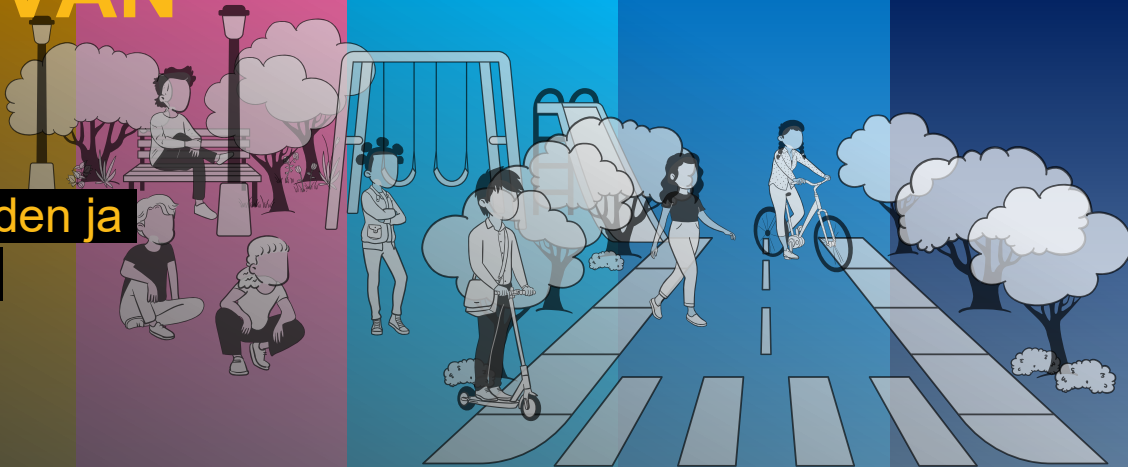


MISTÄ LASTEN JA NUORTEN PÄIVÄN AKTIIVISUUS KOOSTUU?

Lasten ja nuorten aktiivisuuden ja
paikallaanolon mittaamisen
erityispiirteitä

Arto Pesola, LitT
Johtaja, Active Life Lab
Kaakkois-Suomen ammattikorkeakoulu





Saimaa Stadiumi Oy:

- Ravintola
- Liikuntahalli ja tapahtumakeskus
- Hyvinvointipalvelut



Xamk Active Life Lab:

- TKI
- Wellbeing management -tutkinto
- Elintapaohjausyhteistyö
- Yritysyhteistyö

Mikkeli Kalevankangas



Muutos

Toimenpiteet

Näkemykset

Analyysi

Data

Sensorit

Ei käytössä

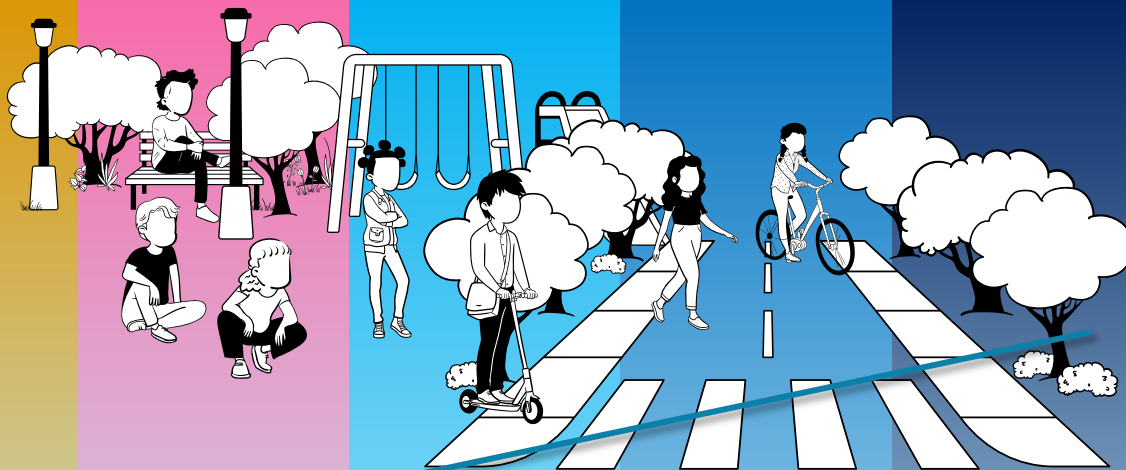
Uni

Paikallaanolo

Kevyttehoinen

Keskitehoinen

Kovatehoinen



Suhteellinen intensiteetti



Aktiivisuustyyppien tunnistaminen



Asennon tunnistaminen



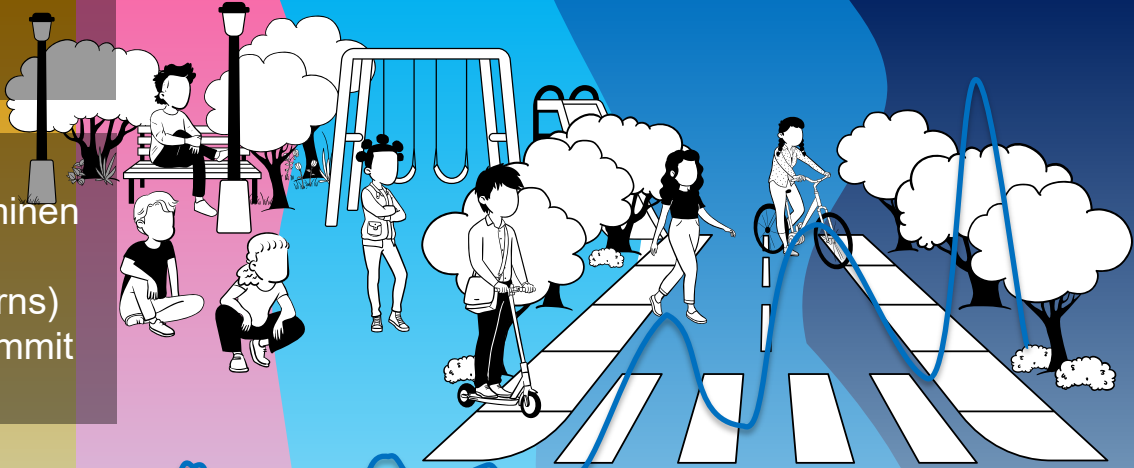
Kesto intensiteetti-alueilla



Energiankulutus

- Person-centered analysis (esim. latent profile analysis)
- Kompositiomallit

- (epälineaaristen) jakaumien mallintaminen
- Kumuloitumismallit (accumulation patterns)
- Intensiteettihistogrammit



Ei käytössä

Uni

Paikallaanolo

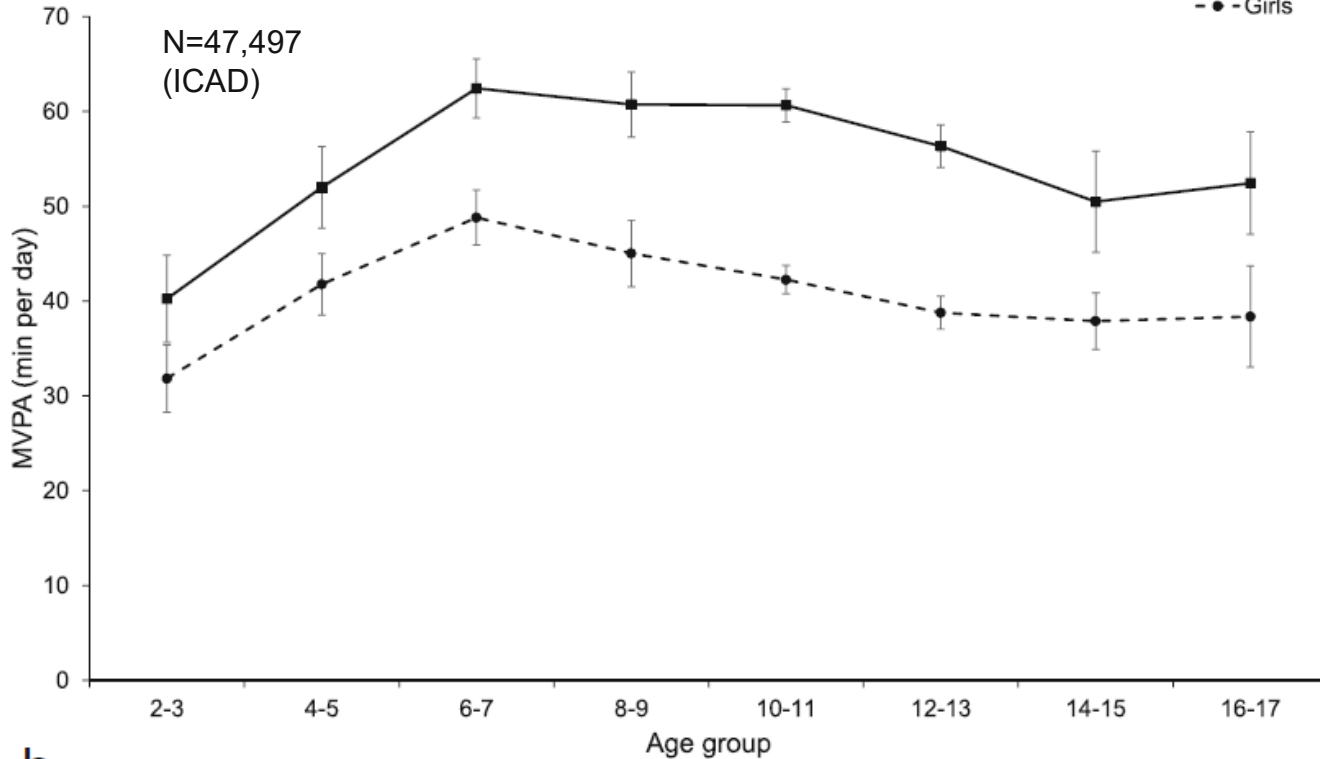
Kevyttehoinen

Keskitehoinen

Kovatehoinen

24-tunnin datat, uni!

