ASSESSING PHYSICAL ACTIVITY

QUESTIONNAIRES
MOTION SENSORS
OTHERS (E.G.: PHYSIOLOGICAL MARKERS, BEHAVIOURAL OBSERVATION)

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Measuring Physical Activity among Individuals and Populations

Why measure our levels of activity?

- Document how active our population is
- Gives feedback on health programs
- Study the factors that influence our participation

- Measuring the amount of physical activity is a complex procedure.
- Information collected needs to address the types of activities, frequency, intensity and duration.
- Physical activity covers many domains

Domains of Physical Activity

Domains	Examples
Leisure-time physical activity	Various types of activity; different surveys use generic or activity specific questions, and may ask details of activity frequency, duration and intensity.
Gardening and yard work	Various definitions, of varied intensities; may range from light-intensity gardening to vigorous chores or digging/moving heavy objects.
Household chores	Heterogeneous set of tasks; large gender differences; energy expenditure across tasks not well understood.
Active transport	Walking or cycling for transportation.
Occupational physical activity	Diverse occupations, with changes in energy expended in many occupations over recent decades.

Dimensions of Physical Activity

- **Frequency** – Number of times a person engages in an activity
- **Duration** – Length of time engaged in an activity
- **Intensity** – How hard an activity is
- **Type** – Domains
- **Context** – Where you are, when, who with etc.
- **Energy** – Measured in METs
- **Expense** – Cost in dollars
- **Reactivity** – How much the measure biases towards the result.

Methods of Measuring Physical Activity

Instruments used to measure physical activity									
Instrument	Measure	Frequency	Intensity	Duration	Type	Context	Energy expenditure	Expense	Reactivity
Self-report	Subjective	Y	Y	Y	Y	Y	N	L	H
Heart-rate monitoring	Objective	Y*	Y	Y*	N	N	N	M	L
Pedometer	Objective	N	N	N	N	N	Y*	L	L
Accelerometer	Objective	Y*	Y*	Y*	N	N	Y*	H	L
Direct observation	Objective	Y	Y	Y	Y	Y	N	M	H
Doubly labelled water	Objective	N	N	N	N	N	Y	H	None

Notes: Y = yes, can assess that aspect of physical activity; N = no, cannot assess that aspect of physical activity; asterisk (*) denotes that this information is available only from certain versions of this type of instrument; L = Low; M = Moderate; H = High.

http://www.ucsdeparc.org/index.php?option=com_content&view=article&id=94&Itemid=82 **Exercise and Physical Activity Resource Center**

