why Maui Matters Nationally: A Sentinel for Rural Wildfire Recovery

SCALE OF THE DISASTER

Deadliest U.S. wildfire in over a century

Lahaina + Kula sustained the highest exposure and structural damage during the fires.



LOCAL SHOCK → NATIONAL MECHANISMS

Maui is a high-resolution sentinel: it shows what becomes visible when exposure, biology, health, and social recovery are measured together.

3,263

structures exposed
Lahaina + Kula

2,848

acres burned
exposure estimate

11K+

Displaced
Individuals in a
rural area with
limited housing

Mechanisms to monitor nationally



Environmental footprint

smoke + ash + metals +
burn debris

physical
health



Recovery instability

housing + income
+ food security

mental
health



Access & visibility gaps

care access + language +
trust

hidden
burden

NATIONAL LESSON

Measure both:

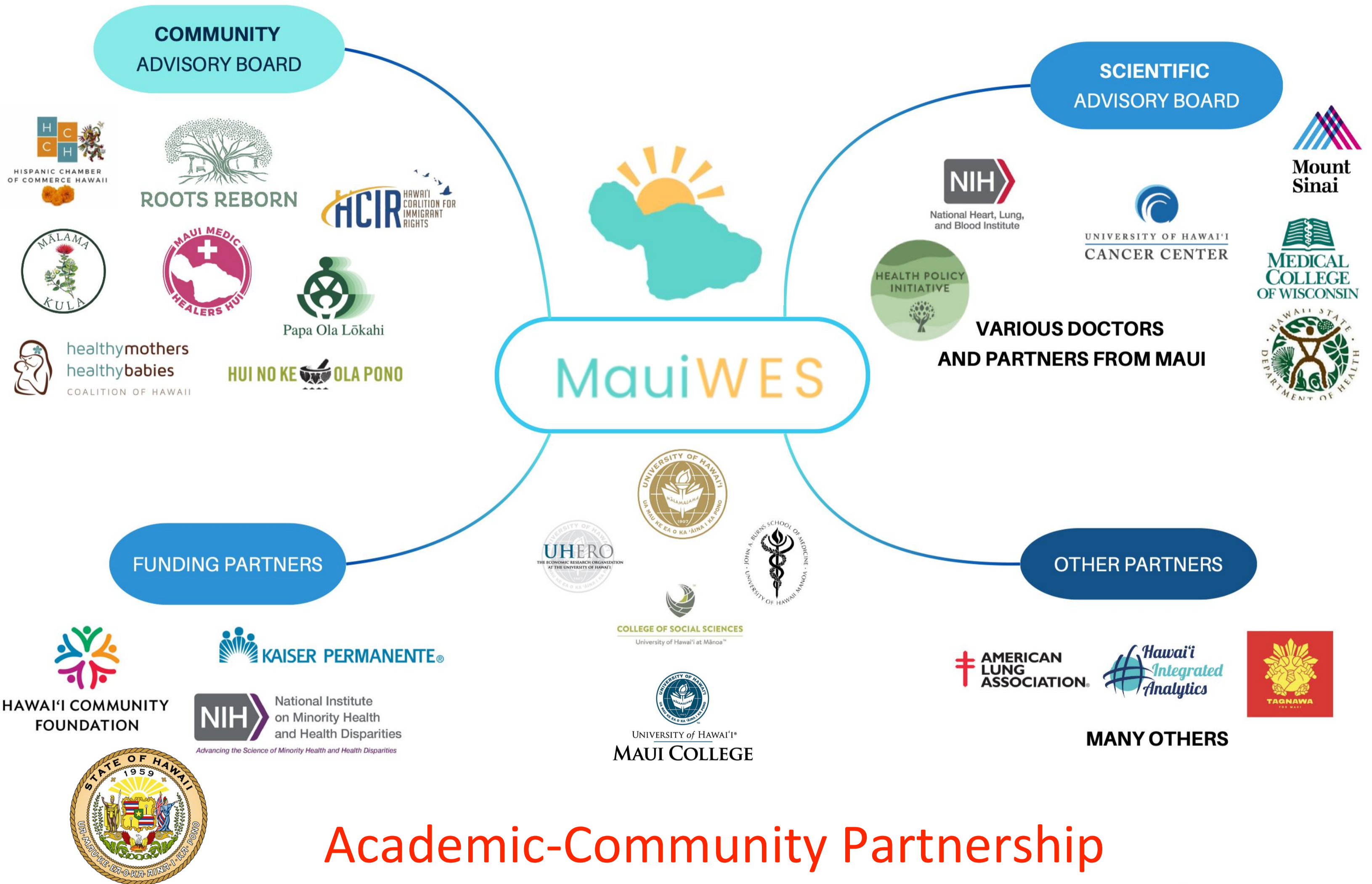
exposure
+
recovery conditions
+
trajectories over time

Not just burn perimeters
or hospital visits.

The fire was local. The mechanisms are national.

Environmental exposure & recovery conditions interact to shape who recovers and who is left behind

Maui Wildfire Exposure Study (MauiWES)



Academic-Community Partnership

to better understand and address short- and long-term health impacts



JOHN A. BURNS
SCHOOL of MEDICINE

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MauiWES: Community-Based Recovery Intelligence System

Data Components

Questionnaires

- Demographics
- Housing Stability
- Food Security
- Employment
- Exposure
- Resiliency
- Social Support
- Health Behaviors
- Perceived Trust
- Etc...

