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Choosing Wisely:
What should be measured in a cohort this large?

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The Qualcomm Institute/Calit2

University of California, San Diego

Building a Large U.S. Cohort for Precision Medicine Research
NIH, February 11-12, 2015

UC San Diego
SCHOOL OF MEDICINE

QUALCOMM INSTITUTE

Co-Invesigator MD2K Center of Excellence for Mobile Sensor Data-to-Knowledge

it² Calit2

What should be measured?

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Editorial

Complementing the Genome with an "Exposome": The Outstanding Challenge of Environmental Exposure Measurement in Molecular Epidemiology

Christopher Paul Wild

Molecular Epidemiology Unit, Centre for Epidemiology and Biostatistics, Leeds Institute of Genetics, Health and Therapeutics, Faculty of Medicine and Health, University of Leeds, Leeds, United Kingdom

Cancer Epidemiology, Biomarkers & Prevention

2005;14(8):1847-50

The Exposome

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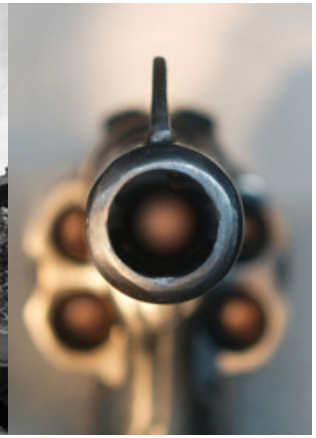
"At it's most complete, the exposome encompasses life-course environmental exposures (including lifestyle factors), from the prenatal period onwards…"

-- Christopher Paul Wild



NIH Exposure Biology Program

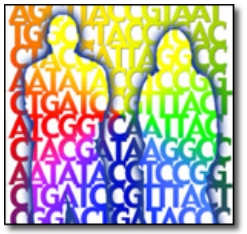
"Genes load the gun; environment pulls the trigger"
– Francis Collins, MD, PhD

2007	2008	2009	2010	2011

Environmental Sensors

- Diet/Physical Activity
- Chemicals/Biologics
- Psychosocial Stress/Addictive Substances

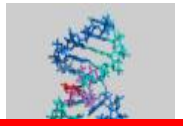
APPLICATION

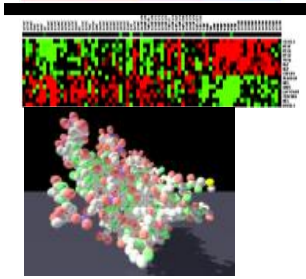


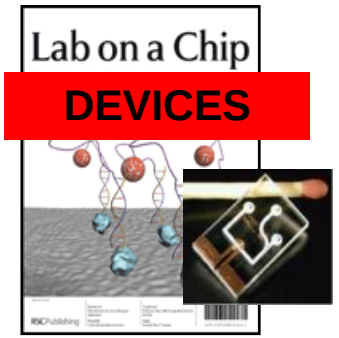
Genome Wide Association & Other Research

Biological Response

- Biomarkers
- Centers–biomarkers/biosensors
  - Inflammation
  - Oxidative stress
  - Programmed cell death
  - Epigenetic markers







How can mobile devices and related technologies enhance Precision Medicine research?

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Greater precision on measures of physiological parameters that can aid in monitoring treatments, treatment response and outcomes.

Wireless and/or wearable sensors for:

- **Heart rate and heart rate variability**
- **Respiration**
- **Blood pressure**
- **Glucose, lactate & electrolytes**
- **Hydration & metabolism**
- **Medication adherence via smart pills, pill bottles and other drug delivery (e.g. inhalers)**
- **Spirometry**

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Greater precision on measures of behaviors and related health states and their context

Wireless and/or wearable sensors for:

- **Physical activity, sedentary behavior, and overall movement patterns that have unique signatures for underlying disease or health risk (e.g. Parkinson's, fall risk, etc.)**
- **Diet through self-report with always-available apps or with cameras**
- **Weight (and with BP, hydration status)**
- **Stress**
- **Sleep**
- **Cognitive function**
- **Location via GPS and other mobile phone-based approaches**

