Sensitivity & specificity of measureng cycling with a thigh-worn sensor and children's active travel following the Mikkeli free-fare bus experiment

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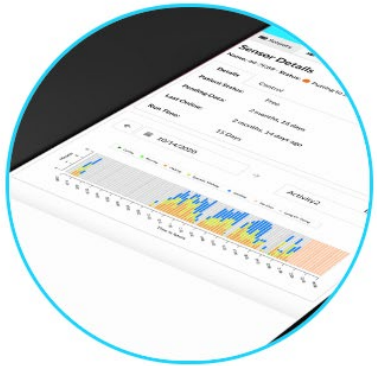
fibionSENS



Innovative device

- Stick-and-Play patch
- Lightweight and waterproof
- Over 5-months 24/7 measurement time
- Over 2 years stand-by time
- Automatic data transmission
- Hotspot upload™

Accurate data

- XYZ accelereration data
- Analysed sitting time, activity types and intensity
- Real-time remote data
- 2 weeks data logging

Smart management

- Data management platform
- Cloud server
- Smart phone app
- Manage all sensors remotely
- Fibion online and PDF participant reports

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Findings from previous free-fare public transport experiments

- Only little evidence from children:
  - London, UK: car use decreased, short (<1 km) walking trips replaced with bus, but no decrease in total walking duration (Edwards ym. 2013)
  - Tallinna, Viro: walking trip share of all trips decreased (Cats ym. 2017)
- Previous studies have not considered total active travel duration and contribution from different travel modes
- City of Mikkeli has provided free-fair transport for all primary school students since 2017: a 30% increase in public transport use in the first years!
- → a topic of active political debate

Mikkeli and Kouvola school pairs

- Mikkeli (54,000 inhabitants, free-fair bus)
- Kouvola (83,000 inhabitants, reference)
- 10 school pairs based on 10 accessibility indicators

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STUDY PROTOCOL Open Access

Does free public transit increase physical activity and independent mobility in children? Study protocol for comparing children's activity between two Finnish towns with and without free public transit

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Table 1 Objective public transit (PT) accessibility measures of each school in Mikkeli and Kouvola and school pairs of the study

Pair nr.	City	School id	YKR zone[a]	PT stop density (PT stops per school network area)	PT trips per day	Average PT trips per day	Daily PT trips per school network area	PT trips per hour	Hourly PT trips per school network area	PT trips 07–10 am	Average PT trips 07–10 am	PT trips on weekdays	Average PT trips per weekdays
1	Mikkeli	1007	2	15	910	51	555	38	23	181	10	500	28
	Kouvola	2011		10	344	31	268	14	11	65	6	172	16
2	Mikkeli	1010	41	18	1646	57	998	69	42	281	10	784	27
	Kouvola	2023		14	1190	70	734	50	31	253	15	607	36
3	Mikkeli	1012	5	10	674	48	478	28	20	80	6	300	21
	Kouvola	2029		9	544	49	429	23	18	110	10	290	26
4	Mikkeli	1013	5	8	400	40	313	17	13	51	5	163	16
	Kouvola	2007		6	418	60	331	17	14	99	14	264	38
5	Mikkeli	1016	5	7	52	9	55	2	2	23	4	52	9
	Kouvola	2000		4	107	27	75	4	3	24	6	64	16
6	Mikkeli	1006	5	12	249	16	182	10	8	50	3	138	9
	Kouvola	2006		6	93	16	98	4	4	12	2	93	16
7	Mikkeli	1003	5	8	689	57	420	29	18	119	10	356	30
	Kouvola	2026		5	364	46	230	15	10	66	8	158	20
8	Mikkeli	1018	0	12	172	11	123	7	5	52	3	117	8
	Kouvola	2022		7	92	9	65	4	3	27	3	92	9
9	Mikkeli	1005	0	9	117	17	78	5	3	23	3	100	14
	Kouvola	2033		7	169	19	127	7	5	45	5	121	13
10	Mikkeli	1022	0	8	221	18	149	9	6	71	6	162	14
	Kouvola	2031		8	314	31	252	13	11	90	9	174	17

[a] 2 = walking zone, 41 = intensive public transit zone, 5 = car zone, 0 = out of urban zones