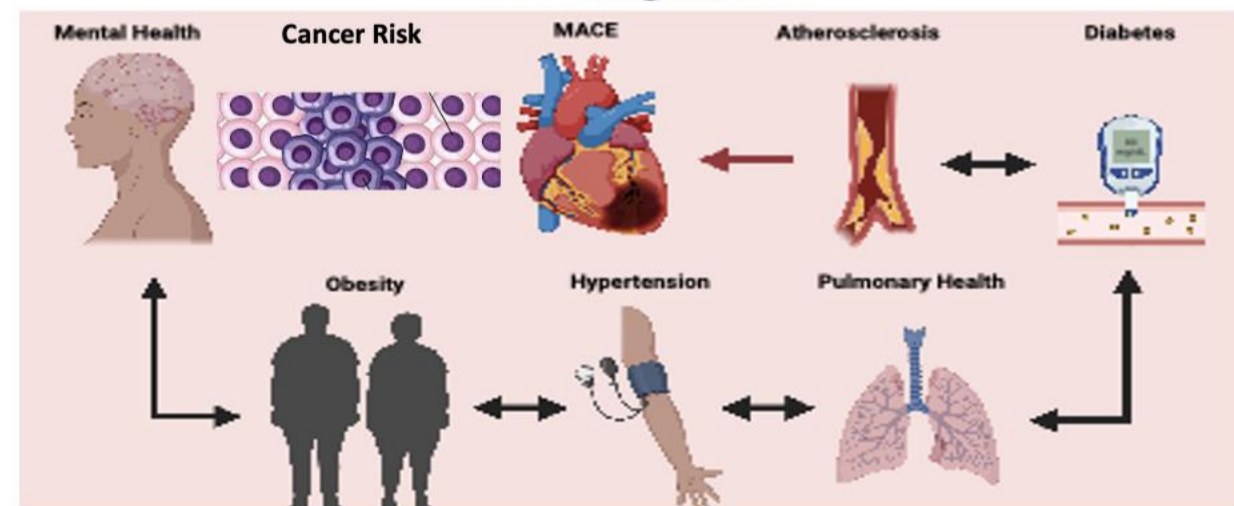
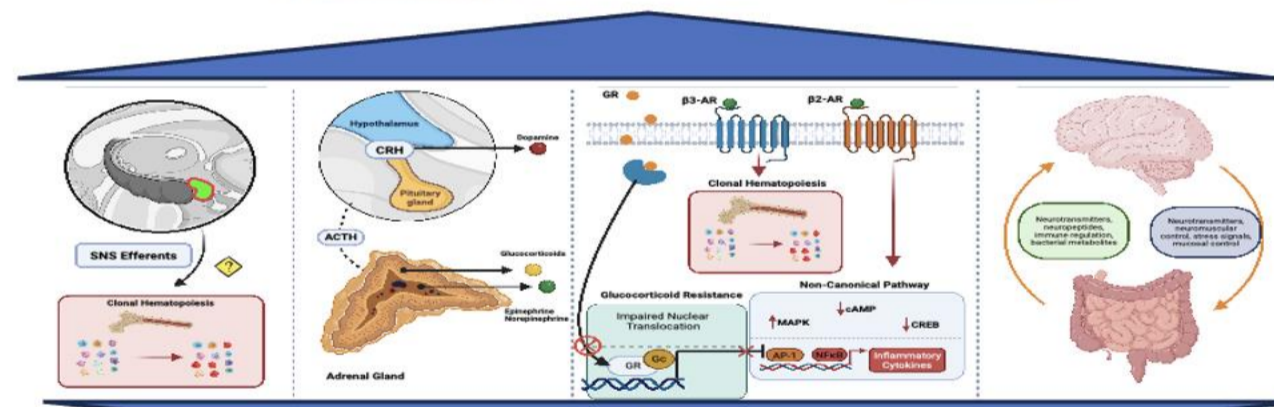
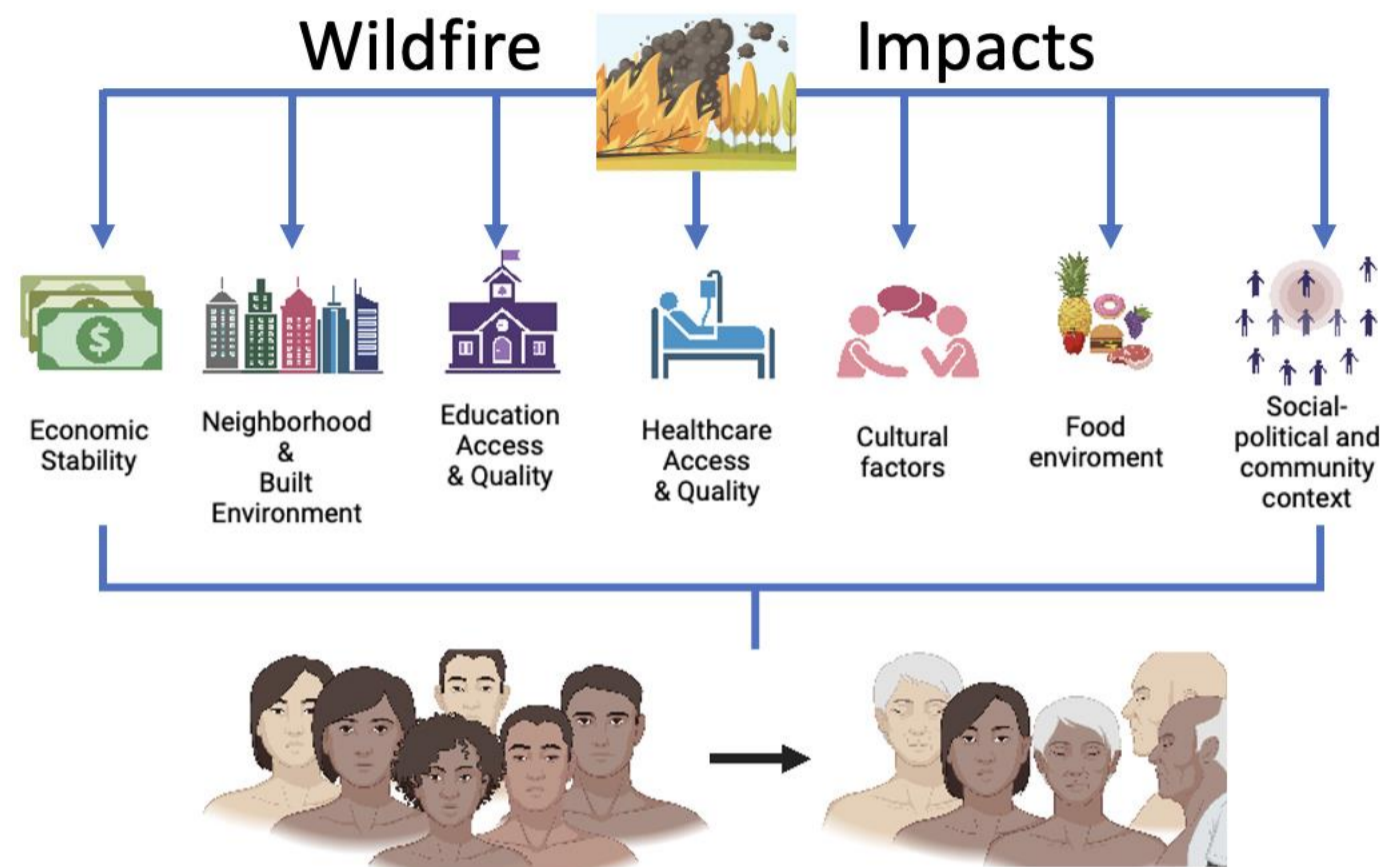
Biospecimens

- Stress Response
- Inflammation
- Environmental Toxicants

Health Exam

- Lung Health
- Cardiovascular Health
- Metabolic Health
- Mental Health
- Cancer Risk (EMR)

Participant Involvement



Since Jan. 2024: **2,000+** adults and children (8-17 y/o); annual follow-up

MauiWES captures health impacts that never appear in emergency room or hospitalization data, especially in rural, under-resourced communities.