Importance of Place to Precision Medicine

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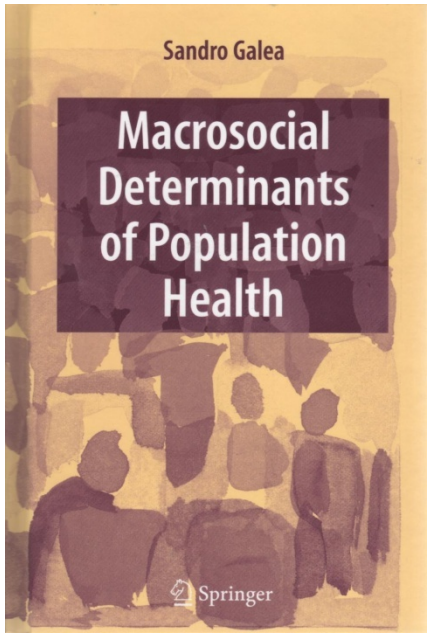
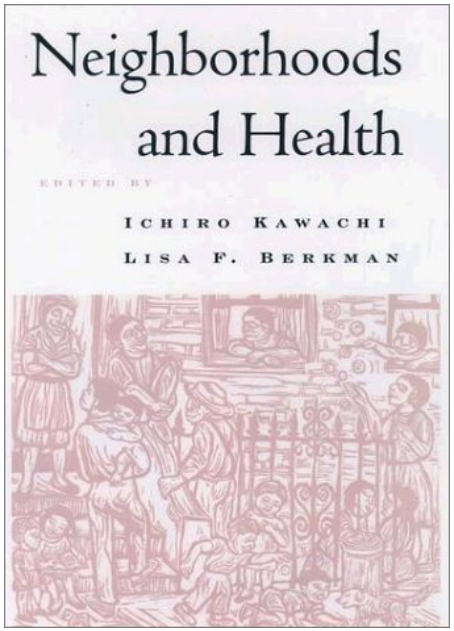
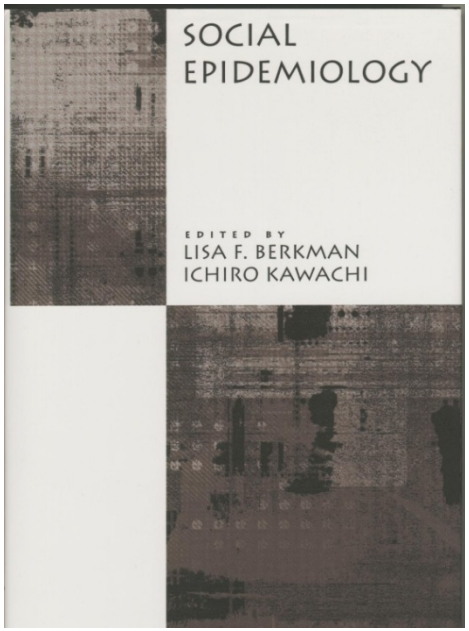
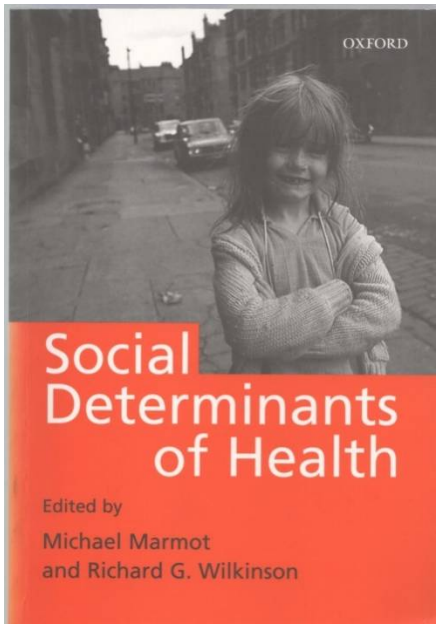
- Disease clusters
- Toxic exposure
- Health disparities
- Stress & incivilities