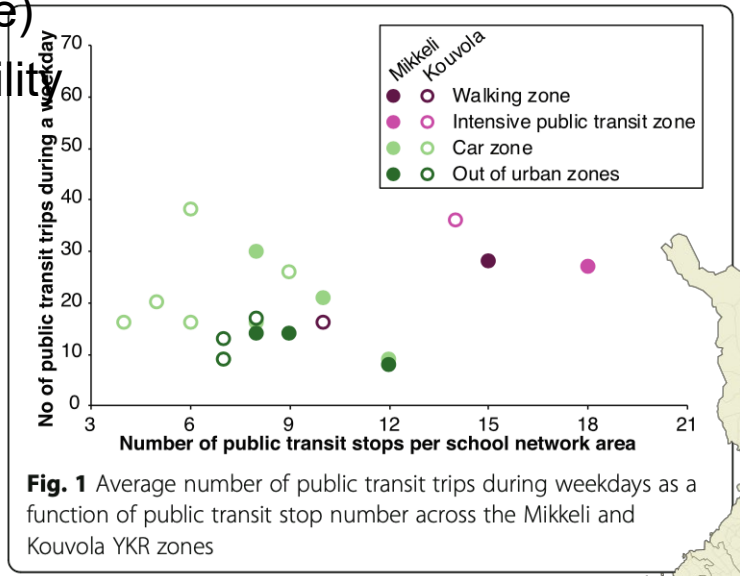
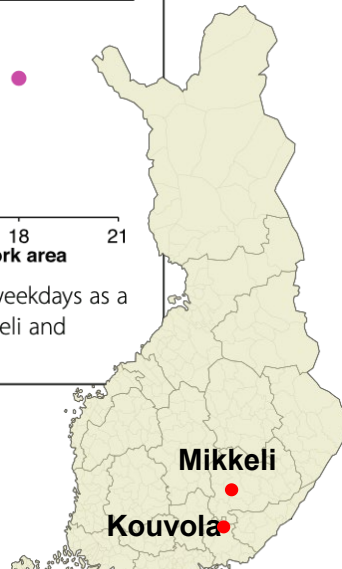


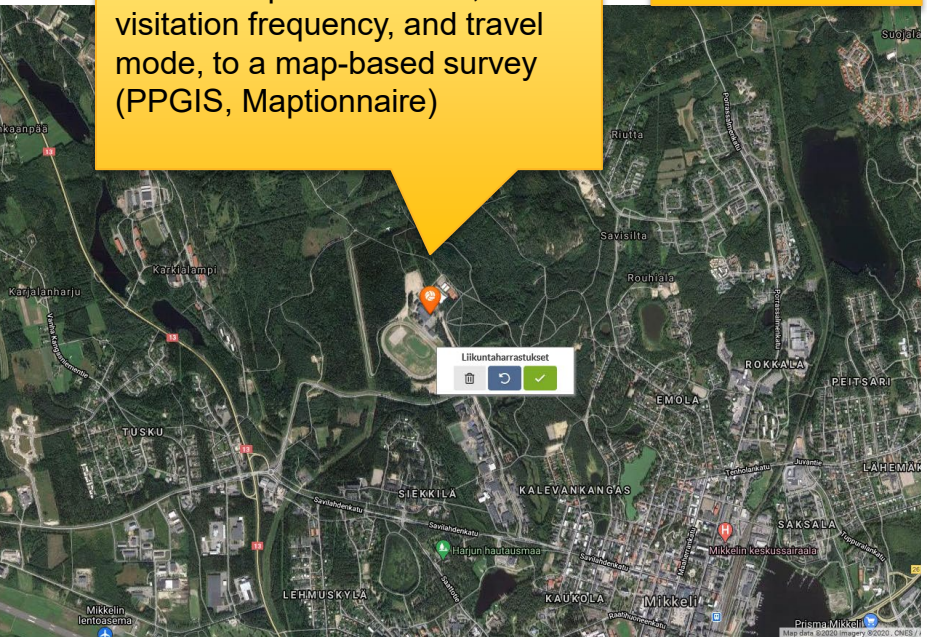
Fig. 1 Average number of public transit trips during weekdays as a function of public transit stop number across the Mikkeli and Kouvola YKR zones



Methods

Fibion worn on right thigh for 8 days, 24h

Children marked all places they visited the previous week, visitation frequency, and travel mode, to a map-based survey (PPGIS, Maptionnaire)



1. tutkimuspäivän matkat

1. tutkimuspäivän päivämäärä: _____

Tutkimusviikon ensimmäinen päivä on kirjoitettu valmiiksi.

