Do Wearable Devices Impact Health?

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Understanding physical activity

Exercise is physical activity, but physical activity is not always exercise!

Physical activity refers to movement, normally for leisure, transport, or an occupation. It is most often walking but need not be locomotion. Physical activity can be incidental.

Exercise refers to a deliberate effort. It is conscious, thought out, and planned. The aim of exercise is to improve (cardio-respiratory) fitness and/or exercise performance. Exercise is often a form of self-expression, i.e. “I am a runner.”
Three types of physical activity

**Leisure**
- Walking, gardening, playing frisbee; includes exercise

**Transport**
- Locomotion; walking from point A to point B; walking to work

**Occupation**
- Assembly line employees, delivery persons, postal workers

Being “active” means not being sedentary. Although running 10 miles a day is being active, engaging in any of the above also means you are being “active.”
The continuum of physical activity

- Inactivity: No benefit; Harmful
- Physical activity: Some benefit
- Moderate Exercise: More benefit
- Vigorous Exercise: Most benefit
A brief history of physical activity measurement

**Paffenbarger and Morris**
Continued work on the epidemiology of physical activity

**Jerry Morris**
First published evidence that physical activity is linked to less heart disease

**Health policy**
Physical fitness and exercise become one of 15 priority areas in a national health promotion/disease prevention

**The study of exercise**
As a field of study, exercise physiology begins to mature

**Health promotion becomes a thing**
Companies like J&J begin to offer programs for their employees and include physical activity, health, occupational health, and EAP access.
What we didn’t know: Circa 1950

Dr. Jerry Morris studied London transportation workers. He compared the drivers (sitting all day) to the conductors, who spent their days climbing up and down 500-750 steps each day.

He was the first to show, in a large, population-based study, that physical activity is linked to lower rates of heart disease and death from heart disease.

This early hypothesis that men doing physically active work have a lower mortality from coronary heart disease in middle age than men in less active work was met with considerable skepticism by medical scientists and practitioners.
The work of Dr. Ralph Paffenbarger

Ralph Paffenbarger (1922-2007)  
Professor, Harvard and later Stanford

Internationally renowned for his work on the improvement in longevity through *regular lifetime physical activity*, which confirmed prior evidence that more physically active people reduce their risk of heart disease and live longer.

Studied longshoremen for 22 years, or age 75, or until death.

He had three categories of workers, defined by the activity of their jobs:

1. Light work
2. Moderate work
3. Strenuous work

Paffenbarger’s 1975 study showed that in the longshoremen, those whose jobs required “strenuous work” experienced fewer coronary events than those in the light and moderate work jobs. *This work confirmed the work of Dr. Morris, and made a substantial impact on American health policy in the 1970s.*
For the record: The recommendations

2008 Physical Activity Guidelines for Americans

www.health.gov/paguidelines

60 min or more of physical activity *daily.*
Most of the 60 min should be aerobic in nature, so lots of running, skipping, jumping, etc

**Don’t be inactive. Some activity is better than none.**
Substantial health benefit: At least 2.5 hours/week of moderate activity, or 1.25 hours/week of vigorous
Additional benefit from at least 5 hours/week of moderate or 2.5 h/week of vigorous activity

When older adults cannot do 2.5 h of moderate-intensity aerobic activity a week because of chronic conditions, they should be as physically active as their abilities and conditions allow.
How to get to 150 min/week of MVPA

- Continuous activities work your cardiovascular system and are better:
  - Walking, jogging, swimming, or cycling hard enough so that you breathe a little faster and notice some sweat
  - At least 30 min is best—but it’s not always possible
    - Even very short bouts of continuous activity are valuable
    - Aim for at least 10 min at a time, and add it up over the day

Walking part of the way to work  Walking the dog  Playing with the kids
The most recent debate and discussion?

What is the role of physical activity in preventing and managing obesity?

“The goal of the workshop was to provide an expert summary of the state of the science regarding the impact of physical activity in the prevention and treatment of overweight and obesity and to highlight innovative strategies for promoting physical activity across segments of the population.”
Context is everything: Where are we?

What are the physical activity levels of Americans as measured objectively via accelerometry (i.e. device)?

1. Define thresholds for moderate and vigorous to estimate the total number of minutes people spent per day in each.
2. Counted in 1-min and 10-min sessions.
3. Allowed for up to two minutes of “below threshold activity” before considering the session to be finished.
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Vigorous
Moderate
Light
Sedentary

Yeah. . . it’s that bad.