MauiWES Enrollment 6-30 months after the Wildfire



2,000+

Served in Year 1

Maui residents affected by the 2023 fires

1,200+

Returned in Year 2

A signal of trust, need, and sustained impact



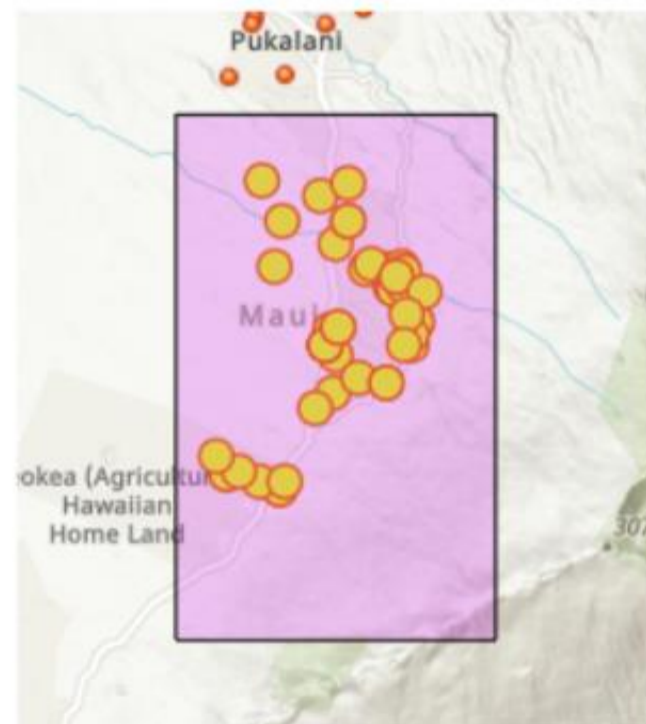
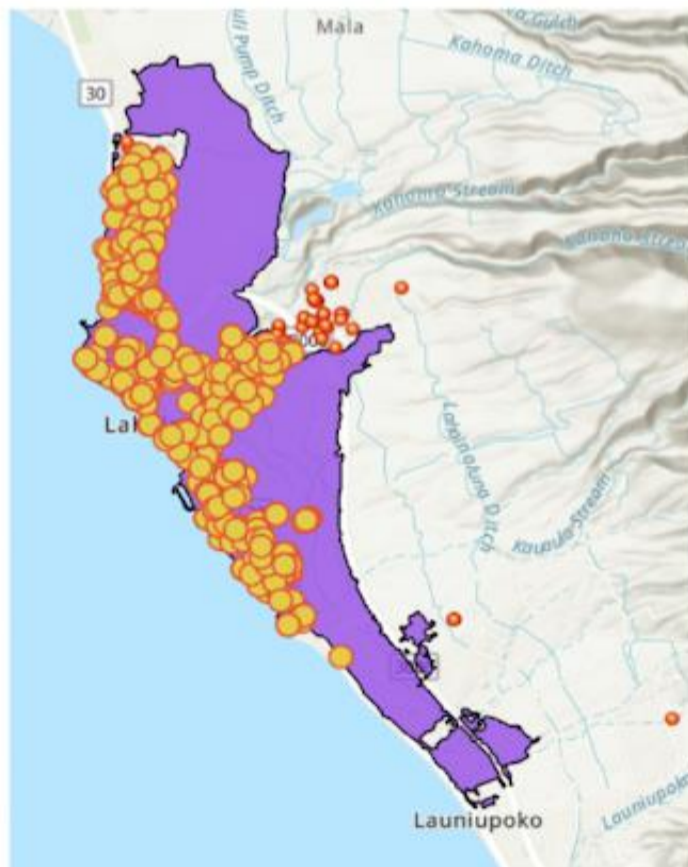
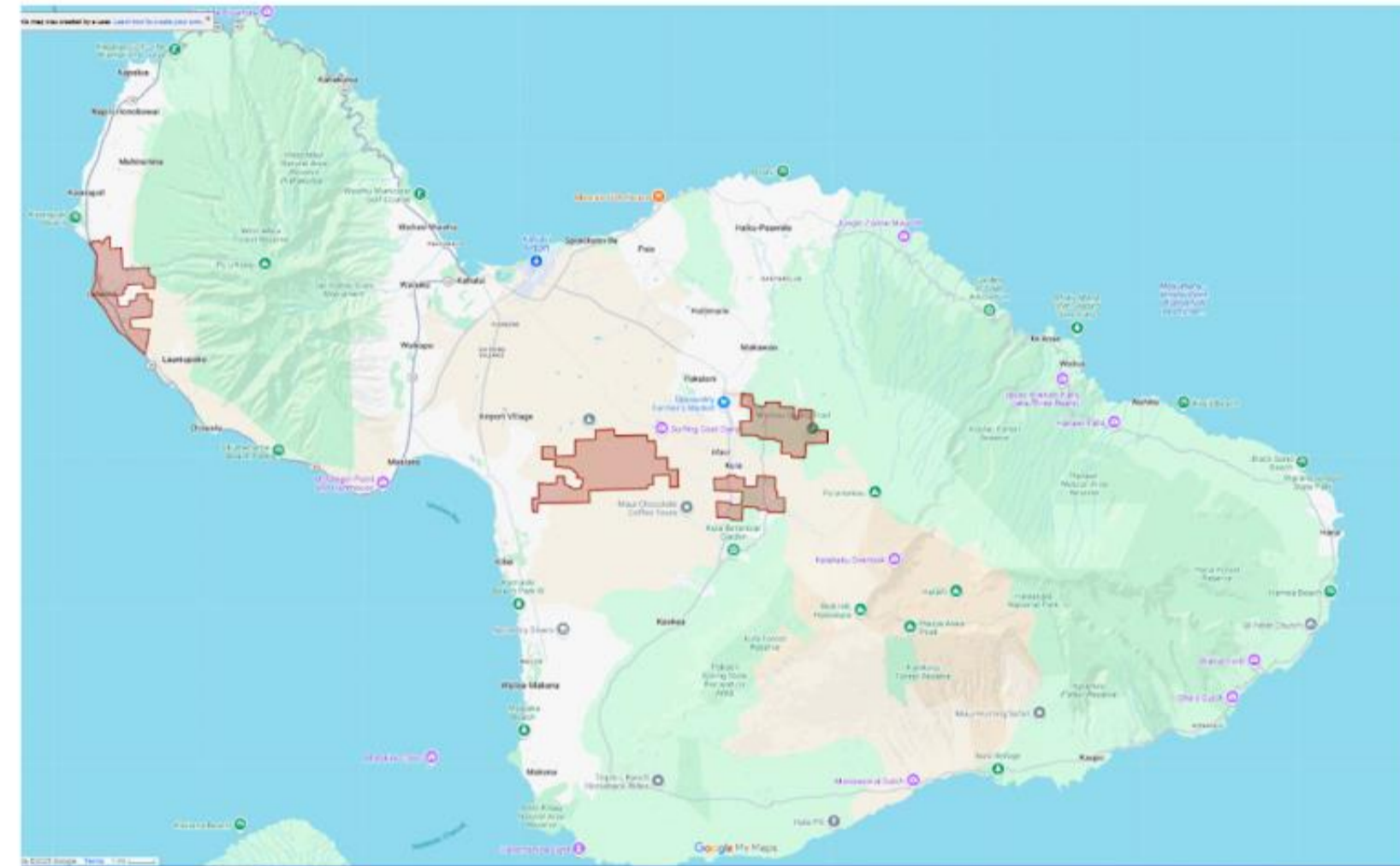
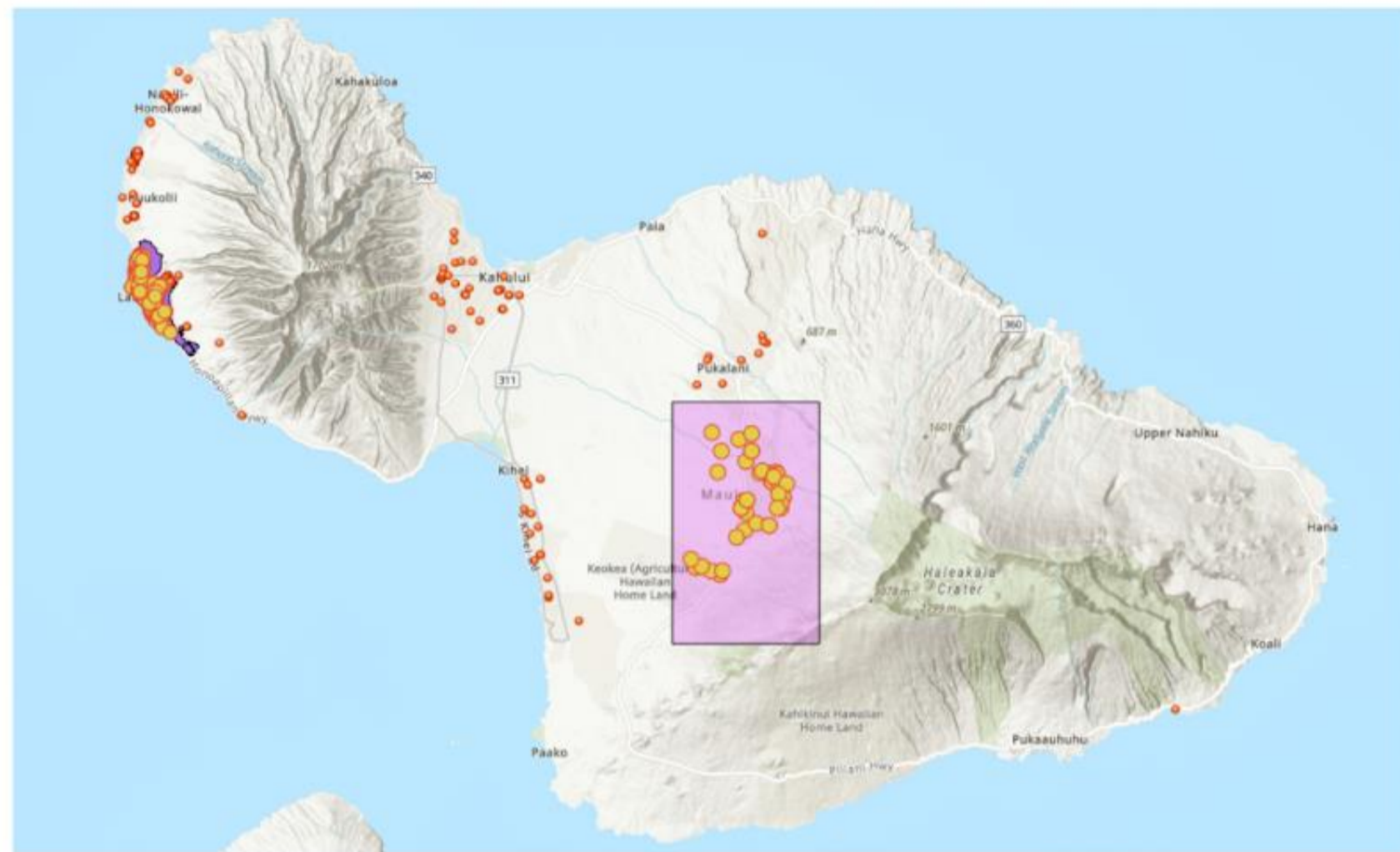
3,000+

