Personalized Lifestyle Interventions – opportunities and challenges

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Content

• Lifestyle and population health

• Promoting healthy lifestyles

• Ecological momentary assessment/Personalized lifestyle interventions

• Practice examples
Public Health

### Top 10 global causes of deaths, 2016

<table>
<thead>
<tr>
<th>Cause Group</th>
<th>Deaths (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communicable, maternal, neonatal and nutritional conditions</td>
<td></td>
</tr>
<tr>
<td>Ischaemic heart disease</td>
<td>12.2</td>
</tr>
<tr>
<td>Stroke</td>
<td>11.6</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>7.2</td>
</tr>
<tr>
<td>Lower respiratory infections</td>
<td>4.9</td>
</tr>
<tr>
<td>Alzheimer disease and other dementias</td>
<td>4.0</td>
</tr>
<tr>
<td>Trachea, bronchus, lung cancers</td>
<td>3.5</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>3.4</td>
</tr>
<tr>
<td>Road injury</td>
<td>2.6</td>
</tr>
<tr>
<td>Diarrhoeal diseases</td>
<td>1.5</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Lifestyle factors cause chronic diseases

Willett et al. Science 2002
A healthy lifestyle

...commonly relates to these behaviors...
A healthy lifestyle

...Is becoming increasingly important...

Singapre at risk of becoming fat nation

Parliament: Health Minister Gan Kim Yong declares 'war on diabetes'; new task force set up
Promoting lifestyle behaviours
Promoting healthy lifestyles

Knowledge → Attitudes → Intention/Motivation → Volition → Behaviour

New Study Finds 73% Of People Who Set Fitness Goals As New Year's Resolutions Give Them Up

Whether aiming to lose weight, get fit, or train for an athletic event, simply setting a resolution doesn't guarantee success. On average, people who have set fitness resolutions say they have given up on them four times in the past, and cited a number of stumbling blocks when it comes to achieving their fitness goals:

- 42 percent say it's too difficult to follow a diet or workout regimen
- 38 percent say it's too hard to get back on track once they fall off
- 36 percent say it's hard to find time

Nearly half of those who gave up before reaching their fitness resolution goal did so within six weeks or less.
Increasing personal relevance of lifestyle interventions

Interventions based on these approaches

1. Targeting
   • Based on group characteristics
   • Same for all participants

2. Tailoring
   • Reach one specific person
   • Based on individual characteristics (age, attitudes etc.)
   • Related to outcome of interest

(Belton (2014). Youth-Physical Activity Towards Health: evidence and background to the development of the Y-PATH physical activity intervention for adolescents.)
Problems with traditional approaches

Static and lack Adaptation

Personal Relevance

Contextual Factors

Artificial setting and not in real-life

Do not consider micro-temporal relationships

A Social Model of Health (Dahlgren & Whitehead, 1991)
Physical activity and mHealth
Physical activity and health

Physical Activity
1. Some is good!
2. More is better!
3. It cannot be too much!

# Measuring physical activity

## GPAQ – Global Physical Activity Questionnaire

**Physical Activity**

Next I am going to ask you about the time you spend doing different types of physical activity in a typical week. Please even if you do not consider yourself to be a physically active person.

Think first about the time you spend doing work. Think of work as the things that you have to do such as paid or unpaid household chores, harvesting food/produce, fishing or hunting for food, seeking employment. Insert other examples in the following questions: vigorous-intensity activities are activities that require hard physical effort and cause large increases in breathing or heart rate like: [examples of vigorous intensity activities]. Moderate-intensity activities are activities that require moderate physical effort and cause small increases in breathing or heart rate like: [examples of moderate intensity activities].

<table>
<thead>
<tr>
<th>Questions</th>
<th>Response</th>
</tr>
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<tbody>
<tr>
<td><strong>Activity at work</strong></td>
<td></td>
</tr>
<tr>
<td>1. Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like (barring or lifting heavy loads, digging or construction work) for at least 10 minutes continuously?</td>
<td>Yes 1</td>
</tr>
</tbody>
</table>
| No 2 | FGF P 4

*INSERT EXAMPLES (USE SHOWBOARD)*

2. In a typical week, on how many days do you do vigorous-intensity activities as part of your work? Number of days |

3. How much time do you spend doing vigorous-intensity activities at work on a typical day? Hours: minutes |

4. Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate like: [examples of vigorous intensity activities]. Insert examples (USE SHOWBOARD) | Yes 1 |

No 2 | FGF P 4

5. In a typical week, on how many days do you do moderate-intensity activities as part of your work? Number of days |

6. How much time do you spend doing moderate-intensity activities at work on a typical day? Hours: minutes |

**Travel to and from places**

The most questions include the physical activities at work that you have already mentioned.