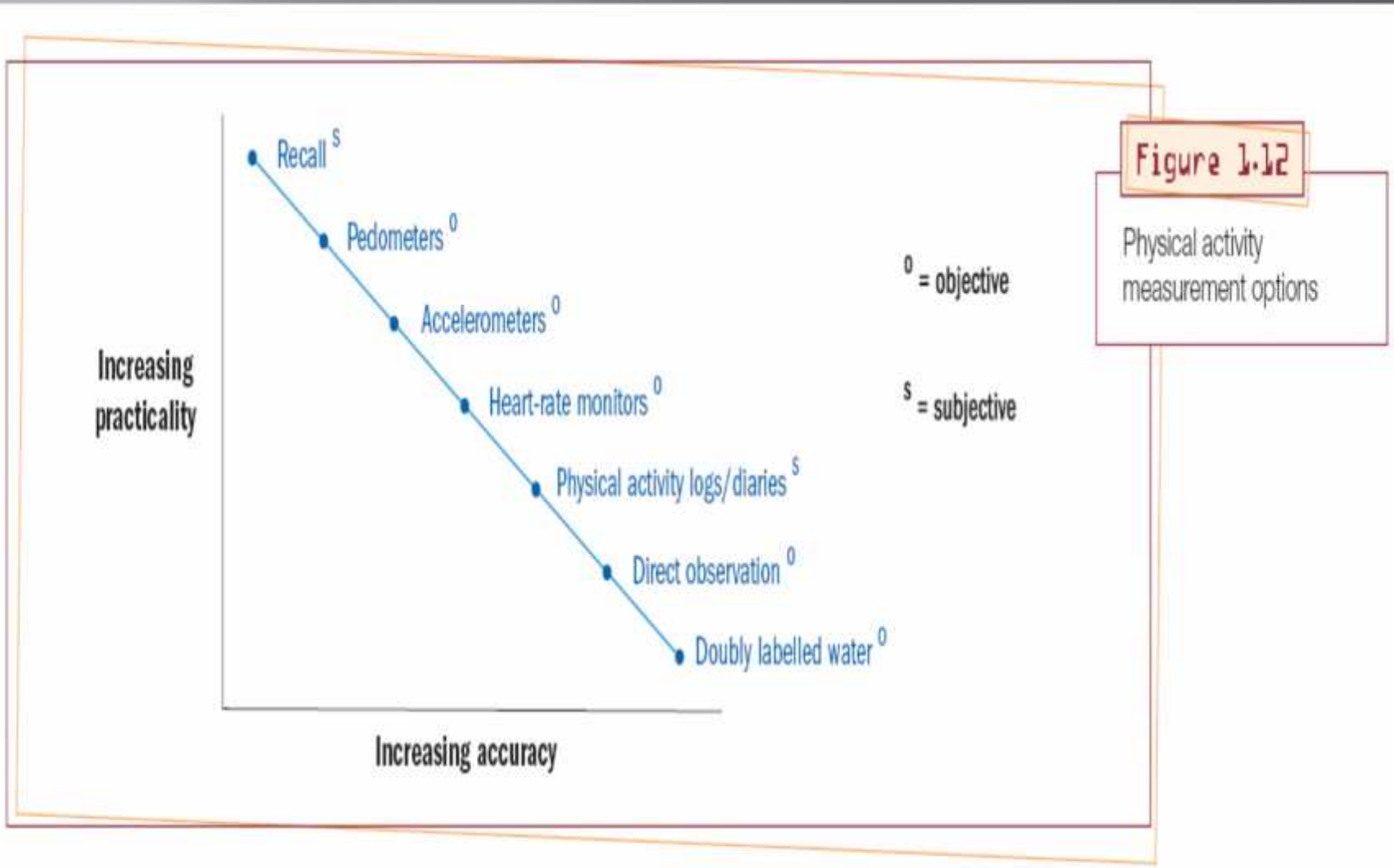


Figure 1.12

Physical activity measurement options

Subjective Measures

Self reports Questionnaires – Activity Logs / Diaries

Subjective Measures

- **Self-report** measures are the **most common** approach to quantifying physical activity levels and patterns in free-living adult populations.
- Individual data obtained from self-report measures are typically converted into estimates, which allow researchers to categorize or rank individuals or populations by physical activity level.
  - Physical Activity Questionnaires
  - Physical Activity Logs
  - Physical Activity Diaries

Advantages

- Low cost
- Applicable to a wide range of ages
- Wide distribution allows researchers to collect data from a large number of people
- Recall does not alter current behavior under study, which can occur with physical activity logs and diaries
- Measures can be adapted to fit the needs of a particular population or research question
- Several forms of administration (face-to-face, telephone interviews, mailed forms)

Disadvantages

Due to their subjective nature, these instruments are inherently limited by factors such as:

- recall error,
- social desirability or gender bias,
- floor effects,
- misinterpretation of terminology,
- some questionnaires fail to quantify the totality of physical activity dimensions and contexts

Questionnaires

International Physical Activity Questionnaire

- The IPAQ was developed by an international group of physical activity assessment experts as an instrument for measuring health-related physical activity suitable for both research and surveillance.
- In an international study over 12 countries this questionnaire proved to have acceptable measurement properties (Craig et al., 2003).
- The long 'last 7 days recall' form is recommended for use in research

IPAQ

- Telephone = telephone-adminstered
  Self-admin = self-adminstered
  Short = short version (last 7 days)
  Long = long version (usual)
- Scoring protocol

1a. During the last 7 days, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling,?

Think about *only* those physical activities that you did for at least 10 minutes at a time.

_____ days per week ⇨

or

☐ **none**

1b. How much time in total did you usually spend on one of those days doing vigorous physical activities?

_____ hours _____ minutes

https://sites.google.com/site/theipaq/

The Leisure Time Exercise Questionnaire (Godin & Shephard, 1985)

(1) Considering a 7-day period (a week) how many times on the average do you do the following kinds of exercise **for more than 15 minutes** during your free time?

- strenous exercise (heart beats rapidly): number of times in week
- moderate exercise (not exhausting): number of times in week
- mild exercise (minimal effort): number of times in week

(2) Considering a 7-day period (a week) during your leisure time how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?

- often
- sometimes
- never or rarely

The Leisure Time Exercise Questionnaire (Godin & Shephard, 1985)

Strenous exercise (9 METS): running jogging hockey football soccer squash basketball cross country skiing judo roller skating vigorous swimming vigorous long distance bicycling.

