Introduction to human physiology (related to Physical Activity)

DBB170 – Sensors for physiology

Prof.dr. Steven Vos

Outline

- About me
- Objective(s)
- Physiology – health related challenges
- Some examples – energy expenditure
- …

About me

Professional - present
- Professor ‘Chair Design & Analysis of Intelligent Systems for Leisure Time Sports & Vitality’ (Tu/e)
- Head of Research at ‘Move to Be Research Group’ (Fontys Sporthogeschool)
- Research Fellow at Policy in Sports & Physical Activity Research Group (KU Leuven)

Educational background
- PhD in Human Kinesiology (Human Movement Sciences)
- MSc in Social Psychology
- Statistics, econometrics, qualitative methods

Research topics
- Profiling people (during physical activity and/or sports participation) in different settings
- Designing tailored services and products to improve physical activity, pleasure and vitality
- Evaluating the effectiveness, efficiency and impact of these social and/or technical innovations.

Objective

To develop a basic understanding of aspects of human physiology, in particular those aspects which can be measured unobtrusively or almost unobtrusively, which are important for many medical areas and vitality areas (such as sports).

Human Physiology

" The study of how body structures function / The science of body functions"

SUBSPECIALTIES OF PHYSIOLOGY	STUDY OF
Neurophysiology (NOOR-ō-fiz-ē-ol9-ō-jē; *neuro-* = nerve)	Functional properties of nerve cells.
Endocrinology (en'-dō-kri-NOL-ō-jē; *endo-* = within; *-crin* = secretion)	Hormones (chemical regulators in the blood) and how they control body functions.
Cardiovascular physiology (kar-dē-ō-VAS-kū-lar; *cardi-* = heart; -vascular = blood vessels)	Functions of the heart and blood vessels.
Immunology (im'-ū-NOL-ō-jē; *immun-* = not susceptible)	How the body defends itself against disease-causing agents.
Respiratory physiology (RES-pir-a-to'-rē; respira- = to breathe)	Functions of the air passageways and lungs.
Renal physiology (RĒ-nal; *ren-* = kidney)	Functions of the kidneys.
Exercise physiology	Changes in cell and organ functions as a result of muscular activity.
Pathophysiology (PATH-ō-fiz-ē-ol'-ō-jē)	Functional changes associated with disease and aging.

Source: Tortora & Derrickson, 2009.

Human Physiology

The human body consists of 6 levels of organization

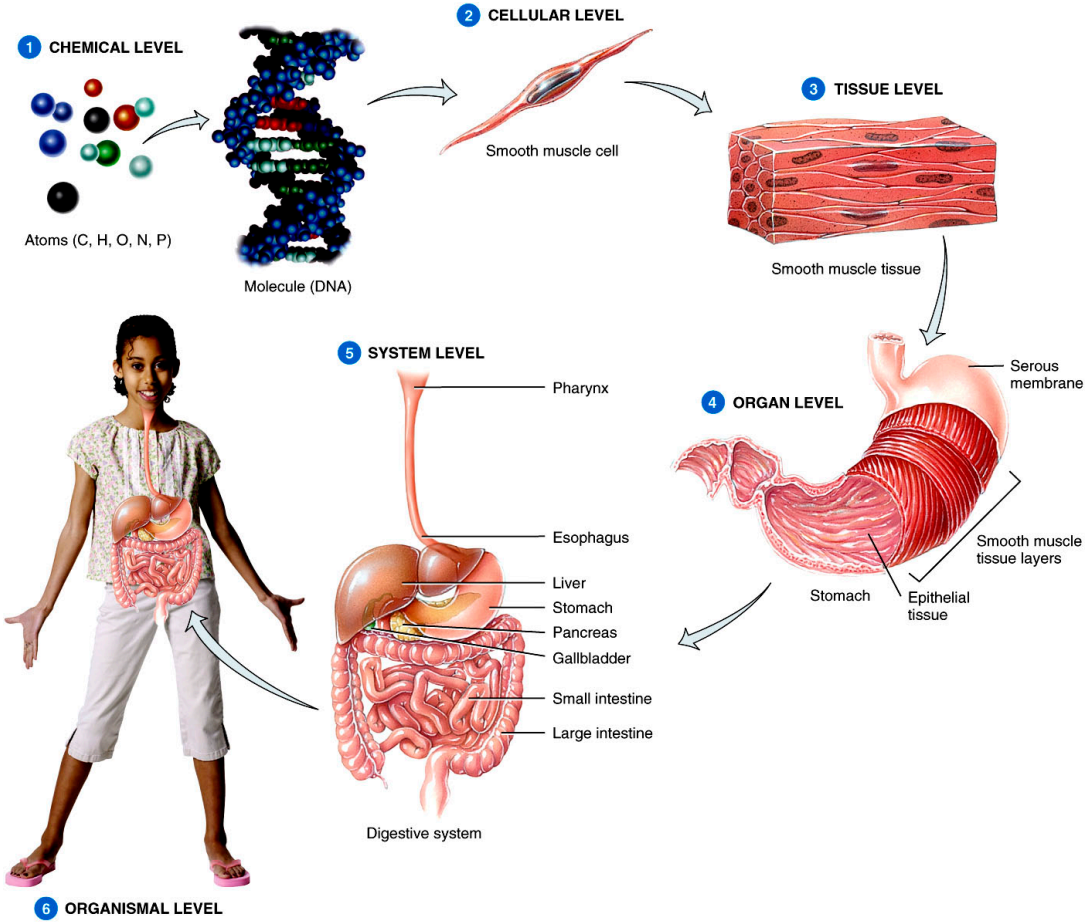
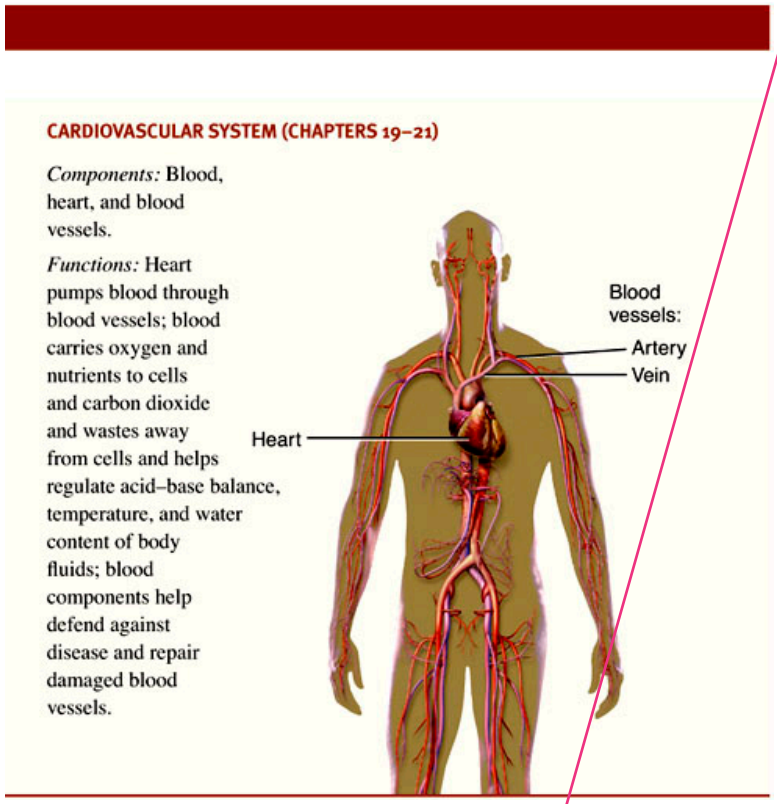
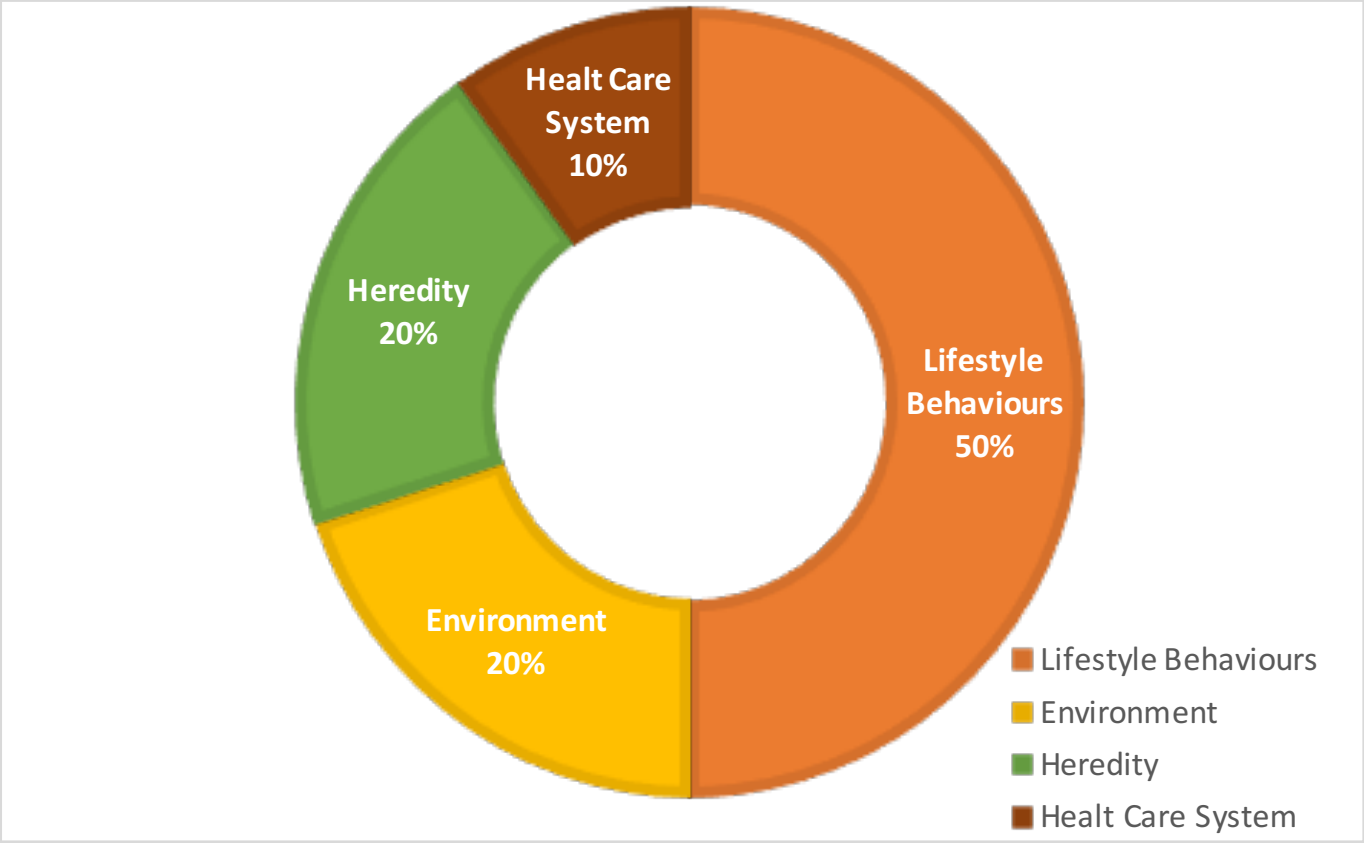


Figure 01.01 Tortora - PAP 12/e



Source: Tortora & Derrickson, 2009.