Goal in Year 3

Scaling monitoring and service connections across Maui

From response to medical infrastructure in a rural / underserved community

Island-Wide Recruitment With Direct and Indirect Wildfire Exposure



Participants were recruited island-wide, spanning both direct wildfire exposure in burn zones and indirect exposure outside burn zones.

Health Impacts 6–36 Months After the Maui Wildfires



Overall Health Decline

46% report worse health than before the fire



Mental Health

1 in 5 PTSD • 1 in 2 depression
• 1 in 4 anxiety



Lung Function

25% reduced FEV₁; steepest declines in burn zone



Toxic Exposures

Antimony >10× • Mn 5× •
Arsenic ~3× vs NHANES

**Juarez & Maunakea et al, *JAMA Network Open* 2025; *JAMA Psychiatry* 2026
& other reports available at [MauiWES.org](https://mauiwes.org)**

Environmental exposure leaves a biological footprint

Recovery surveillance must connect place, exposure, biology, and health rather than treat them as separate systems.

MauiWES links exposure data to human outcomes

Wildfire recovery is not only social or psychological.

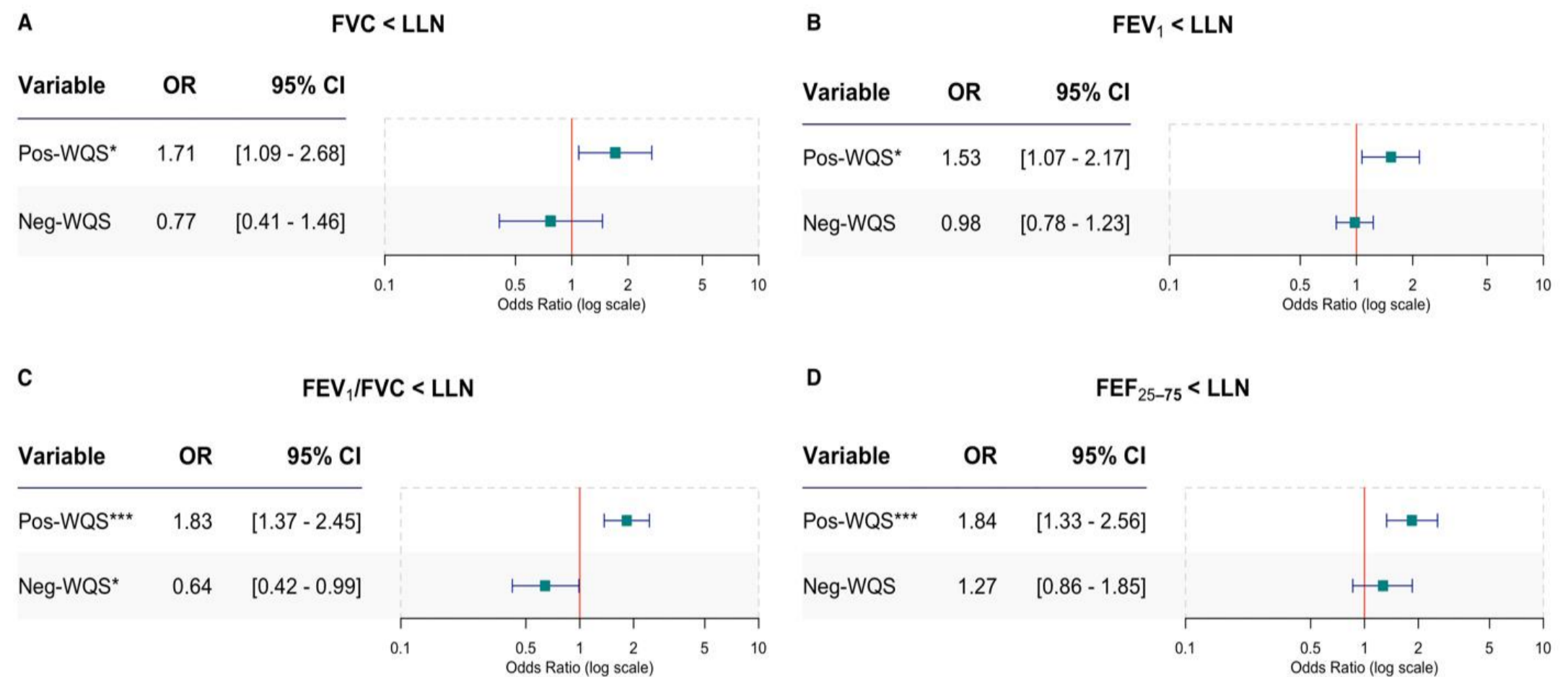
Smoke, ash, metals, and burn debris can leave measurable biological signals months after the fire.

smoke + ash

metals

burn debris

Biomonitoring + spirometry reveal risks that may never appear in the emergency room or claims data.