Keski-kovatehoisen liikunta-aktiivisuuden kesto Eurooppalaisissa aineistoissa (Actigraph)



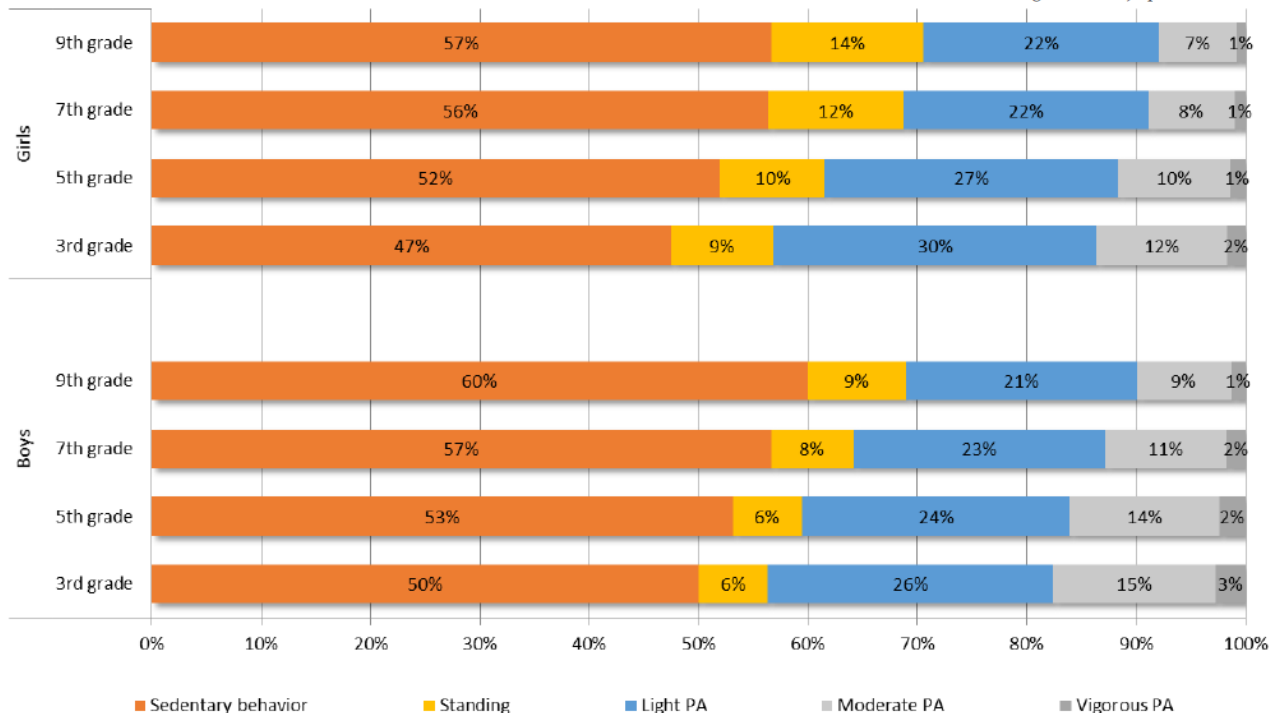
- Actigraph, vertical axis
- 60s epoch
- Evenson cut-points (moderate: ≥ 2296 CPM)
- Excluded data recorded from 23:59 to 06:00
- Valid day ≥ 8 h
- Sufficiently active: ≥ 60 min of MVPA per valid day

- *Boys were more active and less sedentary in all age-categories.*
- *The onset of age-related lowering or leveling-off of physical activity and increase in sedentary time at around 6 to 7 years of age.*
- *“Two third of European children and adolescents are not sufficiently active.”*



Sedentaariaika ja aktiivisuus Suomessa (UKK AM30 and RM42)

N=2981
(LIITU)



Citation: Jussila, A.-M.; Husu, P.; Vähä-Ypyä, H.; Tokola, K.; Kokko, S.; Sievänen, H.; Vasankari, T. Accelerometer-Measured Physical Activity Levels and Patterns Vary in an Age- and Sex-Dependent Fashion among Finnish Children and Adolescents. *Int. J. Environ. Res. Public Health* 2022, 19, 6950. <https://doi.org/10.3390/ijerph19116950>

- triaxial hip-worn
- 6-s epochs and angle for posture estimation
- Converted to METs and smoothed with 60s epoch
- MVPA 3+ METs
- during waking hours
- at least four days (one weekend day) with a minimum of 10-h daily wearing time
- Sufficiently active: ≥ 60 min of MVPA per valid day

- *Boys were more active than girls*
- *Children were more active than adolescents*
- *Participants were sedentary for more than half of their waking hours*
- **“One third met the PA recommendation”**

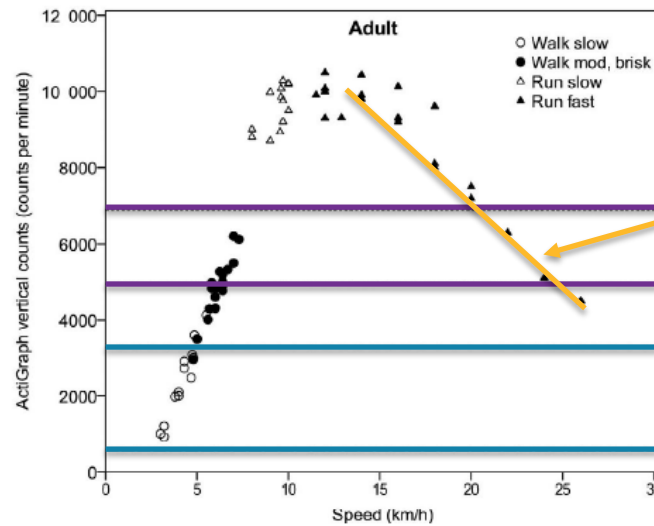
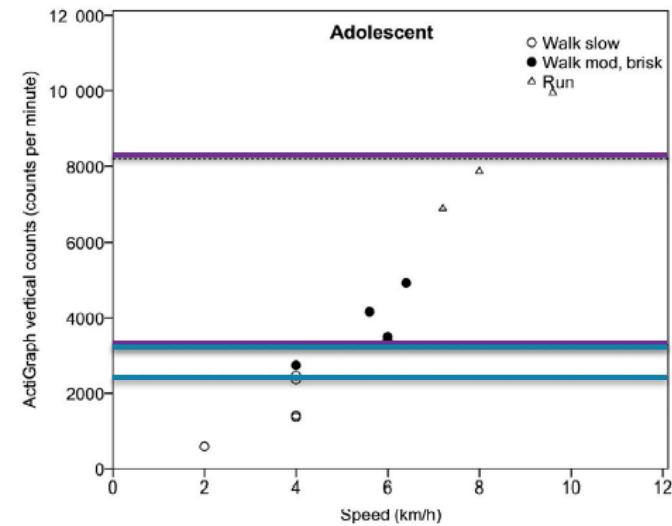
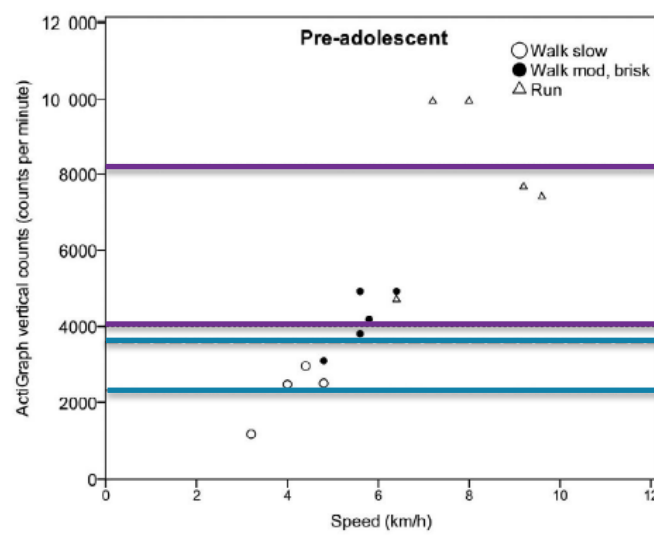
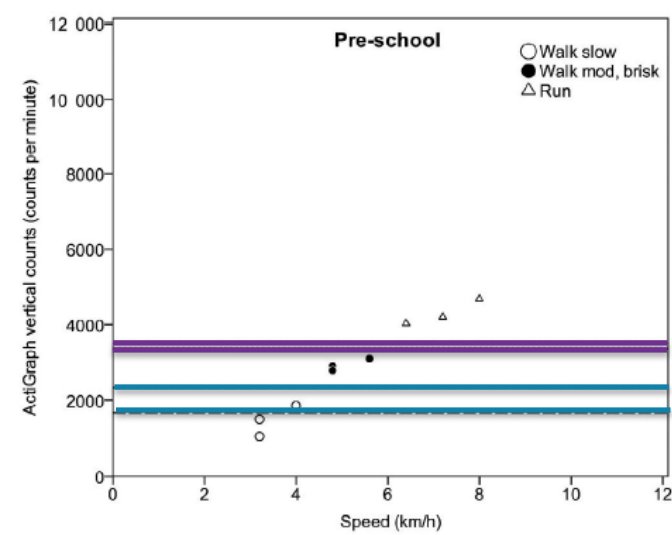
Arvidsson et al. Scand J Med Sci Sports. 2019;29:1442–1452.

