Healthy Distribution Systems

Dr Russell G. Thompson
Healthy Transport Research Group
Melbourne School of Engineering
The University of Melbourne
rgthom@unimelb.edu.au

Outline

- Health and Physical Activity
- Non-motorised distribution in Melbourne
- Measuring Physical Activity
- Modelling energy imbalance
- Benefit Cost Analysis

Health and Physical Activity

A Systems Approach

Problem: sedentary lifestyles

Data Collection: Measurement: objective monitoring systems

- GPS
- Accelerometers

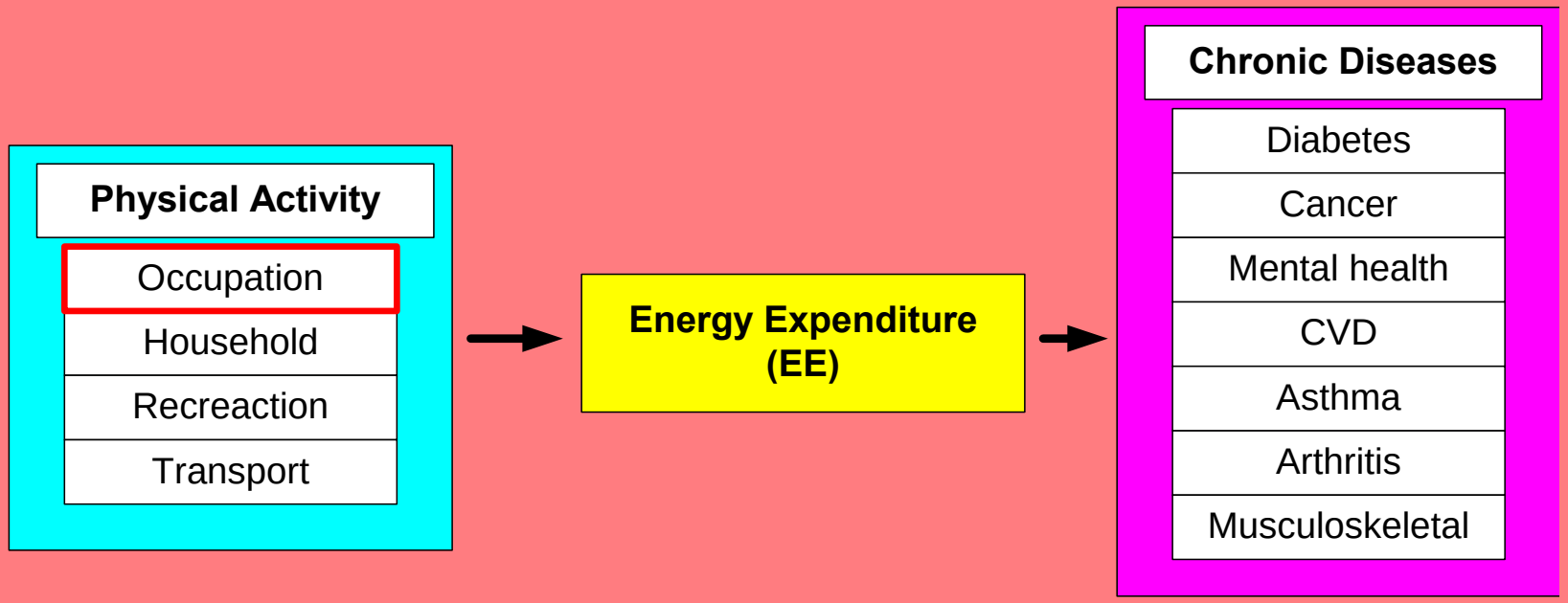
Modelling

- urban ecology
- change processes