Elevated urinary metals
internal exposure signal

Reduced lung function
respiratory impairment

Place-specific patterns
geography matters

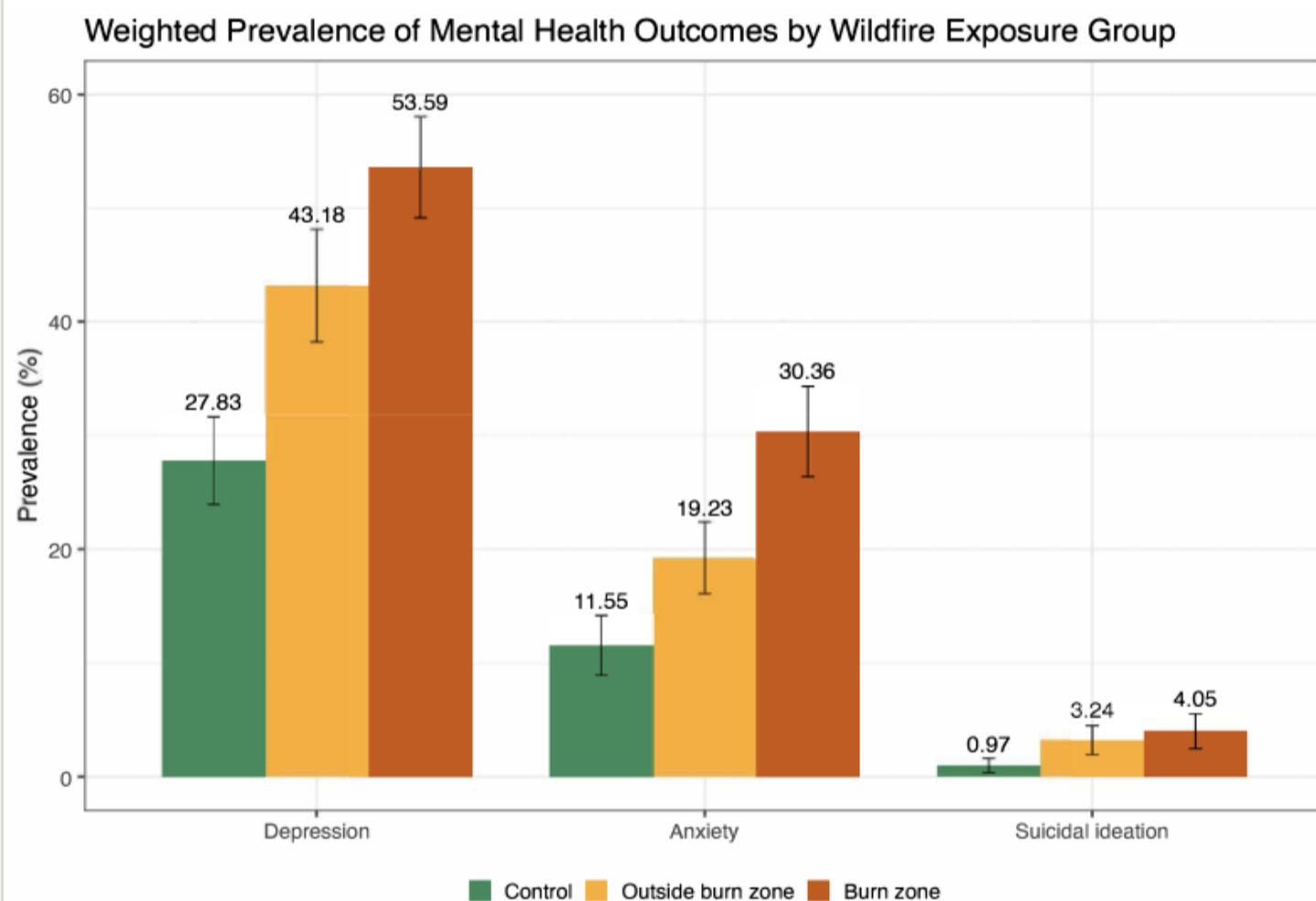
Policy implication

Environmental monitoring must be linked to health screening and longitudinal follow-up; otherwise, we measure hazards without knowing who is harmed.

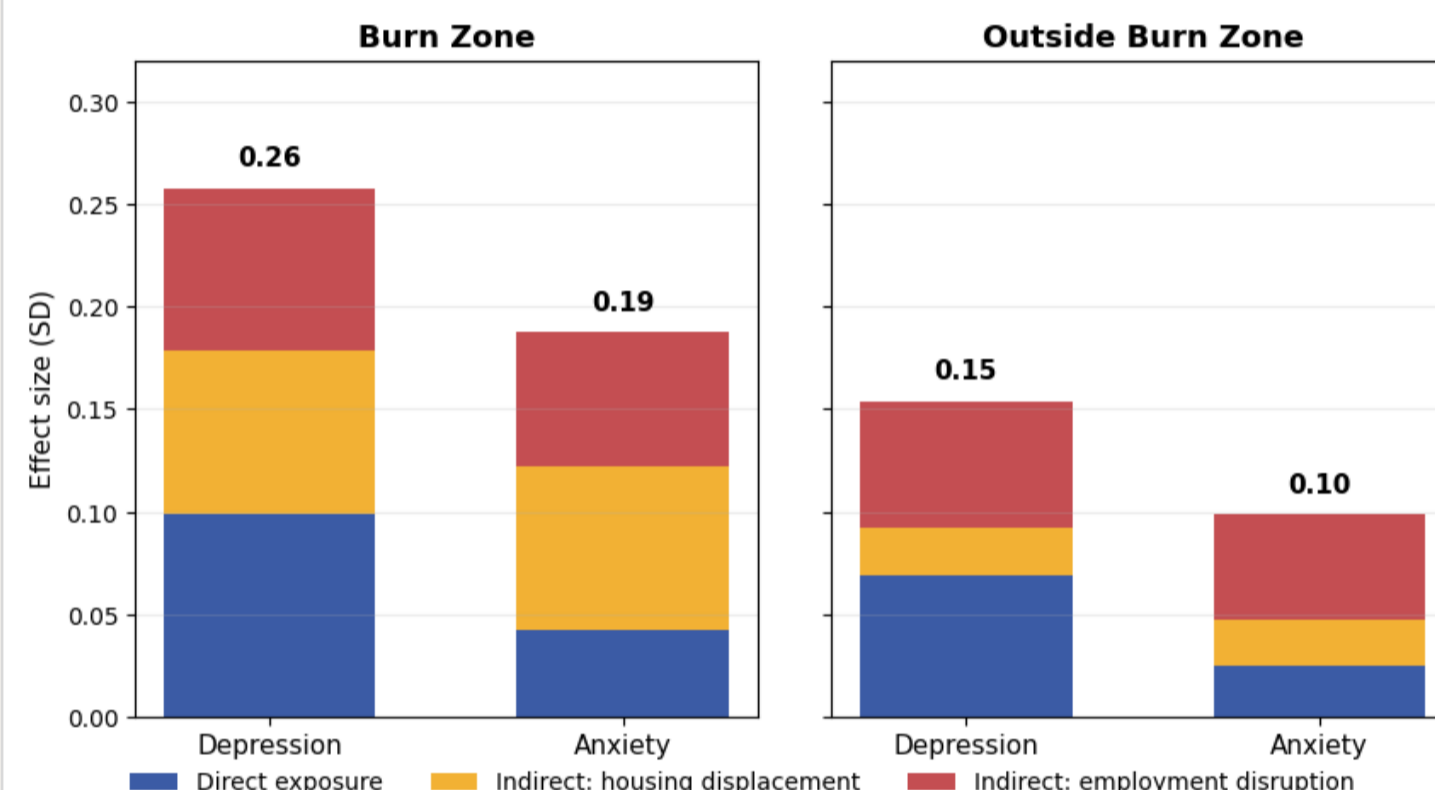
Year 1: Mental health impacts spread beyond the burn zone