Korkein kovatehoisen aktiivisuuden kynnyks

Matalin kovatehoisen aktiivisuuden kynnyks

Matalin keskitehoisen aktiivisuuden kynnyks

Actigraph vertical axis counts bias



Biomekaniikka

Mekaaninen työ

- Kehon mittasuhteet
- Sensorin paikka
- Liikkeen taloudellisuus



Fysiologia

Energiankulutus

- Maturiteetti
- Energiankulutuksen taloudellisuus

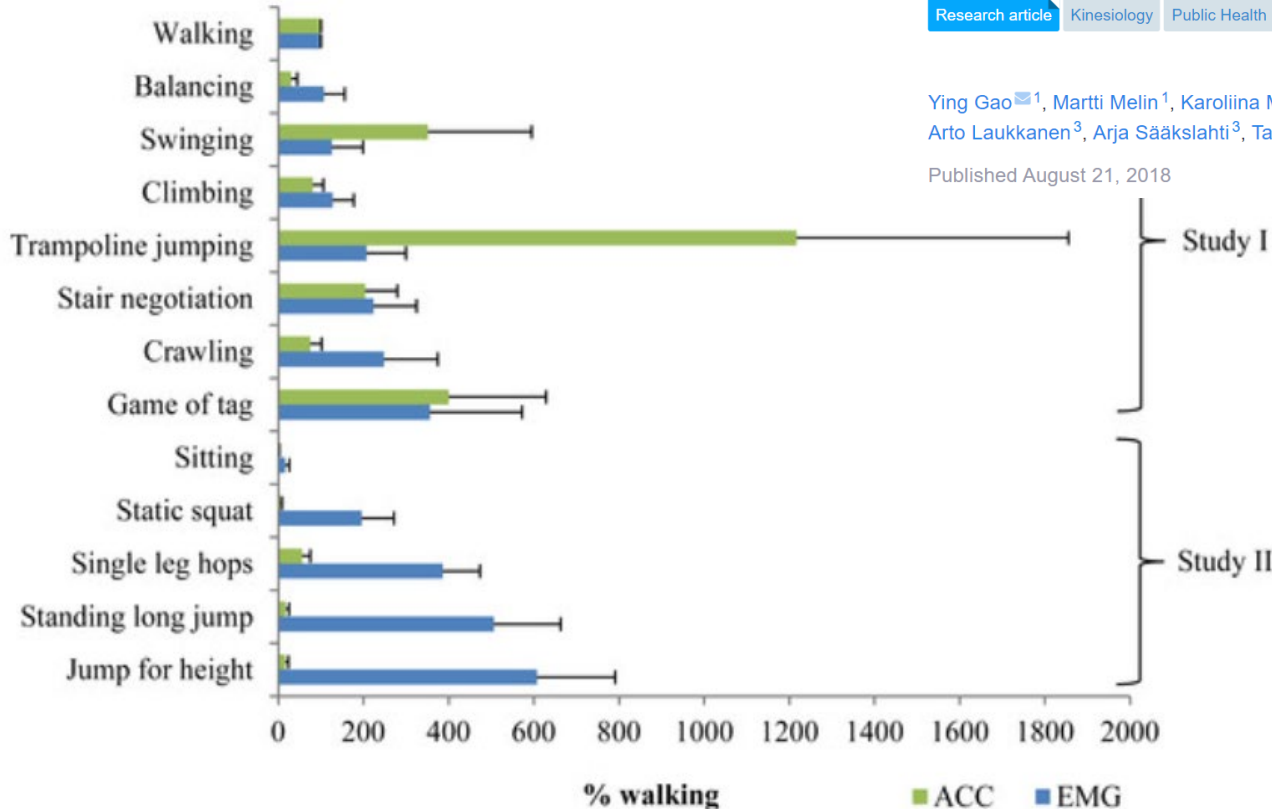
Mitä kaikkea jää huomaamatta jos keskitymme pelkästään energiankulutuksen arviointiin tai validoimme menetelmiä tai intensiteettitasoja suhteessa siihen?

Children's physical activity and sedentary time compared using assessments of accelerometry counts and muscle activity level

Research article Kinesiology Public Health

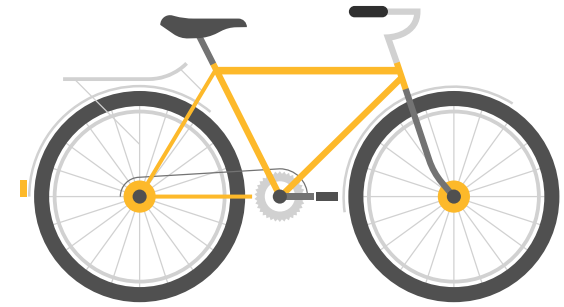
Ying Gao¹, Martti Melin¹, Karoliina Mäkäräinen¹, Timo Rantalainen¹, Arto J. Pesola², Arto Laukkanen³, Arja Säksälahti³, Taina Finni¹

Published August 21, 2018



**Intensiteettialueista (ja
lineaarisisista estimoinneista)
aktiivisuustyyppien
tunnistamiseen**


Pyöräilyn keski-kovatehoinen aktiivisuus aliarvioidaan lantiolla pidettävällä kiihtyvyyssanturilla



at journeys from school. Each kilometer of cycling meant that accelerometers underestimated PA levels by a geometric mean of 9314 (95% CI: 7719–11,238) counts. Only 3.3% and 2.5% (both geometric mean) of HRMVPA were collected by accelerometers at journeys to and from school, respectively. Eleven participants did not achieve any minutes of MVPA during cycling according to accelerometers. Each kilometer of cycling meant that accelerometers underestimated a geometric mean of 2.7 (95% CI: 2.1–3.5) minutes of MVPA.

- hip-worn Actigraph GT3X
- “Epoch was set to 2 seconds but data were extracted in 1 min epochs”
- Freedson/Trost equations which uses 4 metabolic equivalents (METs) as the threshold for MVPA
- Compared to heart rate/qps-derived MVPA

Journal of Physical Activity and Health, 2015, 12, 701-707
<http://dx.doi.org/10.1123/jpah.2013-0212>
© 2015 Human Kinetics, Inc.

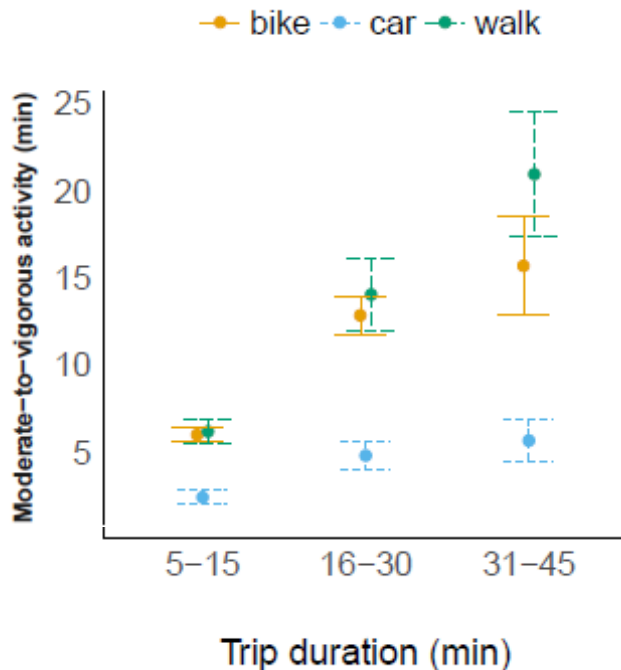
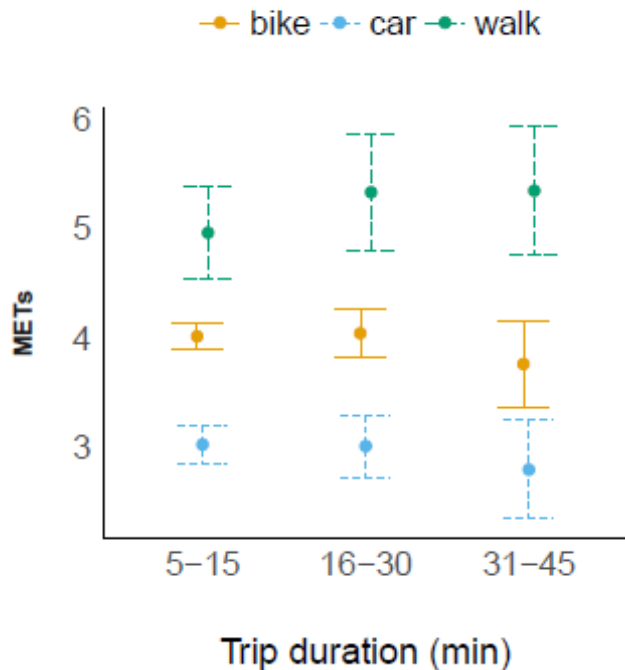
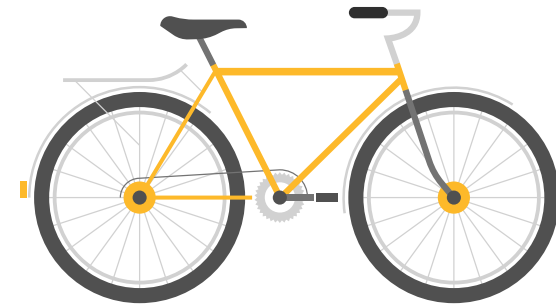
Human Kinetics 
ORIGINAL RESEARCH

