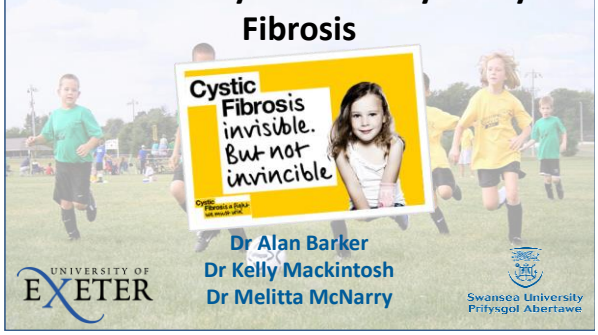
The Role of Physical Activity for Cystic Fibrosis



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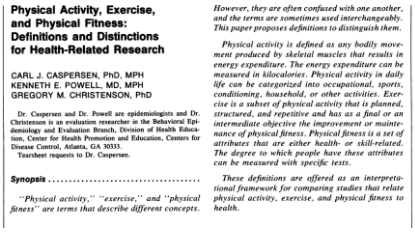
Overview

- What is physical activity?
- Why should we measure physical activity in people with cystic fibrosis (CF)?
- What methods are available to measure physical activity?
- Measuring physical activity using accelerometers – decisions, decisions, decisions.

Definitions

- What is physical activity?
- What is exercise?
- What is physical fitness?



Physical Activity, Exercise, and Physical Fitness: Definitions and Distinctions for Health-Related Research

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Tearsheet requests to Dr. Caspersen.

Synopsis .....

"Physical activity," "exercise," and "physical fitness" are terms that describe different concepts. However, they are often confused with one another, and the terms are sometimes used interchangeably. This paper proposes definitions to distinguish them.

Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure. The energy expenditure can be measured in kilocalories. Physical activity in daily life can be categorized into occupational, sports, conditioning, household, or other activities. Exercise is a subset of physical activity that is planned, structured, and repetitive and has as a final or an intermediate objective the improvement or maintenance of physical fitness. Physical fitness is a set of attributes that are either health- or skill-related. The degree to which people have these attributes can be measured with specific tests.

These definitions are offered as an interpretational framework for comparing studies that relate physical activity, exercise, and physical fitness to health.

Caspersen et al (1985). *Public Health Reports*. 100: 126-131

What is Physical Activity?

"any bodily movement produced by skeletal muscles resulting in energy expenditure above resting"

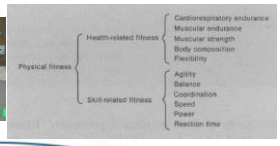
Leisure-time physical activity
Exercise and sport
Transportation
Work
Chores

What is Exercise?

"Exercise is a physical activity that is planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness *[and health]* is an objective"

What is Physical Fitness?

"physical fitness is a set of outcomes or traits that relate to the ability to perform physical activity. That is, physical fitness is seen as something that people possess or achieve, such as aerobic power, muscular endurance, muscular strength, body composition, and flexibility"



Distinction?!

Are physical activity and exercise the same?

What is the relationship between physical activity and physical fitness?

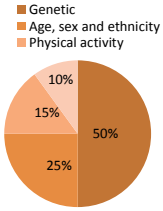
Physical activity ← ? → Physical fitness

Moderate to vigorous physical activity but not total physical activity is positively related to physical fitness

What are the determinants of physical activity in youth?

- Heritability estimates range from ~ 20-50% (Teran-Garcia et al. 2008)
- Review of correlates of physical activity (Van Der Horst et al. 2007)
  - Gender (boys, +)
  - Age/maturation (-)
  - Self-efficacy (+)
  - Parent/sibling physical activity level (+)
  - Parents education (+) and socioeconomic status (+)
  - Attitude (+) and motivation (+)
  - PE participation (+)
  - Friend support (+)

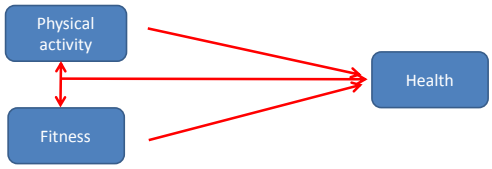
What are the determinants of physical fitness in youth?