What factors influence our health?

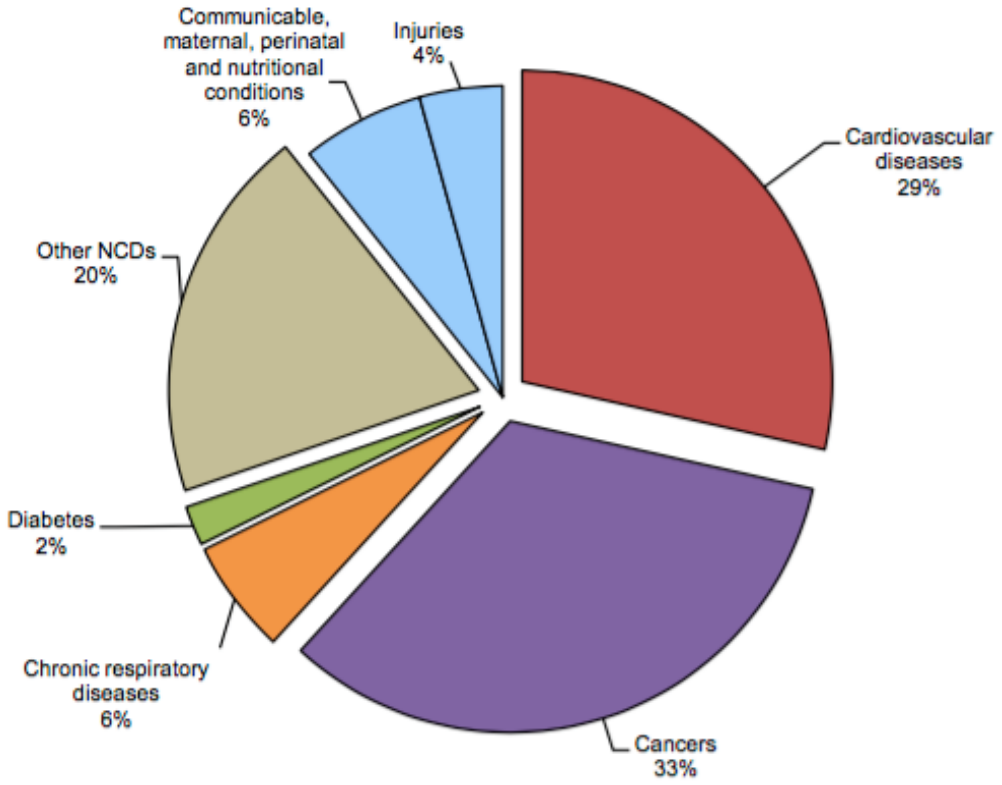


Health report - The Netherlands

Percentage of population living in urban areas: 83.2%

Population proportion between ages 30 and 70 years: 53.5%

Proportional mortality (% of total deaths, all ages, both sexes)



Total deaths: 140,000

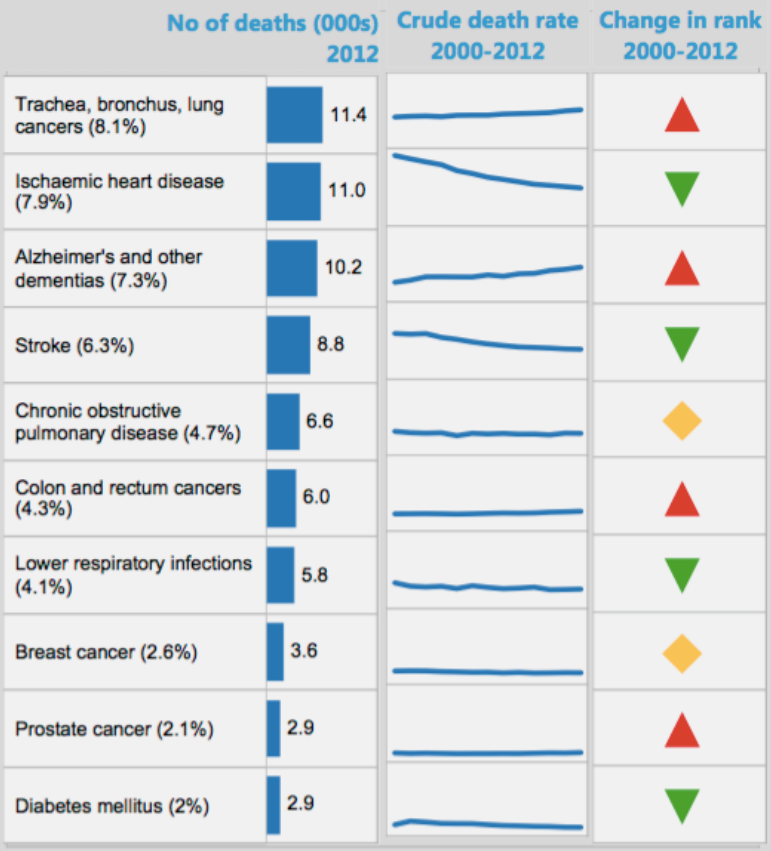
NCDs are estimated to account for 89% of total deaths.

Source: World Health Organization - Noncommunicable Diseases (NCD) Country Profiles , 2014.

Health report - The Netherlands

Top 10 causes of death

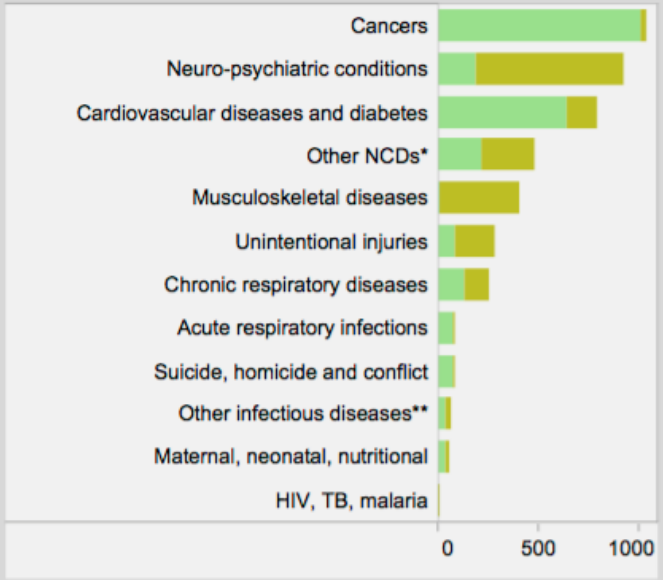
Trachea, bronchus, lung cancers was the leading cause of death, killing 11.4 thousand people in 2012



Burden of disease, 2012

Disability-adjusted life years (DALYs) are the sum of years of life lost due to premature mortality (YLL) and years of healthy life lost due to disability (YLD).

DALYs, YLL and YLD (thousands) by broad cause group

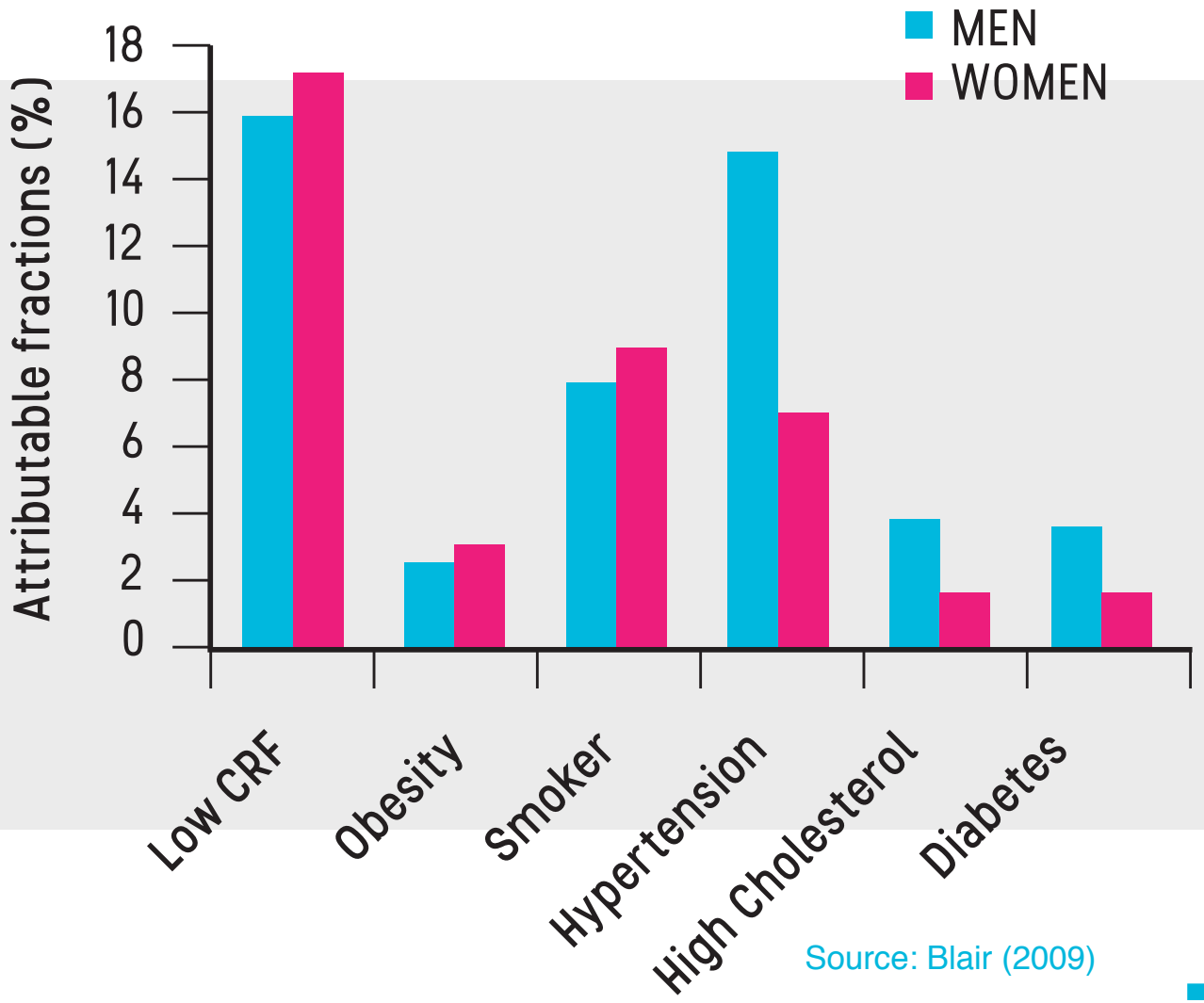


*Other noncommunicable diseases (NCDs) including non-malignant neoplasms; endocrine, blood and immune disorders; sense organ, digestive, genitourinary, and skin diseases; oral conditions; and congenital anomalies.