Quantification of Underestimation of Physical Activity During Cycling to School When Using Accelerometry

Jakob Tarp, Lars B. Andersen, and Lars Østergaard



Pyöräilyn aktiivisuuden arviointi paranee reidessä pidettävällä mittalaitteella ja tunnistamalla ensin aktiivisuustyyppi

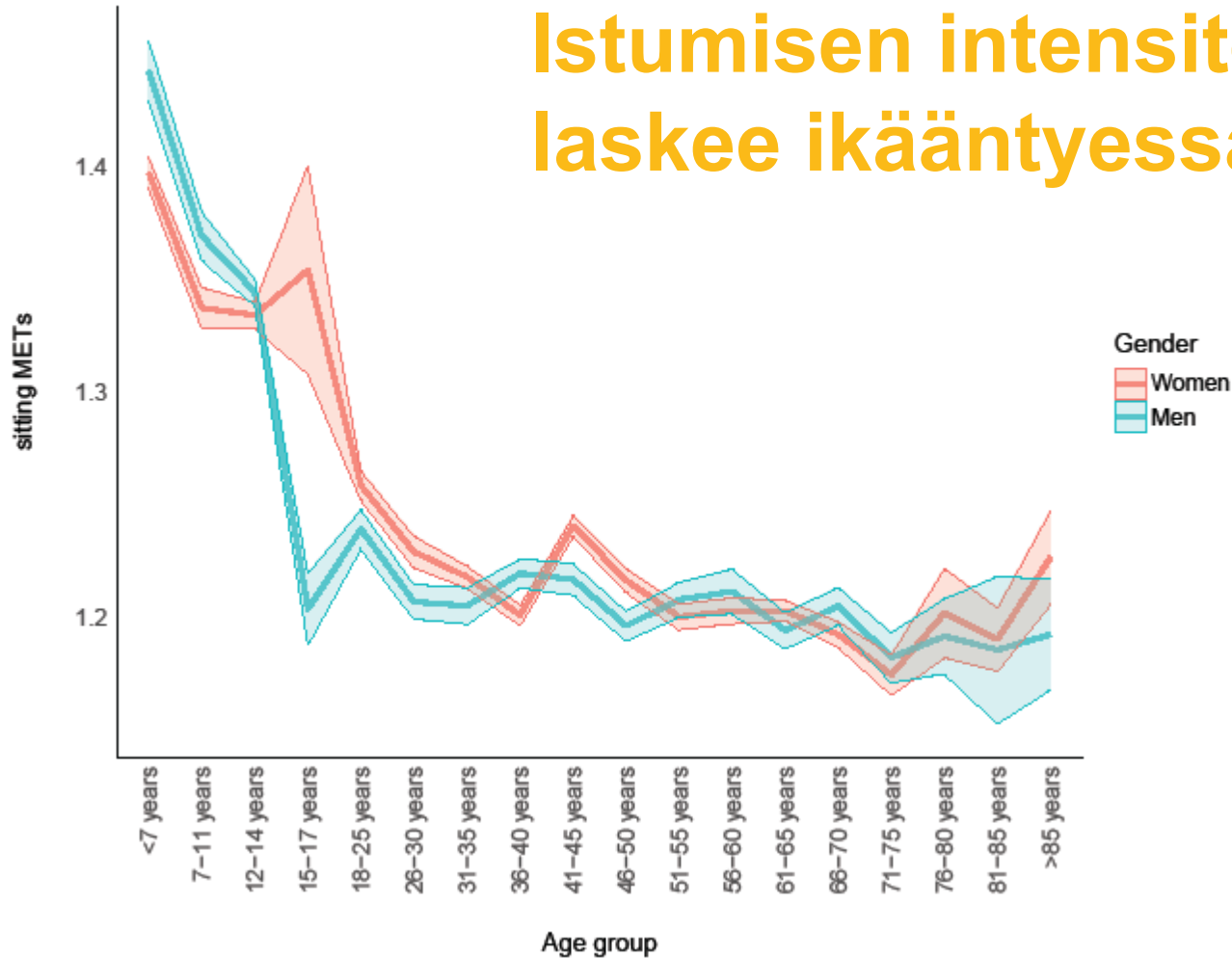


- Fibion, oikeassa reidessä
- 12,5 Hz mittaustaajuus, aktiivisuustyyppin tunnistus 1s tarkkuudella 1 min ikkunoissa
- MVPA-raja 3.5 METiä

- Pesola ym. valmisteilla
- n=160, 2182 trips
- MET-arvo aliarvioidaan, mutta MVPA kesto sama kuin kävelymatkoilla



Istumisen intensiteetti laskee ikääntyessä

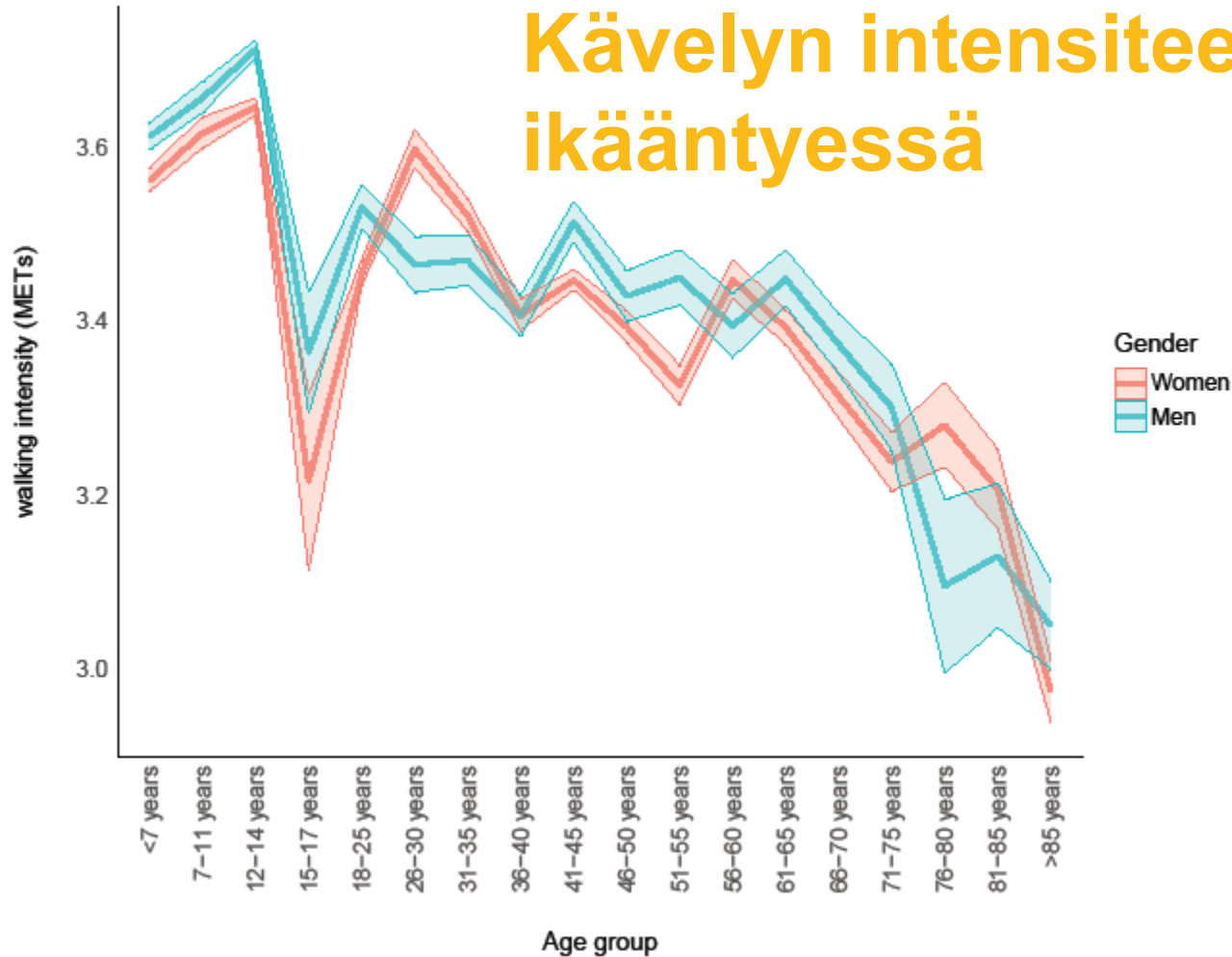


- Fibion, oikeassa reidessä
- 12,5 Hz mittaustaajuus, aktiivisuustyyppin tunnistus 1s tarkkuudella 1 min ikkunoissa
- Validiteetti: Yang ym. 2018 PeerJ; Montoye ym. 2022 J Meas Phys Behav; Alkaliy ym. 2022 Heliyon