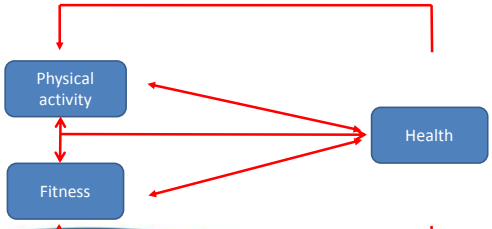
Physical activity and health

Physical activity → Health

Physical activity, fitness and health



Physical activity, fitness and health

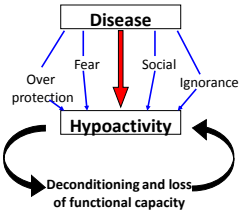


A clinical context

- Why are we interested in the physical activity status of a person with CF?

A clinical context

- Is the individual sufficiently active?
- Will enhanced physical activity benefit the health and wellbeing of the individual?
- Does exercise have a negative impact on the individual's health?



Rowland and Bar-Or (2004)

Is the individual su

- *What do we mean by sufficiently active?*
- There are no CF specific physical activity recommendations
- Use Government guidelines

Physical Activity Guidelines (DoH, 2011)

Discuss in groups what the current physical activity guidelines are for:

- Early years (under 5's)
- Children (5 – 18 years)
- Adults (18 – 64 years)

Government Guidelines: Early Years (Under 5's)

- PA should be encouraged from birth, particularly through floor-based play and water-based activities in safe environments.
- Children of pre-school age who are capable of walking unaided should be physically active daily for at least 180 minutes (3 hours), spread throughout the day.
- Reduce sedentary time.

Government Guidelines: Children (5 – 18 years)

- All children and young people should engage in MVPA for at least 60 minutes and up to several hours every day.
- Vigorous intensity activities, including those that strengthen muscle and bone, should be incorporated at least three days a week.
- Reduce sedentary time.

Government Guidelines: Adults (19 - 64 years)

- Adults should aim to be active daily. Over a week, activity should add up to at least 150 minutes (2½ hours) of MPA in bouts of 10 minutes or more (30 minutes on at least 5 days a week).
- Alternatively, comparable benefits can be achieved through 75 minutes of vigorous intensity activity spread across the week or a combination of MPA & VPA
- Adults should also undertake PA to improve muscle strength on at least two days a week.
- Reduce sedentary time.

Insufficiently Active

"What fits your busy schedule better, exercising one hour a day or being dead 24 hours a day?"

Are individuals with CF sufficiently active?

CF patients performed 363 min/day of total physical activity compared to 280 min/day in healthy controls

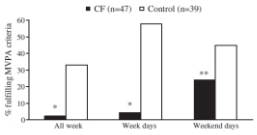


Fig. 2. Percentages of children meeting recommendations for moderate-to-vigorous physical activity (MVPA) by group. $*p < 0.001$, $**p = 0.04$ for between-group comparisons. Abbreviation: CF, cystic fibrosis.

Measuring total physical activity may be misleading

Moderate to vigorous activity levels are low in CF

Aznar et al. (2014)

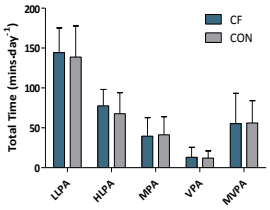
Physical Activity Levels in CF Children

- 18 young patients with CF (12.4 ± 2.8 yrs; FEV_1: 80 ± 9%) in Wales:
  - 8 ΔF508 Homozygote, 10 ΔF508 Heterzygote
  - Diagnosis of CF previously confirmed by positive sweat test
- 18 age- and sex-matched healthy controls (12.5 ± 2.7; FEV_1: 89 ± 17%)
- 7 day objective physical activity levels (ActiSleep GT3X+)
  - Inclusion criteria – ≥ 10 hours for at least 2 weekdays and 1 weekend day
  - Lung function using standard spirometry

Mackintosh et al. (under review)

Physical Activity Levels in CF Children

- Similar total levels and patterns of accumulation
- Higher PA during weekdays than weekend days in both groups
- FEV_1 predicted by high-light PA in those with CF
- Participants were largely pre-pubertal



Mackintosh et al. (under review)

Are individuals with CF sufficiently active?