- behavioural choice

Recognition that physical activity can reduce risk of disease…

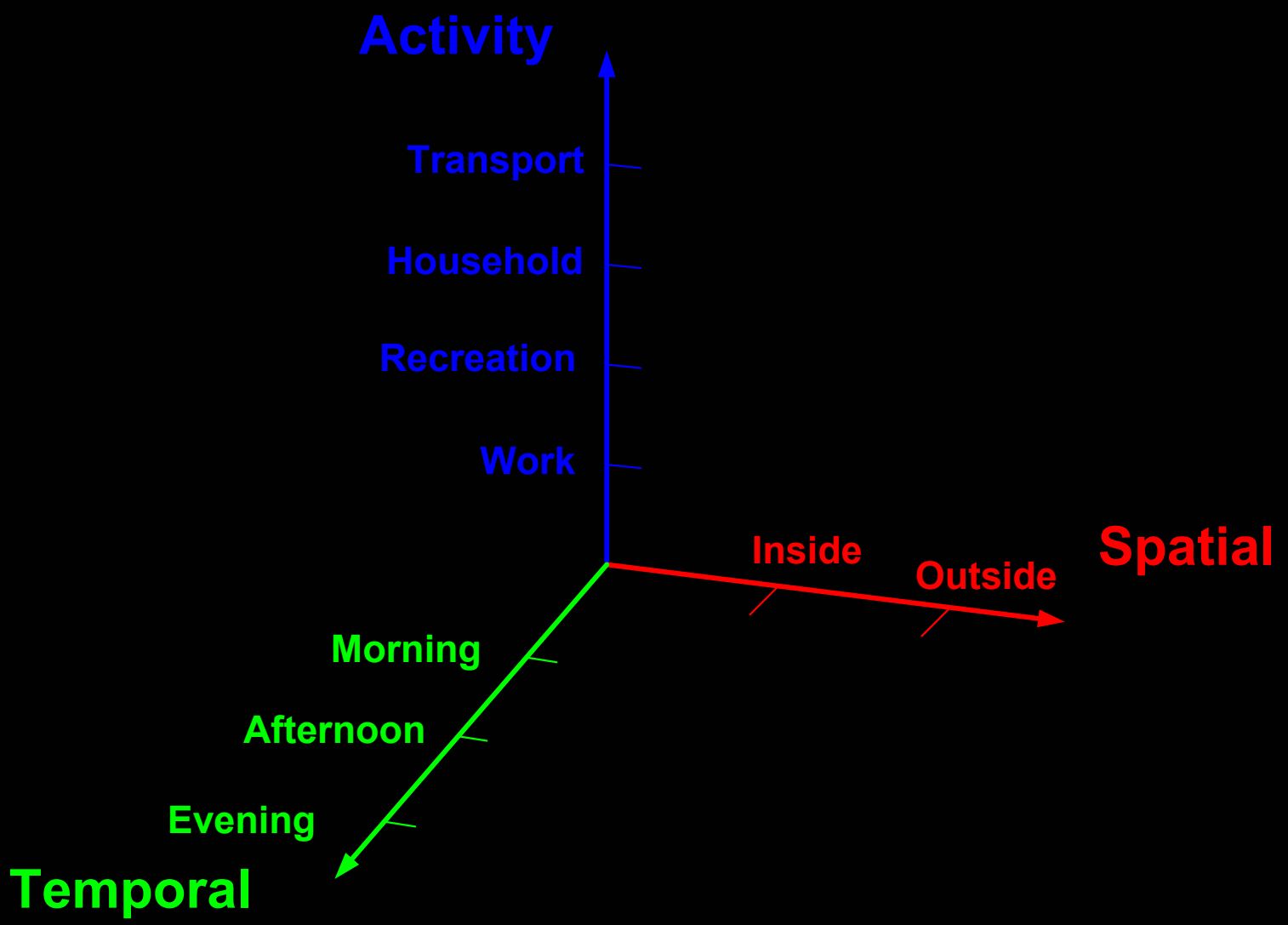
THE UNIVERSITY OF MELBOURNE

Investigating the links

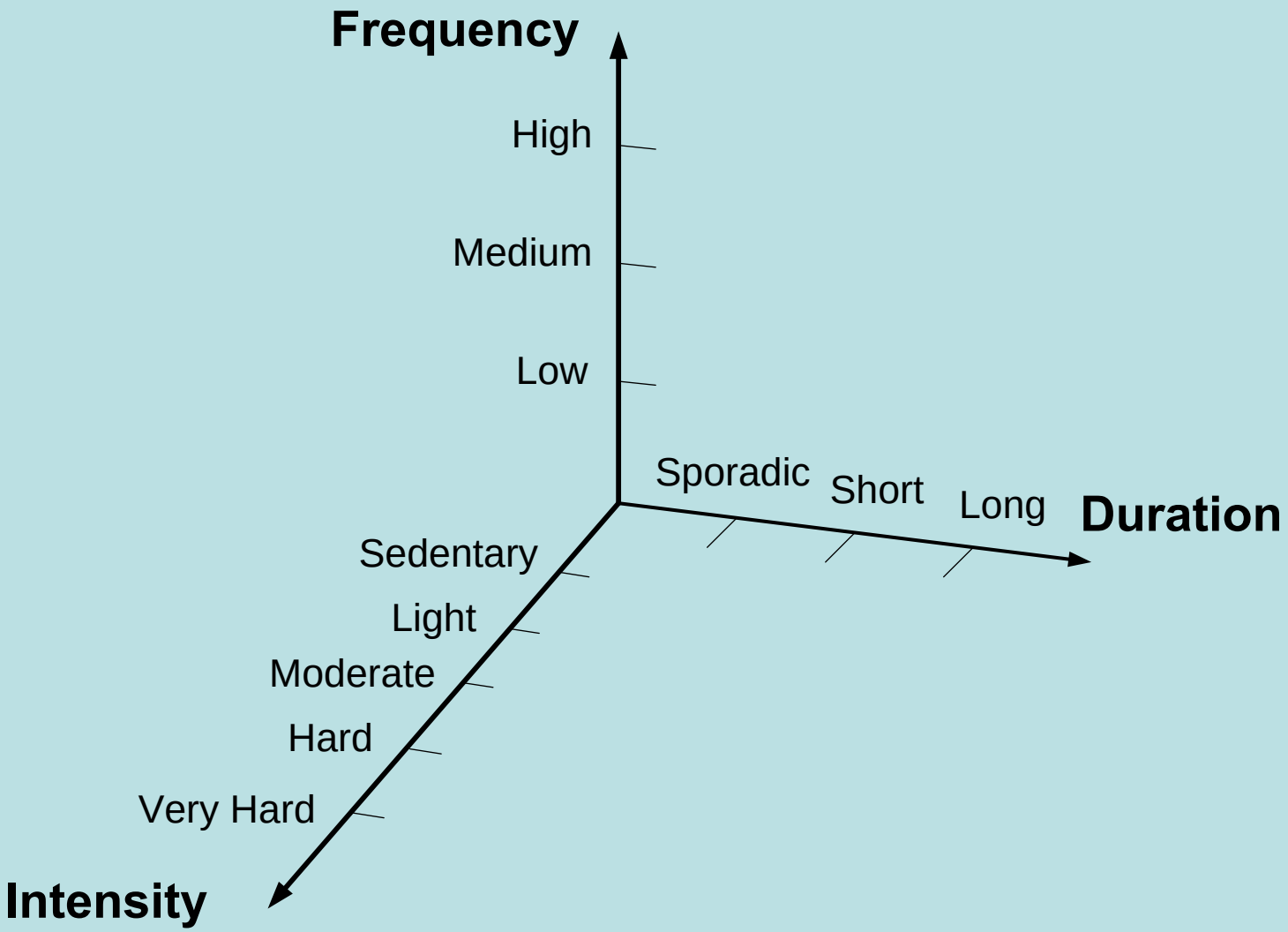


Prevention through healthy lifestyle

Categories of Physical Activity



Physical Activity Bouts



Measuring Burden of Disease

$$DALY = YLD + YLL$$

DALY	Disability Adjusted Life Year
YLD	Number of Years Lived Disabled
YLL	Years of Life Lost

Relative risks per unit increase in BMI by age & specific conditions

	30-44	45-59	60-69	70-79	80+
Ischaemic heart disease	1.13	1.07	1.05	1.03	1.03
Diabetes mellitus	1.36	1.24	1.18	1.27	1.27
Stroke deaths	1.01	1	1.02	1.03	1
Stroke	1.06	1.08	1.06	1.04	1.01
Hypertensive Heart Disease	1.09	1.16	1.16	1.12	1.06
Osteoarthritis	1.04	1.04	1.04	1.04	1.04
Breast Cancer	1.09	1.16	1.16	1.12	1.06
Bowel Cancer	1.03	1.03	1.03	1.03	1.03
Endometrial Cancer	1.1	1.1	1.1	1.1	1.1

Department of Human Services-Public Health Group. (2005)

THE UNIVERSITY OF MELBOURNE

Non-motorised Distribution in Melbourne

Examples

- Mail delivery (Australia Post)
- Parcels couriers
- Food (eg. Tiffins & Pizza)

