Your Heart Counts!

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Co-Chair, Stanford Data Science Initiative
Cardiovascular Disease

MyHeart Counts
Stanford Medicine
University of Oxford

Jeff Williams, Apple COO
Spring Forward Event
March 2015
More than 40,000 people downloaded a smartphone app and joined an ongoing global research study to measure how activity affects heart health.

"Just to be clear, 2 months ago this didn't exist; there was nobody in this study," said Euan Ashley, MD, from Stanford University in California, who is one of the creators of the app. "Over the course of 2 weeks in March, 30,000 people signed up," he reported.

The response demonstrates that big data can be harnessed at minimal cost, which could help revolutionize the way research is done, Dr Ashley explained.

"We're really in a new era, and one we don't really understand," he said at the Big Data in Biomedicine Conference in Stanford.

Stanford researchers, in collaboration with the American Heart Association, designed the free smartphone app called MyHeart Counts. Anyone 18 or older with an iPhone 5s, 6, or 6 Plus can download the app, give consent to be included in the study, answer survey questions about risk factors, and then let sensors record their movements for 7 days. The app will ask users to
Sensor and Data Collection

Data Use

This study will also gather health data from your personal devices with your permission.

Learn more

Protecting your Data

Your coded study data will be shared with other researchers approved by Stanford.

Learn more about how data is shared.

Data Collection

Your data will be encrypted and stored in a secure database, with your name replaced by a random code.

Learn more about how your privacy identity is protected.

Potential Benefits

The information collected by this study may help you better understand and monitor your heart health.

Learn more
Please complete your MyHeart Counts activities today. Thank you for participating in the MyHeart Counts study.

• TeleCheck-in
Machine learning approaches to large scale data

A Proportion of time stationary

B Percent with Condition

C Activity Cluster

JAMA Cardiol. 2017;2(1):67-76
State transitions are associated with health status regardless of total physical activity.
MHC v1: challenge & opportunity

• Rapid, convenient access to large populations
• Mobile, convenient consent
• Sensor measurements > recall
• “live cohort”

• Engagement
  – Lower bar to entry
  – Less individual investment in study
  – For 6 minute walk
    • 2 orders of magnitude more recruited
    • 1 order of magnitude more completed
NEW OPPORTUNITIES
One of the iPhone-based studies, MyHeart Counts, was launched last year by the Stanford University School of Medicine and has enrolled 50,000 people. It is “one of the largest cardiovascular research trials ever conducted,” according to the school. It asks people to fill out survey questions, including one that asks how happy they are, then uses the phone’s accelerometer to track how much they walk, run, or stay still during one week.

The tie-up, expected to be announced today in connection with an Apple product event in Cupertino, California, involves Stanford University, the Icahn School of Medicine at Mount Sinai in New York, and an app developer named LifeMap Solutions, according to people familiar with the plans. It is part of a widening effort by tech companies and scientists to reinvent how medical studies are carried out by encouraging wider sharing of health information.
Large datasets of humans, here or coming

- **UK Biobank**
  - 500k, collected, genotyped 5 years follow up, available to any qualified researcher
- **AllofUs**
  - 1m, not started, phenotyping not defined, access not defined
- **Million Veterans Project**
  - 300k so far, 5 years follow up, very limited access
- **23andme**
  - 1.8m people, proprietary, individual level data shared, multiple collaborations, genotyping not sequencing
- **Regeneron/Geisinger**
  - 100k, fully exome sequenced, medical records
MyHeart Counts v 2.0

- Launched January 2017
- Randomized study of coaching strategies
  - Transition prompts
  - Step count prompt
  - Personalized educational materials
  - Generic educational materials
- More personalized/aggregated data return
- Old and new media campaign to offset population skew towards young/male
  - ACC, WHS
  - Ad word campaign
- 23andme integration
- Coming
  - EHR integration
  - Further international launches
  - Android version
MyHeart Counts Cardiovascular Health Study (MHC)

This study is currently recruiting participants. (see Contacts and Locations)