** Infectious diseases other than acute respiratory diseases, HIV, TB and malaria.

Source: Country statistics and global health estimates by WHO and UN partners (2015)

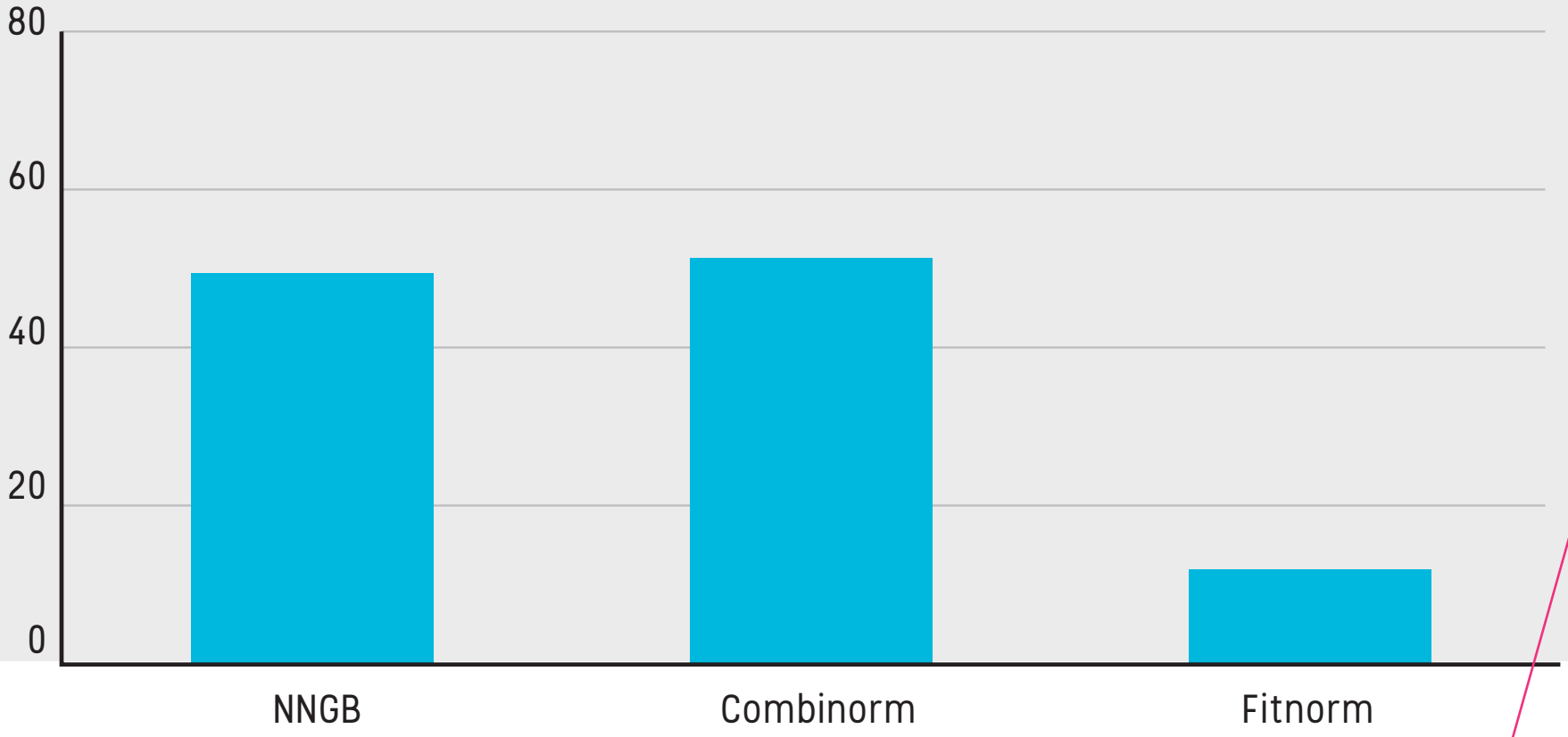
Attributable fractions for all cause deaths



Source: Blair (2009)

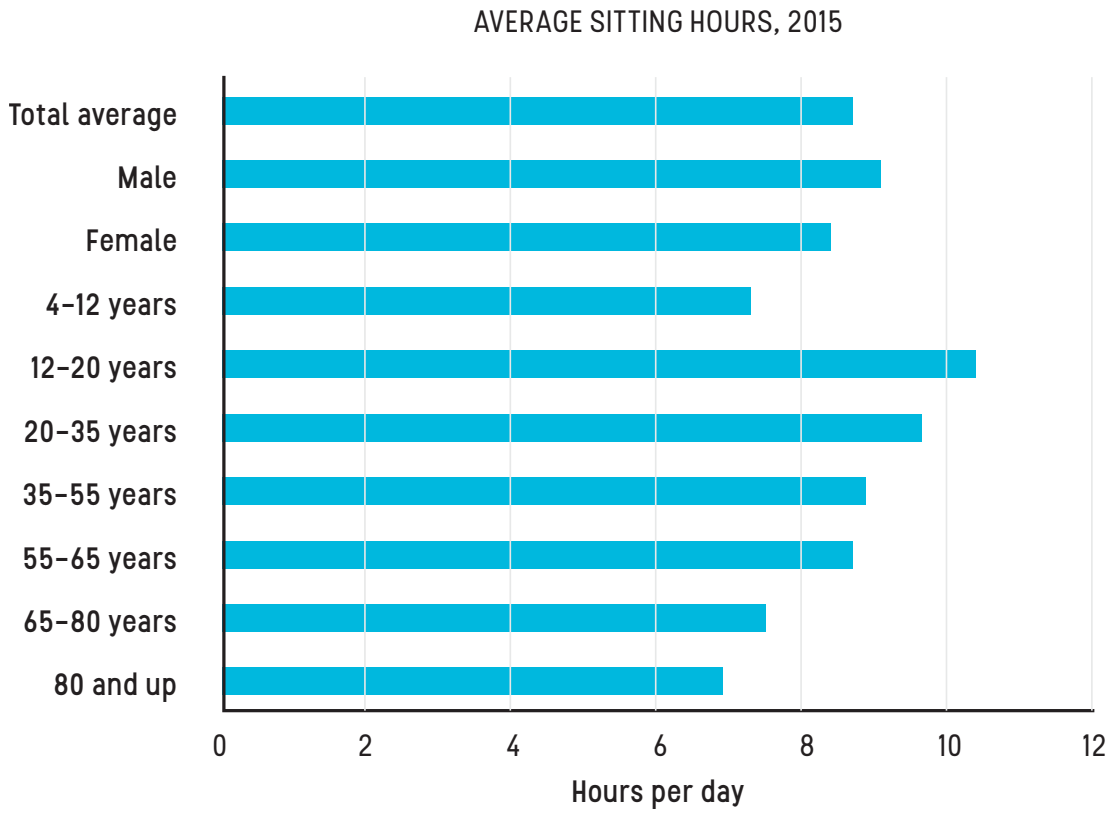
Facing a noticeable increase in physical inactivity