Using bicycles, tricycles & trolleys

THE UNIVERSITY OF MELBOURNE

Tiffin Distribution in Melbourne

Using Tricycles

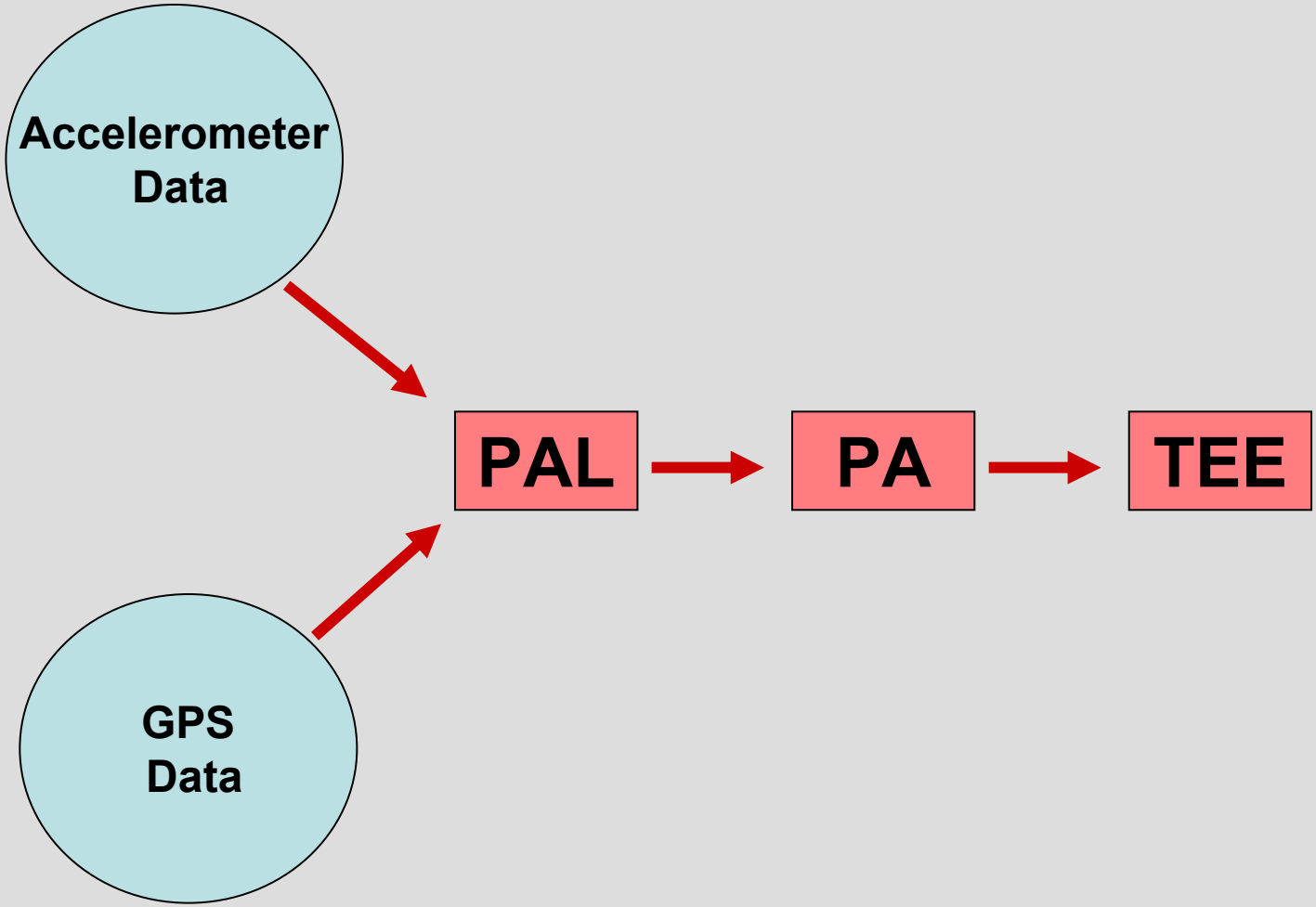
To offices in central City area

Measuring Physical Activity

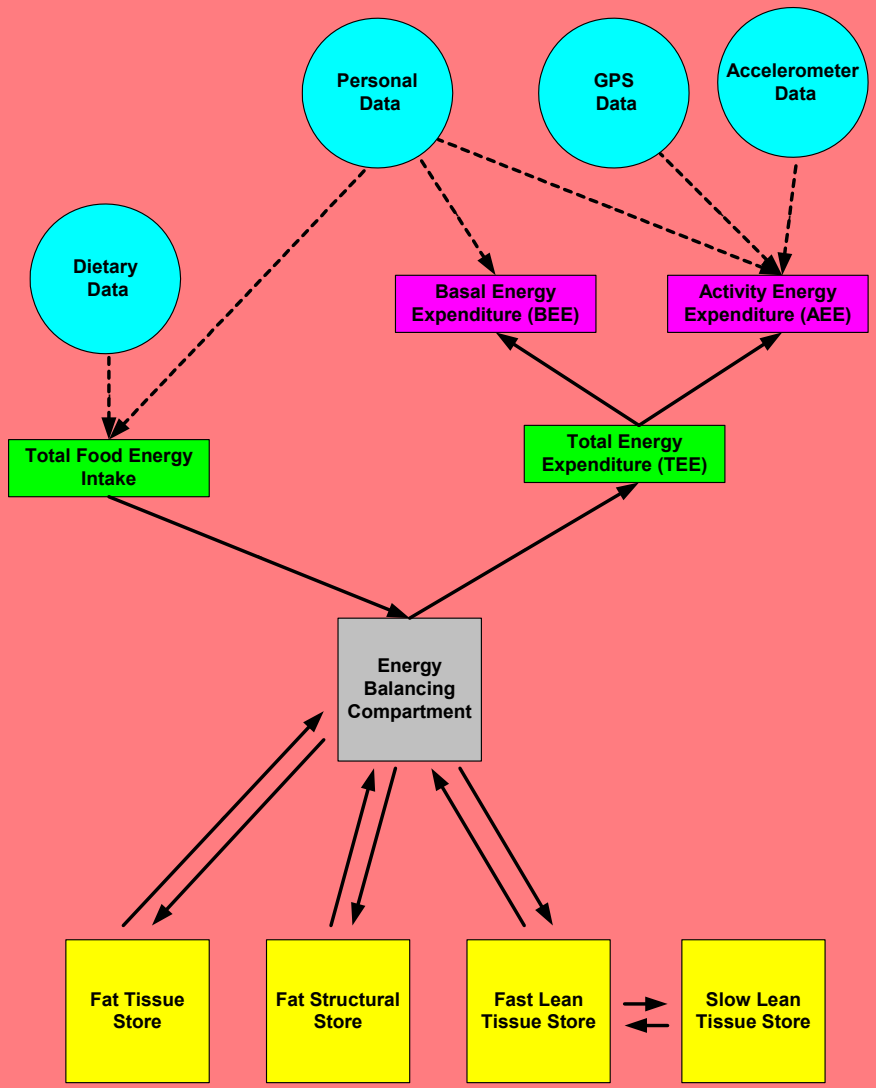
Data Fusion

Integration of ICT for monitoring physical activity

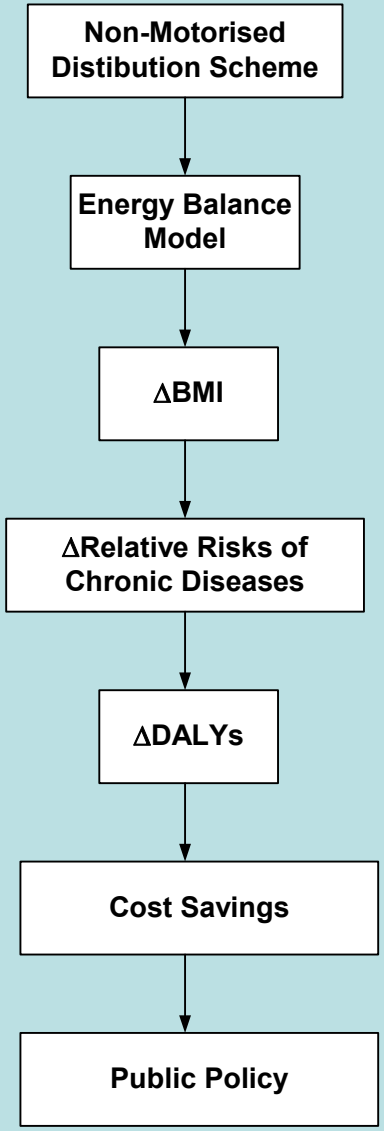
- Geographic Information Systems (GIS)
- Global Position Systems (GPS)
- Accelerometers
- PDA's & mobile phones


Accelerometer Data
GPS Data
PAL
PA
TEE

Modelling Energy Imbalance



Economic Evaluation Framework



Estimating Physical Activity Levels (PALs)

$$PAL_i = 1.1 + \sum_j \Delta PAL_{ij}$$

(PAL for person i)

$$BEE_i = 247 - 2.67a_i + 401.5h_i + 8.6w_i \quad if\ g_i = female$$

$$BEE_i = 293 - 3.8a_i + 456.4h_i + 10.12w_i \quad if\ g_i = male$$

$$\Delta PAL_{ij} = \frac{[(MET_j - 1) \times (1.15/0.9) \times d_{ij}]/1440}{BEE_i/(0.0175 \times 1440 \times w_i)}$$

where,

BEE_i = basal energy expenditure for person *i*

a_i = age of person *i* (years)

h_i = height of person *i* (meters)

w_i = weight of person *i* (kg)

g_i = gender of person *i* ('male' or 'female')

MET_j = metabolic equivalence of activity *j*

d_{ij} = duration of activity *j* for person *i* (minutes)

ΔPAL_{ij} = energy expenditure of activity *j* for person *i*

Gerrior et al, (2006)

Estimating Energy Expenditure (EE)

$$TEE_i = 864 - 9.72a_i + PA(14.2w_i + 503h_i) \quad if\ g_i = 'male'$$

$$TEE_i = 387 - 7.31a_i + PA(10.9w_i + 660.7h_i) \quad if\ g_i = 'female'$$

where,

TEE_i = Total Energy Expenditure for person *i* (kcal/day)
a_i = age of person *i* (years)
h_i = height of person *i* (meters)
w_i = weight of person *i* (kg)
g_i = gender of person *i* ('male' or 'female')

