Biomarkers in the Social Sciences
&
The Biobehavioral Health Lab at UCSB

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Development and use of biomarkers is on the rise...

Because biomarkers are important windows to physiological processes & how our environments “get under the skin.”

PubMed citations referencing “biomarker” as a keyword 2000-2009
Growing synergy of biomedical & life sciences with social science

- Biomedical
- Social

- Social
- Biomedical

- THE LANCET
  Public Health
  Social determinants of health inequalities
  Prof Michael Marmot

- SOCIOLOGY OF HEALTH & ILLNESS
  ORIGINAL ARTICLE
  Messengers of stress: Towards a cortisol sociology
  Celia Roberts, Brigit McVade
  First published: 31 May 2021 | https://doi.org/10.1111/1467-9566.13261
<table>
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<tr>
<th>Biomedical</th>
<th>Social</th>
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<td>NHANES</td>
<td>Women’s Health Initiative</td>
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<td>Whitehall Study</td>
<td>Framingham Heart Study</td>
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<td>MacArthur Study of Successful Aging</td>
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<td>National Longitudinal Study of Adolescent Health</td>
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<td>Reasons for Geographic and Racial Differences in Stroke (REGARDS)</td>
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Biomarker literacy increasingly valuable to social scientists
Biomarkers help identify subclinical signs of disease

Type II Diabetes  Stroke  Alzheimer’s
Oxidative damage  Malnutrition  Hypertension  Inflammation

Determine high risk individuals before major sickness
Target social and medical interventions
Reveal environmental & lifestyle risk factors of morbidity and mortality
Field-friendly techniques with broader impacts to communities

Photos: Mike Gurven
Who am I?

I’m a primate behavioral ecologist.

I use biomarkers, behavioral observations, and demographic data to evaluate

- Social & physical changes with age & exposures
- The hidden costs and benefits of sociality

Stronger social bonds do not always predict greater longevity in a gregarious primate
Nicole A. Thompson, Marina Cords

Urinary markers of oxidative stress respond to infection and late-life in wild chimpanzees
Nicole Thompson González, Emily Otali, Zarin Machanda, Martin N. Muller, Richard Wrangham, Melissa Emery Thompson
Roadmap

- What are biomarkers and what do they measure?
Roadmap

- What are biomarkers and what do they measure?
- How do biomarkers add value to the social sciences?
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- What is the Biobehavioral Health Lab at UCSB?
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- What are the ethics and logistics of biomarker data collection?
What are biomarkers?

A biological measure of a biological state.

“A characteristic objectively measured and evaluated as an indicator of normal biological processes, pathogenic processes, or pharmacological responses to a therapeutic intervention”

- National Institutes of Health
What are biomarkers?

Physical attributes

- Height
- Body Mass Index
- Blood pressure
- Respiratory rate
- Skin fold thickness

Biochemical actors

- Hormones
- Cytokines
- Cells (e.g. immune)
- Their by-products & metabolites

Products of physical damage

- ... to cells, DNA, proteins, and lipids
What are biomarkers?

“Dry”

- Physical attributes
  - Height
  - Body Mass Index
  - Blood pressure
  - Respiratory rate
  - Skin fold thickness

“Wet”

- Biochemical actors
  - Hormones
  - Cytokines
  - Cells (e.g. immune)
  - Their by-products & metabolites

- Products of physical damage
  - ... to cells, DNA, proteins, and lipids
Perspectives: no biomarker is simply “good” or “bad”

Health

Physiological processes relative to a standard or baseline

Evolutionary Life History

Relative investment in different processes given finite energy
What do biomarkers measure?

- Metabolism/Stress
- Immunity/Inflammation
- Reproduction
- Oxidative Damage
Estradiol
Follicle Stimulating & Luteinizing Hormones
Progesterone
Chorionic Gonadotropin
Prolactin
Oxytocin
Testosterone

Metabolism/Stress
Immunity/Inflammation
Oxidative Damage
Reproduction
Metabolism/Stress

Reproduction

8-OHdG (DNA)

Isoprostanes, TBARS (Lipids)

Oxidative Damage

Disease risk & Aging

Immunity/Inflammation

Carbonyls, Dityrosine (Proteins)

Reproduction
Where do we get biomarkers?
Where do we get biomarkers?