N=5843, 35 665 päivää,
Pesola ym. valmisteilla



Kävelyn intensiteetti laskee ikääntyessä



- Fibion, oikeassa reidessä
- 12,5 Hz mittaustaajuus, aktiivisuustyyppin tunnistus 1s tarkkuudella 1 min ikkunoissa
- Validiteetti: Yang ym. 2018 PeerJ; Montoye ym. 2022 J Meas Phys Behav; Alkaliy ym. 2022 Heliyon

N=5843, 35 665 päivää,
Pesola ym. valmisteilla



Current definitions and descriptions of moderate to vigorous intensity exercise are unclear. The lack of consistency and clarity of these definitions has several implications. First, given the multiple formats used for describing moderate and vigorous intensity exercise in the research literature, it is difficult to relate intensity to health outcomes. Second, this ambiguity also makes it challenging for practitioners prescribing exercise and their clients to fully understand what moderate to vigorous intensity exercise is.... intensity needs to be individualized relative to specific boundaries, reflecting precise metabolic conditions above which physiological homeostasis is challenged.

*MacIntosh et al. 2021 What Is Moderate to Vigorous Exercise Intensity?
Front. Physiol. 12:682233. doi: 10.3389/fphys.2021.682233*

Aerobic Capacity Determines Habitual Walking Acceleration, Not Electromyography-Indicated Relative Effort





Arto J. Pesola,¹ Timo Rantalainen,² Ying Gao,³ and Taija Finni⁴

SCIENTIFIC
REPORTS

nature research

 Check for updates

OPEN **Validity of traditional physical activity intensity calibration methods and the feasibility of self-paced walking and running on individualised calibration of physical activity intensity in children**

Eero A. Haapala ^{1,2}, Ying Gao ^{1,3}, Anssi Vanhala^{1,4}, Timo Rantalainen ² & Taija Finni ¹

Conclusions: People with low-average aerobic capacity habitually walk with a lower accelerometer-measured absolute intensity, but the physiological stimulus for lower-extremity muscles is similar to those with excellent aerobic capacity. This should be considered when measuring and prescribing walking for health.

In conclusion, commonly used methods may misclassify PA intensity in children. MAD during self-paced running may provide a novel and practical method for determining individualised VPA intensity in children. [and self-based walking for mpa]



Luokitteluista jatkuviin jakaumiin: histogrammit

Histogrammi huomioi koko intensiteetti- jakauman

European Journal of Applied Physiology (2021) 121:2563–2571
<https://doi.org/10.1007/s00421-021-04731-3>

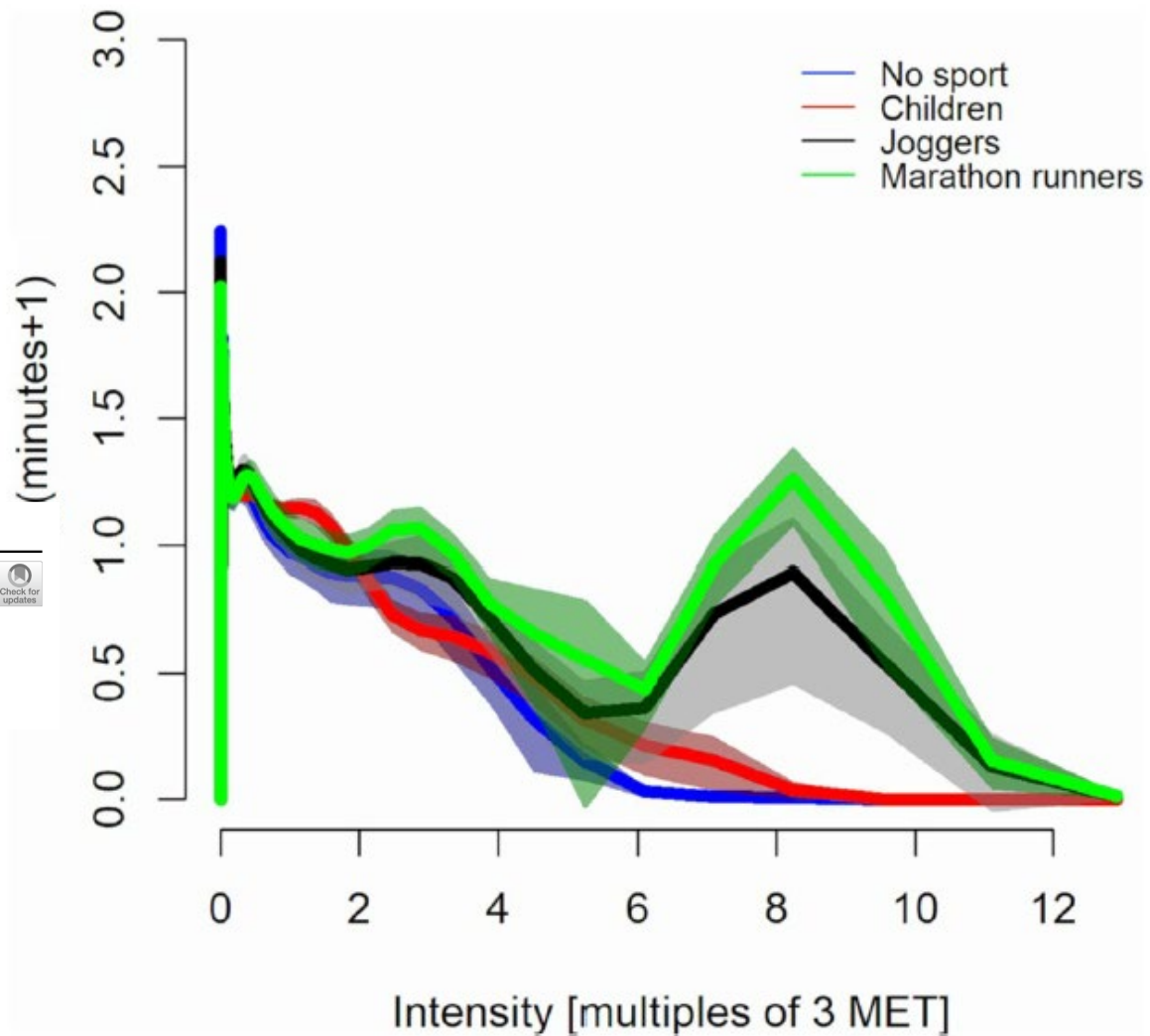
ORIGINAL ARTICLE



Physical activity accumulation along the intensity spectrum differs between children and adults

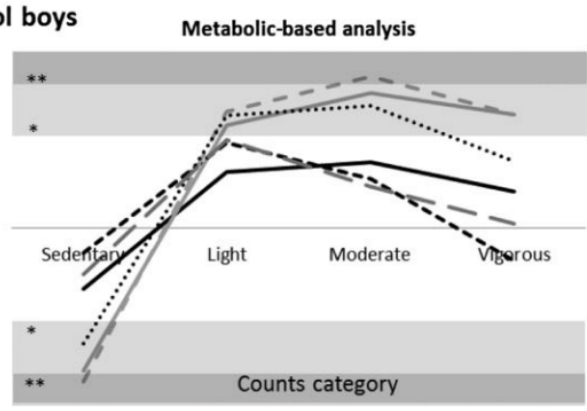
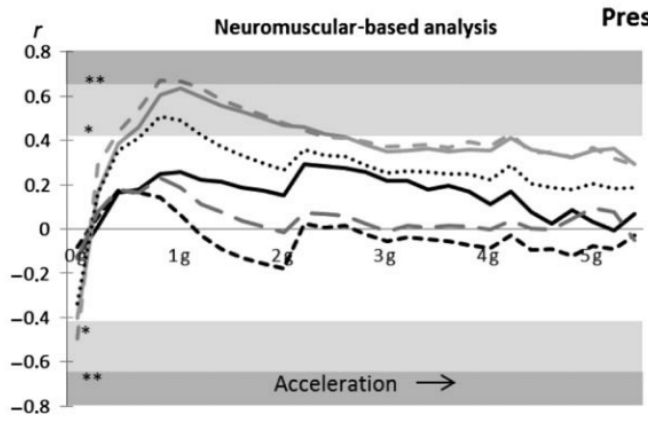
Timo Rantalainen^{1,2} · Nicola D. Ridgers² · Ying Gao^{3,4} · Daniel L. Belavy^{2,6} · Eero A. Haapala^{1,4,5} · Taija Finni⁴