Moneltako heräsit tänään?
klo: _____

Moneltako menit nukkumaan tänään?
klo: _____

- Piditkö liikemittaria kok
- ☐ Kyllä
- ☐ Ei

Mittaus alkoi k
Mittari oli pois
klo: _____

A diary including questions o active travel periods and type

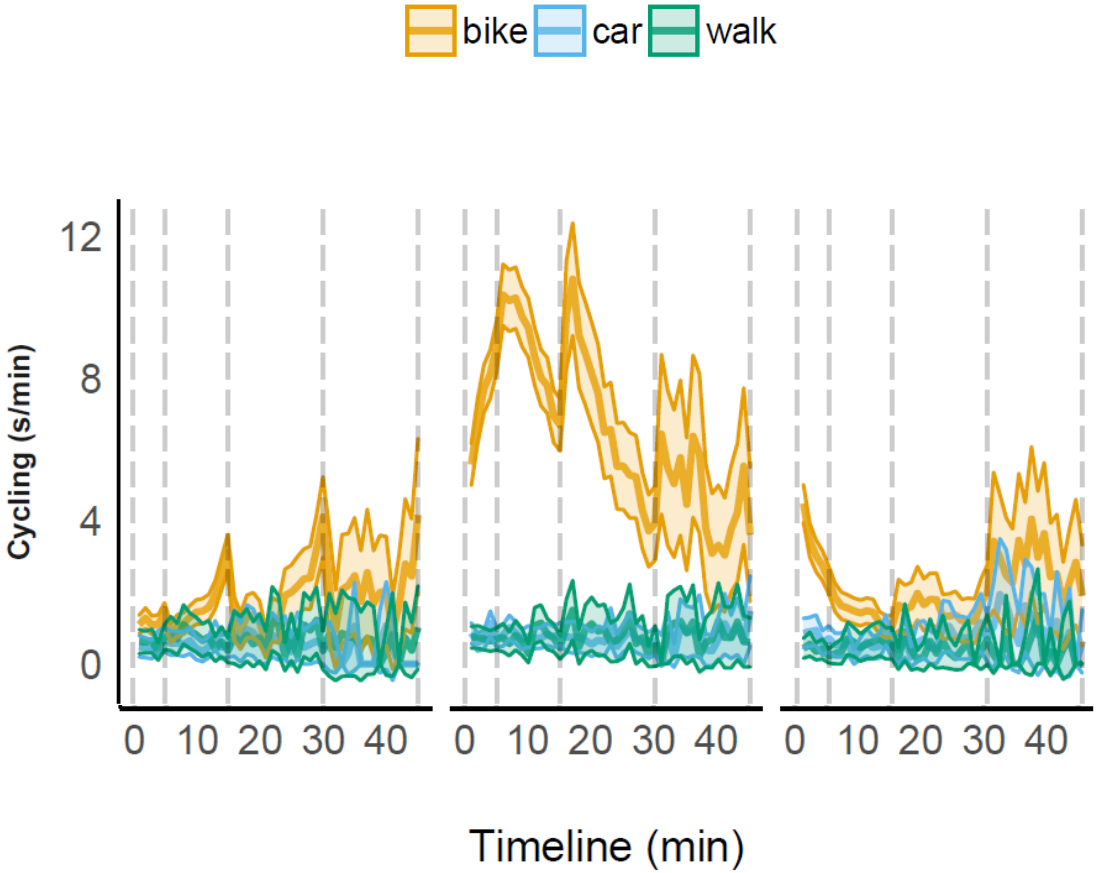
	Matka 1	Matka 2	Matka 3	Matka 4	Matka		Matka	Matka	Matka
Mihin aikaan matka alkoi?									
Matkan tarkoitus									
Koulumatka	☐	☐	☐	☐	☐	☐	☐	☐	☐
Kotimatka	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ohjattu liikuntaharrastus	☐	☐	☐	☐	☐	☐	☐	☐	☐
Muu ohjattu harrastus	☐	☐	☐	☐	☐	☐	☐	☐	☐
Matka omatoimisesti liikkumaan (esim. skeittipuistoon)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Vierailumatka (kaverit ja muut tyypit)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Arkitoimet (esim. ostosmatka)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Muu vapaa-ajan matka	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pääasiallinen kulkutapa									
Kävellen	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pyörällä	☐	☐	☐	☐	☐	☐	☐	☐	☐
Autolla	☐	☐	☐	☐	☐	☐	☐	☐	☐
Bussilla tai koulukyydillä	☐	☐	☐	☐	☐	☐	☐	☐	☐
Kävely tai pyöräillä bussipysäkille	☐	☐	☐	☐	☐	☐	☐	☐	☐
Skeitaten tai skootaten	☐	☐	☐	☐	☐	☐	☐	☐	☐
Jokin muu	☐	☐	☐	☐	☐	☐	☐	☐	☐
Arvio matkan kestosta									
alle 5 min	☐	☐	☐	☐	☐	☐	☐	☐	☐
5–15min	☐	☐	☐	☐	☐	☐	☐	☐	☐
16–30min	☐	☐	☐	☐	☐	☐	☐	☐	☐
31–45min	☐	☐	☐	☐	☐	☐	☐	☐	☐
yli 45 min	☐	☐	☐	☐	☐	☐	☐	☐	☐