Cortisol, Estradiol, Testosterone, Oxytocin, Cytokines

Damn near everything: metabolic, immune, reproductive, oxi-damage

Most metabolic & reproductive hormones, Oxidative damage

Metabolites of metabolic & reproductive hormones, mucosal immunity
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How do biomarkers add value to the social sciences?

- Not the “real” picture - a more holistic one
Nuances of self-rated health (SRH)

- SRH widely used (excellent to poor)
- **Education** can bias individual standards/expectations of health

- In study, biomarkers of cardiovascular health aligned closely with SRH
- But **within each SRH category**, respondents with more education had healthier levels of biomarkers.
How do biomarkers add value to the social sciences?

- Not the “real” picture - a more holistic one
- Develop interdisciplinary collaboration
  - Can lead to novel approaches to important questions
How do biomarkers add value to the social sciences?

- Not the “real” picture - a more holistic one
- Develop interdisciplinary collaboration
  - Can lead to novel approaches to important questions
- Delineating pathways between social experience and health outcomes better informs policy & targeted interventions
Key areas of value

Social Inequalities  Cooperation & Competition
Social Inequality yields Health Disparities

Falling along lines of

Socioeconomic Status
Income
Education
Gender Inequality
Immigration
Racialization
Nested levels of causal influence of sociality on biology
(Adapted from Gravlee 2009, AJPA)

How do social experiences “get under the skin”? 

Genome

Cell

Organ

Systems Biology

Global Political Economy & Ecology

Social Structure & Culture

Social & Physical Environment

Individual Experience

Phenotype

Embodiment

Time
Socioeconomic Status: Wealth

Wealth inequality corresponds with higher blood pressure in the absence of large lifestyle differences.

Jaeggi, Blackwell, ... Gurven 2021 eLife

- Tsimane of Bolivia
- Risk of hypertension increase with lower household wealth and community-wide inequality (Gini)
Blood pressure increases with cortisol

**Background: Cortisol regulation**

Cortisol follows a circadian rhythm

Peak at waking, then decline

Slope of decline indicates regulation, total area under the curve indicates absolute exposure

Both predict metabolic and cardiovascular health outcomes
Socioeconomic Status: Wealth and Prestige

Perceived SES corresponds with salivary cortisol & its regulation.

*Utila Island; Garcia, Blackwell, Gurven 2017 AJHB*

Perceived lifestyle discrepancy:

How great is your inability to meet your perceived needs?

High Medium Low

Categories correspond with “area under the curve”
Socioeconomic Status: Wealth and Prestige

Life at the top isn’t always easy.

In Tsimane, salivary cortisol increases with income among men (Von Reuden ... Gurven 2014 EMPH)

Activity & pressure/vigilance associated with market integration

“Executive stress” apparent when hierarchies are unstable
Mo $ mo problems: A cross-species trend

Mirrors stressors of highest rank in non-human primates: chimpanzees (Muller Wrangham 2004 BES), baboons (Gesquiere et al 2011, Science)

Why males? Common differences in male vs female hierarchies

Important to tease apart energetic and psychosocial stressors associated with status.
Gender Inequality

Background: Matriliny & Patriliny

Systems for recognizing kinship
Allocating wealth/resources to kin
Under matriliny, wealth is passed to daughters’ children
Opposite in patriliny
Women have greater authority over resources in matriliny vs patriliny

Lowes 2020
In Mosuo of China, women’s health risks under patriliny reversed under matriliny.

Reynolds et al. 2020 PNAS
Racialization

- The assignment of a racial character to some one or thing
- A social categorization of physical differences
- Does not represent biologically meaningful categories
Racialization

Assigned race predicted women’s live birth ratios whereas SES did not.

*Shirazi & Rosinger 2021, JREHD*

NHANES 2007-2016: Non-Hispanic Black women 10% fewer live births to pregnancies than non-Hispanic White women.

Income and education no effect.
Racialization: possible mechanism on live birth ratio

Salivary estradiol decreases with greater self-reported stress.

*Roney & Simmons 2014, AHBP*

Low estradiol is key in miscarriage.

HPA axis interacts with HPG axis.

In NHANES study, greater perceived discrimination could complicate reproductive outcomes.
Cooperation and Competition

Testosterone

Oxytocin
Oxytocin (OT): selective cooperation

- Oxytocin’s prosocial effects appear parochial.
- OT release promotes social discrimination.
- Suppresses cooperation with out-group.
- Measurable in saliva.