Moderate exercise (5 METS): fast walking baseball tennis easy bicycling volleyball badminton easy swimming alpine skiing popular and folk dancing

Mild exercise (3 METS): yoga archery fishing from river bank bowling horseshoes golf snow mobiling easy walking.

activity score in arbitrary units =

= (9 * (number of strenuous exercise episodes)) + (5 * (number of moderate exercise episodes)) + (3 * (number of mild exercise episodes))

Interpretation:

- A person reporting strenuous exercise and frequent sweating episodes was likely to be thin.
- An effective exercise promotion program will result in an increase in the activity score.

SQUASH: Wendel-Vos, Schuita, Sarisc & Kromhouta, 2003

Appendix A: ***The short questionnaire to assess health enhancing physical activity (SQUASH)***

Think about an average week in the past months. Please indicate **how many days per week** you performed the following activities, how much time **on average** you were engaged in this, and (if applicable) how strenuous this activity was for you?

COMMUTING ACTIVITIES (round trip)	**days per *week***	**average time per *day***	**Effort (circle please)**
Walking to/from work or school	days	hour minutes	slow/moderate/fast
Bicycling to/from work or school	days	hour minutes	slow/moderate/fast
Not applicable			

SQUASH

LEISURE TIME ACTIVITIES	days per *week*	average time per *day*	Effort (circle please)
Walking	days	hour minutes	slow/moderate /fast
Bicycling	days	hour minutes	slow/moderate /fast
Gardening	days	hour minutes	light/moderate /intense
Odd jobs	days	hour minutes	light/moderate /intense
Sports (please write down yourself) *e.g., tennis, fitness, skating, swimming, dancing*			
1.	days	hour minutes	light/moderate /intense
2.	days	hour minutes	light/moderate /intense
3.	days	hour minutes	light/moderate /intense
4.	days	hour minutes	light/moderate /intense

HOUSEHOLD ACTIVITIES	days per *week*	average time per day
Light household work (cooking, washing dishes, ironing, child care)	days days	hour minutes hour minutes
Intense household work (scrubbing floor, walking with heavy shopping bags)		

ACTIVITY AT WORK AND SCHOOL	average time per *week*
Light work (sitting/standing with some walking, e.g., a desk job)	hour minutes hour minutes
Intense work (regularly lifting heavy objects at work)	
Not applicable	

SQUASH Scoring

Table 1
Intensity scores used for calculation of the SQUASH activity scores

	Intensity scores based on reported effort[a]		
	Light	Moderate	Intense
Commuting activities			
Walking to/from work or school	1	2	3
Bicycling to/from work or school	4	5	6
Leisure time activities			
Walking	1	2	3
Bicycling	4	5	6
Gardening	4	5	6
Odd jobs	1	2	3
Sports			
2 to <4 MET	1	2	3
4 to <6.5 MET	4	5	6
≥6.5 MET	7	8	9
Household activities			
Light household work		2	
Intense household work		5	
Activity at work and school			
Light work		2	
Intense work		5	

[a] Intensity scores ≥3 were assumed to represent health-enhancing physical activity.

The Active Australia Survey

Are you sufficiently active for health benefits?	
Walking: total times/week = _____	Total hours/week = _____
Moderate PA (MPA): total times/week = _____	Total hours/week = _____
Vigorous PA (VPA): total times/week = _____	Total hours/week = _____
Calculate:	
Sessions: walking _____ + MPA sessions _____ + VPA sessions _____ = _____ sessions/week	
Hours: walking _____ + MPA hours _____ + (VPA hours _____ × 2) = _____ hours/week	
Sufficiently active? (Tick if you meet either or both criteria.)	
☐ ≥ 150 minutes/week	
☐ ≥ 150 minutes/week and ≥ 5 sessions/week	

Physical Activity Logs

- Physical activity logs are continuous records of participation in specific types of listed activities.
- The participant is required to **record the duration and intensity immediately or shortly after one of the listed activities is performed**.
- This information can be utilized to calculate the energy cost of each activity and to determine the accumulated energy expenditure of daily activities.

Physical Activity Diaries

- The diary technique of assessing habitual physical activity consists of **periodic recording of all activities**, either by the individual, an observer, or an interviewer.
- Activity diaries are superior to activity recall and are capable of simultaneously collecting data on many subjects at low cost.
- Recording frequency is determined by the investigator, and has ranged from every minute to every 4 hours, and is typically limited to 1-3 days.
- The detail of diary entries also varies, from meticulous records of every single activity throughout the day, to logging specific activities assigned to general categories.