Burn zones have the highest burden. **But the mental health effects spill across Maui.**

Stepwise burden by exposure



Indirect pathways explain most of the effect



1 Mental health worsens outside the burn zone too: evidence of island-wide spillover effects, not just burn-zone harm.

2 More than half of depression and anxiety impacts are mediated by displacement and job disruption: especially in burn zones.

This is not only a burn-zone problem. It is an island-wide recovery problem.

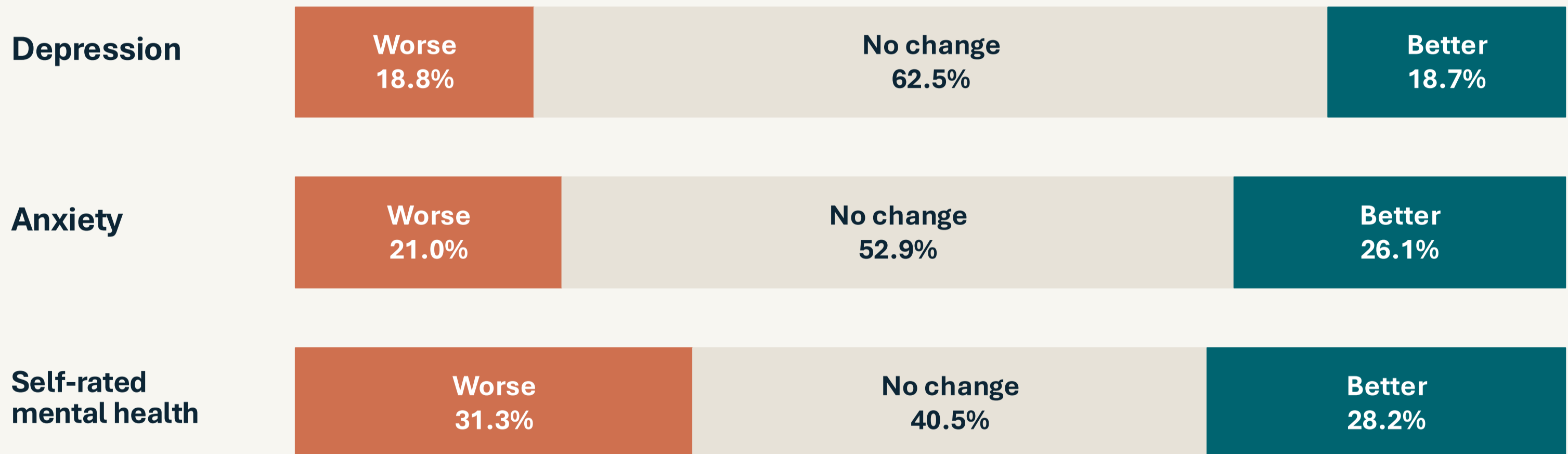
Year 2 Paradox: Stable Averages, Divided Recovery

Depression and anxiety changed little on average for 1000+ adults across years 1 and 2, but many participants worsened or improved.

Worse No change Better

Year 2 prevalence context:
Depression: 52.6% | Mod/sev anxiety: 24.7%

IMPROVED / STABLE / WORSENE D TRAJECTORIES FOR 1000+ ADULTS



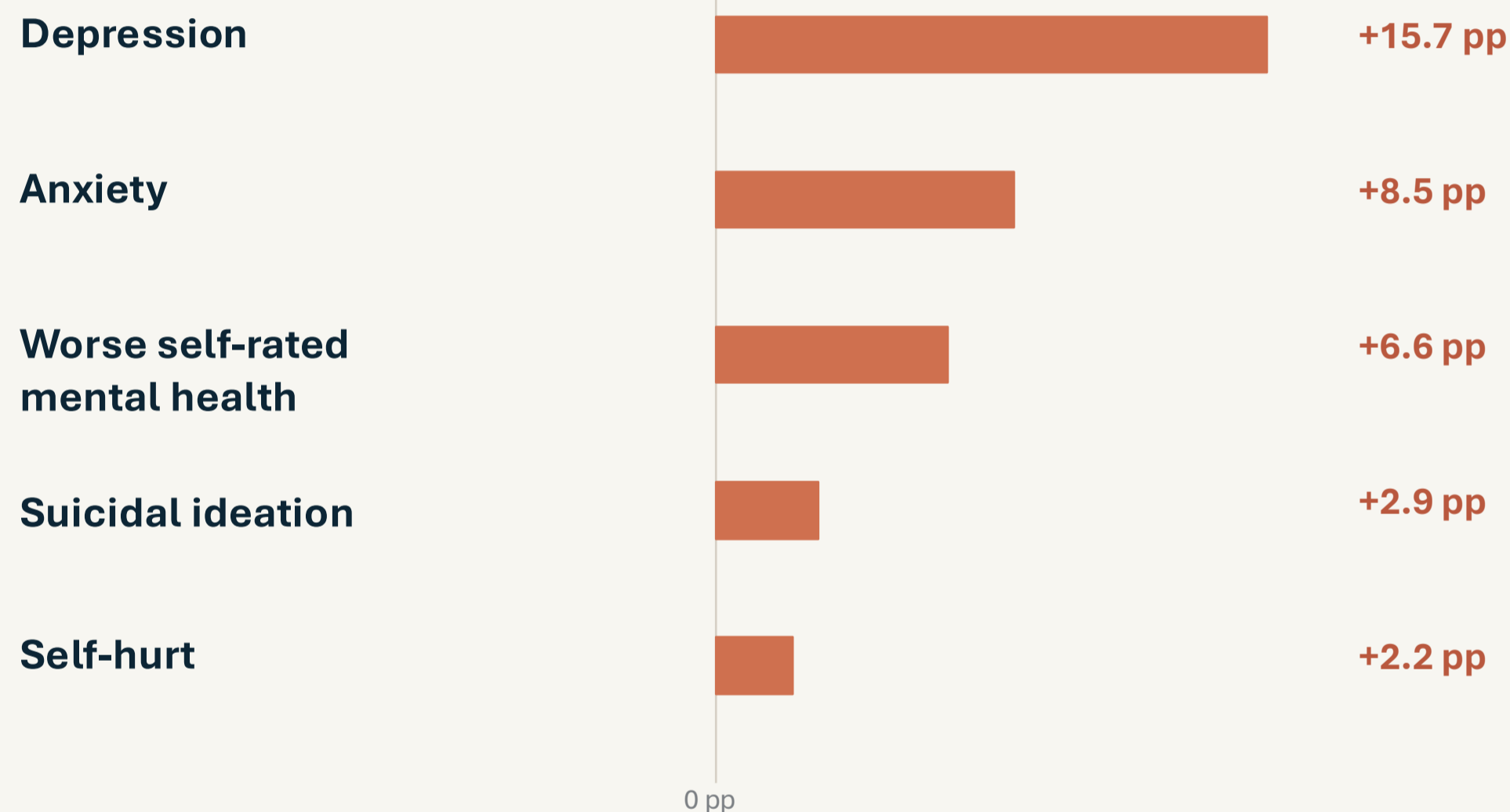
Policy Implication: Measure trajectory, not just averages. The averages mask the disparity.