- No (according to guidelines for healthy individuals)
- BUT - the majority of the population are inactive
- What do we know:
  - Individuals with CF are less active than healthy peers, especially for MVPA
  - Levels of physical activity decline with age
  - Girls are less active than boys

What are the possible benefits of physical activity in CF?

Benefits of physical activity

Health related QoL
Reported not measured PA

FEV_1
Respiratory symptoms
Daily step count

Higher increase in PA (~ 17 min/day/yr) related to lower decline in FEV_1 (-1.4 vs. 1.9%)
Subjective PA

Cardiorespiratory fitness (VO_2 max)
MVPA
<80% FEV_1

Bone strength
LPA/MPA

Measures of habitual physical activity reviewed in Bradley et al. (2015). *J Cystic fibrosis*. 14: e25-e32.

Why may the relationship between physical activity and fitness be clinically relevant?

- Fitness is a powerful marker of overall health status and patient mortality
- Nixon et al. (1992). *NEJM*. 25: 1785-1788.

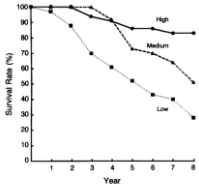
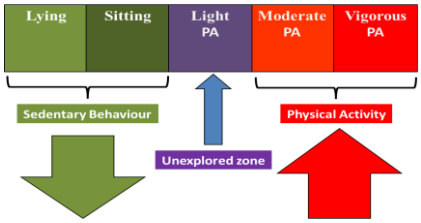


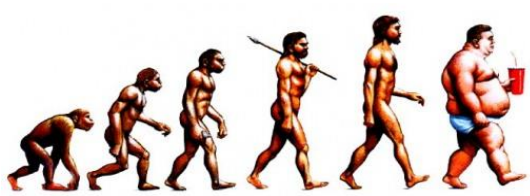
Figure 1. Survival among 109 Patients with Cystic Fibrosis, According to Fitness Level.

Statistics That Will Make You Scared Sit Less

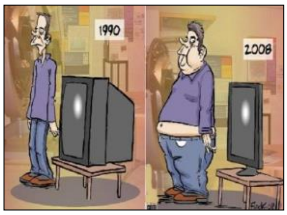
Move More, Sit Less



Evolution



Obesogenic Environment



Obesogenic Environment

Obesogenic Environment

Obesogenic Environment

From Concept to Measurement…

Physical Activity Measurement

How many different types of physical activity measurements can you think of?

Physical Activity Measurement

- 30+ different instruments
- Pros and cons
- Tempo of physical activity:
  - Frequency
  - Intensity
  - Time
- 'Habitual' or 'typical' PA usually measured over several days
  - **Why?**

Common Instruments for Physical Activity Measurement

- Self-report questionnaires
- Accelerometers & Pedometers
- Heart rate monitors
- Direct observation instruments
  - mainly children & specific settings

Pedometers

- What are the strengths?
- What are the limitations?

Pedometers

Advantages

- Low cost
- Objective assessment of overall movement

Mainly used for descriptive research

Pedometer steps

- 10,000 steps/day [adults]
- 13,000-16,000 steps/day [young children]

Limitations

- Provides only an indicator of volume of activity
- Inverse relationship between stride length & stride frequency

Heart Rate Monitors

- What are the strengths?
- What are the limitations?

Heart Rate Monitors

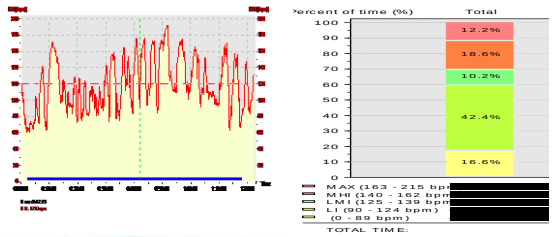
Advantages

- Relationship with energy expenditure
- Valid & reliable in lab & field
- Describes temp
- Easy & quick data collection & analyses

Limitations

- Cost (large samples)
- Data attrition
- Discomfort over long periods
- Age, sex, training status affect

Heart Rate Curve & Thresholds



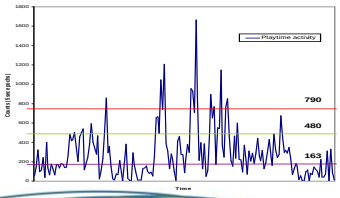
What Are Accelerometers?