Physical Activity logs/diaries

Advantages

- Suitable for small groups or individuals
- Usually easy to complete
- Able to provide detailed information on context of an activity (e.g. location, other participants, subject's feelings)

Disadvantages

- Heavy subject burden (entries completed throughout the day)
- Unreliable due to potential misinterpretation or inaccurate recording

Objective Measures

Accurate assessments of the physical activity dimensions (type, duration, frequency, intensity) **and contexts** (sport or recreation, occupation, transportation, incidental) requires an instrument that objectively quantifies activities performed in free-living conditions.

Direct Observation

Direct Observation – Involves watching people and noting specific behaviours and activities they are participating in.

Commonly used on children while playing.

Advantages

- Quantitative and qualitative information
- Behaviour observed
- Wider variety of information gained
- Software available
- Used in school and community settings

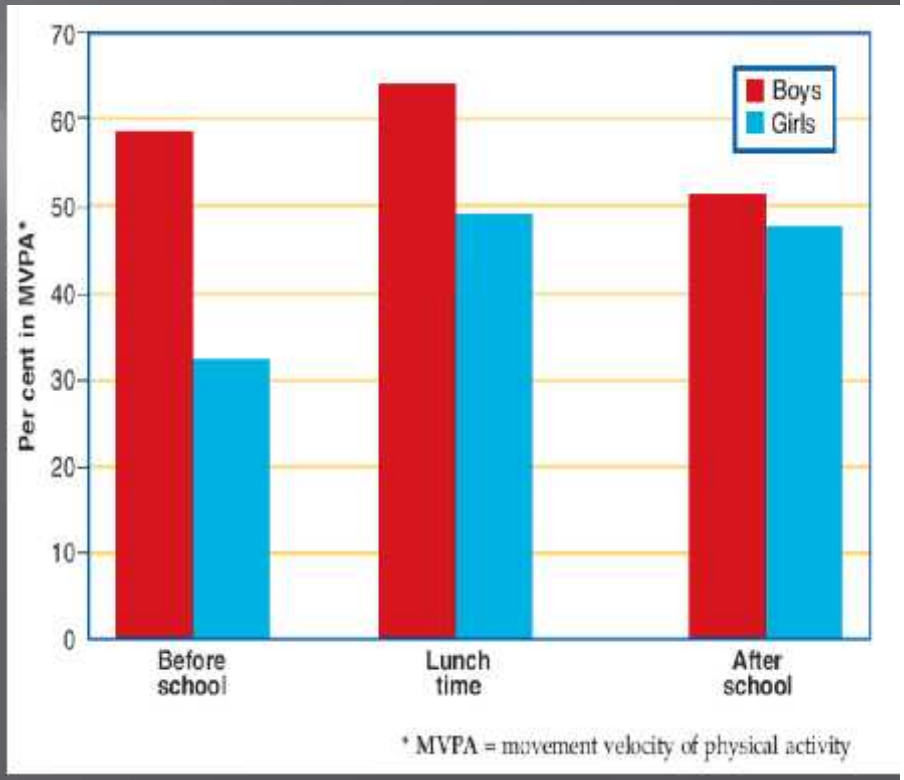
Disadvantages

- Difficult with large populations
- Obtrusive and time consuming
- Can cause bias
- Training for observers

SOPLAY

System of Observing Play and Leisure Activity in Youth (SOPLAY)

- Used to asses groups of people (Commonly school settings).
- Uses a time-sampling technique in a given target area.



SOPLAY OBSERVATION FORM
(System for Observing Play and Leisure Activity in Youth)

Date: ___/___/___ Observer: _____ Period: BS LU AS (circle)

Start time	Area	Condition A	U	S	O	E	Girls S	W	V	Act.	Boys S	W	V	Act.
____:____	1	N Y	N Y	N Y	N Y	N Y	—	—	—	—	—	—	—	—
____:____	2	N Y	N Y	N Y	N Y	N Y	—	—	—	—	—	—	—	—

Form codes:

BS = Before School
LU = Lunchtime
AS = After School
A = Accessible area
U = Useable area
S = Supervised area
O = Organised activity
E = Equipment provided
S = Sedentary
W = Walking
V = Very active
Act. = Prominent activity

Activity codes:

0 = No identifiable activity
1 = Aerobics
2 = Baseball or softball
3 = Basketball
4 = Dance
5 = Football
6 = Gymnastics
7 = Martial arts
8 = Racquet sports
9 = Soccer
10 = Swimming
11 = Volleyball
12 = Weight training
13 = Other playground games
14 = None of the above

