At the Crossroads of Oral Health Inequities and Precision Public Health

UCSF Center to Address Disparities in Oral Health

Director: Stuart A. Gansky, DrPH
Professor and Lee Hysan Chair of Oral Epidemiology
Member, Institute for Computational Health Sciences

AIDPH, San Antonio, Jan 2018

UCSF Center to Address Disparities
in Oral Health

US DHHS NIH/NIDCR U54DE014251, R03DE018116, R21DE018650, R21DE019210, U54DE019285, P30DE020752, U01DE025514, UH2/UH3DE025507

Presenter Disclosures

Stuart A. Gansky, MS, DrPH

(1)The following personal financial relationships with commercial interests relevant to this presentation existed during the past 12 months:

My brother is a 3M employee, but a different division than the one that provided in-kind product.

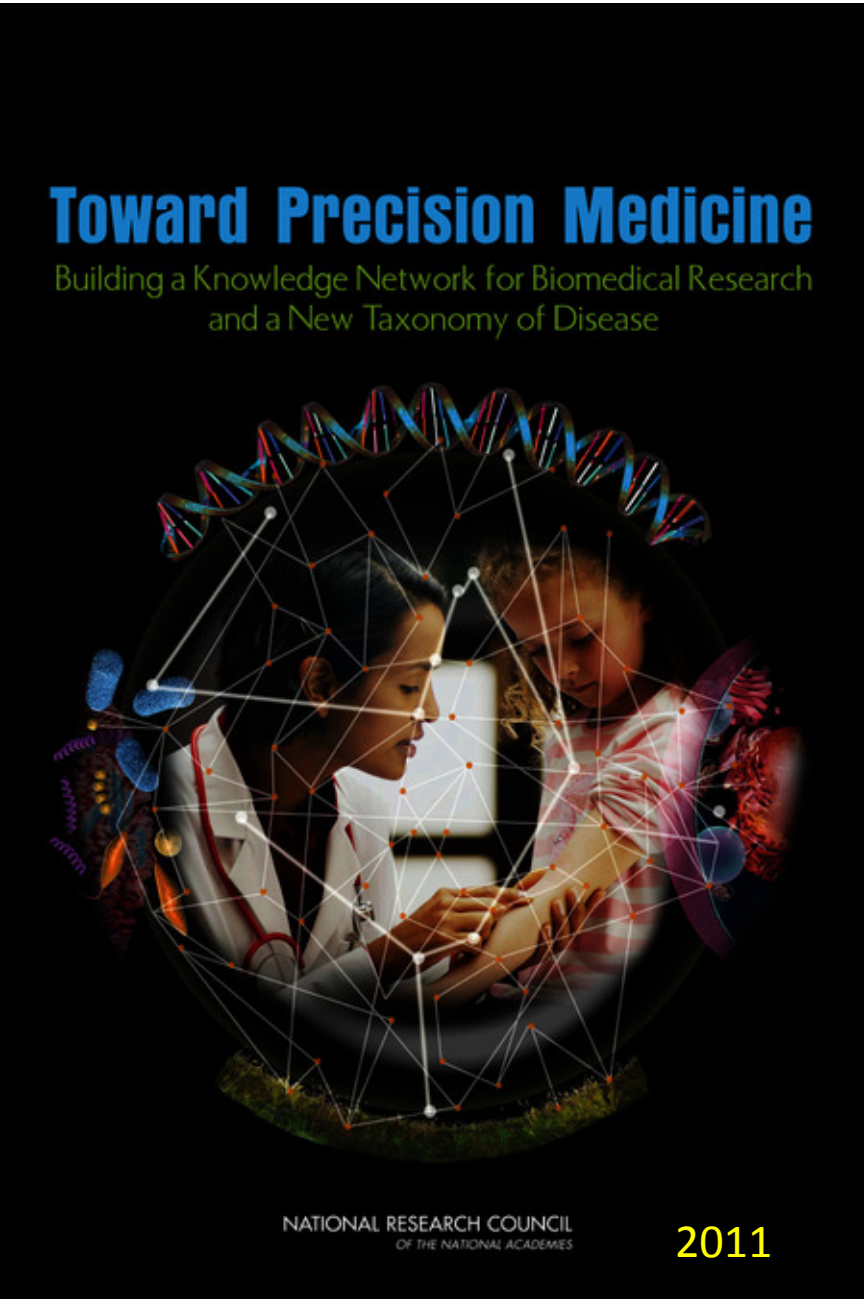
(2)My presentation will include discussion of "off-label" use of the following:

The US FDA only has approved fluoride varnish as a device to be used for tooth sensitivity in a cavity lining preparation;
caries prevention is an off-label use.

54th Annual Scientific Meeting
International Association for Dental Research
Australian & New Zealand Division
29th September – 1st October 2014
Brisbane Convention & Exhibition Centre
Queensland, Australia

Conference Theme:

Inequalities to Personalized Medicine: A Tale of Disparities



COMMITTEE ON A FRAMEWORK FOR DEVELOPING A NEW TAXONOMY OF DISEASE

SUSAN DESMOND-HELLMANN, (*Co-Chair*), University of California, San Francisco, CA
CHARLES L. SAWYERS, (*Co-Chair*), Memorial Sloan-Kettering Cancer Center, New York, NY
DAVID R. COX, Applied Quantitative Genotherapeutics Unit, Pfizer Inc., San Francisco, CA
CLAIRE FRASER-LIGGETT, University of Maryland, School of Medicine, College Park, MD
STEPHEN J. GALLI, Stanford University, Stanford, CA
DAVID B. GOLDSTEIN, Duke University School of Medicine, Durham, NC
DAVID J. HUNTER, Harvard School of Public Health, Boston, MA
ISAAC S. KOHANE, Harvard Medical School, Boston, MA
MANUEL LLINÁS, Princeton University, Princeton, NJ
BERNARD LO, University of California, San Francisco, CA
TOM MISTELI, National Cancer Institute, Bethesda, MD
SEAN J. MORRISON, University of Texas, Southwestern, TX
DAVID G. NICHOLS, The Johns Hopkins University School of Medicine, Baltimore, MD
MAYNARD V. OLSON, University of Washington, Seattle, WA
CHARMAINE D. ROYAL, Duke University, Durham, NC
KEITH R. YAMAMOTO, University of California, San Francisco, CA

OME

Precision Medicine: A Revolution in Health

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June 19, 2013

UCSF Steps Forward to Lead Advances in Precision Medicine

http://www.ucsf.edu/welcome-to-ome

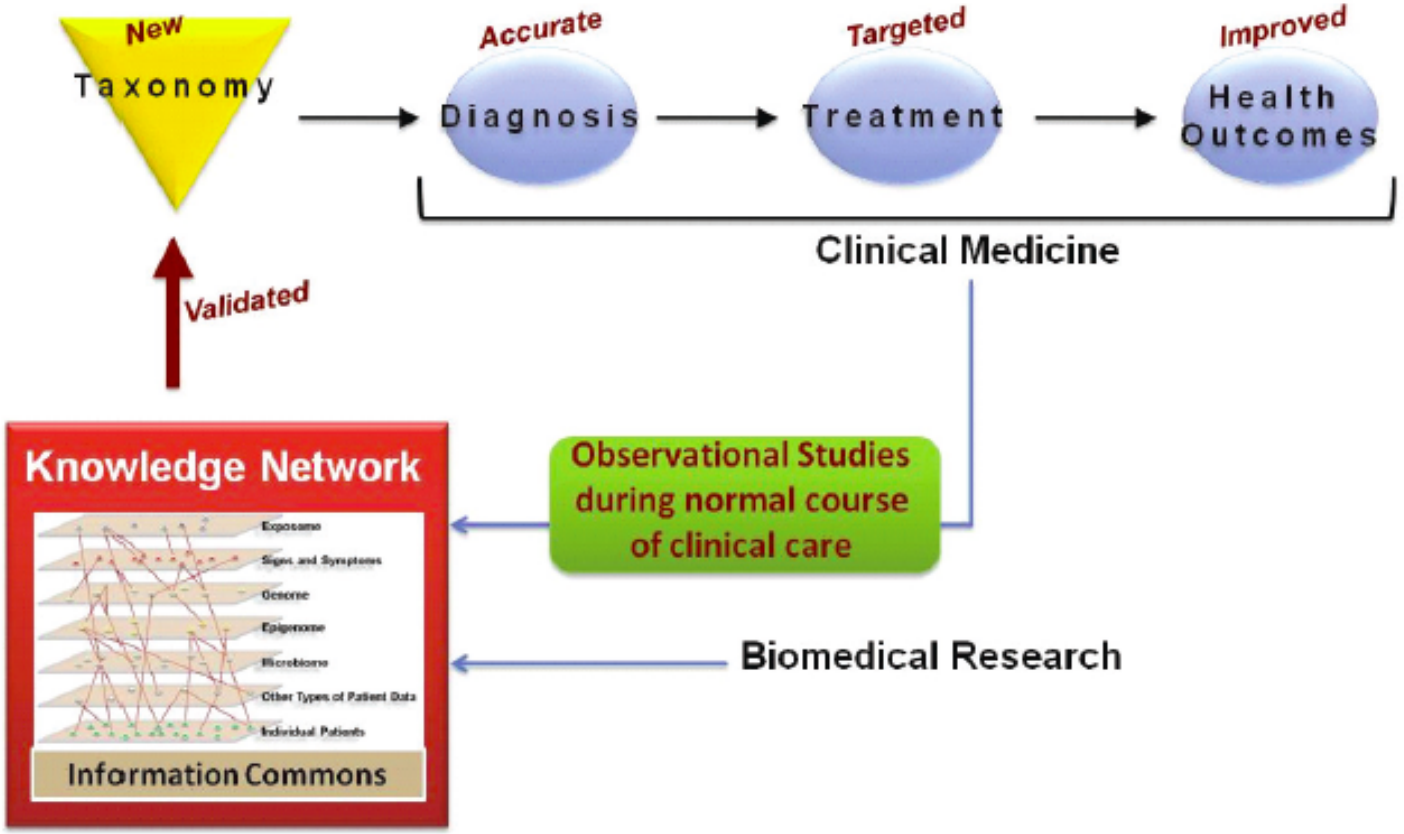


FIGURE S-1 Creation of a New Taxonomy first requires an "Information Commons" in which data on large populations of patients become broadly available for research use and a "Knowledge Network" that adds value to these data by highlighting their inter-connectedness and integrating them with evolving knowledge of fundamental biological processes.