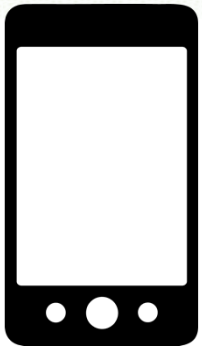


GPS Data & Geographic Information Systems (GIS) data

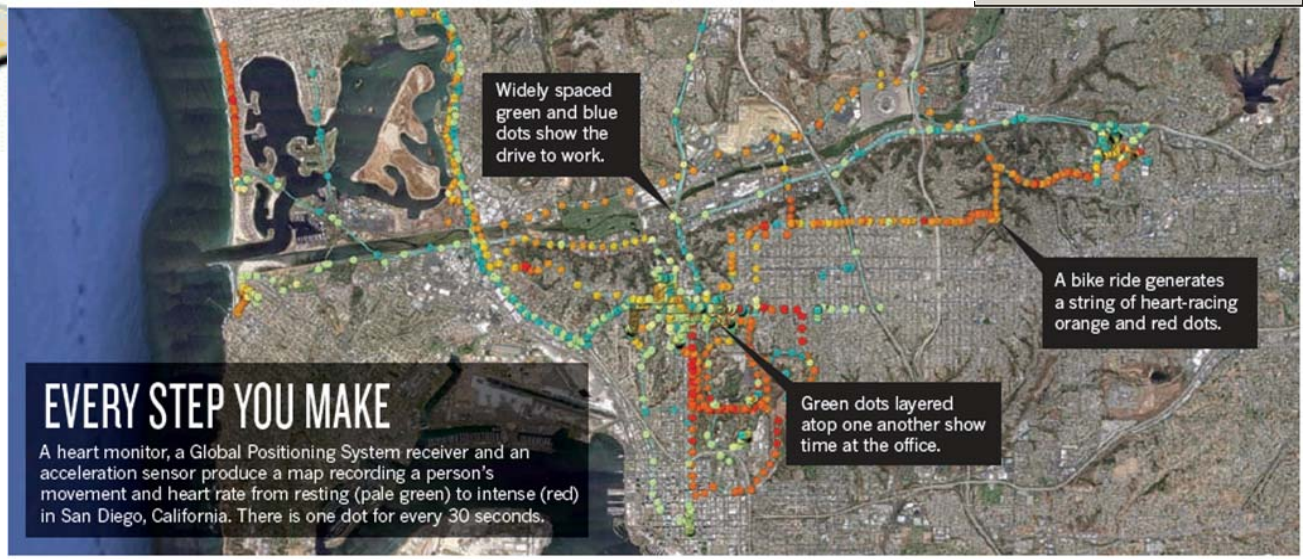
- **Parks**
  - **Distance & density & acreage**
- **Schools**
  - **Distance & density**
- **Recreation Facilities**
  - **Distance & density**
- **Census data**
  - **Housing unit density**
- **Parcel & Land Use**
  - **Commercial, industrial, institutional, residential, office, open space, vacant**
  - **Retail parcel count**
- **CoStar / SD County Tax Assessor**
  - **Retail floor area ratio**
- **Coastline**
  - **Distance to coast**
- **Local & Major Roads**
  - **Intersection & cul-de-sac counts**

Feb 16, 2011

NEWS FEATURE



GPS from Mobile Phone



How can mobile devices and related technologies enhance Precision Medicine research?

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Greater precision on measures of experience and subjective states through Ecological Momentary Assessment (EMA), the use of a mobile device to query participants as events happen

EMA:

- **Is highly configurable to the underlying research question(s)**
- **Can be preset or automatically prompted based upon context (e.g. GPS)**
- **Can be intensive on an App, or "light" via quick-response text messages**
- **Can be offered in any language and at multiple levels of literacy and numeracy**

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Greater precision on measures of social interactions via online social networks, searches and other technologies such as sound, cameras, location and context