Adapted from Welk 2002

SOFIT and BEACHES

SOFIT (System for Observing Fitness Instruction Time)

- Measures physical activity during PE classes
- Content and behaviour is observed

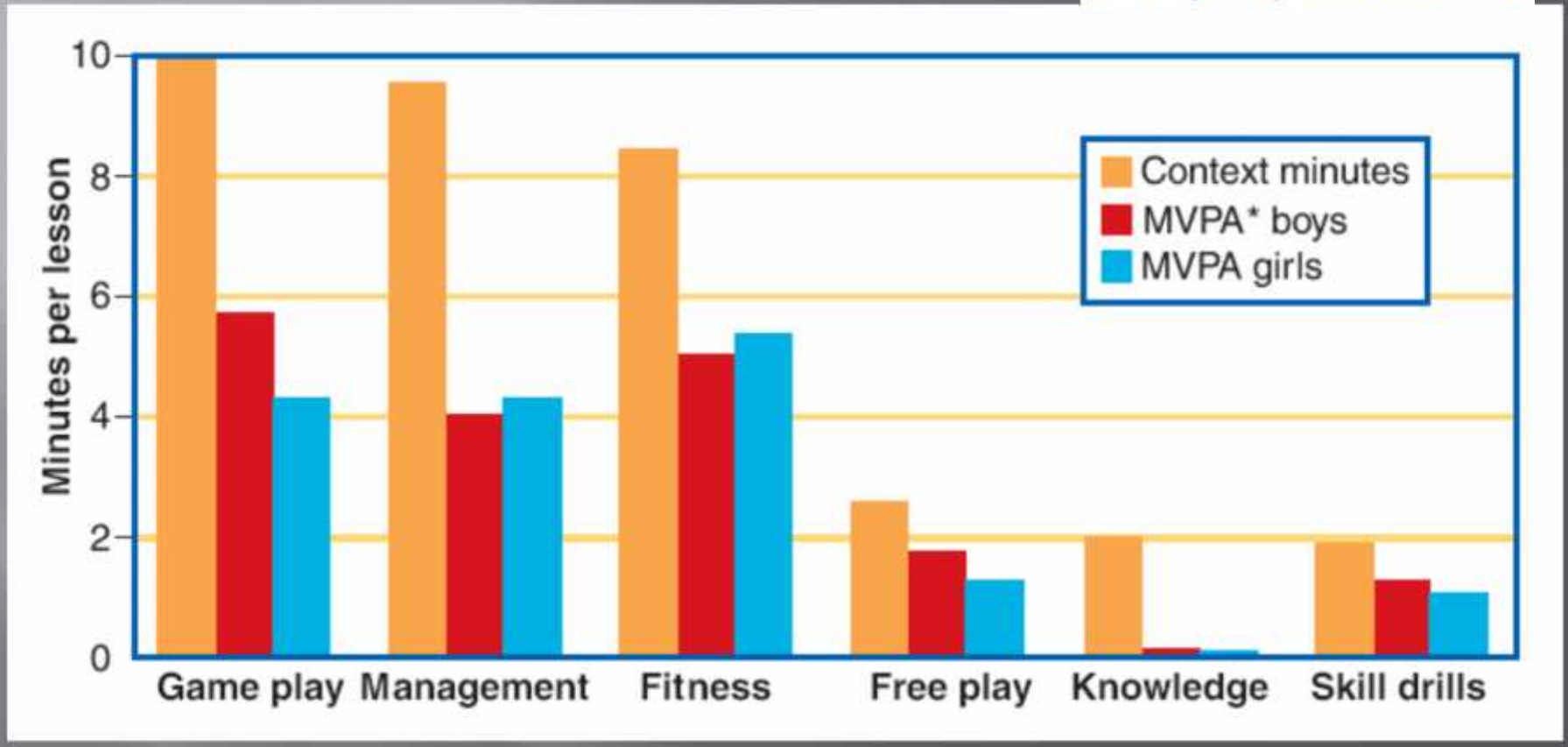
BEACHES (Behaviours of Eating Activity for Children's Health Evaluation System)

- Measures children' eating and physical activity patterns at home and at school.