SOURCE: Committee on A Framework for Developing a New Taxonomy of Disease. 2011

Expanding the Foundation for Personalized Medicine : Implications and Challenges for Dentistry

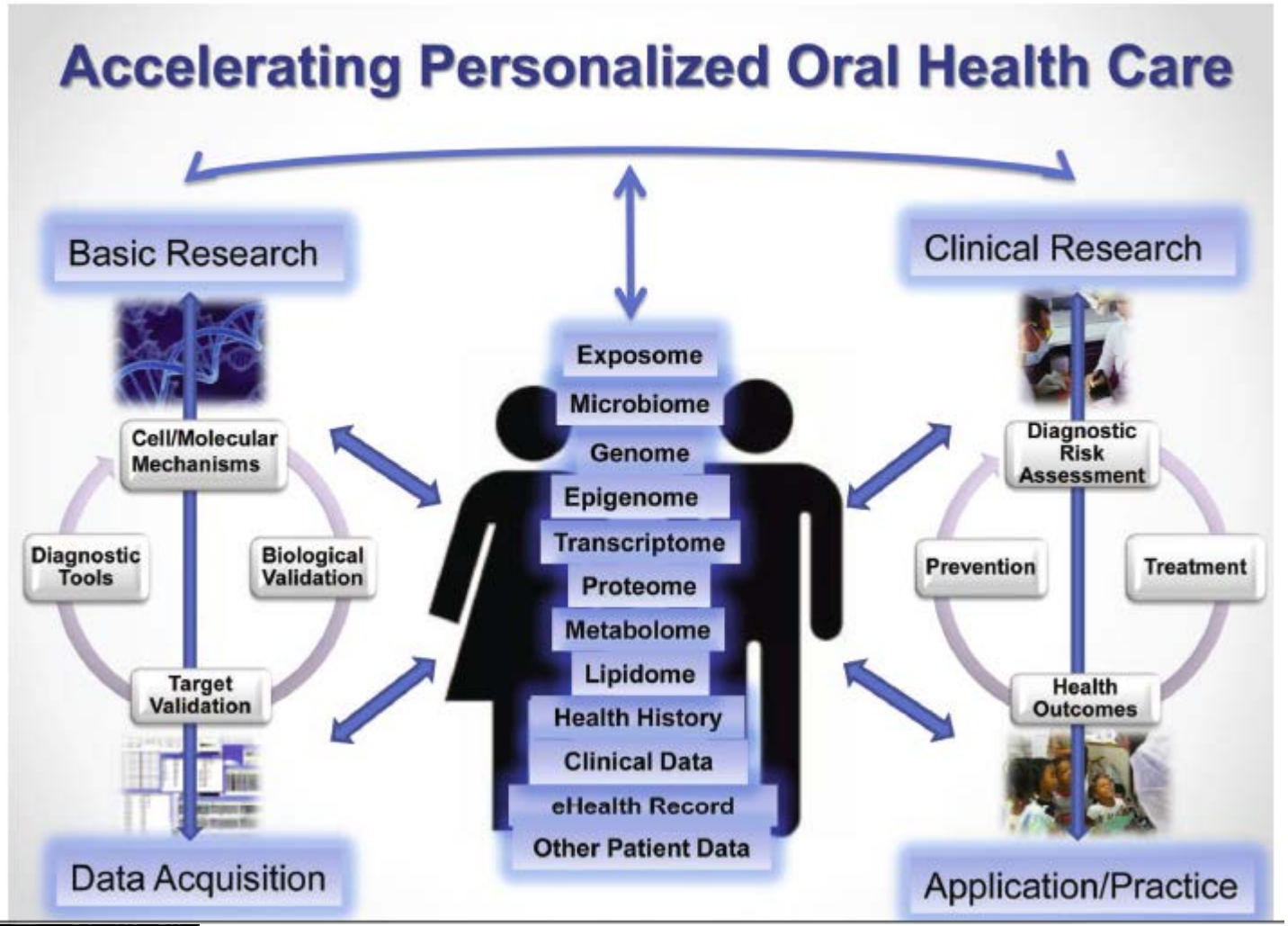
I. Garcia, R. Kuska and M.J. Somerman

J DENT RES 2013 92: S3 originally published online 20 May 2013

Figure.

Accelerating personalized oral health care.

Note: Adapted from Research Council (2011). *Toward precision medicine: Building a knowledge network for biomedical research and a new taxonomy of disease.* Washington DC: The National Academies Press.



-omes

Precision Medicine Initiative
“All of Us”

All of Us RESEARCH PROGRAM

NIH National Institutes of Health
All of Us Research Program

ABOUT FUNDING NEWS, EVENTS, & MEDIA JoinAllofUs.org › Search

The future of health begins with All of Us

The *All of Us* Research Program is a historic effort to gather data from one million or more people living in the United States to accelerate research and improve health. By taking into account individual differences in lifestyle, environment, and biology, researchers will uncover paths toward delivering precision medicine.

WATCH VIDEO

Precision Medicine Initiative

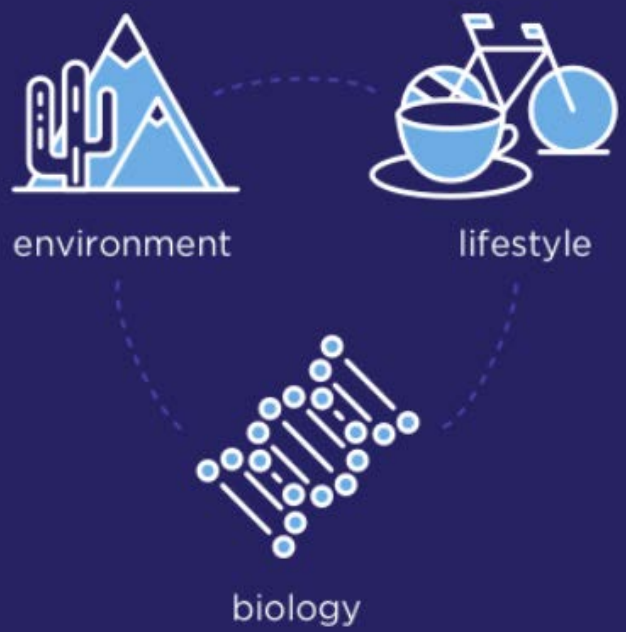
National Institutes of Health
All of Us Research Program

All of Us

All of Us RESEARCH PROGRAM

We are building a research program of 1,000,000+ people

The mission of the *All of Us* Research Program is to accelerate health research and medical breakthroughs, enabling individualized prevention, treatment, and care for all of us.



Research focuses on the intersection of 3 factors

Precision Medicine Initiative

National Institutes of Health
All of Us Research Program

All of Us

All of Us RESEARCH PROGRAM

network of U.S. industry and universities

Precision Medicine Initiative
All of Us

NIH National Institutes of Health
All of Us Research Program

All of Us RESEARCH PROGRAM

Possible Threats to Improving Public Health?

Ethical, Legal, & Social Issues

(Sankar & Parker *Genet Med* 2017)

- Cohort diversity & health disparities
- Participant engagement
- Privacy & security

Genomic Medicine → Increase Disparities?

(Moonesinghe *et al*. *Ethn Dis* 2009)

Health Technologies → Increased Health Status Disparities

Medical Health

Diagnosis

- Colonoscopy
- Pap Smear

Prevention

- Hypertension Medication (Carey)

Treatment

- Coronary Artery Bypass Graft

Dental Health

Diagnosis

- Oral Cancer Stage

Prevention

- Dental Sealant

Treatment

- Tooth Implant

Faustian Bargain?
(Pauwels & Dratma *Scientific American* 2015)

Faustian Bargain

Anyone who has studied the history of technology knows that technological change is always a Faustian bargain:

Technology giveth and technology taketh away, and not always in equal measure.

A new technology sometimes creates more than it destroys. Sometimes, it destroys more than it creates. But it is never one-sided.

Image: *Faust*, Ray Largo, 1998

Neil Postman (1990). "Informing Ourselves to Death"
Talk given at the German Informatics Society

Turn Possible Threats to Opportunities,

Reduce Health Disparities

The *All of Us* Journey

Our traveling educational experience brings the program to local communities.

Upcoming Stops on the *All of Us* Journey

SWIT TABLE

Texas

The University of Texas at El Paso & National Alliance for Hispanic Health

El Paso, TX

Nov 29, 2017, 9 a.m. – 3 p.m.

S.H.A.P.E. Community Center

Houston, TX

Nov 17, 2017, 10 a.m. – 2 p.m.

Via Colori

Houston, TX

Nov 18, 2017, 10 a.m. – 6 p.m.

Nov 19, 2017, 10 a.m. – 5 p.m.

IT'S TIME TEXAS

MAKE HEALTHY EASIER

www.itstimetexas.org

It's Time Texas

Austin, TX

Nov 15, 2017, 11 a.m. – 3 p.m.

Trini Mendenhall Community Center

Houston, TX

Nov 16, 2017, 10 a.m. – 2 p.m.

Expo Mujer 2017

Houston, TX

Nov 12, 2017, 11 a.m. – 6 p.m.

All of Us RESEARCH PROGRAM | The Future of Health Begins With You

We're Beta testing.

ABOUT HOW TO JOIN NEWS & EVENTS COMMUNITY LOG IN

Texas, Arizona, New Mexico

Banner University Medical Center - Tucson

Tucson, AZ

Dec 7, 2017, 9 a.m. – 2 p.m.

Banner University Medical Center - South

Tucson, AZ

Dec 6, 2017, 9 a.m. – 2 p.m.

Health & Wellness Fair for South-Central NM Nat'l Guard and their Families

Las Cruces, NM

Dec 3, 2017, 2 – 4 p.m.

Manzano Mesa Multigenerational Center

Albuquerque, NM

Dec 2, 2017, 9:30 a.m. – 2:30 p.m.

Central New Mexico Community College & National Alliance for Hispanic Health

Albuquerque, NM

Dec 1, 2017, 9:30 a.m. – 2 p.m.

Rio Vista Community Center

El Paso, TX

Nov 30, 2017, 9 a.m. – 1 p.m.

All of Us RESEARCH PROGRAM | The Future of Health Begins With You

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ABOUT HOW TO JOIN NEWS & EVENTS COMMUNITY LOG IN

Arizona, California

Banner Desert Medical Center

Mesa, AZ

Dec 13, 2017, 9 a.m. – 2 p.m.

San Diego Blood Bank - Blood Drive

San Diego, CA

Dec 16, 2017, 8 a.m. – 5 p.m.

Banner Casa Grande Medical Center

Casa Grande, AZ

Dec 14, 2017, 9 a.m. – 2 p.m.

Oro Valley Community Center

Oro Valley, AZ

Dec 10, 2017, 8 a.m. – 12 p.m.

Tucson Marathon

Tucson, AZ

Dec 9, 2017, 8 a.m. – 1 p.m.

Tucson Marathon Expo

Tucson, AZ

Dec 8, 2017, 8 a.m. – 7 p.m.

All of Us RESEARCH PROGRAM | The Future of Health Begins With You

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ABOUT HOW TO JOIN NEWS & EVENTS COMMUNITY LOG IN

California

San Diego Blood Bank

San Diego, CA

Jan 14, 2018, 11 a.m. – 4 p.m.

Family Health Centers of San Diego - El Cajon Clinic & NAHH

El Cajon, CA

Jan 15, 2018, 9 a.m. – 2 p.m.

San Diego Multicultural Festival

San Diego, CA

Jan 13, 2018, 11 a.m. – 5 p.m.

San Ysidro Health

San Diego, CA

Jan 11, 2018, 8:30 a.m. – 4:30 p.m.

Jan 12, 2018, 8:30 a.m. – 4:30 p.m.

Family Health Centers of San Diego & NAHH

San Diego, CA

Jan 10, 2018, 9 a.m. – 2 p.m.

VIP Beauty & Wellness Expo

San Diego, CA

Dec 17, 2017, 11 a.m. – 4 p.m.

All of Us RESEARCH PROGRAM | The Future of Health Begins With You

We're Beta testing.

ABOUT HOW TO JOIN NEWS & EVENTS COMMUNITY LOG IN

Upcoming Stops on the *All of Us* Journey

LPGA Volunteer Training

Phoenix, AZ

Mar 10, 2018, 8 a.m. – 4 p.m.

Cabrillo College

Aptos, CA

Feb 1, 2018, 2 – 6 p.m.

Mercy Housing at Depot Park

Santa Cruz, CA

Jan 31, 2018, 2 – 6 p.m.

California, Arizona

Tully Community Branch Library

San Jose, CA

Jan 28, 2018, 10 a.m. – 2 p.m.

NAHH & Maya Cinemas

Fresno, CA

Jan 26, 2018, 11 a.m. – 5 p.m.