facebook

Google

twitter

Instagram


ELSEVIER

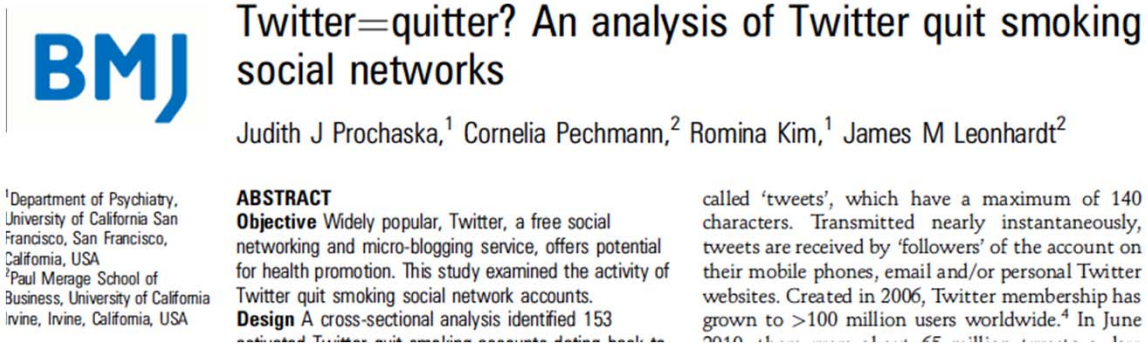
American Journal of Preventive Medicine

Volume 44, Issue 5, May 2013, Pages 520–525

Research and practice methods

Seasonality in Seeking Mental Health Information on Google

John W. Ayers, PhD, MA[a, c], Benjamin M. Althouse, ScM[d], Jon-Patrick Allem, MA[b], J. Niels Rosenquist, MD, PhD[f], Daniel E. Ford, MD, MPH[e]


BMJ

Twitter=quitter? An analysis of Twitter quit smoking social networks

Judith J Prochaska,[1] Cornelia Pechmann,[2] Romina Kim,[1] James M Leonhardt[2]

[1]Department of Psychiatry, University of California San Francisco, San Francisco, California, USA
[2]Paul Merage School of Business, University of California Irvine, Irvine, California, USA

ABSTRACT
Objective Widely popular, Twitter, a free social networking and micro-blogging service, offers potential for health promotion. This study examined the activity of Twitter quit smoking social network accounts.
Design A cross-sectional analysis identified 153

called 'tweets', which have a maximum of 140 characters. Transmitted nearly instantaneously, tweets are received by 'followers' of the account on their mobile phones, email and/or personal Twitter websites. Created in 2006, Twitter membership has grown to >100 million users worldwide.[4] In June

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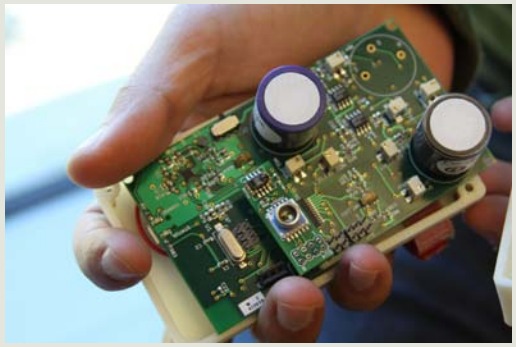
Greater precision on measures of environmental exposures such as particulate matter, noise, electromagnetic fields, environmental toxins & other insults that might impact such things as oxidative stress, immune response, hormonal regulation or other phenomena.

- **Wearable sensors that can store or transmit to/through the mobile phone data on exposures**
- **Combining data from wearable sensors with that from fixed sources in the Environment to enrich the understanding of cumulative exposure**
- **Periodic EMA & other triggered measurement tailored to specific research questions, or such things as occupation, location, natural disaster, or other Circumstance that might influence the natural course of treatment and/or outcomes**

Peters A et al. J Epidemiol Community Health 2012;66:103-105

CitiSense

Always-on Participatory Sensing for Air Quality



PI: Bill Griswold/UCSD, CSE
Co-PIs: K. Patrick, I. Krueger, T. Rosing,
S. Dasgupta, H. Shacham

Cyber-Physical Systems Program, NSF, 0932403

UCSDCSE UCSD

CitiSense: System Overview

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Finally, these devices can support recruitment and retention in Precision Medicine research.

- **Partner with telcomms on enrollment and tracking over time as participants move (opt in, of course)**
- **Text message reminders for data collection, in-person visits, special queries**
- **Use of text messages, social media, and other communication channels to support queries from and among study participants if questions/issues arise**

Recommendations

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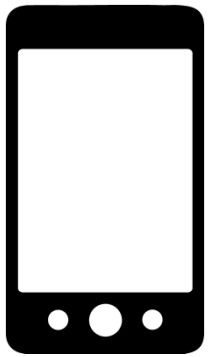
Ideally, <u>all</u> cohort participants will carry a Smartphone and wear a Smartwatch

- Movement (accel/gyro)
- GPS
- Ecological Momentary Assessment (EMA)
- Voice/Sound
- Image
- Bluetooth connectivity to other devices
- Specialized apps

Carried as usual



- Movement (accel/gyro)
- Light EMA via SMS
- Heart rate/HR variability
- Specialized apps

Worn 24x7

Recommendations

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Other mobile and wireless devices - and sources of data - will be used in subsets of the cohort based upon research questions and underlying health state