Measurement Options – Direct Observation

2. SOFIT

Figure 1.11:
Example of SOFIT data



Accelerometers

- Accelerometers are **small, unobtrusive instruments** worn on the trunk and/or limbs and **monitor the intensity of body mass movements in up to three planes** (anteroposterior, mediolateral, and vertical).
- Based on the theory that acceleration is directly proportional to the muscle forces required for movement.
- Data are stored as accelerometer counts over user-specified time intervals, and **estimates of the duration, frequency, intensity, and total volume of physical activity are used to estimate energy expenditure levels**.
- The memory capacities range from days to several weeks and data can be quickly downloaded to a personal computer

Accelerometers

Advantages

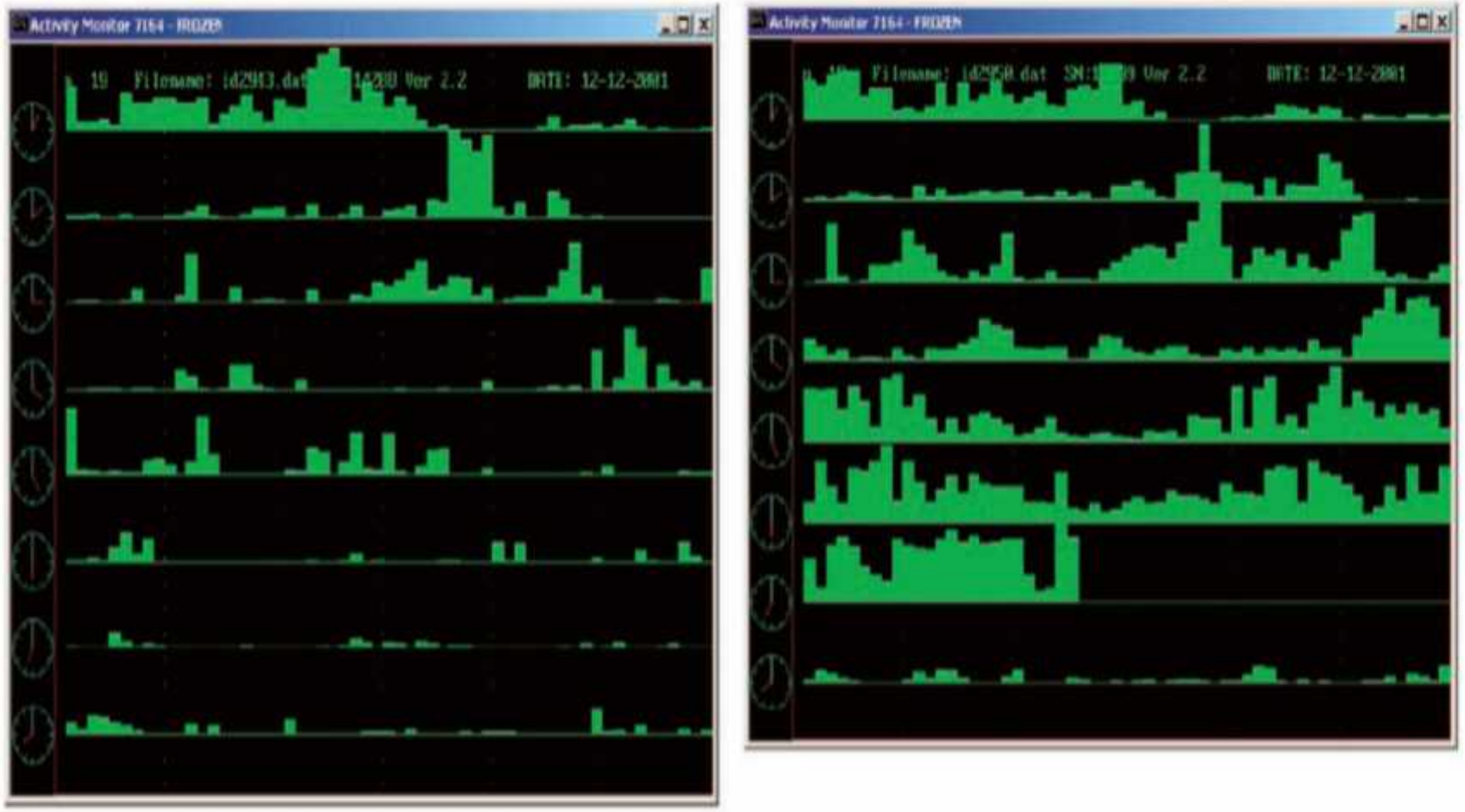
- Clear in describing intensity, frequency and duration
- Non-invasive
- Able to provide minute-by-minute information
- Usable for extended periods
- Simple, quick data collection