Achieving the NNGB, Combinorm and Fitnorm in 2015, 18 to 54 years old

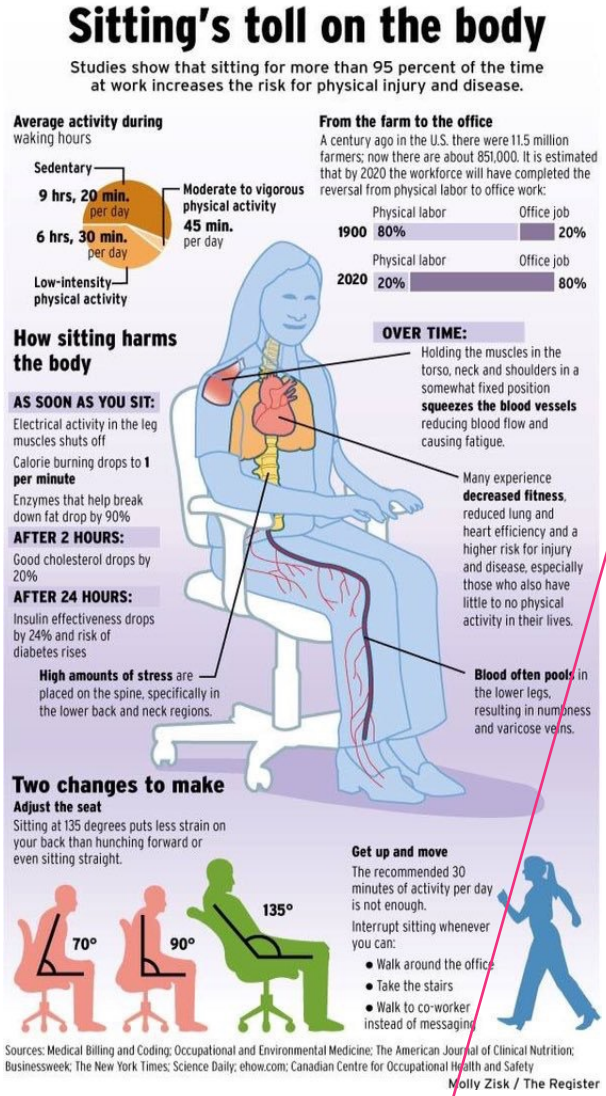


Source: volksgezondheidenzorg.nl

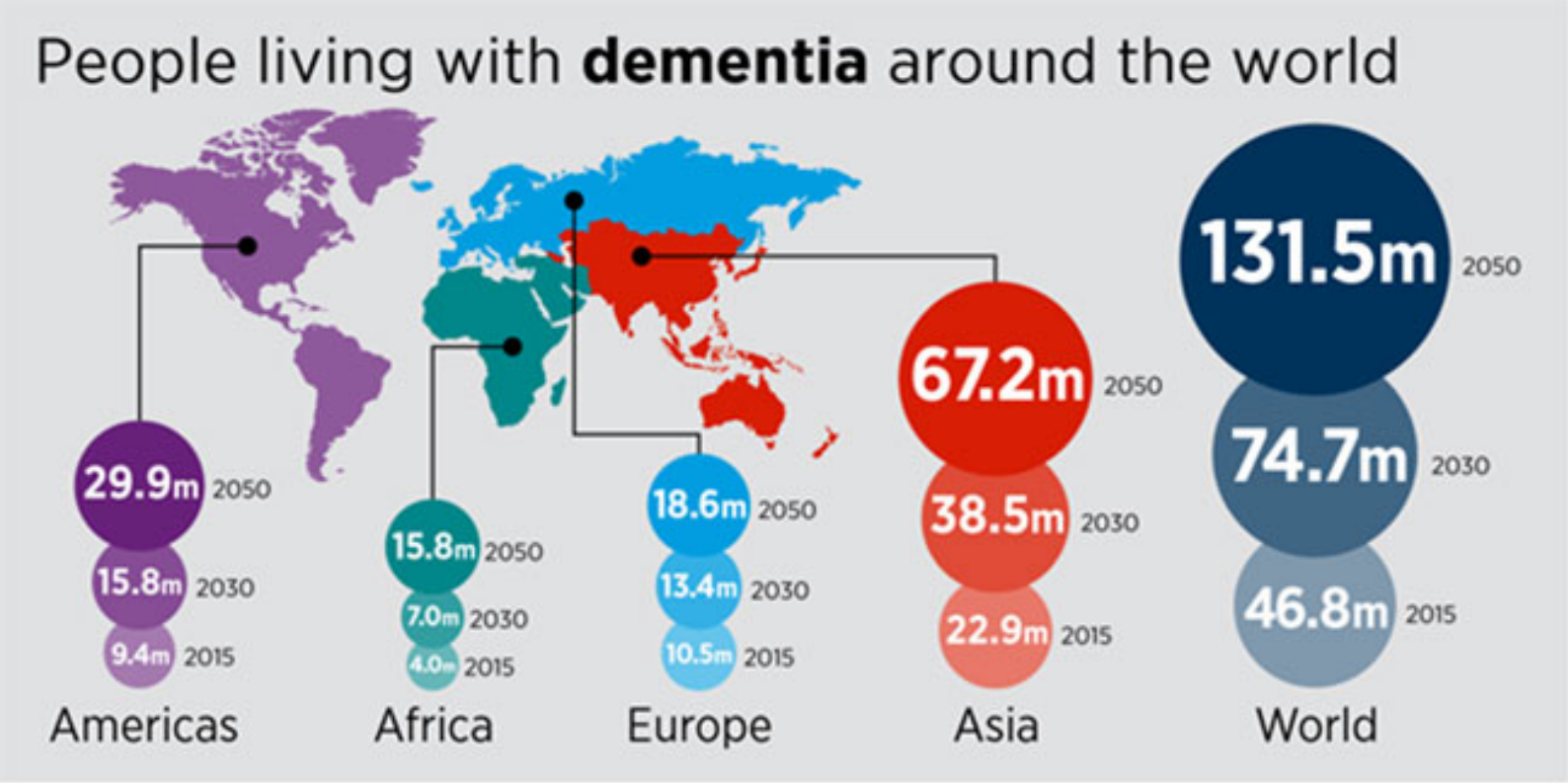
Facing a noticeable increase in physical inactivity



Source: volksgezondheidenzorg.nl



Mental health/disorder (e.g. dementia)

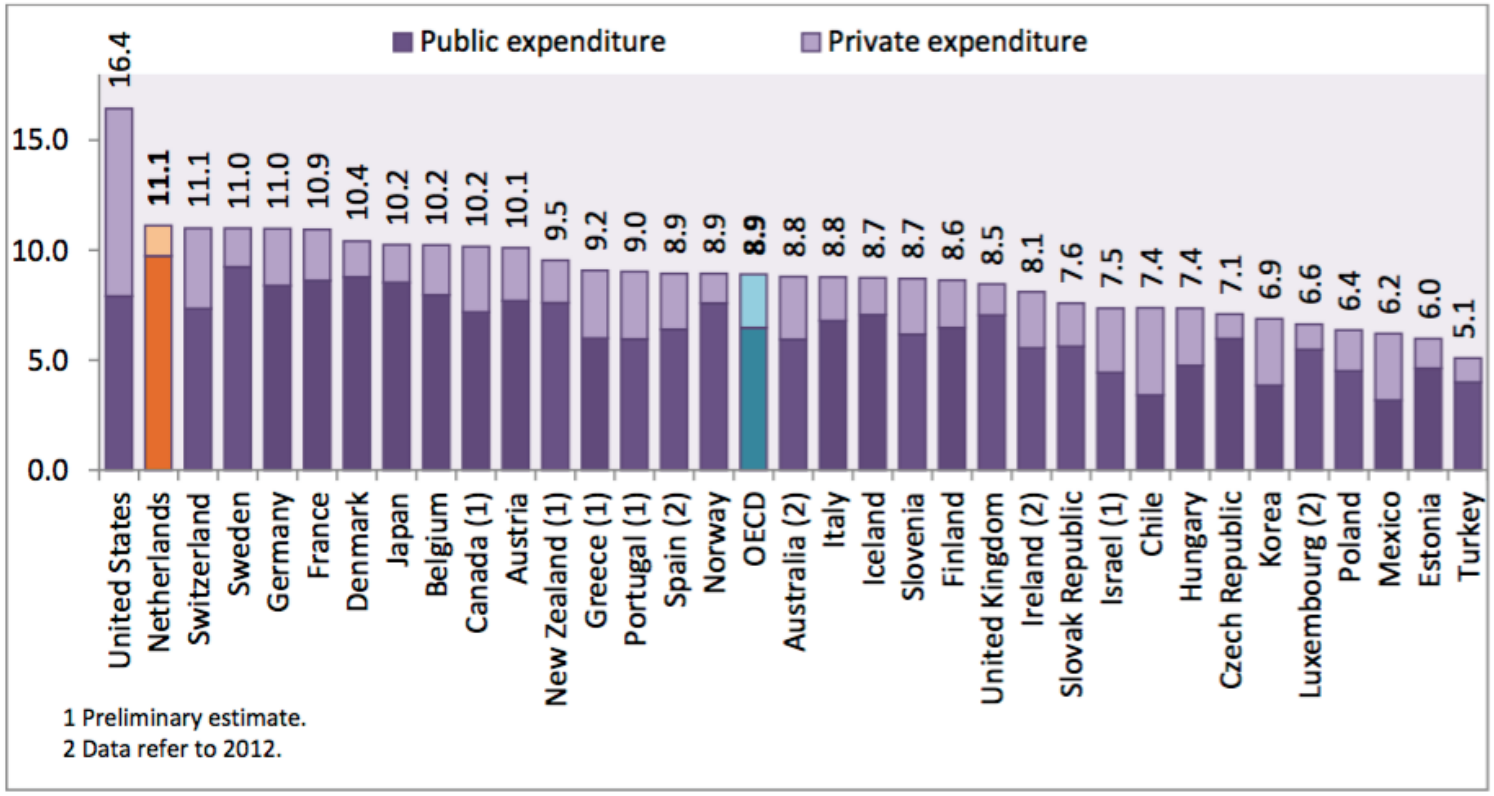


Source: www.bupa.com

Health spending

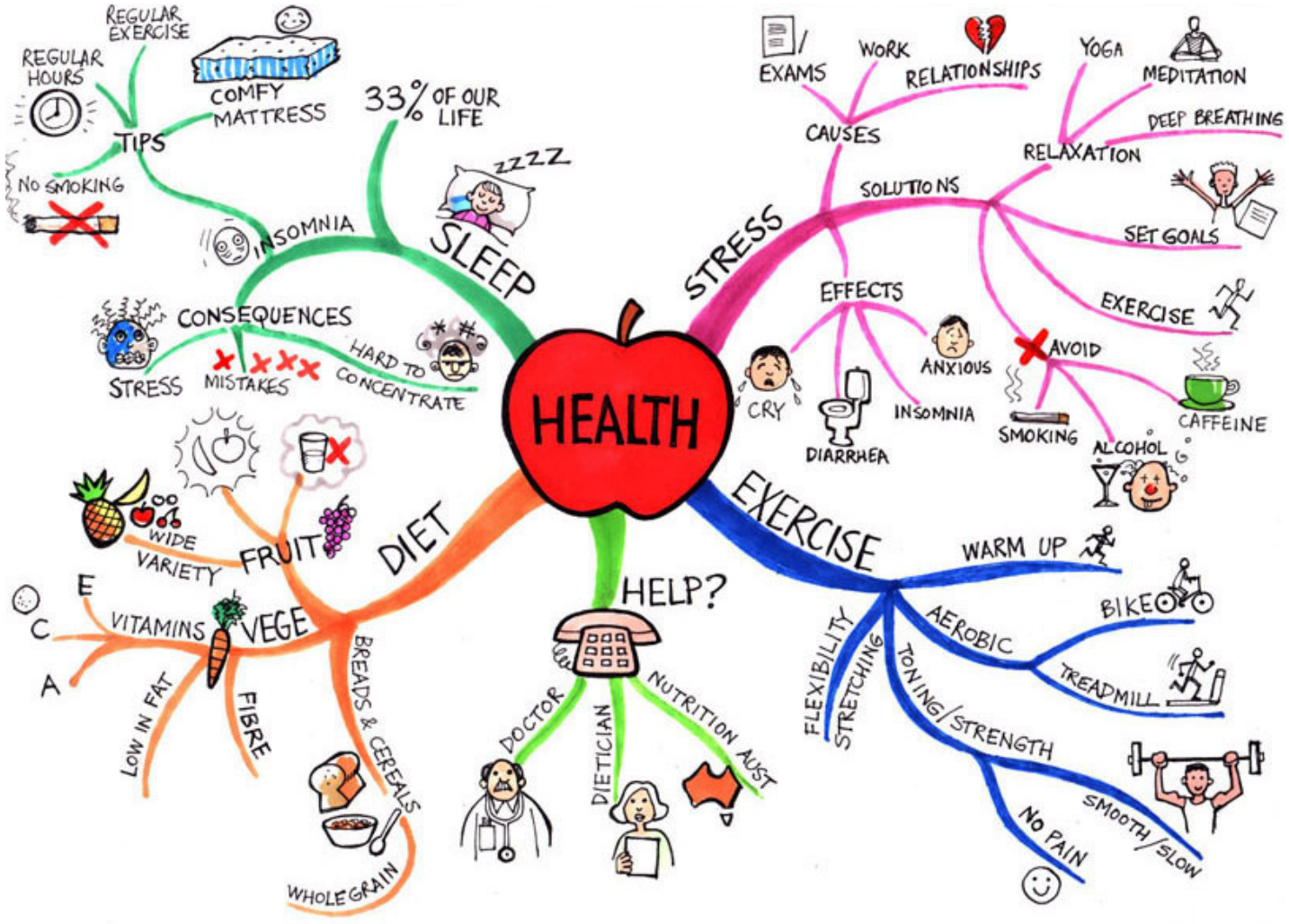
3%

Figure 2. Health spending* as a share of GDP, 2013



** Excluding capital expenditure.*
Source: OECD Health Statistics 2015

A holistic approach to health? - Lifestyle behaviors



Evidence for exercise as a medecine

The British Journal of Diabetes & Vascular Disease

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Prevention of type 2 diabetes by lifestyle intervention in primary health care setting in Poland: Diabetes in Europe Prevention using Lifestyle, phy Activity and Nutritional intervention (DE-PLAN) project