Adapted from De Dreu 2012 H&B
Oxytocin (OT): selective positive parental behavior

Early life adversity moderates OT influence on maternal behavior.

Among impoverished mothers,
Those without adverse childhood experience (ACE) increased positive parenting with OT.
Those with greater childhood adversity decreased positive parenting with OT. More guarding behavior.

Julian et al 2018, AWMH
Testosterone

Robert Sapolsky *The Trouble with Testosterone*

Testosterone does not cause aggression.
Testosterone: competitive generosity

Testosterone enhances punishment and reward.

Ultimatum game

Dreher et al. 2016 PNAS

Men treated with testosterone v. placebo more frequently punish proposers that offer low amounts.

Likewise, more frequently reward proposers that offer high amounts.
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Biobehavioral Health Lab: Who we are and what we do
The Biobehavioral Health Lab at UCSB

- Specialize in radio- and enzyme- immunoassays for biochemical agents
  - Cortisol
  - Energy balance
  - Inflammation and immune activity
  - Reproductive hormones
  - Oxidative damage
- Ready to process and assay blood, saliva, urine, fecal samples
- High throughput
- Aim to purchase reagents and avoid more expensive kits
The Biobehavioral Health Lab at UCSB

Abundant training opportunities on sampling protocols, immunoassays, genotyping, and parasitology.
Undergrad and grad lab seminars

Come learn with me!

Winter:
- ANTH 197: Undergrad lab course on biomarkers and behavior

Spring:
- ANTH 253: Graduate lab course & seminar
- ANTH 123MG: Data analysis for the social sciences using R

Questions? Email me at natg@ucsb.edu
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Ethics & Logistics

This ain’t magic.
Requires community relationships
Careful thought
Some theoretical & logistical expertise
Ethics and community relationships

Specifics vary from project to project

Basics: ongoing transparency & trust

Broader impacts:

- Engagement
- Capacity building
- Education
- Clinical care
- Point of care data
Broader impacts in community

Point of Care glucose data for the Shodagor in Matlab, Bangladesh

Kathrine Starkweather, UIC

- Local physicians/trainees
- Communicating what’s being measured
- Significance of individual scores (e.g. relative to other ranges)
- Opportunity for participant questions

Blood glucose
HbA1c
Logistics of incorporating biomarkers

Consult with the Biobehavioral Health Lab!

We can help you consider

- Community relations and ethics
- Bodily function of interest
- Sample type (e.g. blood, saliva, urine)
- Sampling regime (timing, frequency)
- Sampling protocol (person power, equipment)
- And pipelines for data and sample management
Summary

- Biomarkers are diverse set of proxies of important physiological processes ... and they are becoming widely used in social science.
Summary

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- Biomarkers provide a window onto the pathways by which environments get under the skin and further influence our behavior.
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- The Biobehavioral Health Lab is a vibrant center for advising projects, training students, and generating biomarker data.
Summary

- Biomarkers are diverse set of proxies of important physiological processes.
- Biomarkers provide a window onto the pathways by which environments get under the skin and further influence our behavior.
- The Biobehavioral Health Lab is a vibrant center for advising projects, training students, and generating biomarker data.
- Prioritize ethics and logistics require careful thought and they benefit from consultation.
Thanks to

The Broom Center for Demography

Dean Hale

Integrative Anthropological Sciences lab group

Mike Gurven

Michelle Brown

Amy Boddy

Lab undergrads and trainees

Reach me at natg@ucsb.edu

Twitter @NicoleAlineSci
Appendix slides
Logistics of incorporating biomarkers

Sample type: for physical and temporal scales

- Hair (weeks/months)
- Feces (hours/days)
- Urine (mins/hours)
- Saliva (mins)
- Blood (secs)

Sample timing: thinking in cycles
Logistics: Person power

Whole blood:
- Certified phlebotomist
- Nurse/Physician
- Veterinarian

Blood spots, saliva, urine, stool: any trained researcher
Logistics: Planning your pipeline

We can help you plan...

Short term storage → Transport → Long term storage → Assays

-20° to -80°C

Data interpretation
Costs of assays

Immunooassays range from $1.30 - $15 per sample...

Finding bulk reagents instead of specialized kits saves money.