Disadvantages

- Limited use in large numbers due to financial cost
- Inaccurate assessment of certain activities (e.g. incline walking, weight loads)
- Inability to provide behavioural data (e.g. what people are doing during monitoring)

Figure 1.20

Examples of accelerometer data



Heart Rate Monitors

- An individual's **heart rate is the easiest physiological variable to measure in the field**.
- The monitors are small, unobtrusive instruments that measure the electrical activity of the heart using a chest strap transmitter that sends electrocardiograph signals to a digital receiver watch with an alarm clock.
- Instrument refinements over the last 20 years have resulted in heart rate monitors that can record and store data in 15-second to 1-minute time intervals for up to several days, and can be downloaded to a computer.
- Physical activity and energy expenditure estimates are more accurate when indirect calorimetry is used to establish individual calibration curves for each research participant

HR monitors

Advantages

- Specific to physiological parameters
- Easy to use
- Clear in describing intensity, frequency and duration
- Simple, quick data collection
- Potential to provide educational information

Disadvantages

- Limited use in large numbers due to financial cost
- Some discomfort for participants, especially over extended periods
- Use restricted to aerobic activities
- Factors such as training state need to be considered in analysis
- Variations to heart rate due to personal and environmental factors (e.g. stress, heat, emotions)

Pedometers

- Pedometers are small, belt-mounted devices primarily used for **quantifying the daily number of counts** (i.e., steps) accumulated.
- Each step is recorded as the hip's vertical accelerations trigger a spring-suspended horizontal lever arm.
- Total daily steps can be compared to current physical activity recommendations and classifications.
- Pedometers serve as **motivational tools** for promoting physical activity because immediate feedback on accumulated steps, whether incidental or intentional, provides goal attainment information and is a constant reminder to be active.
- These characteristics, as well as size and self-monitoring capability, allow **pedometers to play a key role in health promotion** campaigns and walking intervention studies

Pedometers

Advantages

- Low cost & non-invasive
- Easy to use motion sensor
- Determine distance travelled on foot
- Newer models also measure energy expended and time.
- Useful in a variety of settings
- Easy for large groups

Disadvantages

- Assess only hip movement
- Can't store data
- Unable to record magnitude of the movement
- Not useful when comparing different age groups
- Energy expenditure based on adult results only.


FUN
ZONE

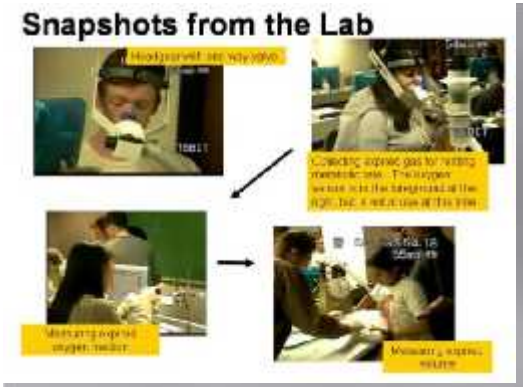

ACCORDING TO MY FITNESS TRACKER, I TOOK 20,000 STEPS YESTERDAY.
Dilbert.com DilbertCartoonist@gmail.com
WHAT? THAT'S DOUBLE WHAT I DID. YOU WON'T WIN THIS! I WILL RUN TO THE ENDS OF THE EARTH TO BEAT YOUR STEP COUNT!
9-29-15 © 2015 Scott Adams, Inc. /Dist. by Universal Uclick
DO YOU REALLY HAVE A FITNESS TRACKER?
NO, IT LOOKS LIKE A LOT OF WORK.

HR+M (Heart Rate plus Motion)

- A **single device** that simultaneously **collects synchronized heart rate and motion** (HR+M) data is preferable in order to overcome the inherent limitations associated with accelerometers and heart rate monitors used separately.
- When measuring heart rate, the accuracy of energy expenditure estimates is increased when the relationship between heart rate and energy expenditure or oxygen consumption (VO2) is determined through a process called **individual calibration**, which requires participants to **perform an exercise test while simultaneous measures of heart rate and VO2 are taken**.
- Although the individual calibration process is not required, performing such a test will increase the accuracy of PAEE estimates.
- Step tests are simple to carry out as no gas analyses are needed, equipment needs are minimal and inexpensive, and they can be performed almost anywhere on large groups of people by non-experts

Anthropometric Measurement

- Researchers have the option of collecting anthropometric measurements (e.g., height, weight, waist circumference, skinfold thickness) as well as other physiological measurements (e.g., blood pressure).
- For many studies, it is imperative to report on physiological variables such as body mass index (BMI), waist-to-hip ratio, and percent body fat in participants to assess risk for various diseases and to analyze the effectiveness of the study intervention