Aleksandra Gilis-Januszewska, Zbigniew Szybinski, Katarzyna Kissimova-Skarbek, Beata Piwonska-Solska, Dorota Pach, Roman Topor-Madry, Jaakko Tuomilehto, Jaana Lindström, Markku Peltonen, Peter Eh Schwarz, Alicja Hubalewska-Dydejczyk

First Published September 2, 2011 | research-article

Does physical activity prevent cognitive decline and dementia?: A systematic review and meta-analysis of longitudinal studies

Sarah J Blondell, Rachel Hammersley-Mather and J Lennert Veerman

BMC Public Health 2014 **14**:510 | **DOI:** 10.1186/1471-2458-14-510 | © Blondell et al.; licensee BioMed Central Ltd. 2014

Received: 1 April 2014 | **Accepted:** 8 May 2014 | **Published:** 27 May 2014

International Journal of Alzheimer's Disease

Int J Alzheimer Dis. 2010; 2010: 393579. PMCID: PMC2915647

Published online 2010 Jun 29. doi: 10.4061/2010/393579

Prevention of Dementia: Focus on Lifestyle

Maria Cristina Polidori,[1,*] Gereon Nelles,[2] and Ludger Pientka[1]

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Abstract Go to:

The objective of this paper is to summarize current knowledge on the possible advantages of lifestyle interventions, with particular attention to physical fitness, cognitive activity, leisure and social activity as

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Review

Exercise as medicine – evidence for prescribing exercise as therapy in 26 different chronic diseases

B. K. Pedersen, B. Saltin

First published: 25 November 2015 Full publication history

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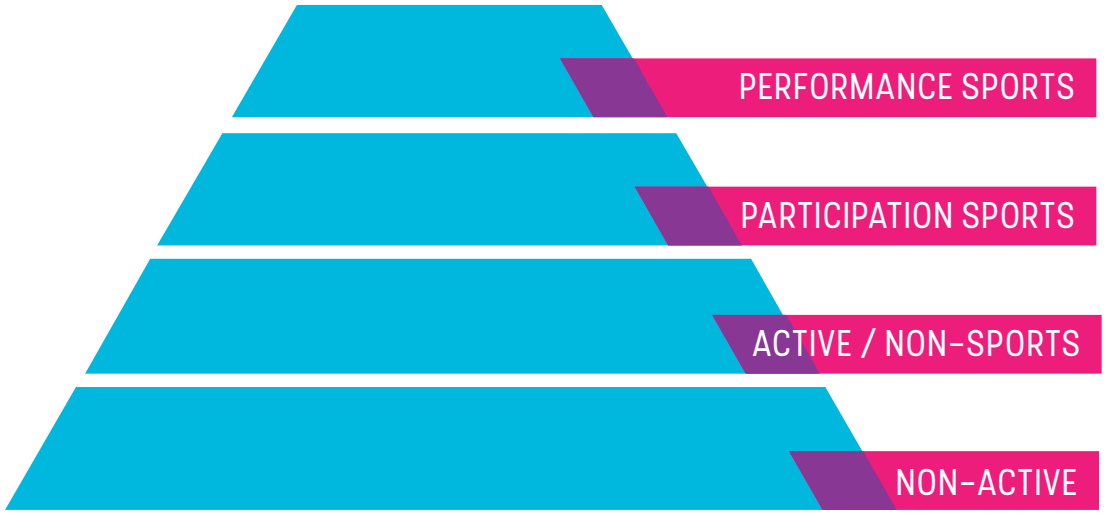
Special Issue:
Exercise as Medicine – Evidence for Prescribing Exercise as Therapy in 26 Different Chronic Diseases

Three main research/design challenges wrt sensoring

Challenge I – Unobtrusive

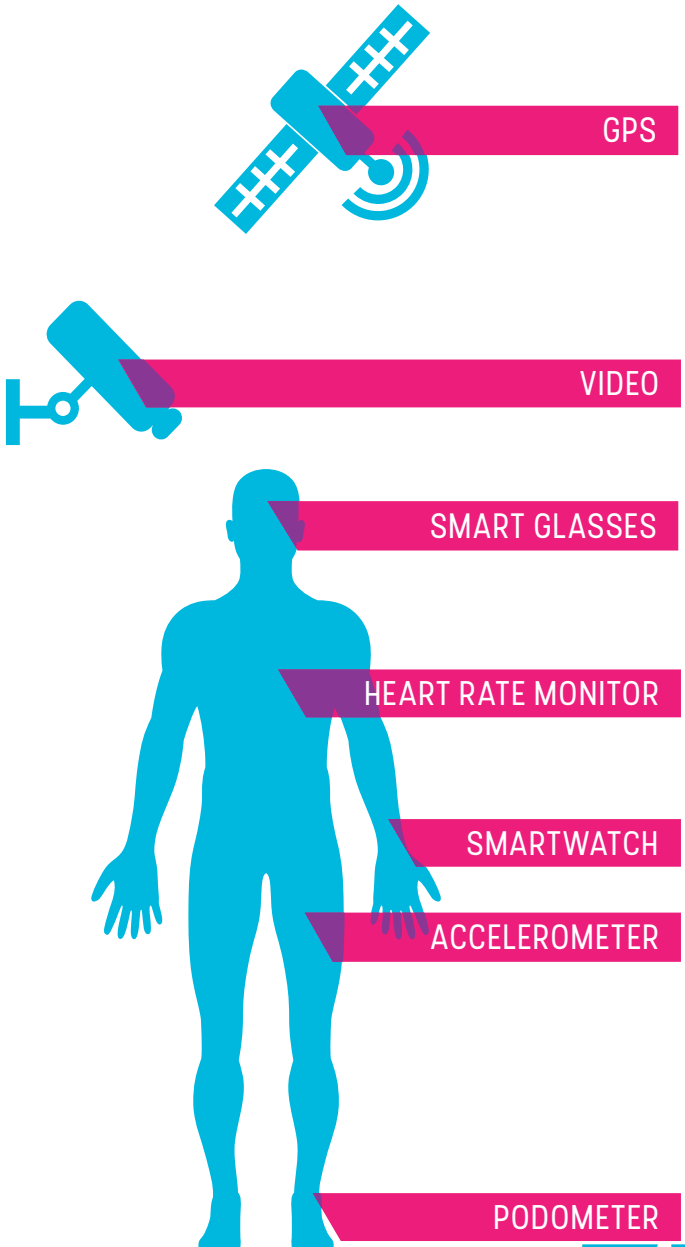
Three main research/design challenges wrt sensoring