Now I would like to ask you about the usual way you travel to and from places. For example to work, for shopping, worship. [Insert other examples if needed].

7. Do you walk or use a bicycle (pedal cycle) for at least 10 minutes continuously? Yes 1
What proportion of Singaporeans is active?

Meeting Physical Activity Recommendations
Singapore Health study

Self-report

- 28% Active
- 72% Inactive
Technology for physical activity measurement

### GPAQ – Global Physical Activity Questionnaire

**Physical Activity**

Next I am going to ask you about the time you spend doing different types of physical activity in a typical week. Please answer yes or no even if you do not consider yourself to be a physically active person.

Think first about the time you spend doing work. Think of work as the things that you have to do such as paid or unpaid household chores, harvesting food/crops, fishing or hunting for food, seeking employment, [insert other examples].

The following questions ‘vigorous-intensity activities’ are activities that require hard physical effort and cause large increases in heart rate. ‘moderate-intensity activities’ are activities that require moderate physical effort and cause small increases in heart rate.

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</tr>
<tr>
<td></td>
<td>No 2</td>
</tr>
<tr>
<td></td>
<td><strong>FAIR, do go to D 4</strong></td>
</tr>
<tr>
<td>2. In a typical week, how many days do you do vigorous-intensity activities as part of your work?</td>
<td>Number of days</td>
</tr>
<tr>
<td>3. How much time do you spend doing vigorous-intensity activities at work on a typical day?</td>
<td>Hours, minutes</td>
</tr>
<tr>
<td>4. Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking or running light loads (for at least 10 minutes continuously)?</td>
<td>Yes 1</td>
</tr>
<tr>
<td></td>
<td>No 2</td>
</tr>
<tr>
<td></td>
<td><strong>FAIR, do go to D 7</strong></td>
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<tr>
<td>5. In a typical week, how many days do you do moderate-intensity activities as part of your work?</td>
<td>Number of days</td>
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<td>6. How much time do you spend doing moderate-intensity activities at work on a typical day?</td>
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<td></td>
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<td>The next questions include the physical activities at work that you have already mentioned. Now I would like to ask you about the usual way you travel to and from places. For example to work, for shopping, working. [insert other examples if needed]</td>
<td></td>
</tr>
<tr>
<td>7. Do you walk or use a bicycle (or car) for at least 10 minutes continuously at least 3 days a week?</td>
<td>Yes 1</td>
</tr>
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</table>
What proportion of Singaporeans is REALLY active?

Key advantages of using technology
- Objective: less social desirability and recall bias

![Pie charts showing meeting physical activity recommendations in Singapore Health study using self-report and accelerometer methods. The self-report method shows 28% active and 72% inactive, while the accelerometer method shows 25% active and 75% inactive.](image-url)
Key advantages of using technology

- Detailed: provide real-time high resolution data
The rise in wearables for objective monitoring

Number of physical activity tracker brands

Developing lifestyle Interventions
The PANDA Research Program

1. Mapping environmental factors
2. Interaction of individuals with their environment
3. Dynamically tailored real-time interventions

P.A.N.A

PHYSICAL ACTIVITY AND NUTRITION DETERMINANTS IN ASIA
Developing (personalized) lifestyle interventions

Mobile health (mHealth)

Behavioral determinants in real life (EMA)
Sense movement and locations. Ask about context.

Behavioral interventions in real life (JITAI)
Continuously adapt support based on data.
What’s EMA?

**Ecological**
- Data collection in real world

**Momentary**
- Data collection in real time

**Assessment**
- Multiple assessments

What’s EMA?

It’s about..
Examining health behaviours and contexts in real time (using smartphone apps and sensors)

How does it work?
Asking questions and sensing behaviour to infer causality
   
   When, where, and with whom are you active?
EMA enables us to understand in REAL-LIFE…

- Behaviors and changes in behaviors across time
- Micro-temporal relationships between e.g. behaviors and health states
- Contextual factors (e.g. social networks, environment, policy) related to behaviors

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(Dunton, 2018; ISBNPA conference Hong Kong)

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Antecedents (e.g., stress level) → Concomitant (e.g., mood) → Consequence (e.g., tiredness)
JITAI: Personalizing lifestyle interventions through mHealth

Use temporally dense data on behaviours, contexts and internal states to:

- Identify state of vulnerability/opportunity for support
- Deliver right type of support when and where needed
- Adapt rules and support continuously
- Avoid support that is interruptive or counter-productive