Persistent food insecurity identifies a high-risk mental-health trajectory

Adjusted marginal effects: percentage-point difference associated with persistent food insecurity.

ADJUSTED PROBABILITY DIFFERENCE



Food insecurity is not only a social outcome associated with income. It is also a clinical risk marker linked to mental health outcomes.

+15.7 pp

higher adjusted probability of depression among participants with persistent food insecurity

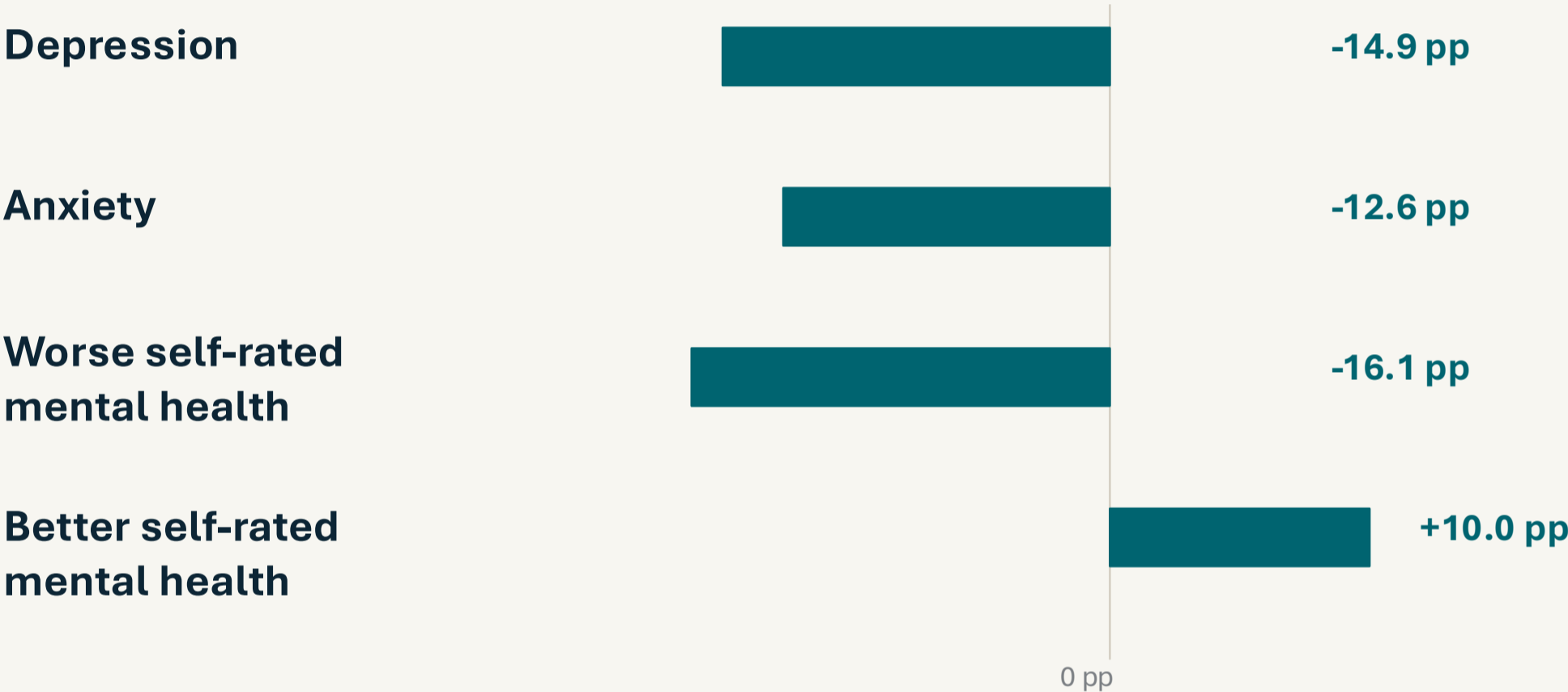
In Year 2, mental-health risk concentrates where basic recovery needs remain unmet. Risk ratios and marginal effects show the same pattern.



Housing security, not temporary housing alone, predicts mental-health recovery

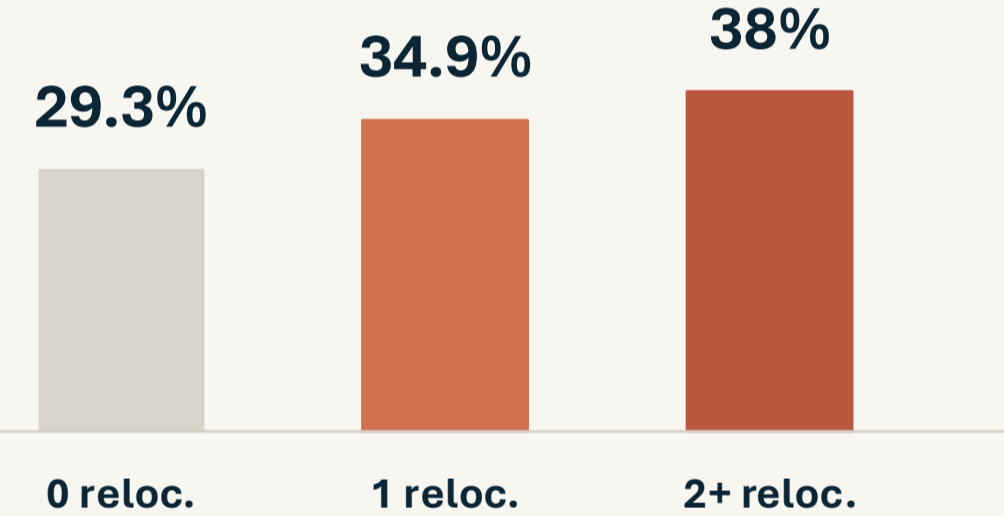
Housing secure = stable and economically secure housing: affordability/rent burden and low risk of another move.