NAHH & Maya Cinemas

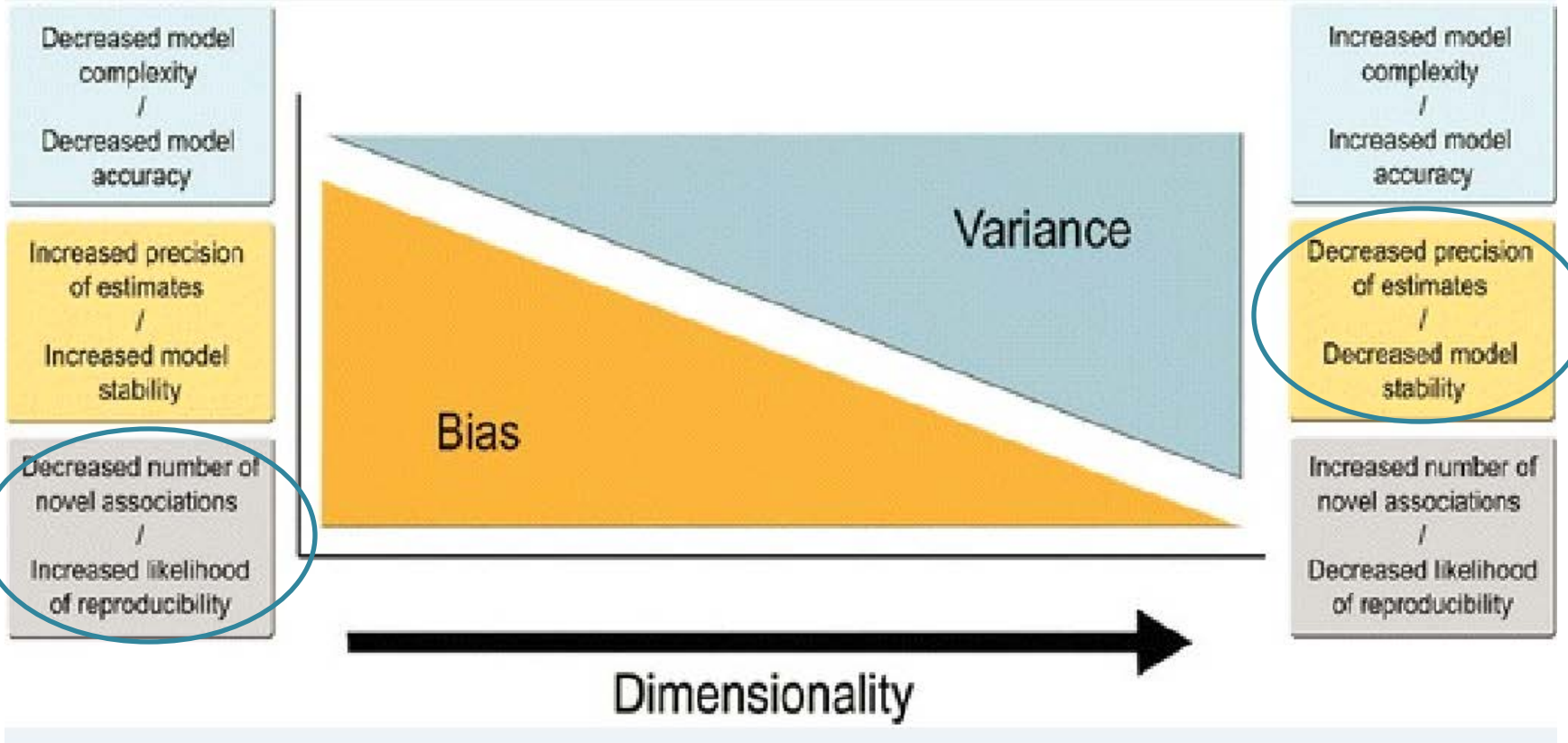
Bakersfield, CA

Jan 25, 2018, 12 – 6 p.m.

Omics Methods May Increase Disparities

- 2-Tiered Healthcare + Omics
  → 2-Tiered Personalized Healthcare
  (Alyass *et al*. *BMC Med Genom* 2015)
- Need Precision Public Health Done Right
  - Bias-Variance tradeoff → curse of dimensionality

Bias-Variance Tradeoff



Alyass *et al*. *BMC Med Genom* 2015

Omics Methods May Increase Disparities

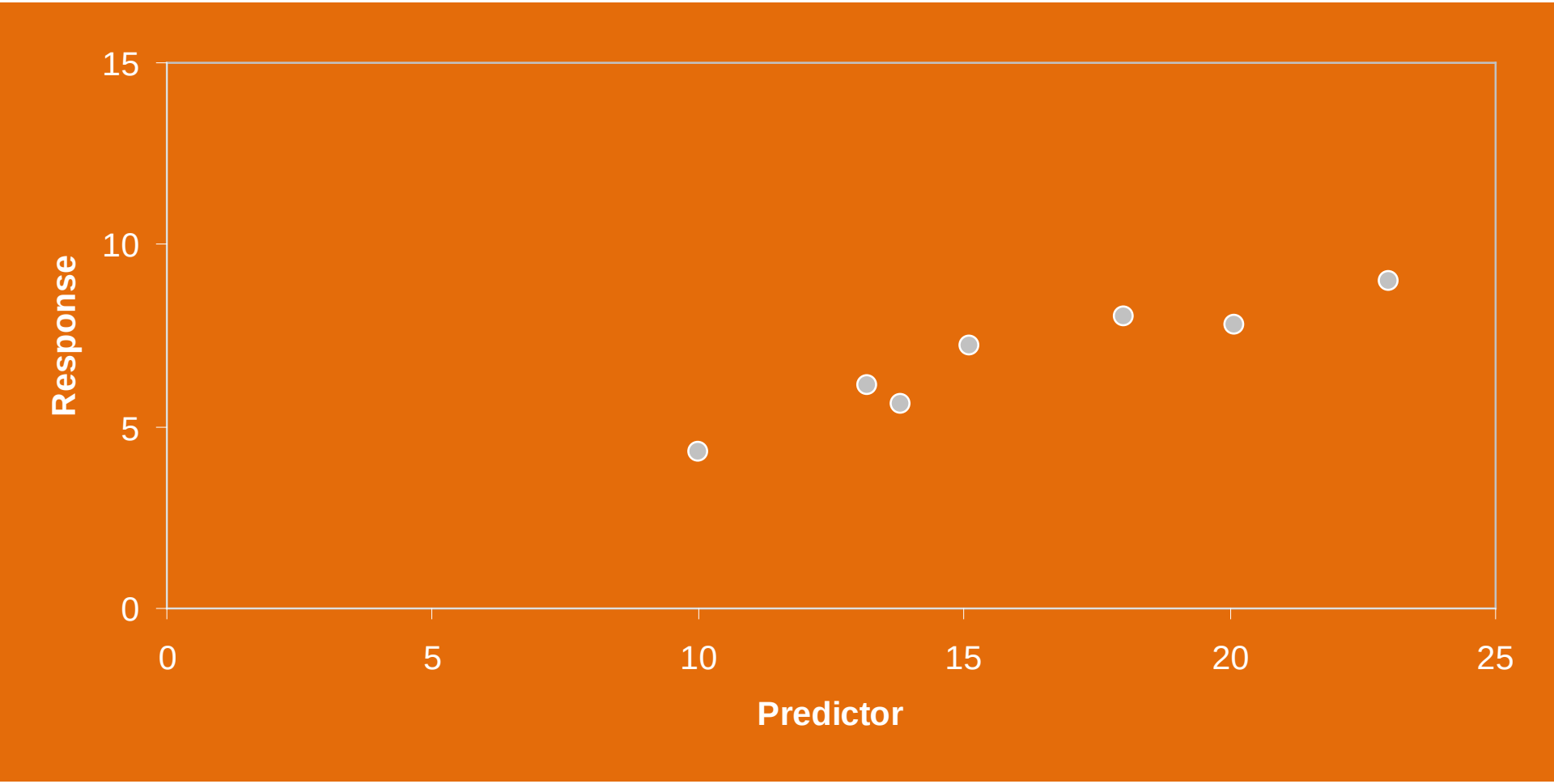
- 2-Tiered Healthcare + Omics
  → 2-Tiered Personalized Healthcare
  (Alyass *et al*. *BMC Med Genom* 2015)
- Need Precision Public Health Done Right
  - Bias-Variance tradeoff → curse of dimensionality
  - Variability from Noise & True Heterogeneity
  - Validate, Validate, Validate – Internal & External

Why Validate?

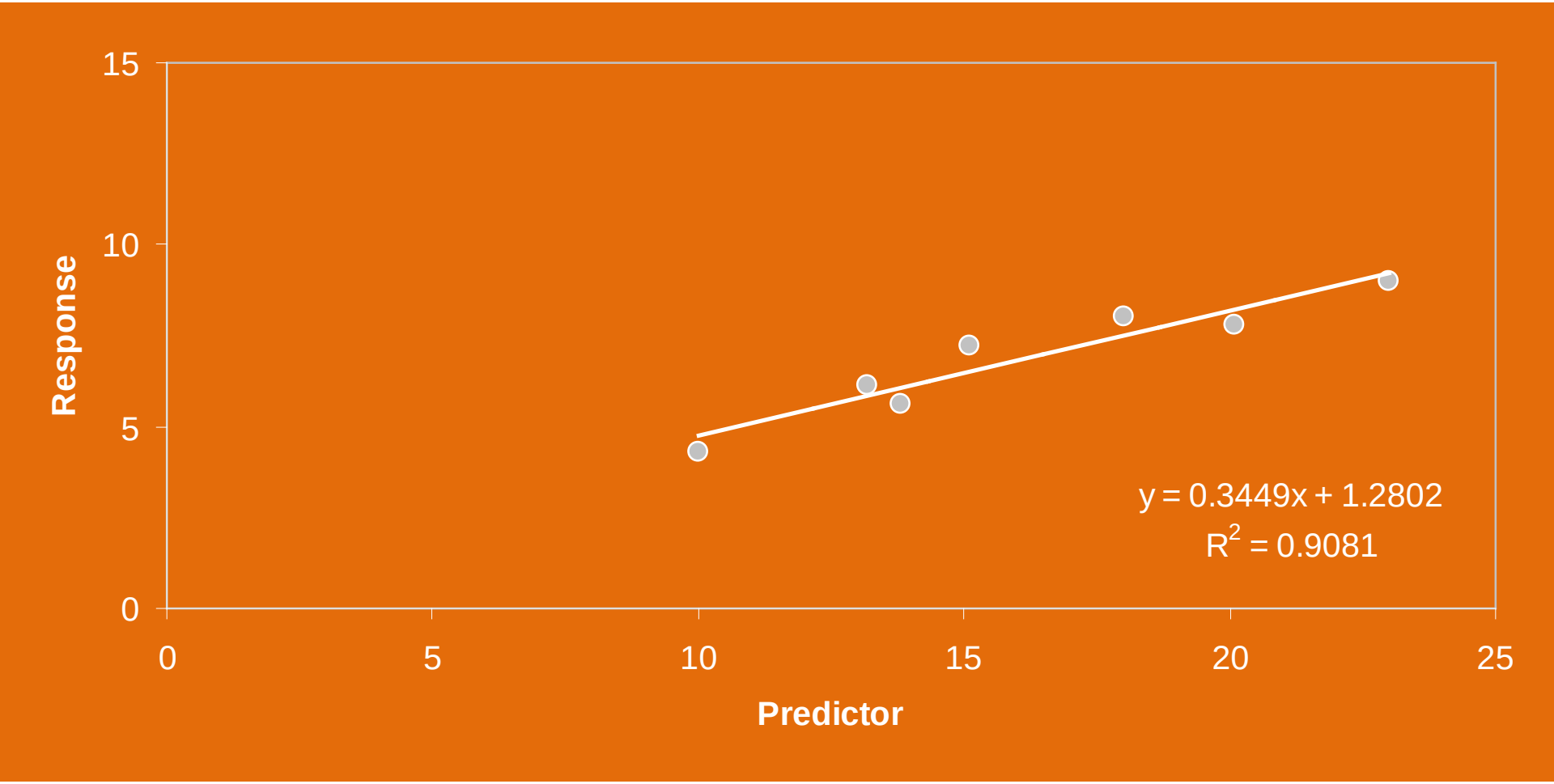
Simple Example:

Overfitting in only 2 dimensions

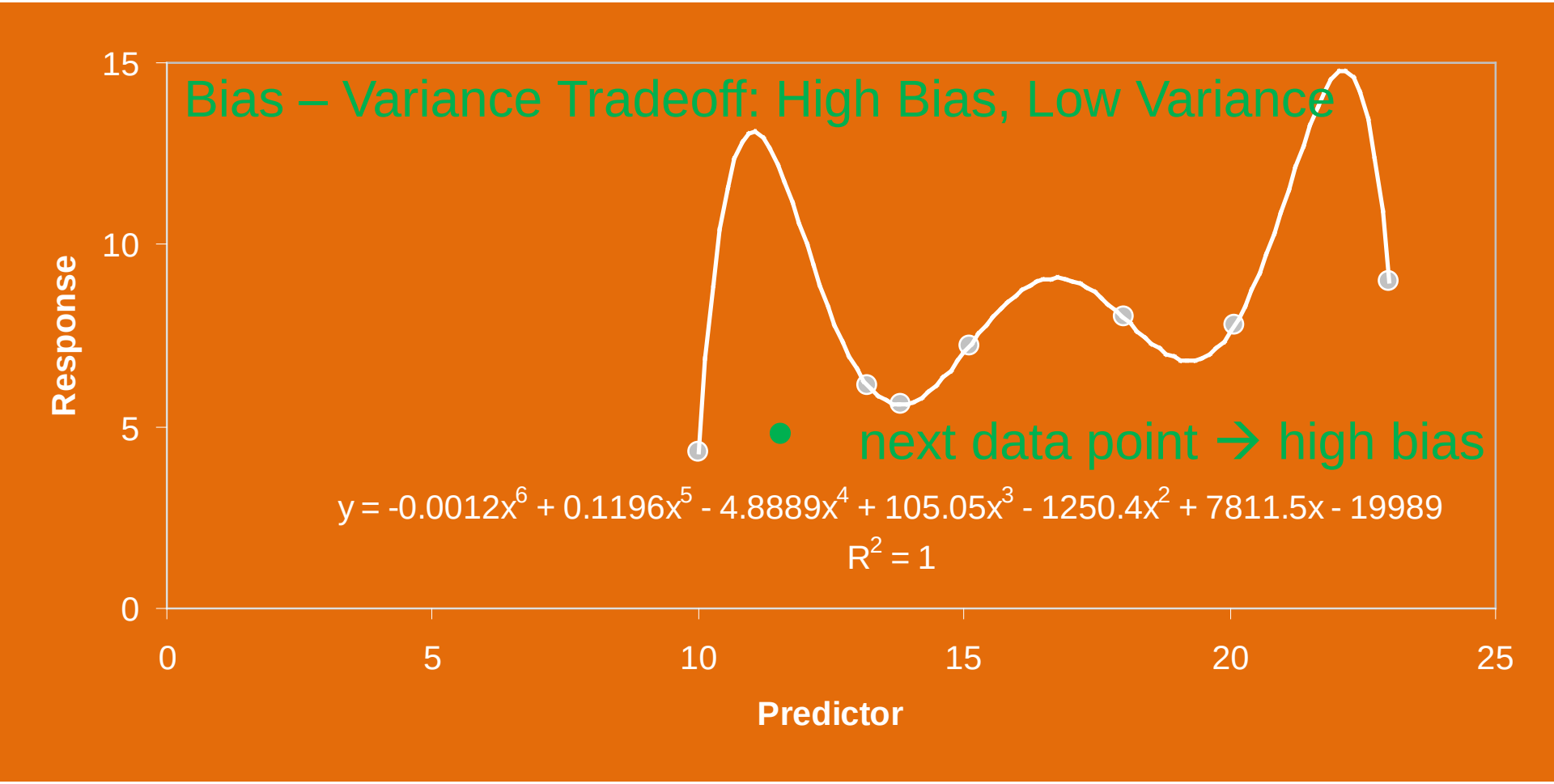
Data



Linear Fit to Data



High Degree Polynomial Fit to Data

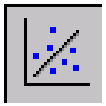
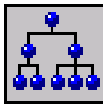
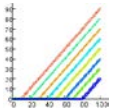
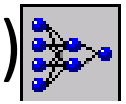


What is Knowledge Discovery and Data Mining (KDD)?

- "Semi-automatic discovery of patterns, associations, anomalies, and statistically significant structures in data" – *MIT Tech Review* (2001)
- Interface of
  - Artificial Intelligence
  - Machine Learning
  - Computer Science
  - Engineering
  - Statistics
- Association for Computing Machinery Special Interest Group on Knowledge Discovery in Data and Data Mining (ACM SIGKDD sponsors KDD Cup)

Data Mining as Alchemy

Supervised Learning

- Regression 
- *k* nearest neighbor
- Trees (CART, MART, boosting, bagging) 
- Random Forests
- Multivariate Adaptive Regression Splines (MARS) 
- Neural Networks (NN) 
- Support Vector Machines
- Machine Learning / Deep Learning

Unsupervised Learning

- Hierarchical clustering
- *k*-means 

No outcome / dependent (output)

KDD Steps

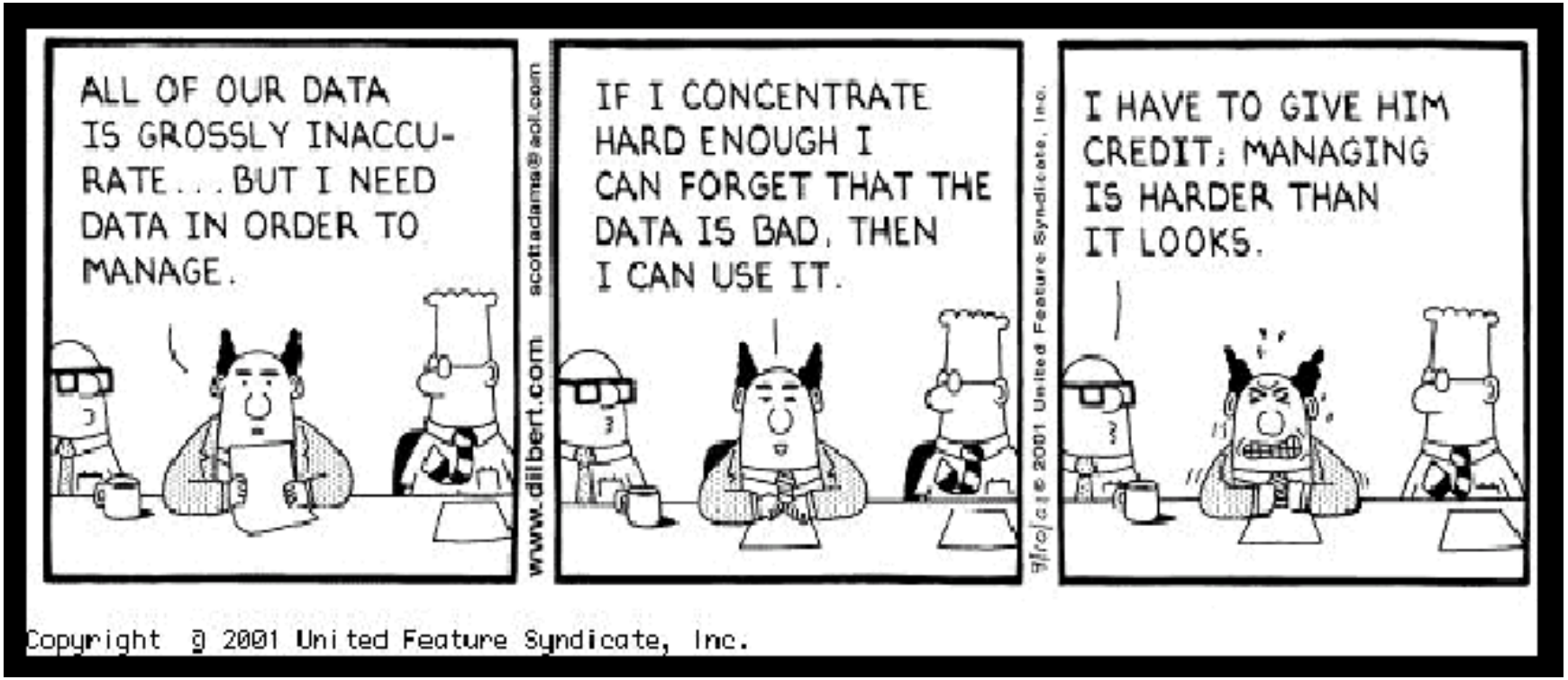
Gansky 2003

Collect & Store → Pre-Process → Analyze → Validate → Act

Collect & Store	Pre-Process	Analyze	Validate	Act
Sample Merge Warehouse	Clean Impute Transform Standardize Register	Supervised Unsupervised Visualize	Internal Split Sample Cross-validate Jackknife* Bootstrap External	Intervene Set Policy

*Leave 1 Out CV

Data Quality



Common Mistakes with Artificial NN

(Scwartzer *et al*, *StatMed*, 2000)

- Too many parameters for sample size
- No validation
- No model complexity penalty
  (eg Akaike Information Criterion (AIC))
- Incorrect misclassification estimation
- Implausible function
- Incorrectly described network complexity
- Inadequate statistical competitors
- Insufficient comparison to competing models

precision public health with textmining

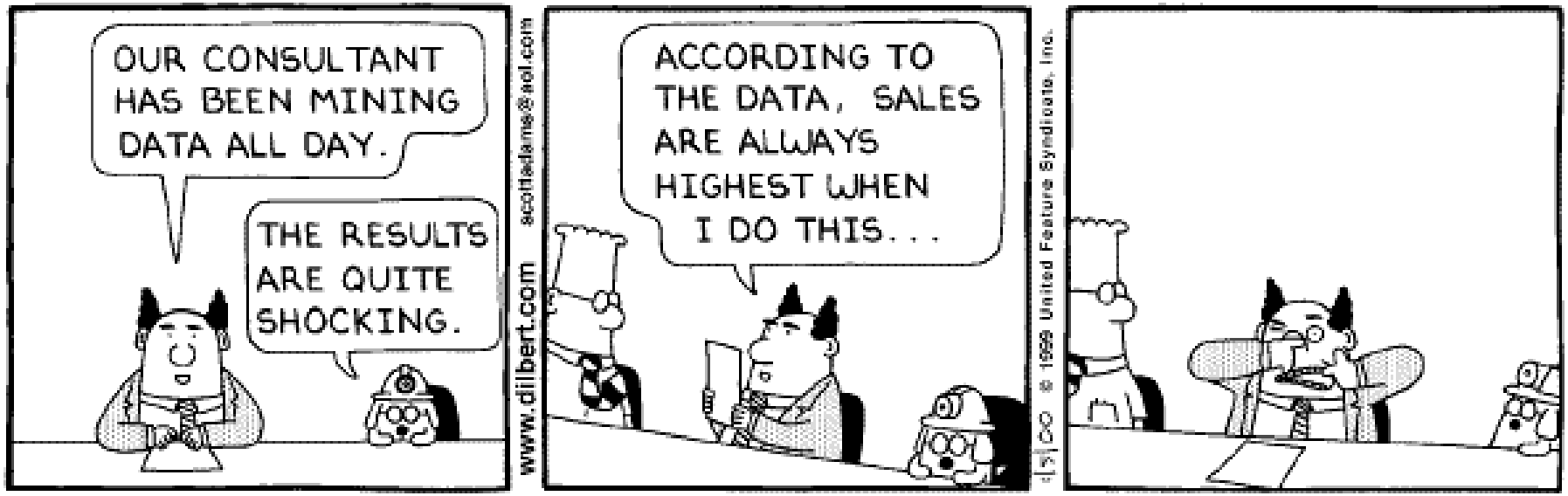
- Adverse childhood experiences / homelessness & health

  (Bejan *et al*. *JAMIA* 2017)

- Care coordination helps overcome psychosocial distress

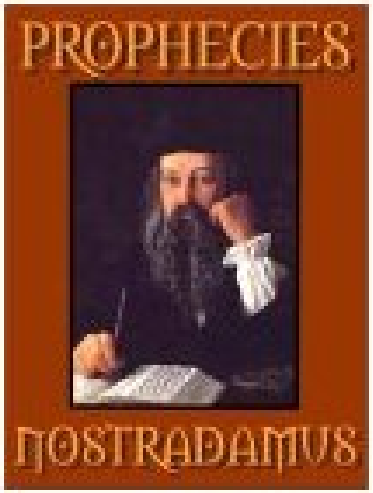
  (Oreskovic *et al*. *JMIR Med Inform* 2017)