The PANDA Research Program

Cutting areas 1 and 2:
- Parks and Health
- GUSTO SRP (Baby PANDA)
- Sedentary behavior review
- Food-EPI
- Apps for life
- NUH HEAL Study
- FEAST Tool
- Digital marketing

Cutting areas 2 and 3:
- National Steps Challenge: Validation and Insights

1. Mapping environmental factors
2. Interaction of individuals with their environment
3. Dynamically tailored real-time interventions

EMA using mobile technologies
Continuous Glucose Monitoring
Bicycle share scheme natural experiment
Health Insights Singapore - NUS Student Cohort
Parks and Health

Geospatial Analyses
- Investigate relationship between parks/green spaces, park attributes as well as the neighbourhood environment with health and well-being.

Participant Survey
- Investigation into use and reasons for parks/green space use, facilitators and barriers of use, perceptions of neighbourhood environments and how these influence relationships between parks/green space, health and well-being.

Objective Movement and Location Monitoring
- Investigate participants engagement with parks/green spaces and their environment through objective movement and activity monitoring.
Participants

Environmental mapping – Geospatial analysis and EAPRS
N > 50,000

Survey on built environment and parks
N ≥ 3,000

mHealth for objective monitoring N ≥ 500
Objective monitoring over multiple consecutive days

**Ecological Momentary Assessment (EMA)**

Collects multiple “in the moment” surveys each day

**Location tracking on mobile phone**

24 hours tracking of participant’s location via GPS, cell-towers and WIFI

**Accelerometer**

Physical activity monitoring through accelerometers
Setting up EMA

movisensXS

- The android app enables EMA and additionally allows to log measurements from a variety of internal sensors such as accelerometer, ambient light sensor, battery status, connectivity status, or location.
Location tracking

In combination with EMA and accelerometer
- Time spend in parks or transport
- Active vs passive transport
- Intensity of activity in parks, transport etc.
- Relationship between e.g. park exposure and stress level
...
Participant recruitment

- Total Participants: 5564
- Not Approached: 2123
- Approached: 3441
- Agreed & Recruited: 413
- Drop out: 1
- Tentatively Agree: 28

Refused/ineligible: 2999

Of 413 who agreed and participated: 75% have complete data
Smartphone incompatibility

This device is maybe not compatible with movisensXS. There is a high chance that alarms are displayed delayed or are not arriving at all. Please consider to use a other smartphone.
Device accuracy – issues with location tracking

- drift during journeys
- missing data between locations
- understanding transportation type
- Inaccuracies in static reporting of location
- signaling strength
Accuracy of wearable devices
How accurate are wearables that measure heart rate or step counts?

Test trackers
- National Steps Challenge heart rate tracker
- Polar A370

Criterion
- Polar H10 chest strap (heart rate)
Study methodology

Laboratory phase: Wear trackers during cycling exercise
Free-living phase: Wear trackers during normal day
Accuracy of wrist-worn heart rate monitors

Overall

According to activity intensity

$r=0.56$

$ICC=0.51$
### Device accuracy – step counts

<table>
<thead>
<tr>
<th></th>
<th>Actigraph</th>
<th>Fitbit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps per day</td>
<td>8,812</td>
<td>10,193</td>
</tr>
</tbody>
</table>

![Average daily steps by devices](chart)

Gold standard

Chu et al. Comparison of wrist-worn Fitbit Flex and waist-worn ActiGraph for measuring steps in free-living adults. Plosone 2017
Participant engagement
Long-term Ecological Momentary Assessment

Device Utilization by Day of Study
(>1499 steps/day)

Responses to Queries on Each Study Day
(157 Qs over 28 days)
Long-term participant engagement

- **Device Utilization by Day of Study**
  - (>1499 steps/day)

- **Responses to Queries on Each Study Day**
  - (157 Qs over 28 days)

- **Participation rate**
  - About 88% (end of engagement period)

- **Participation rate**
  - About 35% (end of real-life observation)
Summary

• Lifestyle behaviours are key to population health

• mHealth holds promise for lifestyle interventions
  – Understanding behaviours using EMA
  – Providing personalized interventions (JITAI)

• Challenges include
  – Participant selection and generalizability
  – Device incompatibilities and data quality
  – Device accuracy and technological failures
  – Continuous participant engagement

• Realistic expectations about effectiveness of personalized lifestyle interventions
Thank you!

http://blog.nus.edu.sg/sphpanda/ ; Twitter: @PANDA_SGSPH