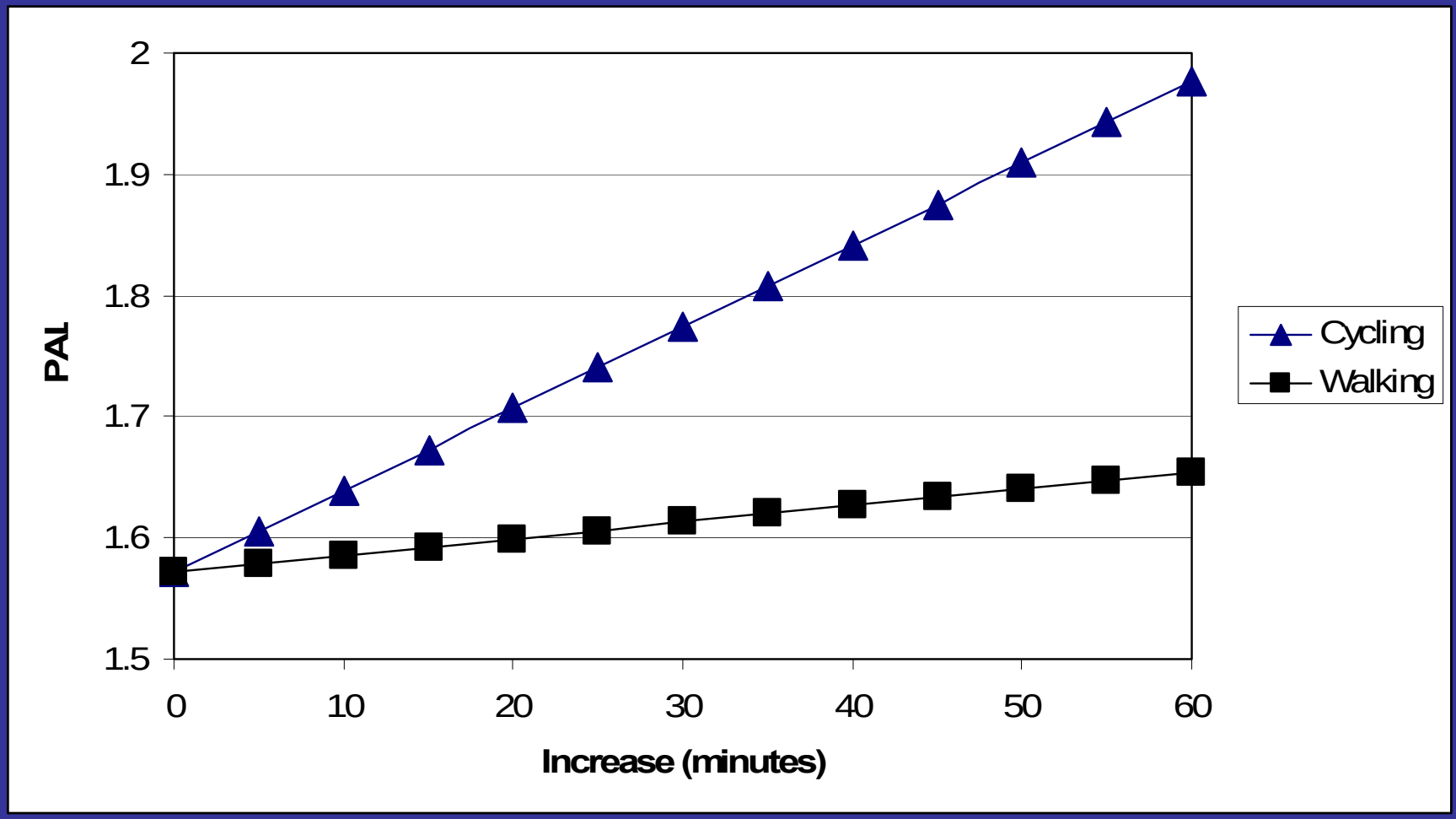
Gerrior et al, (2006)

PAL → PA

Physical Activity Level (PAL)	PA Men	PA Women	Category
[1, 1.4)	1	1	**Sedentary**
[1.4, 1.6)	1.12	1.14	**Low Active**
[1.6, 1.9)	1.27	1.27	**Active**
[1.9, 2.5)	1.54	1.45	**Very Active**

Gerrior et al, (2006)