Tsekkää myös: Aadland *et al. Int J Behav Nutr Phys Act* **15**, 77 (2018).
<https://doi.org/10.1186/s12966-018-0707-z>

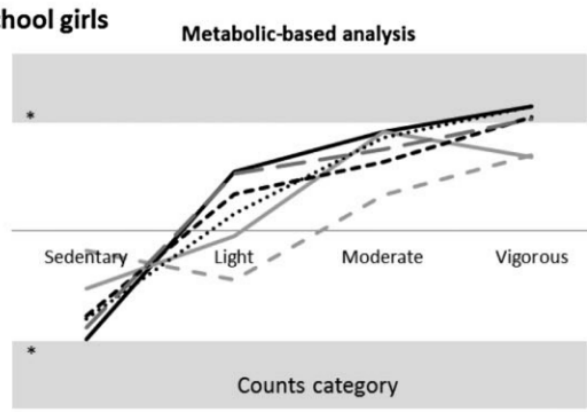
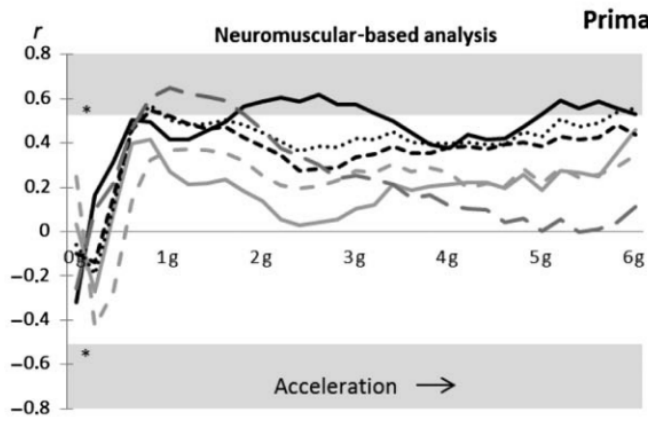


Motoristen taitojen yhteydet intensiteettijatkumoon vs. kategorioihin

Laukkanen, A., Pesola, A., Havu, M., Sääkslähti, A., & Finni, T. (2013) Scand J Med Sci Sports 2013



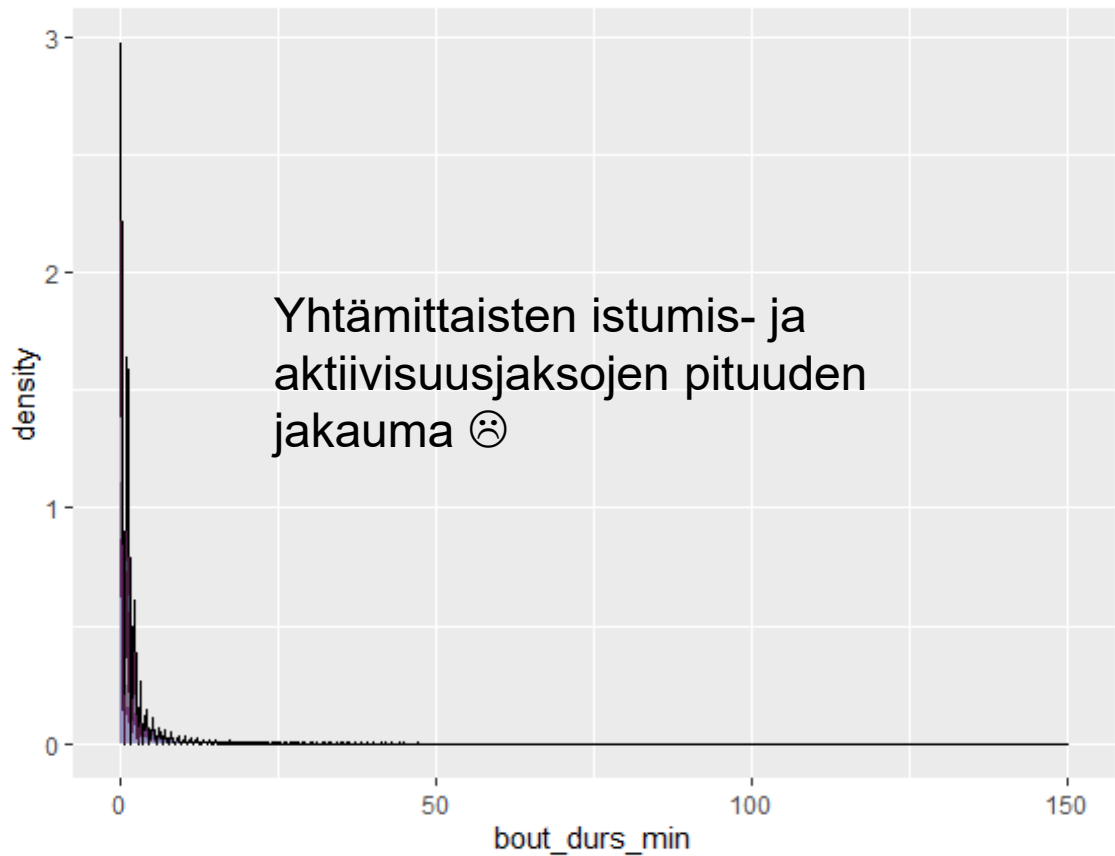
- WB
 - HH
 - - JS
 - - MS
 - MC
 - - TCB
- WB, walking backwards
 HH, hopping for height; JS, jumping sideways;
 MS, moving sideways
 MC, overall gross motor coordination according to KTK;
 TCB, throwing and catching a ball;



- WB
- HH
- - JS
- - MS
- MC
- - TCB



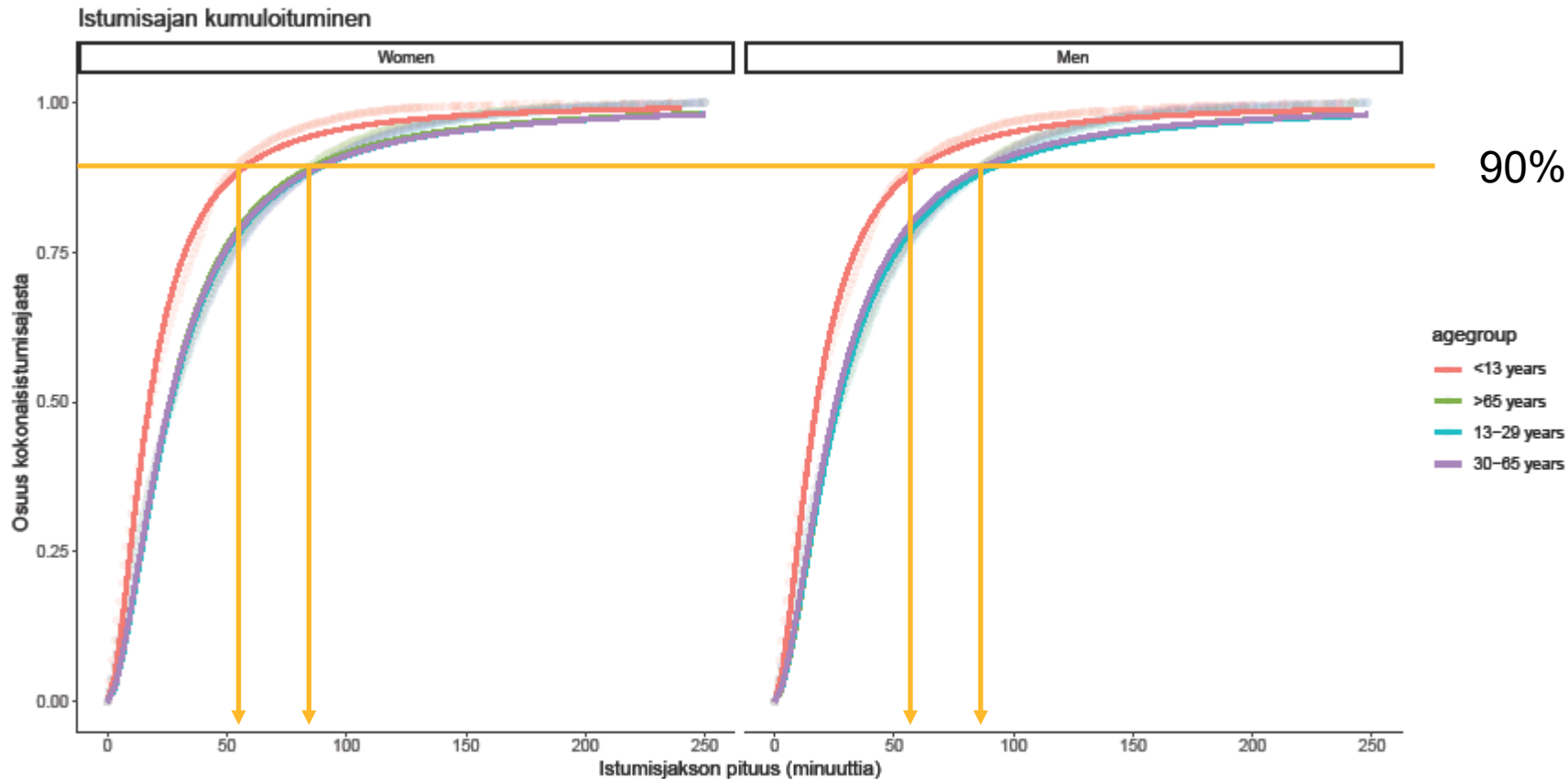
Istumis- ja aktiivisuusajan kumuloituminen