Accelerometry

- Accelerometers worn for 7 days
- Measures movement in the 3 planes (x, y, z)
- ?s epochs - provide counts per minute
- How many counts per minute = MVPA?
- There are a variety of published cut-points
- Weartime?

Example Accelerometer Data

- Quantified intensity, duration and frequency of activity in playtime (10 year-old girl's data shown)

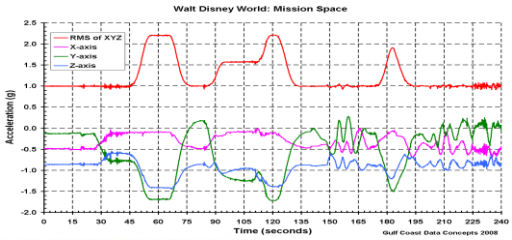


Moderate PA:
46% (6.5 mins)

High PA:
11% (1.7 mins)

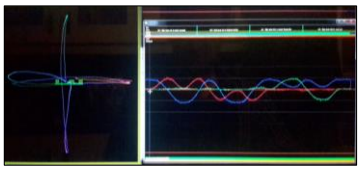
Very high PA:
5.6% (1.0 min)

What a Rollercoaster…



The Slamtracker

- Non-axial accelerometer, magnetomer & gyroscope



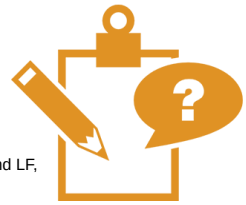
Subjective Vs Objective

Discuss the strengths and weaknesses of PA recall questionnaires and accelerometers

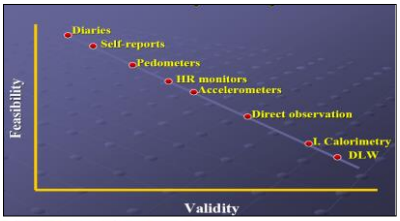
1. How might the type of PA information gained from the accelerometer and PA recall questionnaires differ?
2. What different issues may need to be considered when using accelerometers and self-report questionnaires with children and adults?

Habitual Activity Estimation Scale (HAES)

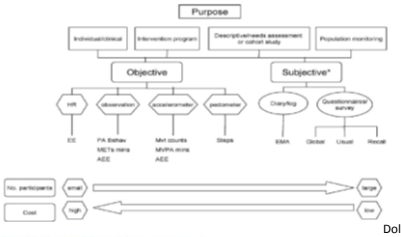
- Most available data (clinimetric)
- Reliability data
- Evidence of convergent reliability
- Evidence of discriminate validity
- Positive correlation between HAES and LF, exercise capacity and body mass



Feasibility (ease of use) vs. Validity (accuracy in estimating EE)



Selecting the Most Appropriate Method



Dollman et al. (2009)

Complete Your Jigsaw

You have 10 minutes

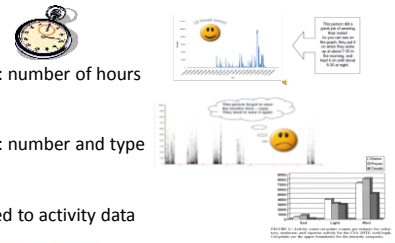
Jigsaw pieces have been provided

Accelerometer Data

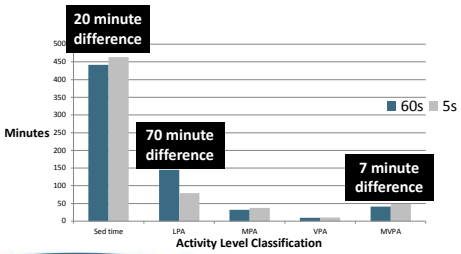
- Discuss how the duration that an accelerometer is worn for might influence the validity of daily PA
- Discuss the problems associated with measuring physical activity using accelerometers

Decisions Influencing Accelerometer Data

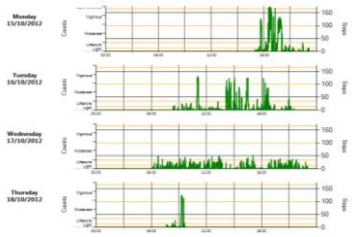
1. Epoch length
1. Sampling period: number of hours per day
1. Sampling period: number and type of days
1. Cut points applied to activity data