Model Face Validity



Prediction

only as good as the



data

and

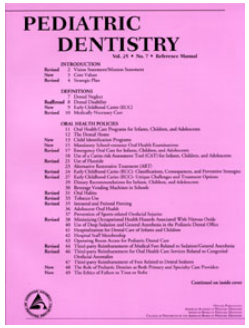
model

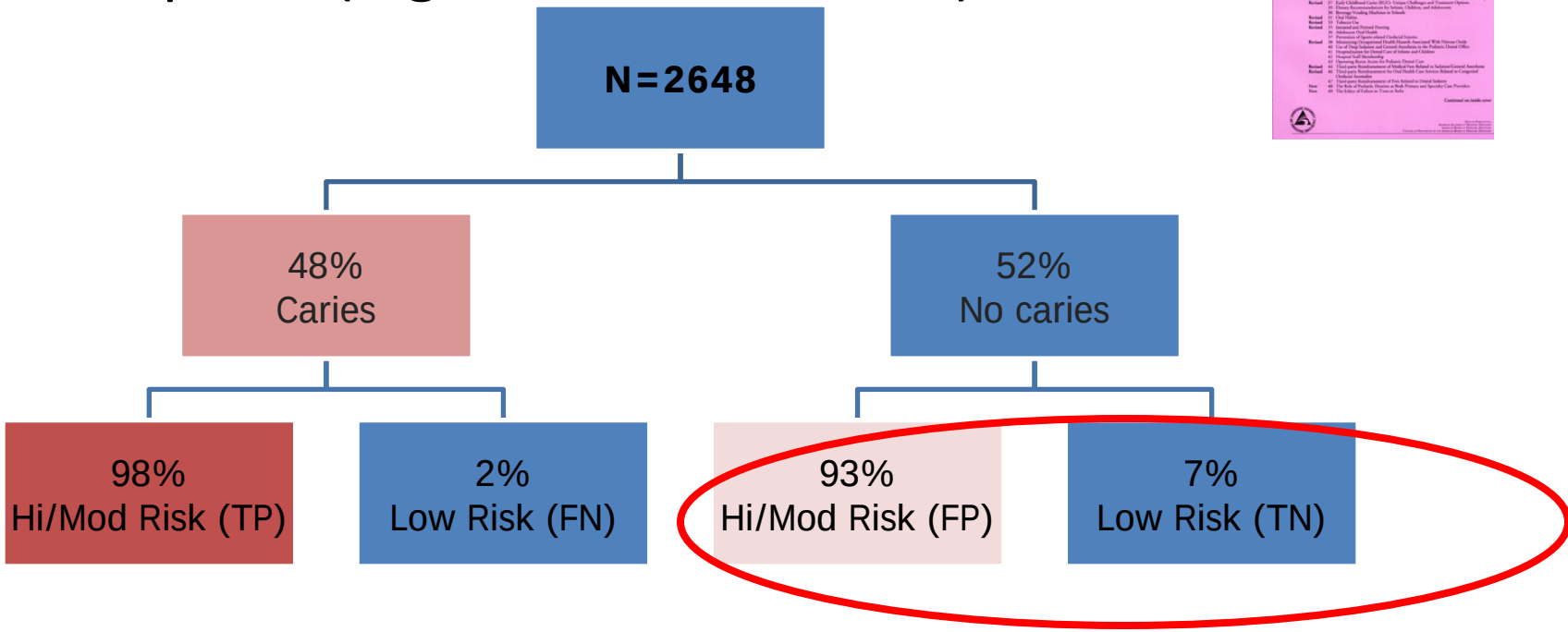
Social Determinants of Health (SDOH) Individual, Family, & Community Levels

- Poverty
- Education
- Health Literacy
- Home conditions
  - Mold → respiratory conditions
    Asthma (Beck *et al*. *Health Affairs* 2017)
  - Secondhand tobacco smoke →resp cond
  - Lead in water → neuro development, caries

CAT Results in California Oral Health Needs Assessment of Children 1993-94

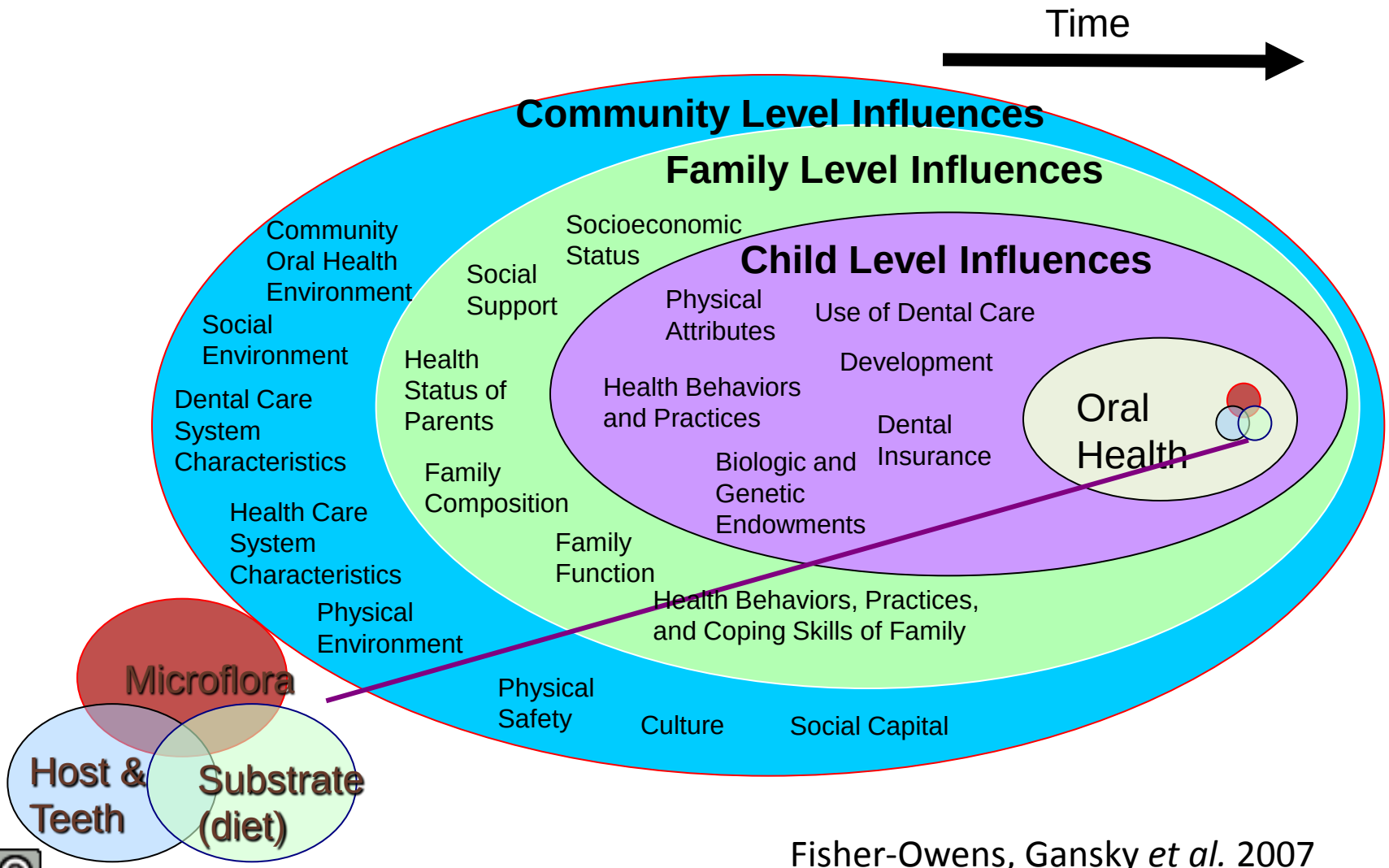
- 48% actually have caries
- CAT estimates 5% at low risk
  95% at moderate/high risk
- Sn: 98% Sp: 8% (high % False Positives)





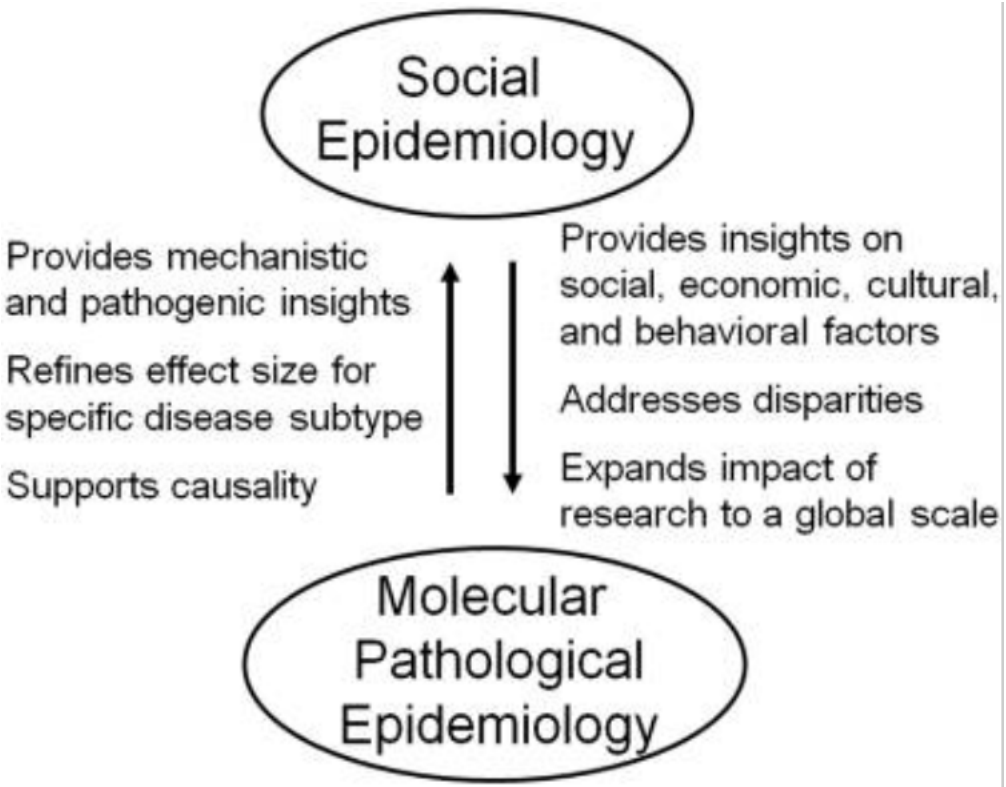
- **Over-classification of risk (95% at mod/high)**

Conceptual Framework of Children's Oral Health
Child, family, & community influences on child oral health outcomes

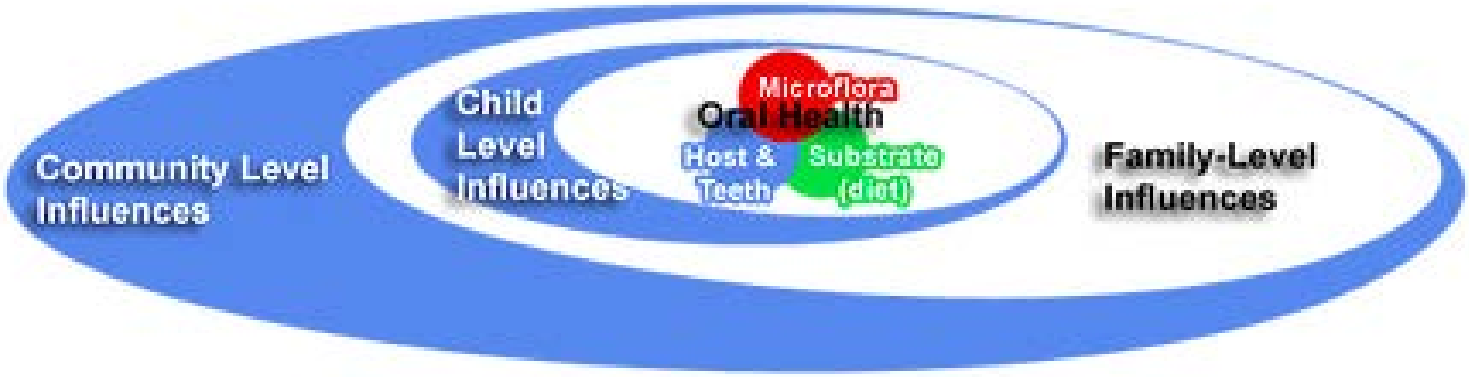


Fisher-Owens, Gansky *et al.* 2007

Integrative Social Molecular Pathologic Epidemiology (ISMPE)