- Activity was accumulated almost entirely in 1-minute sessions (hard to differentiate from artefact).
- According to the objective data, <0.5% of men and women were meeting any recommended amount of activity.
- Vigorous activity was recorded very infrequently—no one had even one session of at least 10 min on any day, and even 1-minute sessions were rare.
- 66% of men and 68% of women did not even accumulate a single 10-min session of moderate or vigorous activity.
Why it’s ok that everyone won’t be “exercisers”

Choosing to *exercise* is equal parts self expression and health. Individuals choose exercise over simply being active because it is (or has become) part of their identity, and by extension a means to express themselves.

Therefore. . .

• It is not realistic to think we can turn a population into exercisers.
• Rather, we should expect and aim to get most people to identify themselves as leading an “active lifestyle.” That means simply *choosing* not to be sedentary via selecting activity whenever they can—on the way to work, around the house, and even during leisure time.
• Our aim is to help people make being active the norm. It does not have to be a form of self-expression, although it can be.
HMMM... BETTER REMEMBER TO REPORT MYSELF TOMORROW FOR STEALING.
A tendency toward bias

For many reasons we have a tendency toward bias, so that we over-report socially acceptable behaviors (i.e. physical activity) while under-reporting “unacceptable” behaviors (i.e. bad dietary habits).

Potential reasons for misreporting activity levels

1. Simple recall error
2. Method of collection
   a) Discrete, i.e. 0-30, 60-90 min, etc., can be problematic
   b) Continuous, i.e. individual fills in a minute value, can also be problematic
   c) Interviewed or self-completion
3. Little understanding of what “active” really means
Bring in the devices!

The past decade has seen a proliferation of devices and electronics we can wear on our body or clothing.

The devices span a range of product types and aims, from activity to capturing images and other environmental information.

Today, we will focus on those devices that measure physical activity.
Not your parents’ devices

Accelerometer *noun*

An electromechanical device that will measure acceleration forces caused by movement or vibration.

As the accelerometer is moved, it measures the forces from the acceleration of that movement—for example when you walk your center of mass accelerates as you take a step.

Even better—they can measure accelerations in all directions: up/down, forward/backward, left/right
Accelerometers in everyday life

Accelerometers are used more and more widely each year as engineers learn more ways to apply them to everyday life in useful ways.

Take-home message: They are very sophisticated hardware that can leverage increasingly sophisticated software.
A few categories of wearables

Heart rate monitors were perhaps the original wearable.

First available in the early 1990s, they simply recorded heart rate. Now they also predict energy expenditure and other metrics.

In the form of apps, we “wear” our smart phone.

The apps measure a range of different metrics while being worn and/or by holding in your hand.
A few categories of wearables
A few categories of wearables

GPS devices in the form of watches mostly. They use satellites to physically locate you and measure the distance you travel.

They measure distance (and speed) accurately and predict energy expenditure.

Becoming the go to device. Increasingly affordable, durable (or easily replaceable), and with better battery life.

Initially they just counted steps, but are more sophisticated and do more than just translate activity into steps.

Will eventually be GPS enabled.
Why we bother with wearable devices

The “wow” factor. Often they represent a cutting edge technology that is just really cool. . .WANT!

More often, they actually help us do something that is important and meaningful to us—such as being more active or helping us manage our weight.
The financial factor

Devices can range from $50 for the Fitbit Zip to $600 for the most expensive Garmin GPS cycling device—think about the application of the device to help you choose the “right” one.

When used as intended, we will likely get years of use from a device, so try to think of it as an investment.

BONUS: device manufacturers have built many “bells and whistles” on their web portals, so you actually get more than just a piece of hardware.
The power of activity monitors

Remember the continuum. . .
It is not realistic to think that everyone is going to choose deliberate exercise for 30+ min at a time.

Most will achieve their activity via *incidental* behaviors that occur as part of their daily lives. Therefore activity monitors become the superior choice for the vast majority of individuals.
Scientists are studying pedometers

A growing body of evidence is emerging that is helping us understand how pedometers (activity monitors) can help people of all ages and health increase their physical activity.

Since 2012, 428 peer-reviewed papers have been published that have studied “pedometers” in some way, shape or form.
Meet an expert

Dr. Catrine Tudor-Locke, Ph.D., a leading walking behavior researcher at Pennington Biomedical Research Center, has published widely on pedometers and physical activity.

http://www.pbrc.edu/research-and-faculty/faculty/?faculty=3706


A step-defined sedentary lifestyle index in adults

- **Physically active Lifestyle**: ≥7500 steps/day; Meeting MVPA recommendations
- **Low active Lifestyle**: 5000-7499 steps/day; Not meeting MVPA recommendations
- **Sedentary Lifestyle**: <5000 steps/day; Non-exercise physical activity deficiency; Lack of movement; Higher accumulated time in sedentary behaviors

Are activity monitors accurate?

Short answer: YES!

Long answer: YES!