- (epälineaaristen) jakaumien mallintaminen
- Kumuloitumismallit (accumulation patterns)

Variable

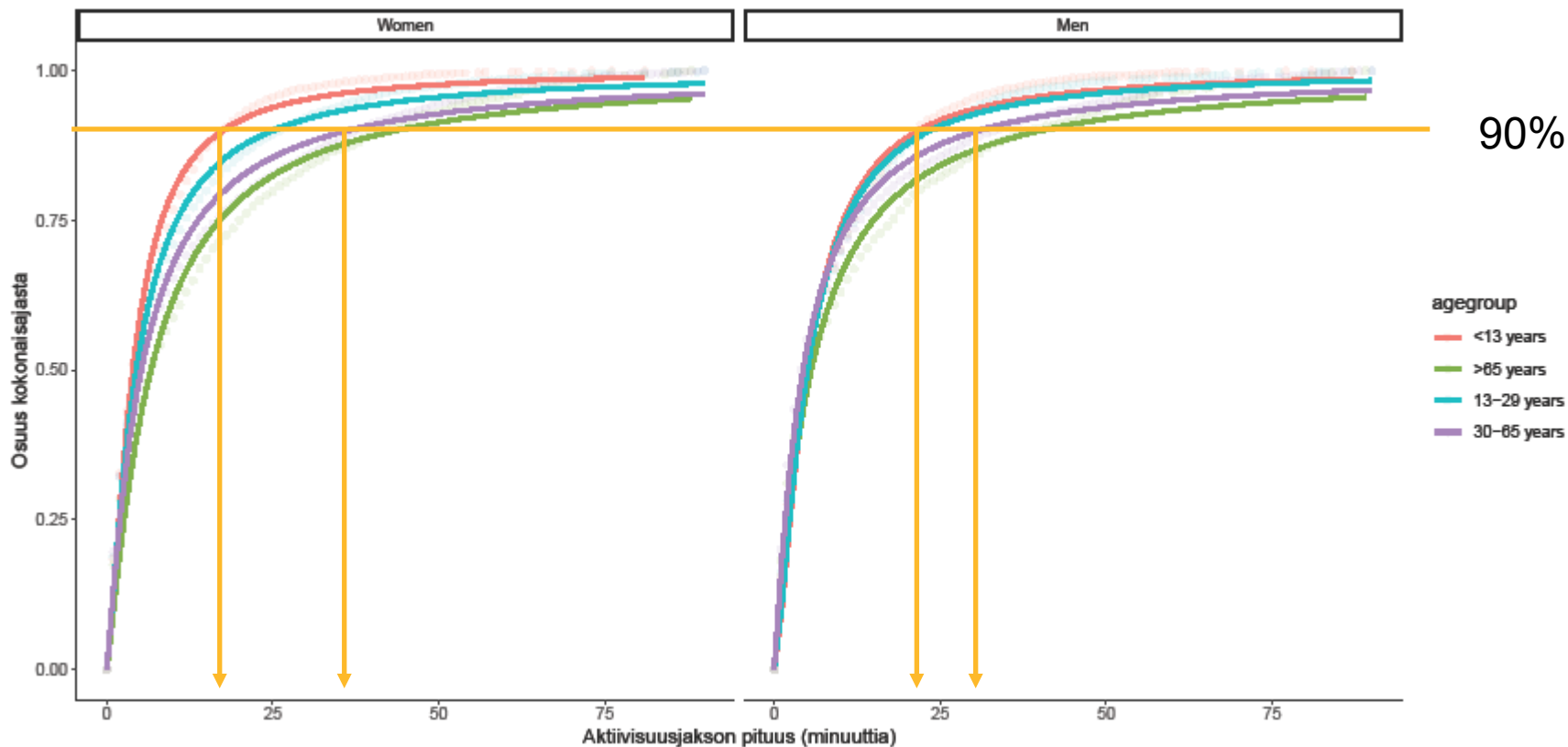




N=5843, 35 665 päivää, Pesola ym. valmisteilla

Chastin et al. 2015 Measurement in Physical Education and Exercise Science:
“Measures of sedentary time accumulation, in particular half-life bout duration (W50%), were consistently more sensitive than total sedentary time.”

Keski-kovatehoisen aktiivisuuden kumuloituminen



N=5843, 35 665 päivää, Pesola ym. valmisteilla



Compositional data analysis



Available online at www.sciencedirect.com

ScienceDirect

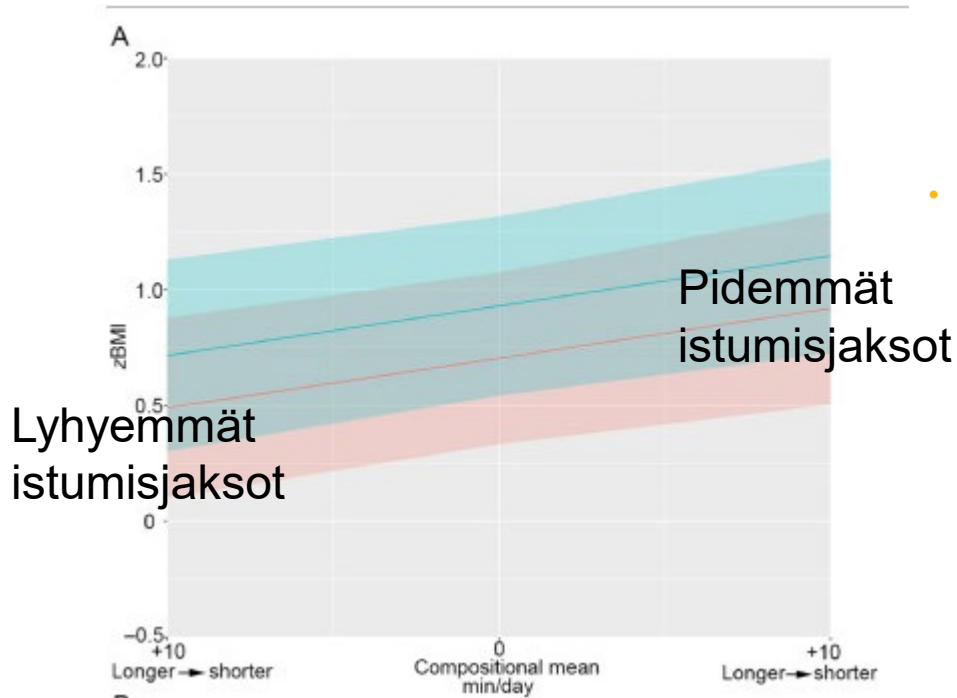
Journal of Sport and Health Science 11 (2022) 234–243



Original article

Using compositional data analysis to explore accumulation of sedentary behavior, physical activity and youth health

Simone J.J.M. Verswijveren^{a,*}, Karen E. Lamb^b, Josep A. Martín-Fernández^c, Elisabeth Winkler^d, Rebecca M. Leech^a, Anna Timperio^a, Jo Salmon^a, Robin M. Daly^a, Ester Cerin^{e,f}, David W. Dunstan^{e,g}, Rohan M. Telford^h, Richard D. Telford^h, Lisa S. Olive^{i,j,k}, Nicola D. Ridgers^a



- The respective elements of time-use can be modelled **simultaneously** and tested for their **combined associations** with biomarkers of cardiometabolic health. This compositional data analysis approach is more advanced than other types of analyses in that it allows for the simultaneous consideration of components that sum to a whole, **without statistical problems such as collinearity**, which is often encountered in some traditional approaches