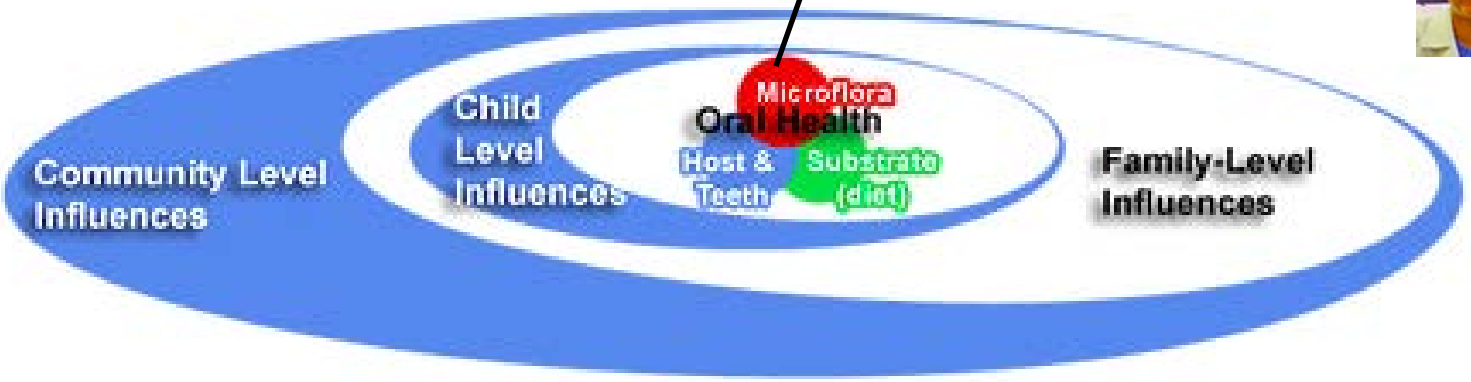


Nishi *et al*. *Expert Rev Mol Diagn* 2016


Community Level Influences
Child Level Influences
Microflora
Oral Health
Host & Teeth
Substrate (diet)
Family-Level Influences

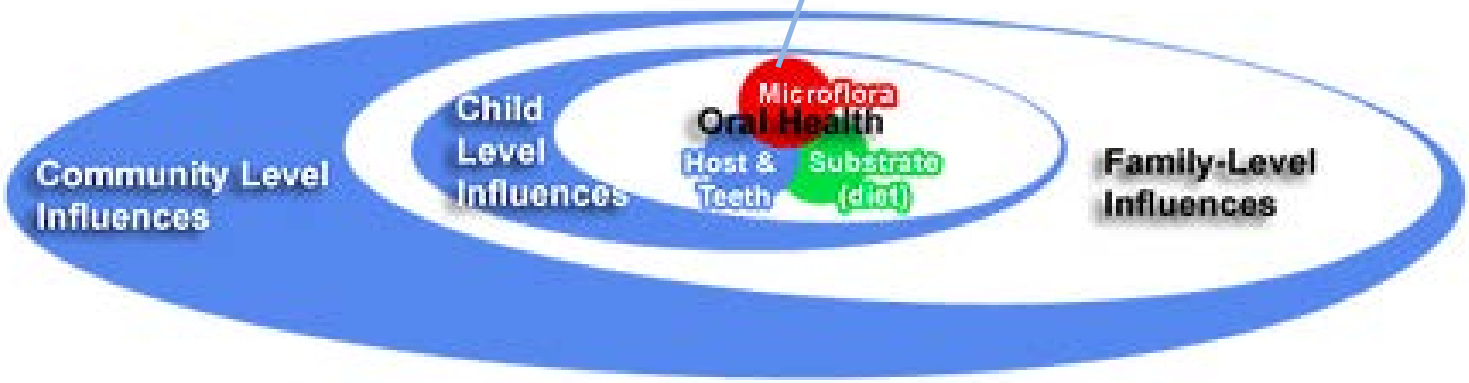
Metagenomics (Metagene)

Ling Zhan, PI



Metagenomics (Metagene)

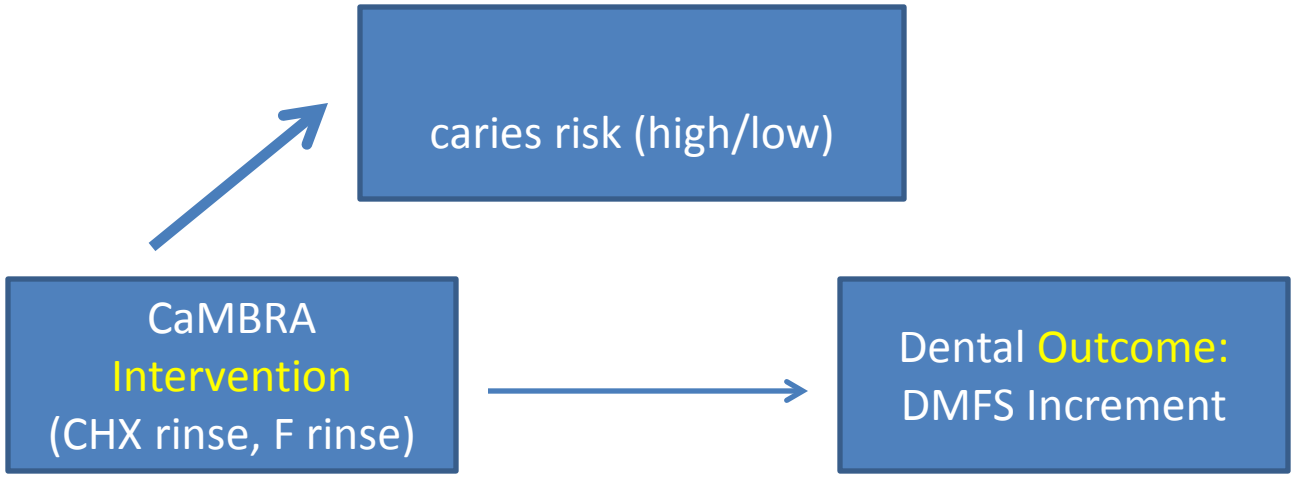
Ling Zhan, PI



Mediation Model

Jing Cheng, PI

Mechanism of action?

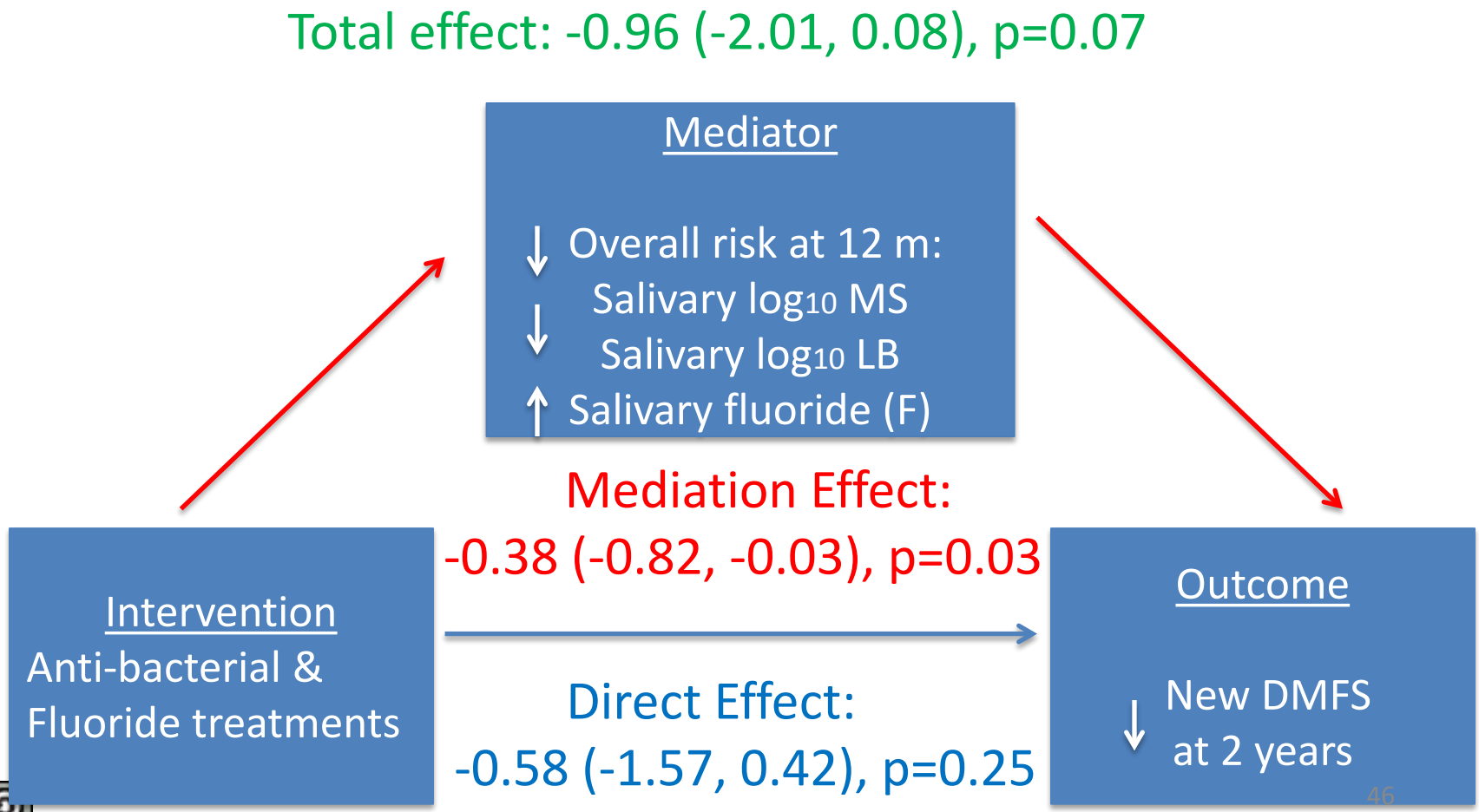


Featherstone *et al. Caries Res* 2012

CaMBRA Effects

About 36% of the intervention effect on 24-month DMFS increment was through its mediation effect on the 12-month overall risk (p=0.03).