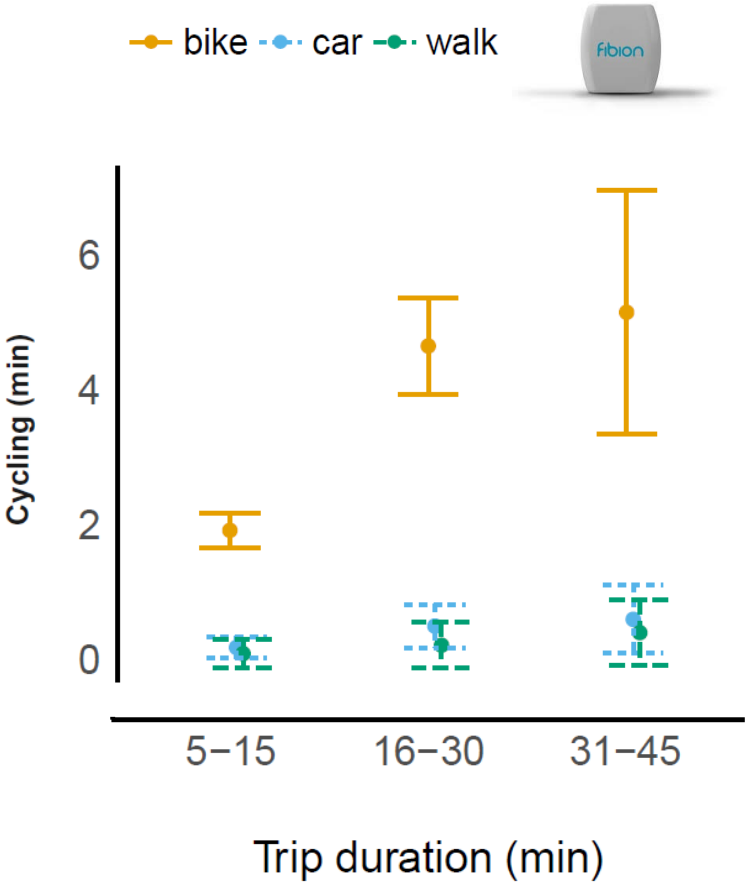
Measuring free-living cycling remains a challenge

- Low impacts during cyclic leg movement , or stationary hand movement are disproportional with actual energy expenditure of cycling (Herman Hansen et al., 2014; Jakicic et al., 1999; Treuth et al., 2004; Welch et al., 2013)
- Data collected with waist-worn accelerometers and analyzed with contemporary counts-based methods under-estimates cycling intensity by 73% as compared to directly measured energy expenditure (Herman Hansen et al., 2014).
- Similarly, moderate-to-vigorous intensity of free-living cycling is often starkly under-estimated (Evenson et al., 2008; Tarp et al., 2015)