Muuttujakeskeisestä analyysistä henkilökeskeiseen analyysiin

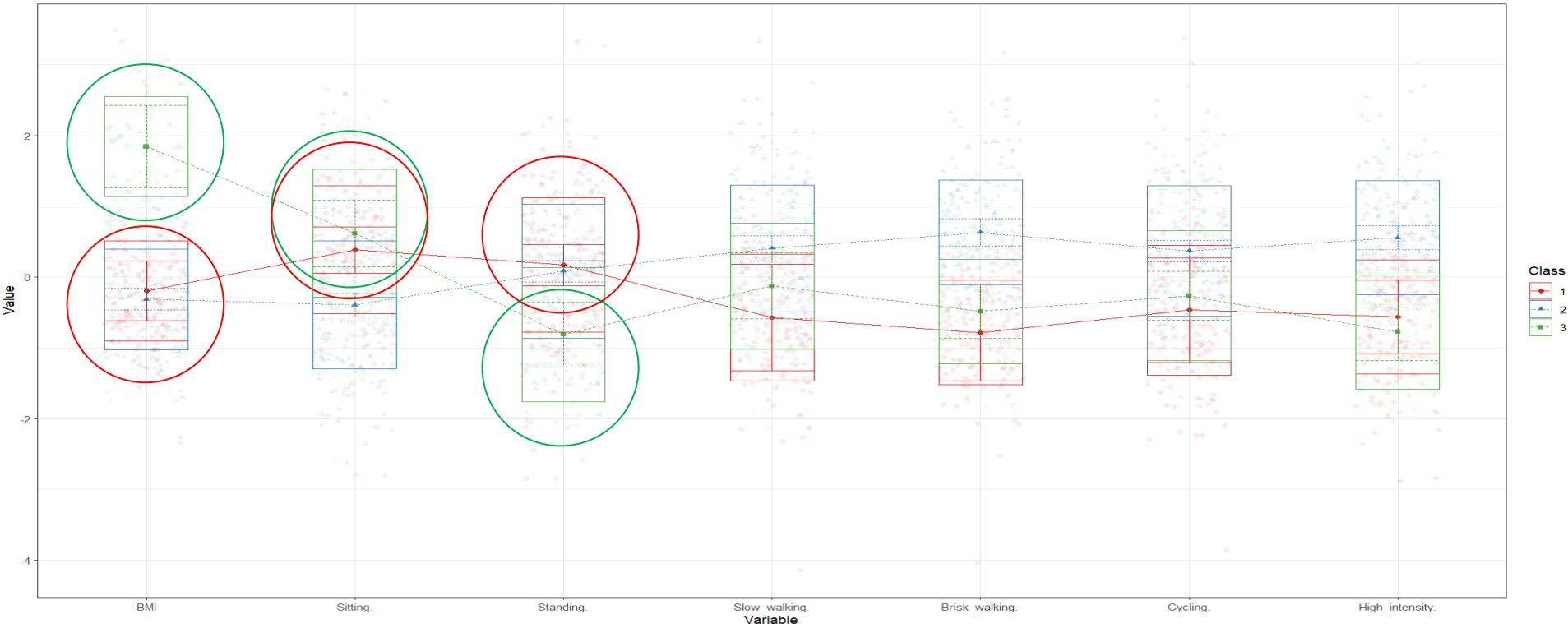
Morin, Gagne, and Bujacz (2016) state: “Whereas variable-centered approaches . . . assume that all individuals from a sample are drawn from a single population for which a single set of “averaged” parameters can be estimated, person-centered approaches . . . relax this assumption and consider the possibility that the sample might include multiple subpopulations characterized by different sets of parameters. “

Variable-centered approach (esim. korrelaatio)

- Results of Pearson correlation between variables in a sample of 10-13 years old children (n=344). BMI is associated with either sitting or all different physical activity proportions (except for slow walking).

	<i>Sitting</i>	<i>BMI</i>	<i>Cycling</i>	<i>Slow-walking</i>	<i>Brisk-walking</i>	<i>Standing</i>
<i>BMI</i>	0.258***					
<i>Cycling</i>	-0.140**	-0.117*				
<i>Slow-walking</i>	-0.189***	-0.080	0.390***			
<i>Brisk-walking</i>	-0.274***	-0.139**	0.330***	0.462***		
<i>Standing</i>	0.017	-0.316***	0.062	0.175**	-0.001	
<i>High-intensity</i>	-0.328***	-0.250***	0.037	0.107*	0.592***	-0.035

Computed correlation used Pearson-method with listwise-deletion.



Class 1 = normal BMI – high sitting – high standing – lowest slow-walking – lowest brisk-walking – low cycling – low high-intensity
Class 2 = normal BMI – lowest sitting – high standing – highest slow walking – highest brisk-walking – highest cycling – highest high-intensity
Class 3 = Highest BMI – high sitting – lowest standing – low slow walking – low brisk walking – low cycling – low high-intensity

Sekä normaalipainoisilla että ylipainoisilla lapsilla voi olla paljon istumista ja vähän fyysistä aktiivisuutta. Korkea painoindeksi JA/TAI korkea istumisen määrä EIVÄT ilmenneet samassa profiilissa korkean fyysisen aktiivisuuden kanssa.

Esmaeilzadeh et al. under preparation



Pohdintaa

Relevanssi terveyteen ja kehittymiseen

- MVPA → histogrammit
- Kokonaiskesto → kumuloitumismallit
- Absoluuttiset kynnykset → suhteelliset kynnykset (normaali kävely??)
- Muuttujakeskeisestä analyysistä henkilökeskeiseen analyysiin
- Ei vain validiteetti ja reliabiliteetti, vaan myös muutosherkkyys

Relevanssi käyttäytymisen muuttamiseen

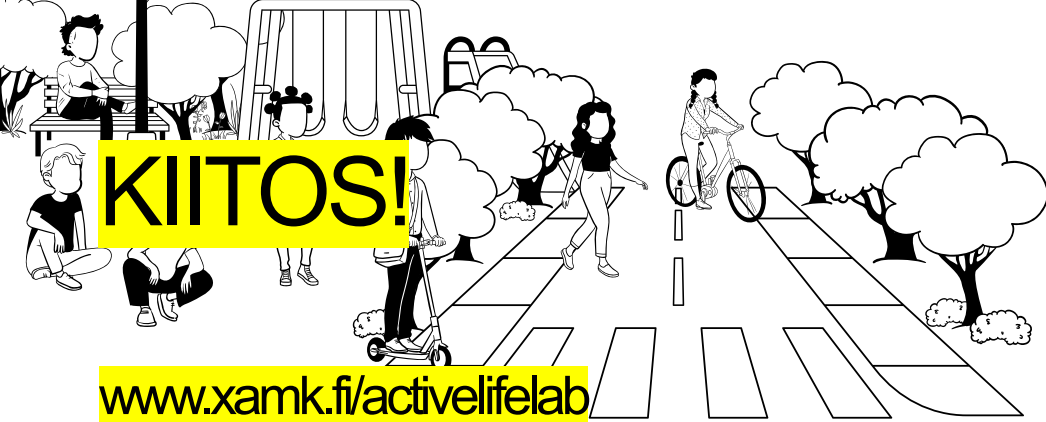
- MVPA:n kesto → esim koneoppiminen → aktiivisuustyytit → palaute
- Innovatiiviset aktiivisuusdataa hyödyntävät interventiot (ei vain ulkoista motivaatiota ruokkivat)
- Määrällisen datan tulkitseminen laadullisen datan valossa
- Menetelmien kehittäminen lasten ja nuorten ehdoilla, heidän näkökulmastaan



24-tunnin datat, uni!

Miten tehdä tiedosta merkityksellistä?





KIITOS!

www.xamk.fi/activelifelab

arto.pesola@xamk.fi

Twitter: [@artopesola](https://twitter.com/artopesola)

LinkedIn: <https://fi.linkedin.com/in/thesittingdoctor>

Kiitokset:

- Xamk: Samad Esmailzadeh, Pirjo Hakala, Päivi Berg
- Aalto: Tiina Rinne
- Fibion: Olli Tikkanen, Ari Peltoniemi, Sini Lindqvist, Miriam Cabrita, Marko Havu
- Jyu: Taija Juutinen, Ying Gao, Arto Laukkanen ym!

- Youssef Alkaliha, H., Pesola, A.J., Arumugam, A. 2022. A new accelerometer (Fibion) device provides valid sedentary and upright time measurements compared to the ActivPAL4 in healthy individuals. *Heliyon*. <https://doi.org/10.1016/j.heliyon.2022.e11103>
- Pesola, A.J. Hakala, P. Berg, P., Ramezani, S., Villanueva, K. Rinne, T. 2022. The effects of free-fare public transportation on the total active travel in children: A cross-sectional comparison between two Finnish towns, *Journal of Transport & Health* 27, 101506, <https://doi.org/10.1016/j.jth.2022.101506>.
- Esmailzadeh, S., Rodriguez-Negro, J, Pesola, A.J. 2022. A Greater Intrinsic, but Not External, Motivation Toward Physical Activity Is Associated With a Lower Sitting Time. *Front. Psychol.* 13:888758. doi: 10.3389/fpsyg.2022.888758
- Alsamman, R.A., Pesola, A.J., Shousha, T.M., Hagrass, M.S., Arumugam, A. 2022. Effect of night-time data on sedentary and upright time and energy expenditure measured with the Fibion accelerometer in Emirati women, *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 2022, 102415, <https://doi.org/10.1016/j.dsx.2022.102415>.
- Pesola, A.J., Rantalainen, T., Gao, Y., Finni, T. 2022. Aerobic Capacity Determines Habitual Walking Acceleration, Not Electromyography-Indicated Relative Effort. *Journal for the Measurement of Physical Behaviour*, <https://doi.org/10.1123/jmpb.2021-0018>