- Most devices have been scientifically validated in the lab against some gold standard
- The software gets better and the chips get more powerful all the time, leading to more reliable functioning and better accuracy
- Dr. Dugas’ prediction: eventually the device will automatically recognize your activity based on the movement pattern.
A note on the “the JAMA paper”

We found that many smartphone applications and wearable devices were accurate for tracking step counts.

The authors indicated that the measurements were "mostly consistent" between trials, indicating good intra-device repeatability. That makes accuracy a little less of an issue.

Take-home message: Don’t believe the hype, get a device and use it to improve your health!
How devices work to increase physical activity

Oh, you don’t have any weaknesses?
Excellent, because we really only like to hire people with no self-awareness.

Often the simple act of wearing a device (and receiving feedback) is enough to increase physical activity.
How well do they work to increase activity?

The use of pedometers in behaviour modification programs increases physical activity by approximately 2,000 to 2,500 steps/day. This level of increase is associated with modest weight loss and improvements in blood pressure.

Studies employing a step goal, and in particular a 10,000 steps/day goal, appear to have had the greatest impact on increasing physical activity.
Ok, they work, but do people wear them?

It is a fair question. . .
A recent study followed participants wearing a Fitbit Ultra for one year. Common feedback was that remembering to wear it or not having a pocket (women) to put it in were common issues!

Fortunately the market has shifted to devices one can wear on the wrist and leave on 24 h a day, even when washing and bathing.
Translating the evidence into practice
In early 2014 we completed an in-depth analysis of device users among our entire population.

This included tens of thousands of members using a variety of ways to verify their physical activity with us.

We were then able to unpack how different health attributes were related to different device usage.
The hype is real

As we expected, activity monitors are seeing rapid growth in Vitality that mirrors their uptake among the public.
The hype is real

As membership grows, activities grow, but as a proportion of all ways to verify physical activity, activity trackers are growing outright.
Device users come in all shapes and sizes

A slightly larger percentage of women are using a pedometer, activity tracker or smartphone device, whereas heart rate monitors are more popular with men. Most importantly, no device is favored solely by men or women, indicating some parity between men and women with devices.
Device users come in all shapes and sizes

Importantly, device user characteristics mirror population characteristics—most users are overweight or obese.
Device users come in all ages

Generally, devices do not discriminate by age—this was unexpected, as we thought there would be a large age bias toward younger members.

<table>
<thead>
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<th>AGE</th>
<th>18-24</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65+</th>
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</thead>
<tbody>
<tr>
<td>Pedometers &amp; Activity Trackers</td>
<td>21.6%</td>
<td>30.3%</td>
<td>28.8%</td>
<td>15.8%</td>
<td>1.7%</td>
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</tr>
<tr>
<td>Heart rate monitor</td>
<td>25.2%</td>
<td>35.3%</td>
<td>26.7%</td>
<td>10.8%</td>
<td>1.8%</td>
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<tr>
<td>Smartphone</td>
<td>29.4%</td>
<td>35.3%</td>
<td>23.0%</td>
<td>8.7%</td>
<td>0.6%</td>
<td></td>
</tr>
</tbody>
</table>
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The right incentives **motivate change**

Member steps peak at the Vitality point incentive thresholds: 5,000 and 10,000 steps per day.

Take home message? “Targets” work, and the 10,000 steps/day metric is widely known and accepted.
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Movement can modify risk for disease

Additional research shows:

1. Women with >7,500 steps/day had a 50% lower prevalence of depression (McKercher et al., 2009).
2. Taking 8,000-12,000 steps/day is strongly associated with a BMI <25 kg/m² in men and women (Krumm et al. 2006).
A note on HIPAA compliance and privacy

Remember, being compliant means *not* sharing individual-level information. Compliant health promotion companies will report device data to employers *only* in aggregate without an individual’s consent!

**Vitality’s Views:**
- An increasing number of companies across sectors are collecting data about consumers.
- In mid-July, the Vitality Institute launched a three-month public consultation on a draft set of guidelines for personalized health technology.
- The guidelines aim to operate as a self-regulatory framework for the personalized health technology industry.
- Once finalized, the guidelines will be independently monitored and evaluated.

Use #TrustTech to be part of the conversation, and submit comments at www.thevitalityinstitute.org/ELSI until October 15, 2015!
Summary and conclusions

Wearable devices continue to become more ubiquitous. We should expect higher uptake over time as battery life and functionality continue to improve.

Wearables create self-awareness that can help improve physical activity levels (and therefore health), especially by reducing sedentary behavior.

We found in our own population that all age, gender, and risk groups use devices on a more or less equal basis. This is encouraging!

Because privacy will continue to be a concern for some individuals, we should help employees understand that their data is safe and cannot be shared without their consent.