Challenge I – Unobtrusive



24/7 monitoring of behaviour

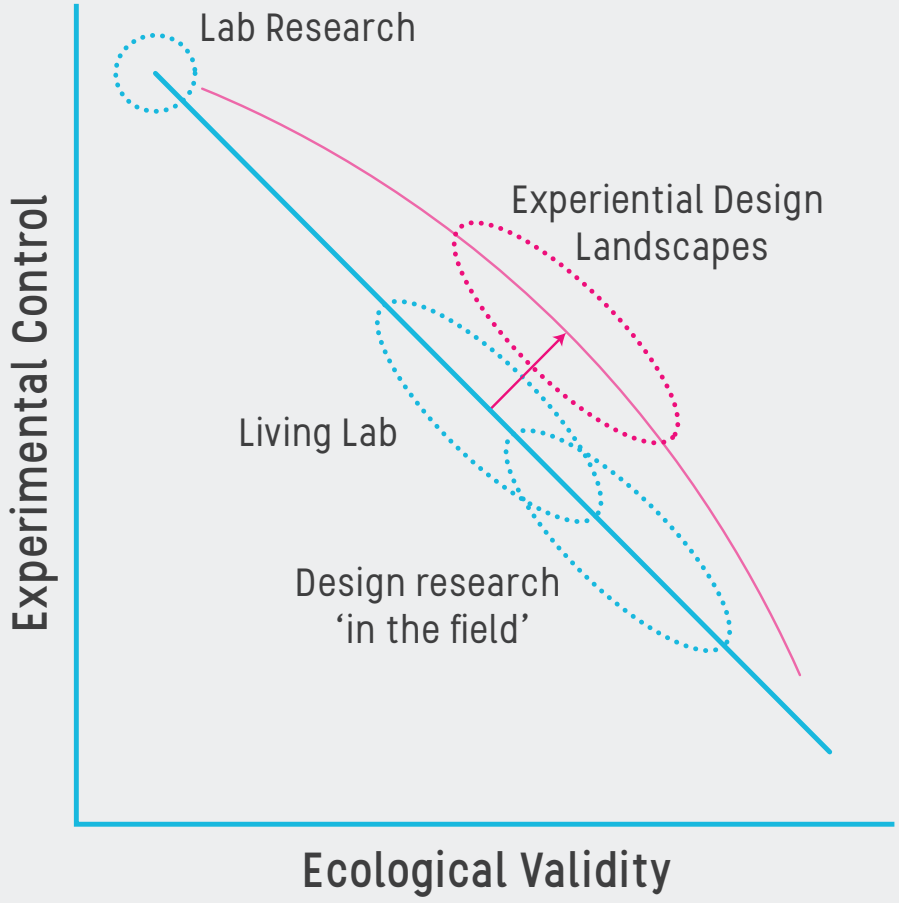
the connected individual



Three main research/design challenges wrt sensoring

Challenge I – The truth is out there

Experimental control versus ecological validity



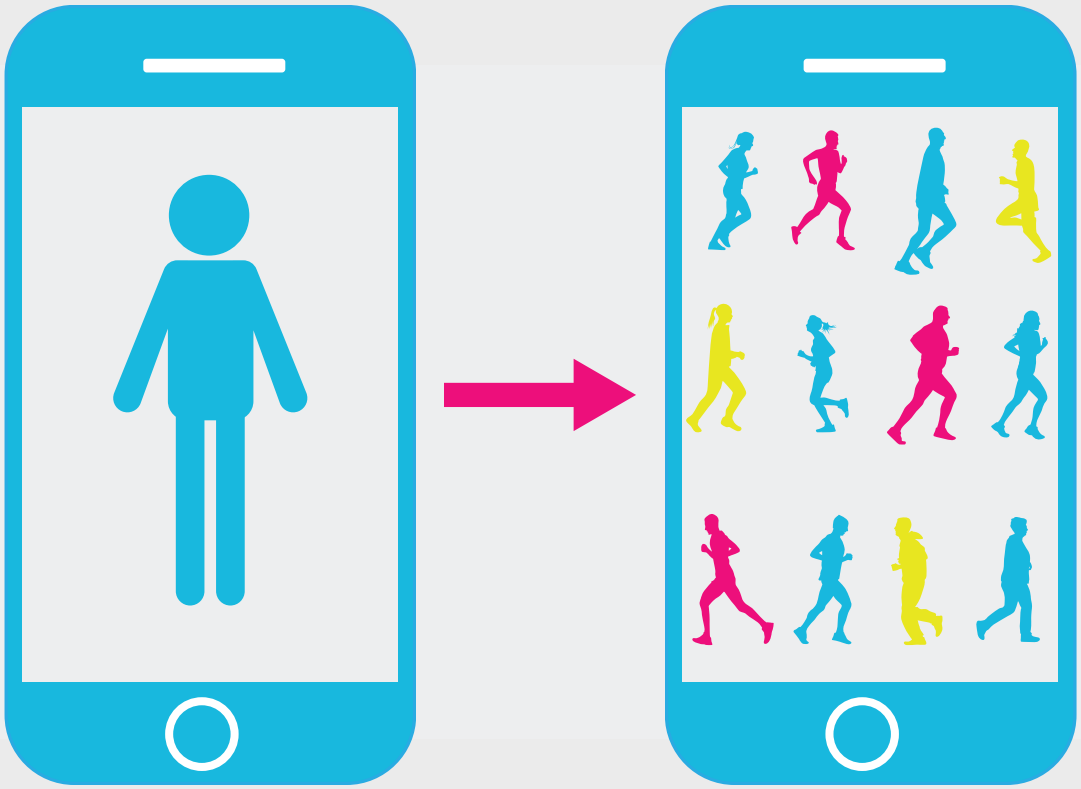
Source: Peeters & Megens (2014)

Three main research/design challenges wrt censoring

Challenge II – Acquisition, integration and application of meaningful data

Three main research/design challenges wrt sensoring

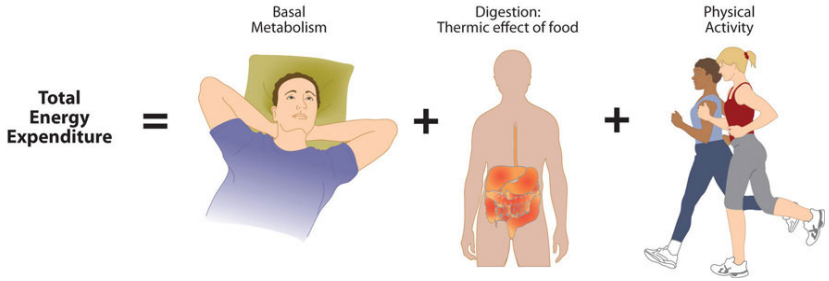
Challenge III – Personalized feedback – one size does not fit all



TU/e

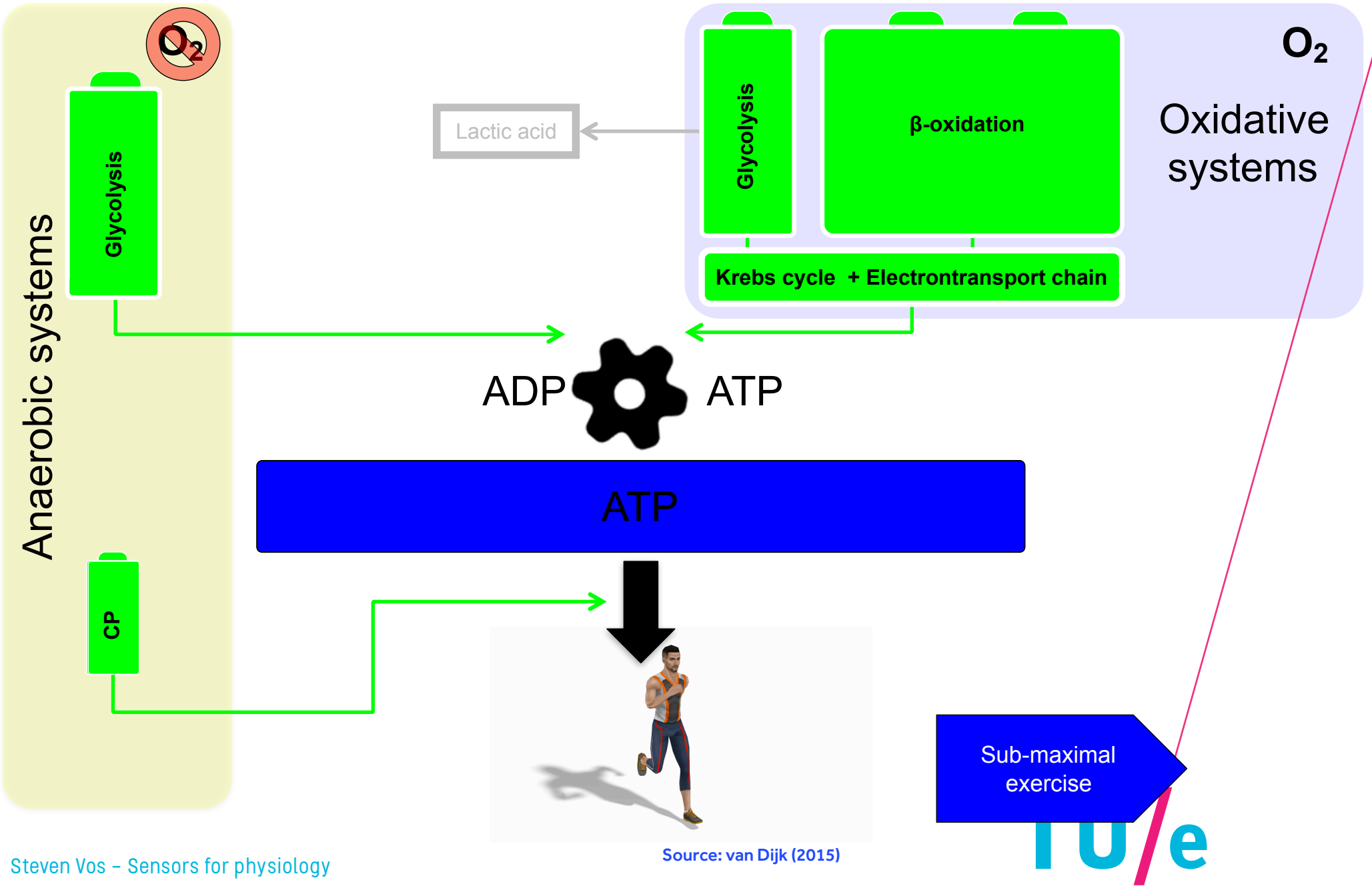
Example - energy expenditure

Metabolic equivalent tasks …



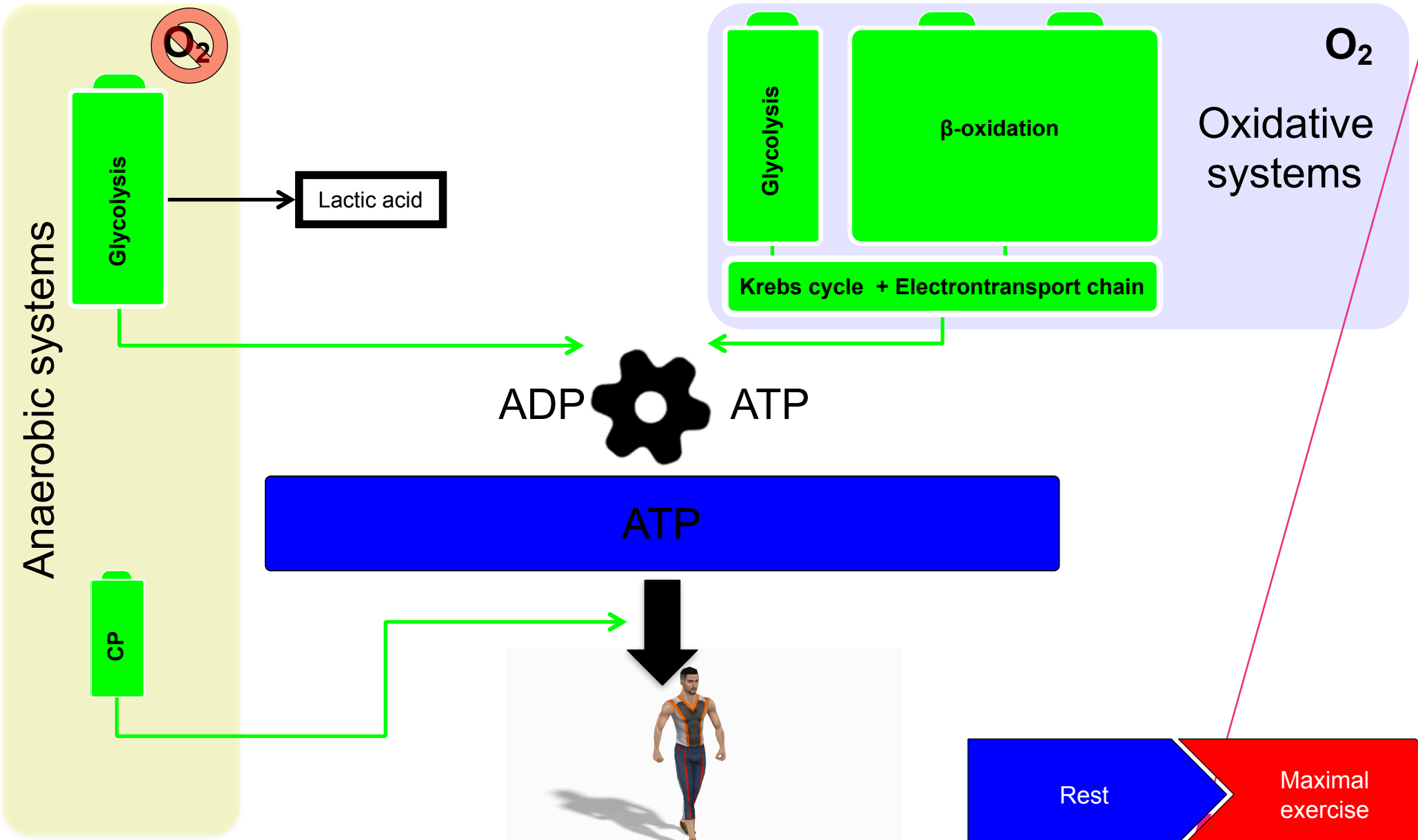
Physical activity	MET
Light intensity activities	**< 3**
sleeping	0.9
watching television	1.0
writing, desk work, typing	1.8
walking, 1.7 mph (2.7 km/h), level ground, strolling, very slow	2.3
walking, 2.5 mph (4 km/h)	2.9
Moderate intensity activities	**3 to 6**
bicycling, stationary, 50 watts, very light effort	3.0
walking 3.0 mph (4.8 km/h)	3.3
calisthenics, home exercise, light or moderate effort, general	3.5
walking 3.4 mph (5.5 km/h)	3.6
bicycling, <10 mph (16 km/h), leisure, to work or for pleasure	4.0
bicycling, stationary, 100 watts, light effort	5.5
Vigorous intensity activities	**> 6**
jogging, general	7.0
calisthenics (e.g. pushups, situps, pullups,jumping jacks), heavy, vigorous effort	8.0
running jogging, in place	8.0
rope jumping	10.0