PALs Sensitivity Analysis

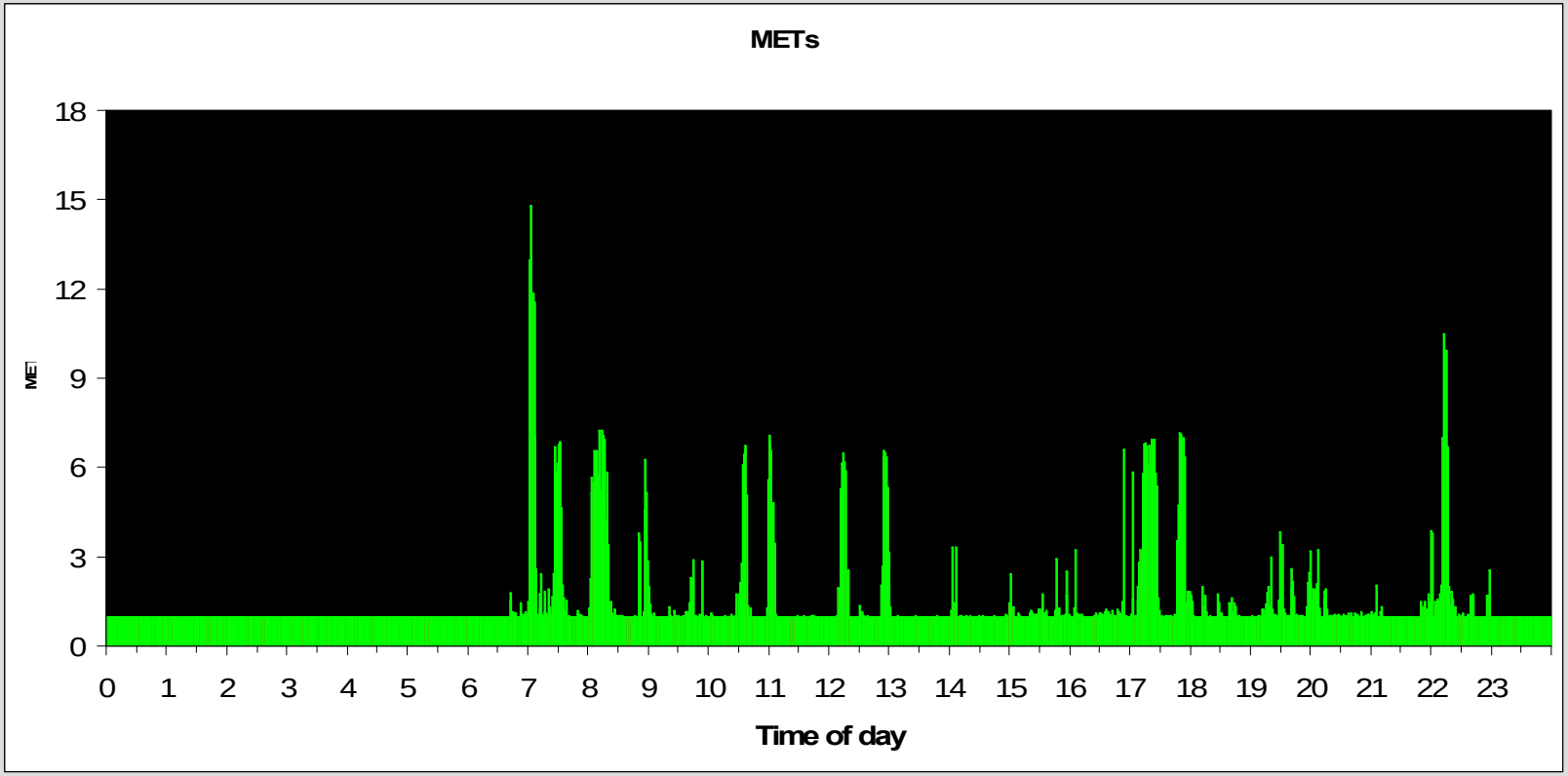


Cycling METs

For leisure or work < 16 km/h	4
General	8
Fast, vigorous effort (22-25 km/h)	10

Ainsworth et al, 2000

Daily Physical Activity Profile

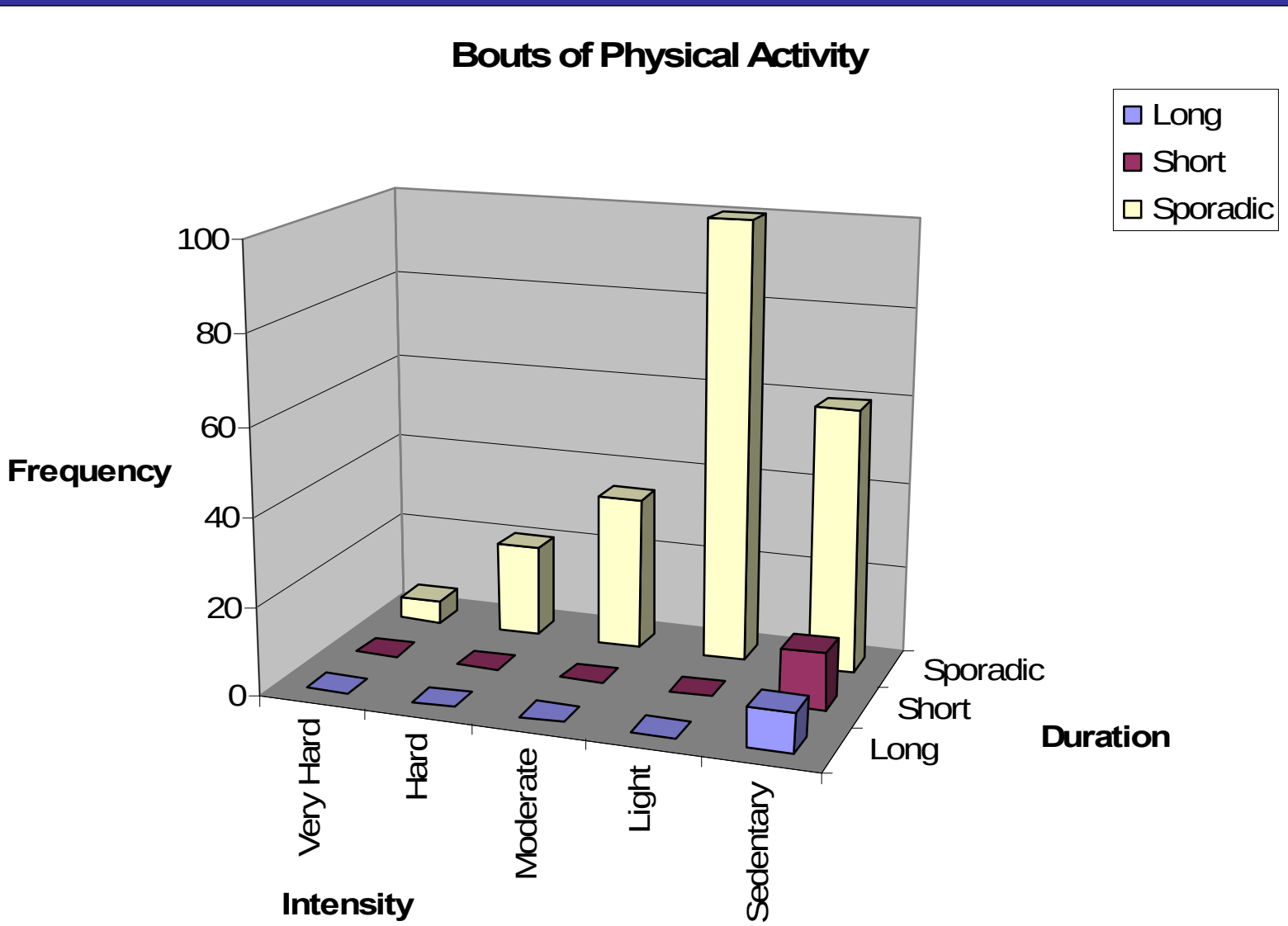


Healthy Lifestyle through Physical Activity

Statistics over a week period

- Physical Activity Level (PAL)
- Moderate and Vigorous Physical Activity (MVPA)
- Sedentary bouts, frequency by duration

THE UNIVERSITY OF MELBOURNE


Bouts of Physical Activity
Long
Short
Sporadic
100
80
60
40
20
0
Frequency
Very Hard
Hard
Moderate
Light
Sedentary
Intensity
Sporadic
Short
Long
Duration

Benefit Cost Analysis

Benefits

- Health of riders
- Less short-term absence from work
- Less severe diseases & ailments and long term absence/disability
- Reduced externalities (eg. emissions, noise, road traffic accidents, congestion & climate change)
- Reduced transport costs (esp. capital & fuel costs)

Costs

- Safety risk
- Increased labour (time) costs

Evaluation of Interventions

Workplace Programs (non-motorised distribution)

Developing a set of PA Monitoring Tools from Accelerometer & GPS data

- Indicators
- Profiles
- Audits
- Diagnostics

THE UNIVERSITY OF MELBOURNE

Research Issues

- Estimating intensity of PA
  - vehicles (eg. tricycles, trolleys & bikes)
  - routes (eg. gradients)
  - safety (eg. loads)

- Modelling health effects
  - weight
  - heart rate