Cheng *et al. JDR* 2015



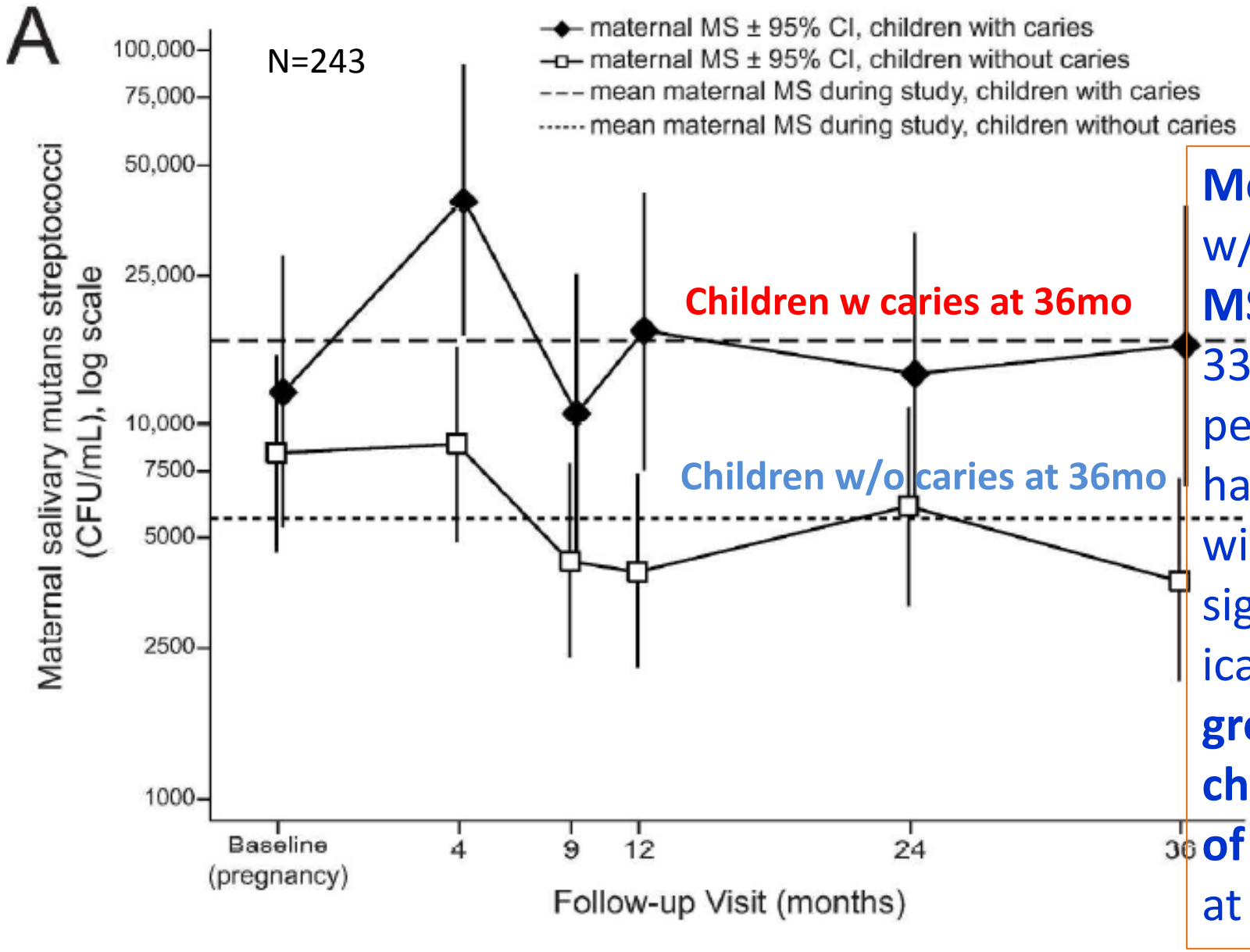
Precision Public Health Analyses

R01 subcontract
R03-like grant
Jing Cheng

LRP
KL2
Benjamin Chaffee

UCSF RAP
R03
Ann Lazar

Does mother's salivary mutans strep cause caries in preschoolers?

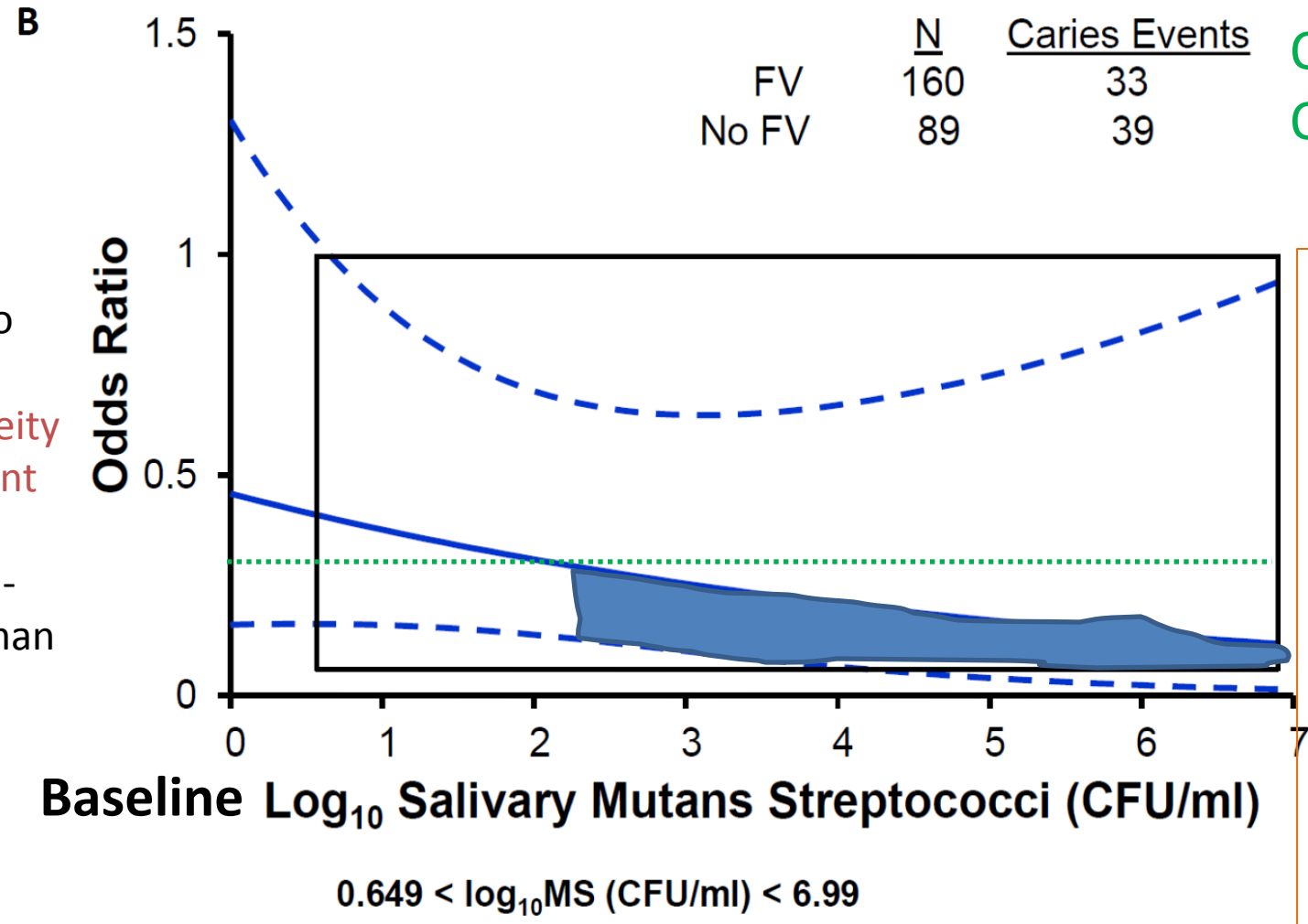


Mothers w/ **high MS** over 33 mo period had **kids** with signif-icantly **greater chance of caries** at 36mo

Chaffee, Gansky *et al. JDR* 2014

Does Fluoride Varnish better prevent caries in some preschoolers?

Methods to determine Heterogeneity of Treatment Effect:
- Johnson-Neyman
- and STEPP



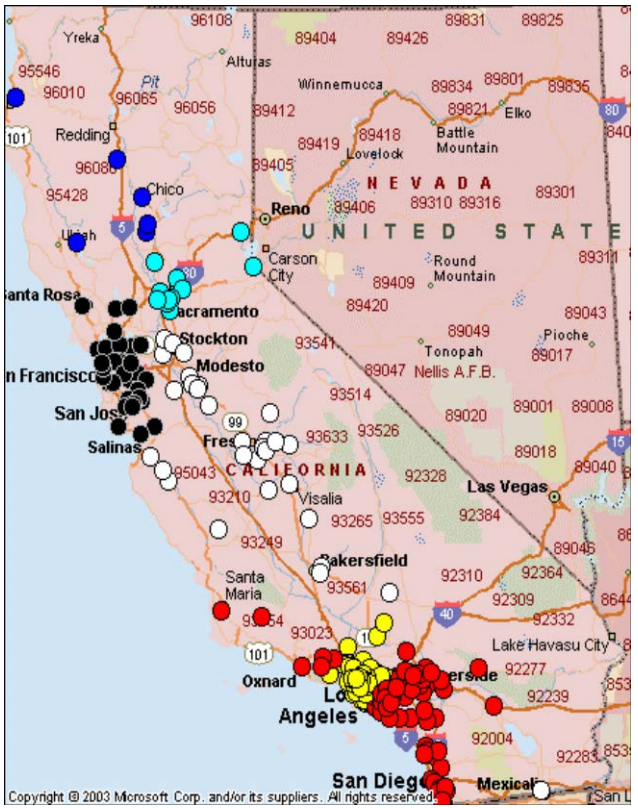
Kids with **more** baseline **MS** had signif-icantly **greater pre-ventive benefit** from FV

Lazar, Gansky *et al. JDOCE* 2014

Social Determinants of Health

2004-5 cohnac

- Stratified, complex survey sample
  - Strata: 21 Regions x Density
  - Clusters: 186 Schools
  - Grades: Kindergarten and 3rd
- Probability proportional to size (PPS) sampling
- ASTDD design



Association of State and Territorial Dental Directors. *Basic Screening Surveys: An Approach to Monitoring Community Oral Health.* www.astdd.org

oral health measures

- Untreated caries (dt / DT > 0)
- Caries experience (dft / DFT > 0)
- Rampant caries (dft / DFT $\geq$ 7)
- Treatment urgency
  (none, early, urgent)

Trained calibrated examiners

(dentists, hygienists, nurses)

factors potentially related to caries

Demographics

- Race/ethnicity, Gender, Age, Grade

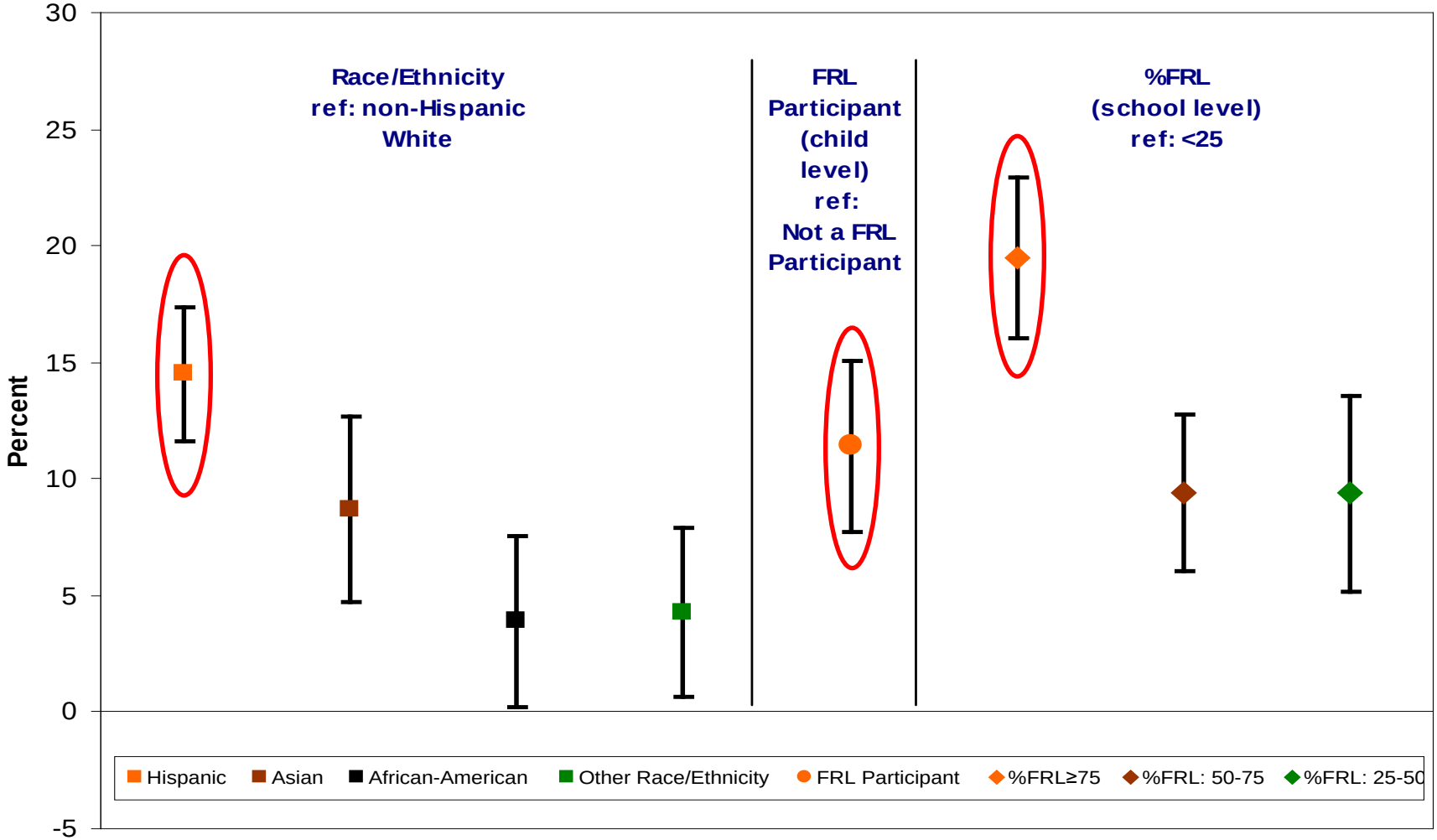
Socioeconomic status

- Free/reduced cost lunch (FRL) program
  - Individual
  - Percent of children at School
  - CA School Academic Perfomance Index