Example - physiology of energy metabolism during different levels of exercise



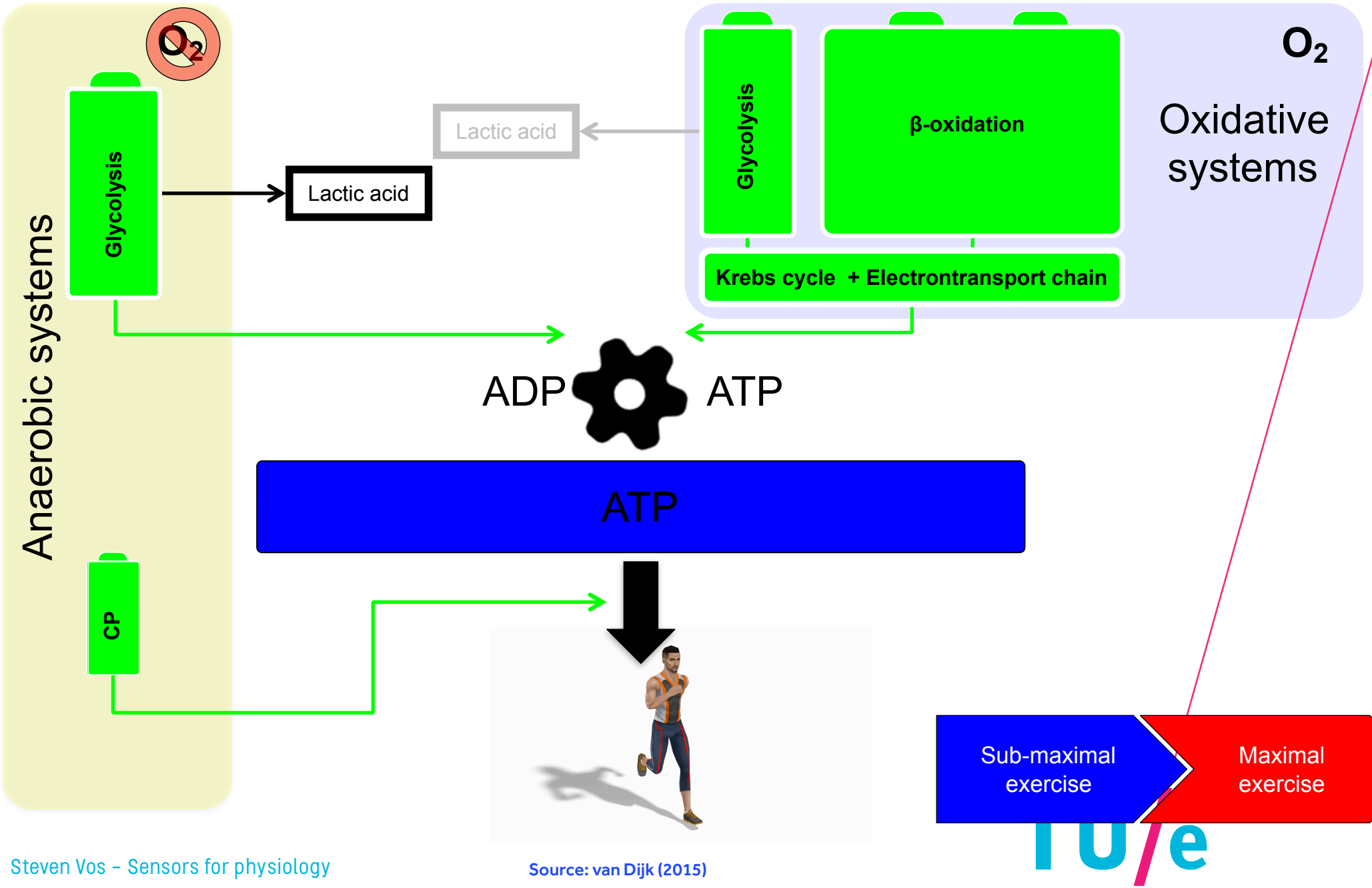
Source: van Dijk (2015)

Example - physiology of energy metabolism during different levels of exercise



Source: van Dijk (2015)

Example - physiology of energy metabolism during different levels of exercise



Sub-maximal exercise

Maximal exercise

Source: van Dijk (2015)

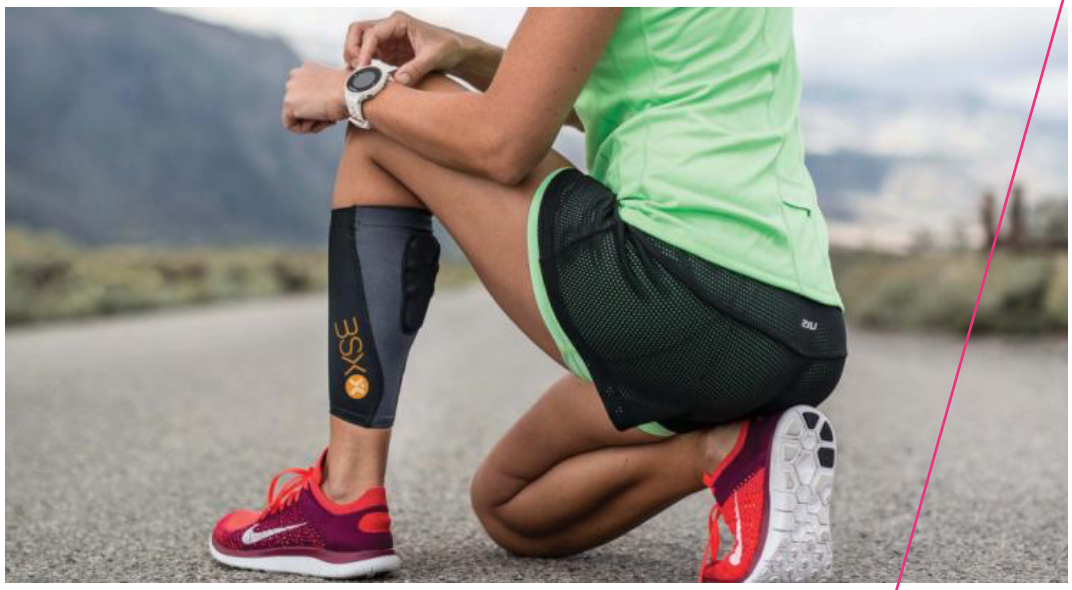
Some examples - measuring lactic acid

Ultrafit: Fitness in the blood

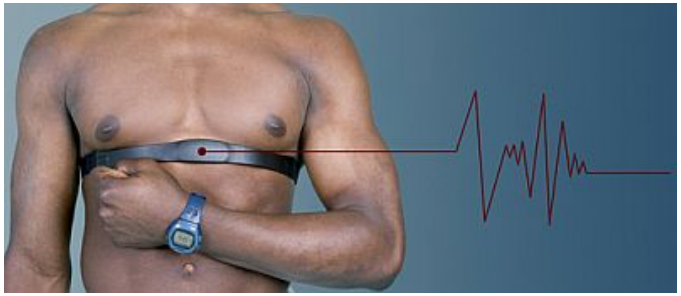
Photo by Jeffrey Thompson

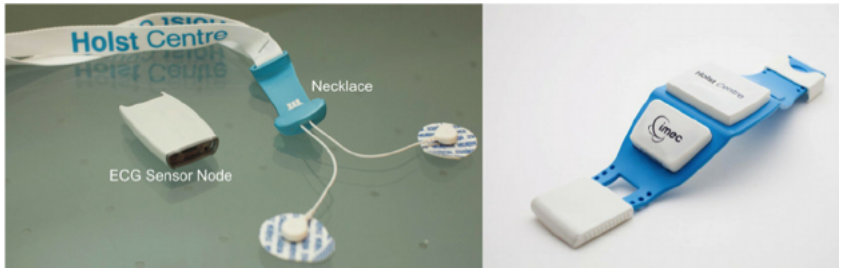
Ben Popp uses a blood lactate meter to measure levels during a workout at Now Bikes and Fitness in St. Paul.