ADJUSTED PROBABILITY DIFFERENCE



RELOCATION BURDEN

Worse self-rated mental health rises with repeated relocation



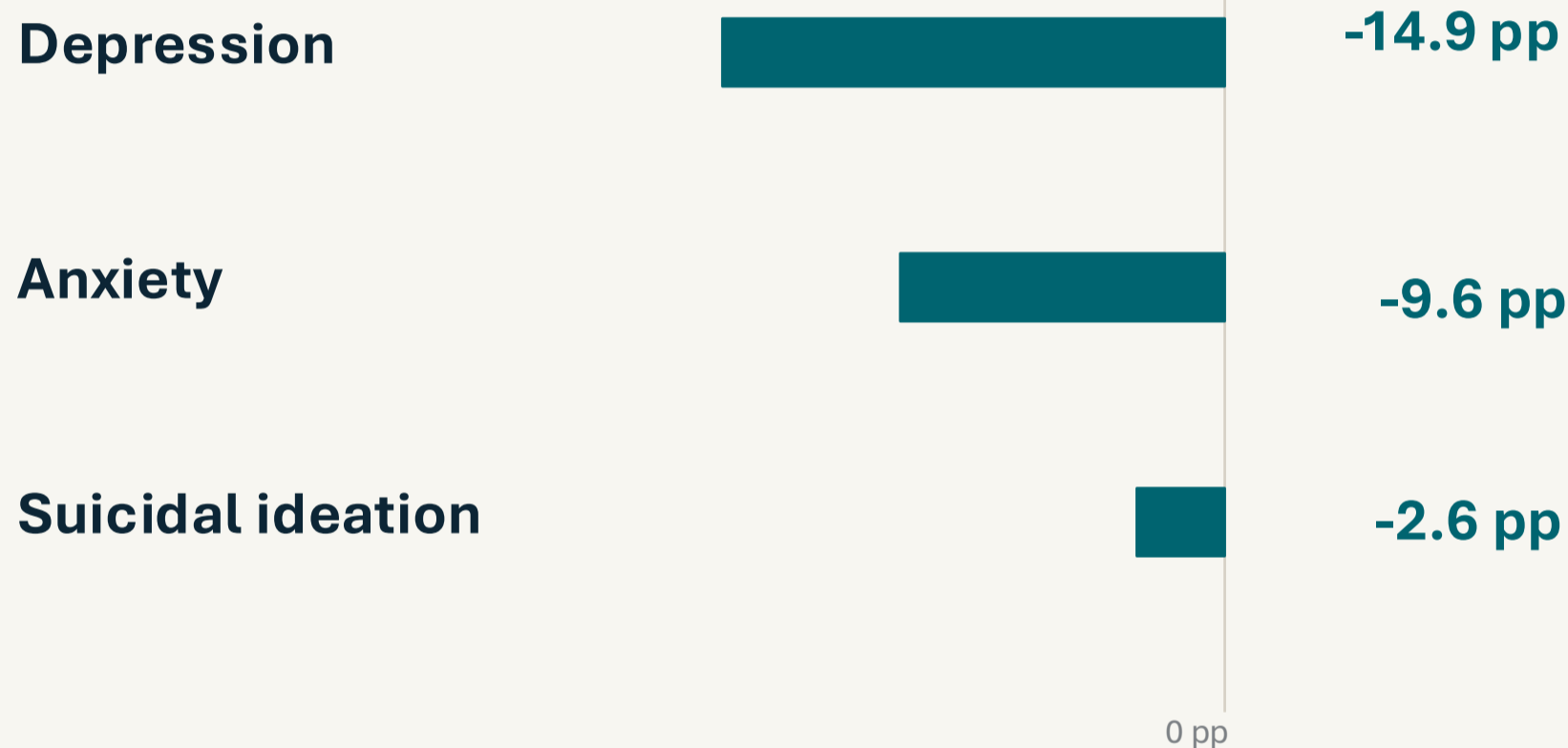
Persistent temporary housing alone was not significant for depression, anxiety, or self-rated mental health.

Policy implication: Count not only housing placement, but housing affordability, stability, and relocation burden.

Social Support Is Measurable Recovery Infrastructure

Adjusted marginal effects: persistent or gained high social support is associated with lower mental-health burden.

PROTECTIVE ASSOCIATION



Persistent/gained high social support is a measurable recovery resource.

OTHER ANALYSIS IN PROGRESS: Recovery infrastructure



Mental & Physical Health Recovery

Rebuilding after a disaster must focus on restoring the social conditions that make recovery possible: food, housing, social support, access to healthcare, income, etc.

The National Opportunity: Build Recovery Intelligence Before the Next Fire

From Hawai‘i, California, Colorado & Alaska → Nebraska, Florida & beyond

A public-health infrastructure opportunity: detect risk, target support, and learn across fires.

What must be linked:

● **Exposure + environment**
smoke • ash • metals •
burn debris

● **Biology + health**
lung • mental health •
chronic disease • children

● **Recovery conditions**
housing • food • income •
care • support



So systems can:

SEE EARLIER
hidden burden before crisis

ACT FASTER
referrals, outreach, housing +
food support

LEARN NATIONALLY
compare fires; target
prevention; measure recovery

A registry should not only count exposure but also help prevent delayed harm

Not an archive of harm but an operating system for prevention.

FINAL TAKEAWAY

Recovery is a trajectory, and trajectories can be changed.

The future of wildfire preparedness is not only fire suppression, evacuation, and rebuilding. It is recovery intelligence.

Measure who is exposed, who is worsening, what support changes trajectories, and whether recovery reaches the people most at risk.

SEE

Hidden burden before crisis

ACT

Connect people to services and stabilization support

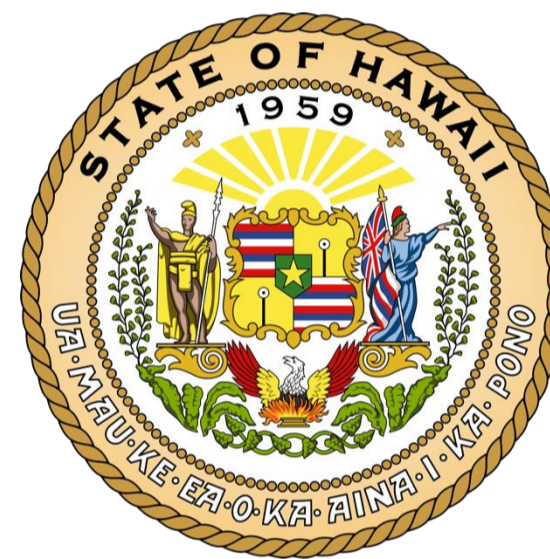
LEARN

Evaluate what works across fires

The fire was local. The mechanisms are national. The recovery infrastructure should also be national.

Build recovery intelligence before the next fire to enable prevention.

Mahalo to Our Partners and Funders



State of Hawaii, NIH R61MD019793, AirHEALTH (P01HL152953) UHERO