Epoch Selection



Hours Per Day

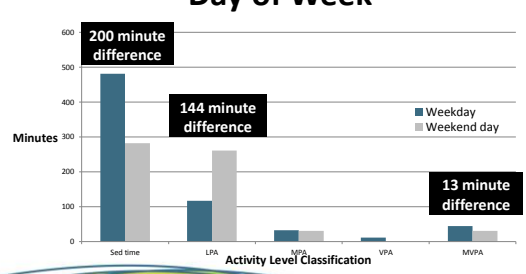


Hours Per Day

Date	Day of Week	Sedentary	Light	Moderate	Vigorous	Very Vigorous	Total MVPA	Axis 1 CPM	Steps Count	Time
28/08/2013	Wednesday	371	111	37	0	0	37	377.9	3907	519
29/08/2013	Thursday	440	111	32	35	1	68	730.8	9193	619
30/08/2013	Friday	202	288	17	4	12	33	667.8	7974	523
31/08/2013	Saturday	259	261	31	0	0	31	359.9	7191	551
02/09/2013	Monday	436	81	30	0	0	30	266.8	4541	547
03/09/2013	Tuesday	418	154	30	6	6	42	474.5	7427	614

- 10 hours/600 minutes per day = Thursday + Tuesday
- 9 hours/540 minutes per day = Thursday + Saturday + Monday + Tuesday
- 8 hours per day/480 minutes = all six days

Day of Week

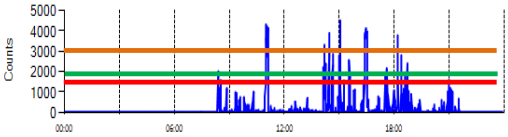


Data Scoring: Intensity Thresholds

Issues associated with intensity cutpoints	Recommendations
Huge variation in cut points	Choice based on population tested and how the sample compares to the population the empirical cut points were derived from
No consensus for children and adults	Individual calibration
Cut point influences activity levels, classification of active vs. inactive	Standardise methods across studies/research groups
Limits cross-study comparisons	Move away from cut points to pattern recognition methods


A Calibration Protocol for Population-Specific Accelerometer Cut-Points in Children

Example Cut-Points

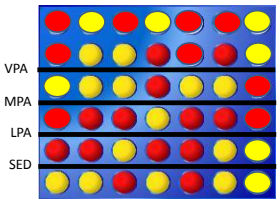


E.g. (1500 cpm) = 54 mins MVPA = ACTIVE

Freedson (1952 cpm) = 38 mins MVPA = ACTIVE

E.g. (3000 cpm) = 22 mins MVPA = INACTIVE

Think Connect 4!



Summary

Thank You For Listening

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@CHERC_UoE
@Kel_Mackintosh
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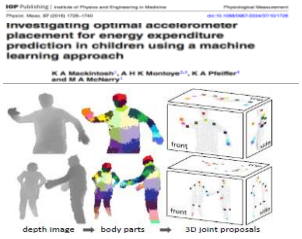
Completed Jigsaws…

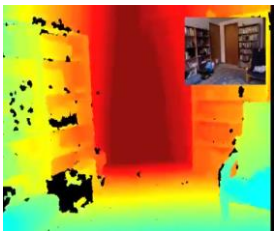
Technology

Vs

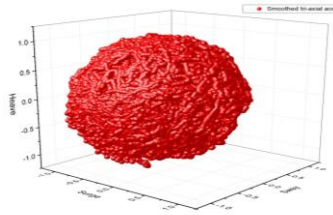
Intervention or Measurement Tool?

Machine Learning



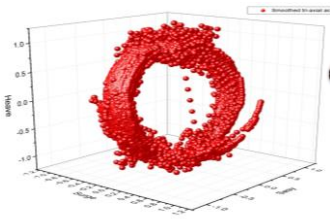


The G-Sphere



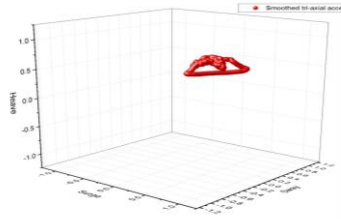
Red-ruffed lemur

The G-Sphere



Elephant seal

The G-Sphere



Water vole