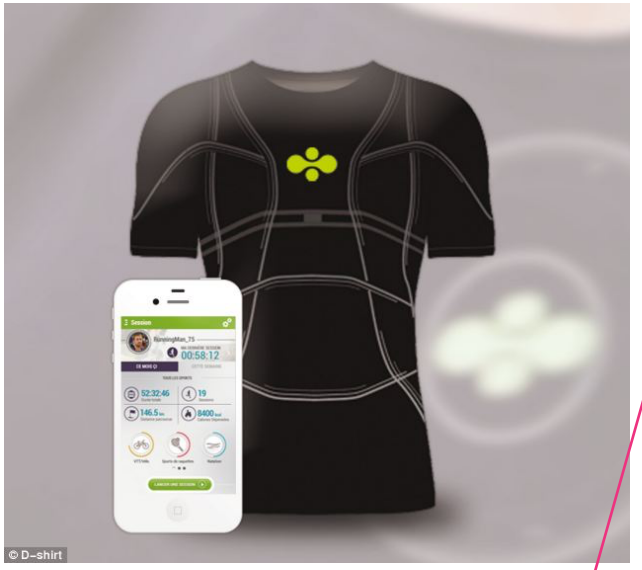
BSX Insights – indirect through measurement of oxygen saturation in the muscles

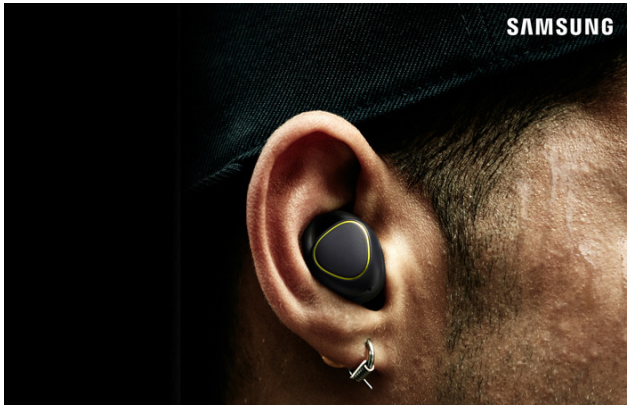


Some examples - measuring heart rate



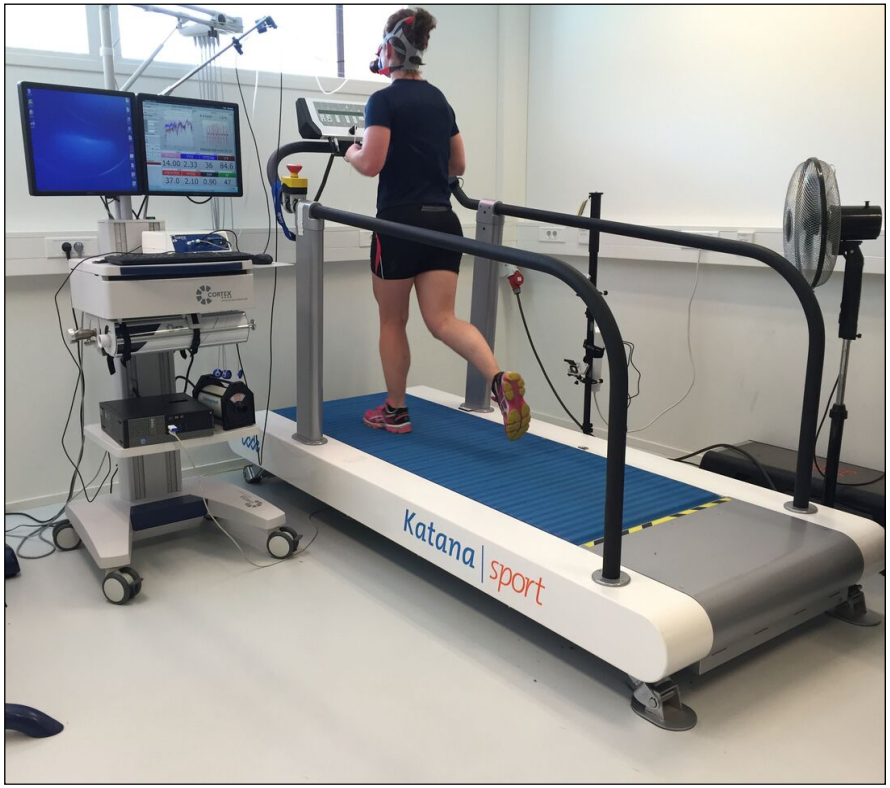






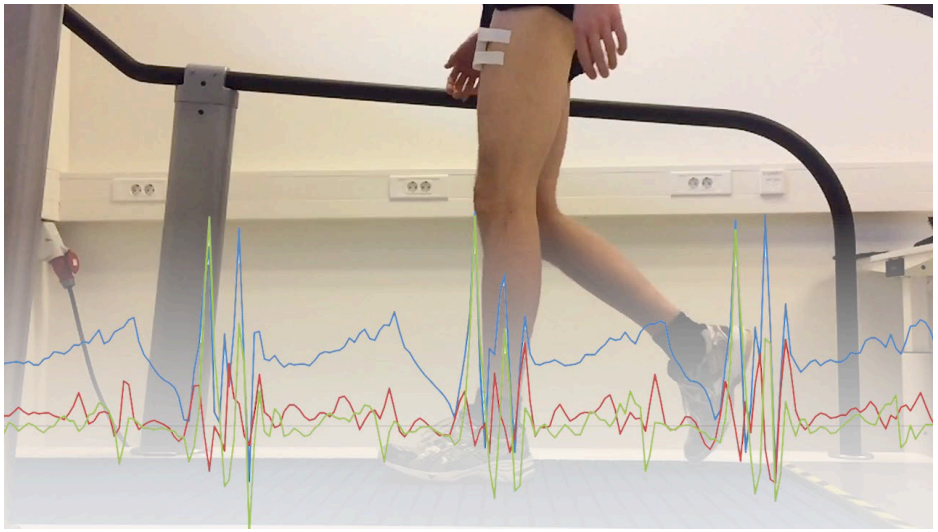
Some examples - measuring energy expenditure

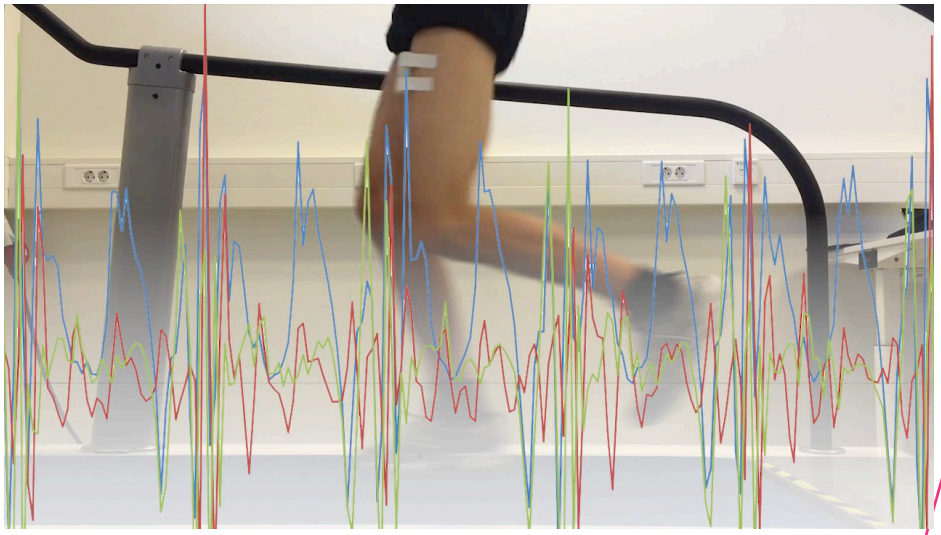
Indirect calorimetry – determined by measuring O2 consumption and CO2 production



Some examples - measuring energy expenditure?

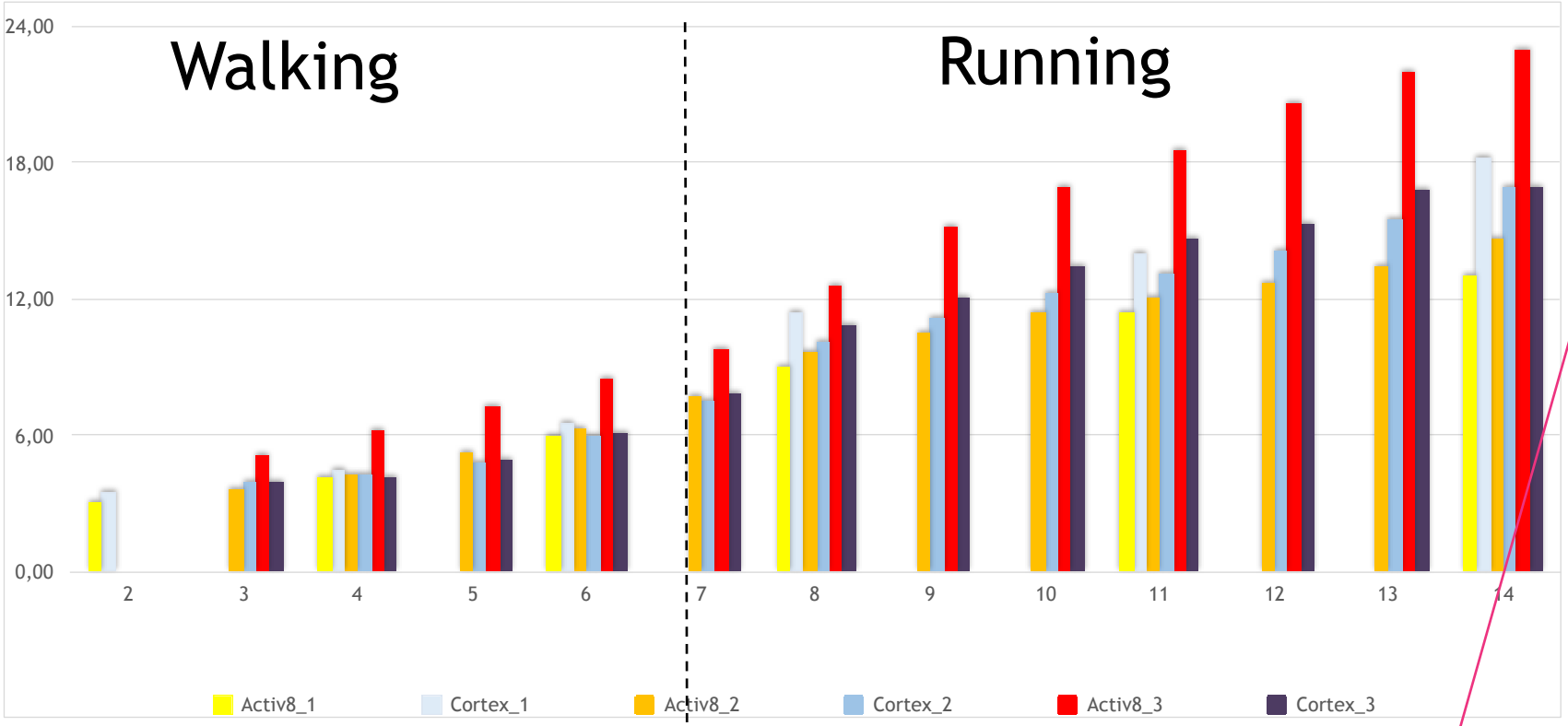
Some examples - optimizing algorithms for measuring energy expenditure through a 3-axial accelerometer





Source: Oomen, Arts & Vos (2015; 2016)

Some examples - optimizing algorithms for measuring energy expenditure through a wearable device



Source: Oomen, Arts & Vos (2015; 2016)

To be continued in the upcoming weeks ...

DBB170 – Sensors for physiology

Prof.dr. Steven Vos