Acculturation

- Non-English language at home

California Oral Health Needs Assessment of Children 2004-5
Absolute difference (95% CI) in rampant caries prevalence by race/ethnicity and socioeconomic position



2004-5 California Oral Health Needs Assessment of Children (Smile Survey) Socioeconomic Status & Language

N=10,450 Third Graders in 182 schools

Table 2. Health disparities indices by percent school participation in free/reduced-price lunch program and percent school English learners: children with no sealants

Independent variable	Index	Estimate	95% CI rescaling bootstrap (500 resamples)
% Free/reduced-price lunch (school level)	SII	−5.84	(−13.87, 1.82)
	RII-mean	−0.08	(−0.19, 0.02)
	ACI	−0.009	(−0.021, 0.003)
% English language learners (school level)	SII	−7.64	(−14.58, −0.01)*
	RII-mean	−0.11	(−0.20, −0.001)*
	ACI	−0.011	(−0.021, −0.00001)*

SII, Slope Index of Inequality; RII-mean, Relative Index of Inequality for the mean; ACI, Absolute Concentration Index.
*$P \leq 0.05$.

Mejia *et al. CDOE* 2010

Individual child level:
free/reduced price lunch participation NS
language other than English spoken at home $p \leq 0.05$

R03 DE 018116 Dental Health Fdn, HRSA, CDA Fdn, ASTDD, CA First 5, CA Endowment

Approach: Population vs High Risk

Targeted Risk (Lalonde, 1974) →

Prevent Disease in Higher Risk Individuals

or

Whole Population Approach (Rose, 1992) →

Increase Overall Public Health but also Disparities

Third Way:

Targeted Vulnerable Popns (Frolich&Potvin, 2008)
→ Reduce Disparities in Health

Proportionate Universalism

Proportionate Universalism

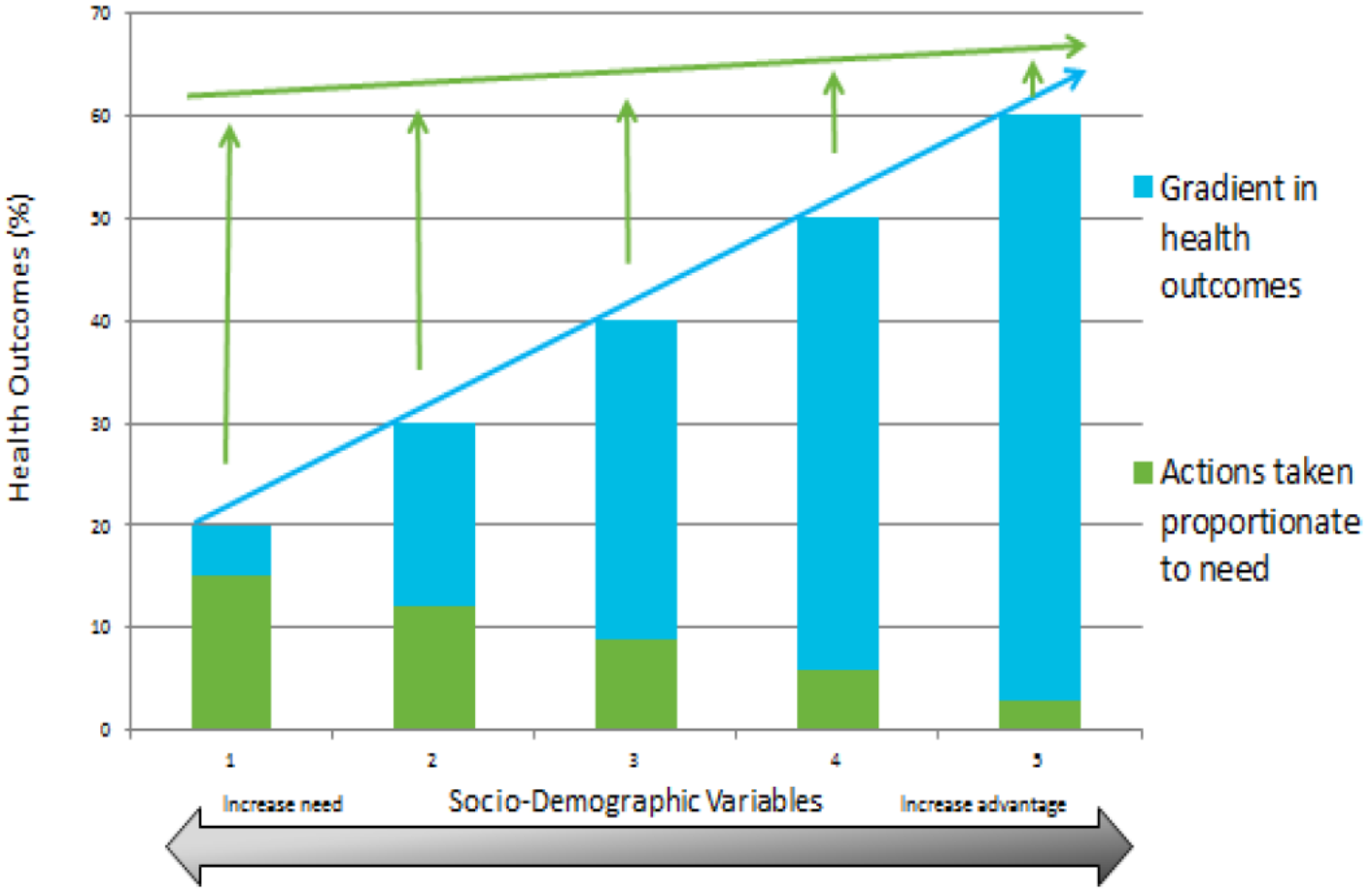


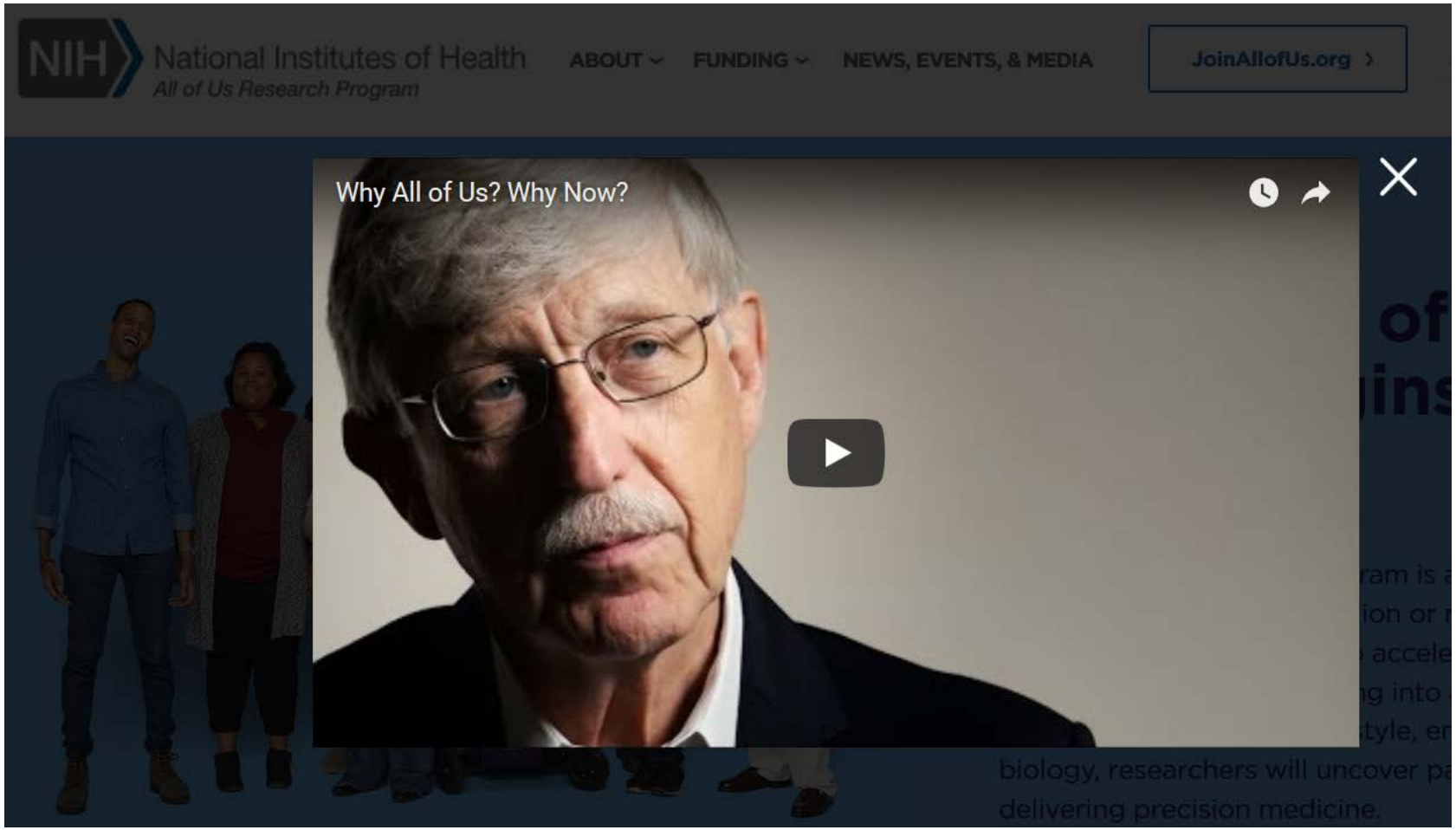
Figure 1: Schematic illustration of proportionate universalism

Ontario Agency for Health Protection and Promotion (Public Health Ontario), Lu, Tyler. 2015

Precision Proportionate Universalism Public Health Needs to Answer:

- Who are the vulnerable groups?
- What is the public health prevention/intervention?
- Where are the populations?
- How do we deliver precise public health?

All of Us



https://youtu.be/B7m5rNkDjHE

MeForYou.Org campaign

We do it for Georgia

http://www.ucsf.edu/news/2013/05/105616/meforyou-campaign-rallies-public-join-push-precision-medicine

MeForYou Campaign Rallies Public to Join Push for Precision Medicine

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By Louise Chu on May 03, 2013

Follow @loochoo Email

Precision medicine is more than just a scientific concept or an academic theory. At

At the Crossroads:

what direction will we choose?

what bargains will we strike?

https://www.polyvore.com/meet_robert_johnson_at_crossroads/set?id=4219175