Verified March 2017 by Stanford University

Sponsor:
Stanford University

Information provided by (Responsible Party):
Euan Ashley, Stanford University

ClinicalTrials.gov Identifier:
NCT03090321

First received: December 14, 2016
Last updated: March 18, 2017
Last verified: March 2017

Purpose

The MyHeart Counts Cardiovascular Health Study will utilize mobile health capabilities of smartphones and wearables to assess daily activity measures of the general population and compare these to measures of cardiovascular health risk factors and fitness. How people divide their time among exercise, sedentary behavior, and sleep all affect cardiovascular health, yet to date these have largely gone unmeasured. With the advancement of phone sensors and wearable fitness tracking devices these factors are now more straightforward to gather and measure. The use of smartphones by a large segment of the population allows for data collection on an unprecedented scale. The investigators aim to amass activity and cardiovascular health data on thousands of participants as well as provide significantly more quantitative data on type, duration, and intensity of daily activities.

In the second phase of the MyHeart Counts Cardiovascular Health Study (Randomized Assessment of Physical Activity Prompts In A Large Ambulatory Population) the researchers will conduct a randomized controlled clinical trial of four different physical activity prompts (intervention) and their effect on the level of physical activity in the study population as measured by change in step count.
A randomized trial of mobile personalized physical activity coaching

Baseline monitoring
Passive education (American Heart Association)
Personalized coaching based on activity cluster
Daily mid-day 10,000 step prompt
Continuous 1 hour sedentary trigger to stand and walk

Randomized order
7 days per stage

Primary outcome: average daily step count per stage compared to individual baseline
Secondary outcomes: life satisfaction score, personal risk assessment score, sleep duration
User feedback drives engagement
WEARABLE MONITORING
Photoplethysmography
The accuracy of wearable heart rate estimation greatly exceeds that of energy expenditure estimation and is close to clinical grade.
Bidirectional bias exists across activities.
The Apple watch has the greatest overall accuracy
Fitness trackers out of step when measuring calories, research shows

Compared with gold-standard laboratory measurements, scientists found devices poor at tracking calories burned, not good at monitoring heart rate.

Fitness devices can help monitor heart rate but are unreliable at keeping tabs on calories burned, research has revealed.

Forbes

Fitness trackers are terrible at counting calories, says Stanford study

- These devices are woefully bad at tracking calories, but they’re surprisingly accurate at measuring heart rate.
- That’s according to research from researchers at Stanford’s School of Medicine.

Christine Tan \| Alvin Hoang

The Washington Post

This study has good and bad news about fitness trackers

Stanford University study finds a severe weakness in the data obtained from wearables

We know that not all fitness trackers are created equal. A study last year, for example, found that the Apple Watch was the most effective wearable at tracking heart rate, but it appears there’s something they all have in common: they’re pretty lousy at tracking calories burned.
READY FOR CLINICAL APPLICATION?
A woman is throwing a frisbee in a park.

A dog is standing on a hardwood floor.

A little girl sitting on a bed with a teddy bear.

A group of people sitting on a boat in the water.
Stage 1
Pre-Process

Noisy PPG

Accelerometer X

Accelerometer Y

Accelerometer Z

Cleaned PPG

Stage 2
Convolutional Neural Networks

Rhythm State Classification

Estimate Cardiac Hemodynamics
The diagram shows the Receiver Operating Characteristic (ROC) curves for Arrhythmia detection, comparing the performance of different models. The y-axis represents the True Positive Rate and the x-axis represents the False Positive Rate.

The table below summarizes the key performance metrics:

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<th>Metric</th>
<th>Mean</th>
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<tr>
<td>auROC</td>
<td>0.876</td>
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<tr>
<td>auPRC</td>
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<td>Accuracy</td>
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<td>0.876</td>
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<td>Sensitivity</td>
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<tr>
<td>Specificity</td>
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<td>NPV</td>
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</table>
“You can’t list your iPhone as your primary-care physician.”
Support
NIH U01 HG007436 (Clingen)
NIH U01 HG (UDN)
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NIH U01 20150823 (GSP)
NIH HL094274 (T32)
NIH R01 HL113006
NIH R01: HL130020
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