Indirect Calorimetry

- Indirect calorimetry is a technique that **provides accurate estimates of energy expenditure from measures of carbon dioxide production and oxygen consumption during rest and steady-state exercise**.
- There are open- and closed-circuit methods, and technology has advanced from the Douglas bag method to fully-portable, electronic equipment that provides continual and instantaneous breath-by-breath values of pulmonary gas exchange.
- Indirect calorimetry is carried out on an individual basis, which makes this a fairly **time-consuming process ideal for smaller studies.**

Doubly-Labeled Water

- Doubly-labeled water is a noninvasive procedure involving the **ingestion of a quantity of water labeled with a known concentration of naturally occurring, stable isotopes of hydrogen and oxygen.**
- As energy is expended in the body, carbon dioxide and water are produced, and the differences between the isotope elimination rates are used to calculate total energy expenditure.
- This method can be carried out on a wide range of individuals over lengthy time periods, usually between 4 and 21 days, which is advantageous for capturing habitual energy expenditure patterns.
- However, the **cost of materials and expertise required** to analyze the isotope concentrations via mass spectrometry prohibits the use of doubly-labeled water in large epidemiological studies.
- The use of doubly-labeled water to assess free-living energy expenditure is currently regarded as the gold standard technique.
- With a reported precision of ± 3%, this method serves as a reference for validating other instruments or methods designed to measure energy expenditure.

Doubly labelled Water

Advantages

- Unobtrusive and non invasive.
- Accurately measures total energy expenditure related to physical activity
- Allows for the calculation of VO_2
- Can be used with any age group.

Disadvantages

- Extremely expensive, around $2000 per person per test.
- Doesn't provide any information relating to activity type, frequency, intensity or duration.
- Doesn't provide any contextual information (settings where someone is being active) about the physical activity behaviour of an individual.

Environmental Measures

Geographical Information Systems (GIS)

- Develop objective measures of social and physical environments, and spatially map and analyze these data by using Geographic Information Systems (GIS).
- Examples include examining the relationship between adolescents' physical activity and neighborhood factors such as land-use mix, walkability, and proximity and density of intersections, recreational facilities, and parks.

Global Positioning System (GPS)

- The global positioning system is a worldwide radio-based navigation system formed from a constellation of 24 satellites and their ground stations.
- Real-world applications of GPS include location, navigation, tracking, mapping, and timing.
- GPS technology can be used to locate and monitor real-time movement of individuals as they go about their daily activities, tracking their route and distance traveled, which serves as a useful, low-burden tool for physical activity measurement and intervention studies.
- GPS technology is often used in conjunction with GIS software to visualize and analyze GPS data

e/Balance™ (under construction)

- Researchers (Santech, Inc.) have developed a prototype of a portable energy balance assessment and intervention tool supported through data capture and feedback in real time.
- e/Balance™ was built around a cell phone client and a web-based server architecture.
- The software was designed to be adaptable to the specific needs of two groups of researchers: (1) those engaged in individual-level cognitive and behavioral intervention research; and (2) those involved in active living and food environment research.
- In its final form, the tool will support the self-reporting and objective measurement of individual-level energy balance data (e.g., physical activity, heart rate, sedentary behavior, dietary intake, and psychosocial data).
- It will also support the capture and use of environment-based data–in this case, GPS data that can be matched to GIS data–for purposes of environmental tracking and prompting

Wearable Devices as Facilitators, Not Drivers, of Health Behavior Change

Mitesh S. Patel, MD, MBA, MS[1]; David A. Asch, MD, MBA[1]; Kevin G. Volpp, MD, PhD[1] JAMA 2015

- 6,223 wearable users
- A tremendous gap exists between recording data and changing behavior, according to the team, with little evidence to say it could be bridged, or even narrowed, despite increasing popularity.
- wearables appeal to those who need them least, for their survey revealed wearable users to be of a young, high-earning demographic who described themselves as early adopters of technology.
  - Of the gadget itself, the researchers say the additional steps it implies can be just too bothersome for those who may have a difficult time already and to save time spent syncing, charging and connecting, it could be best to stick to smartphones.
  - Not enough tried-and-true principles from theories of health behavior have been applied to the gadgets, says the report, which concludes that wearables need to focus on those who need them most and create strategies appropriate to them.

https://vimeo.com/128873380

Group work

- How you will assess any changes in physical activity you will achieve?

Thank you