Cycling during actual cycling trips

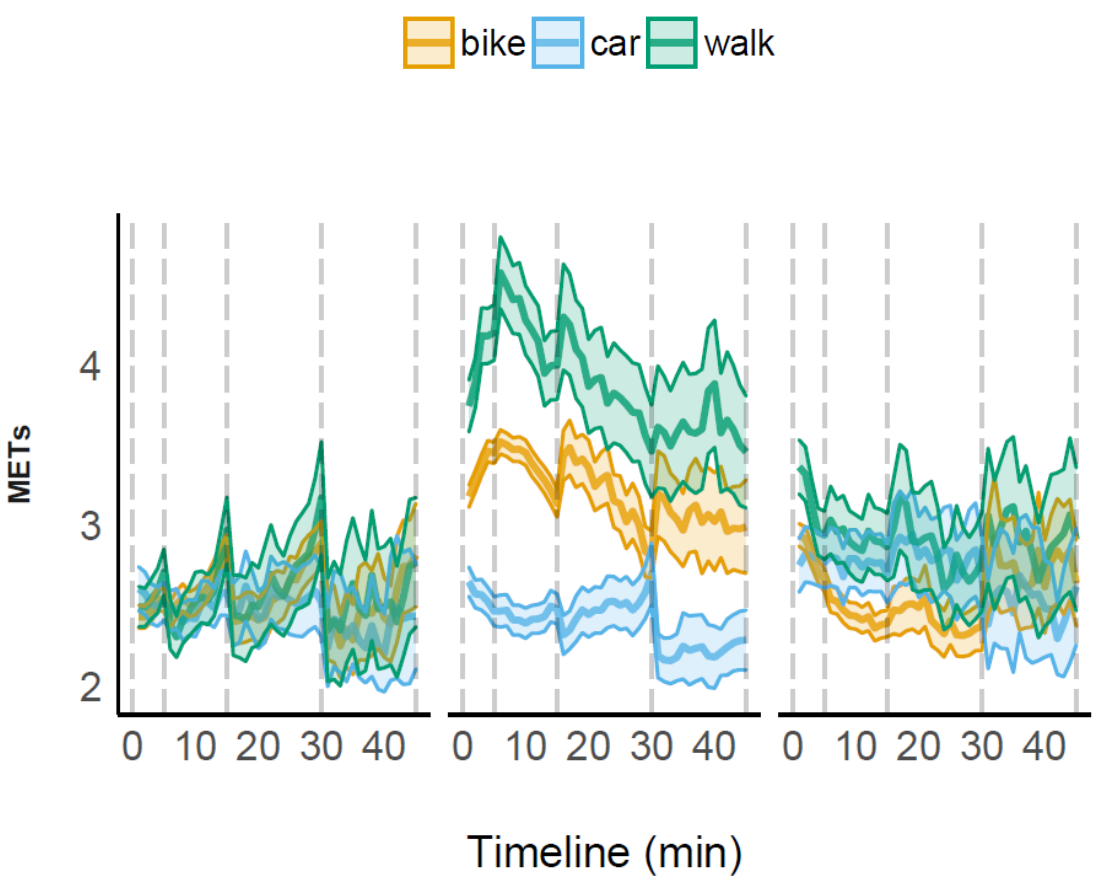
- Pesola et al. Under preparation
- n=160, 2182 trips

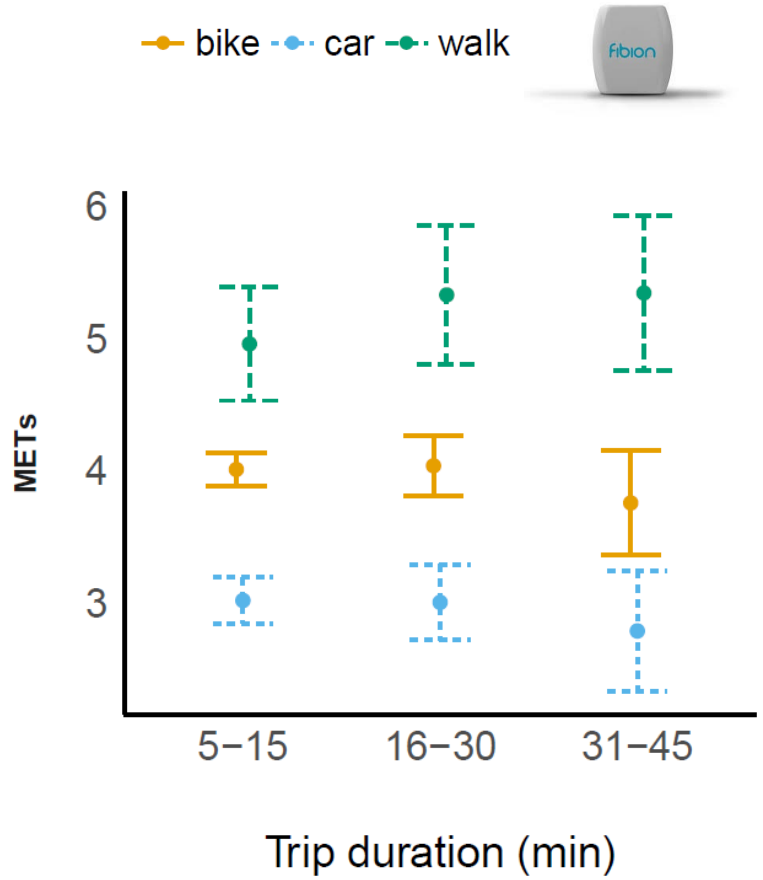




METs during actual cycling trips

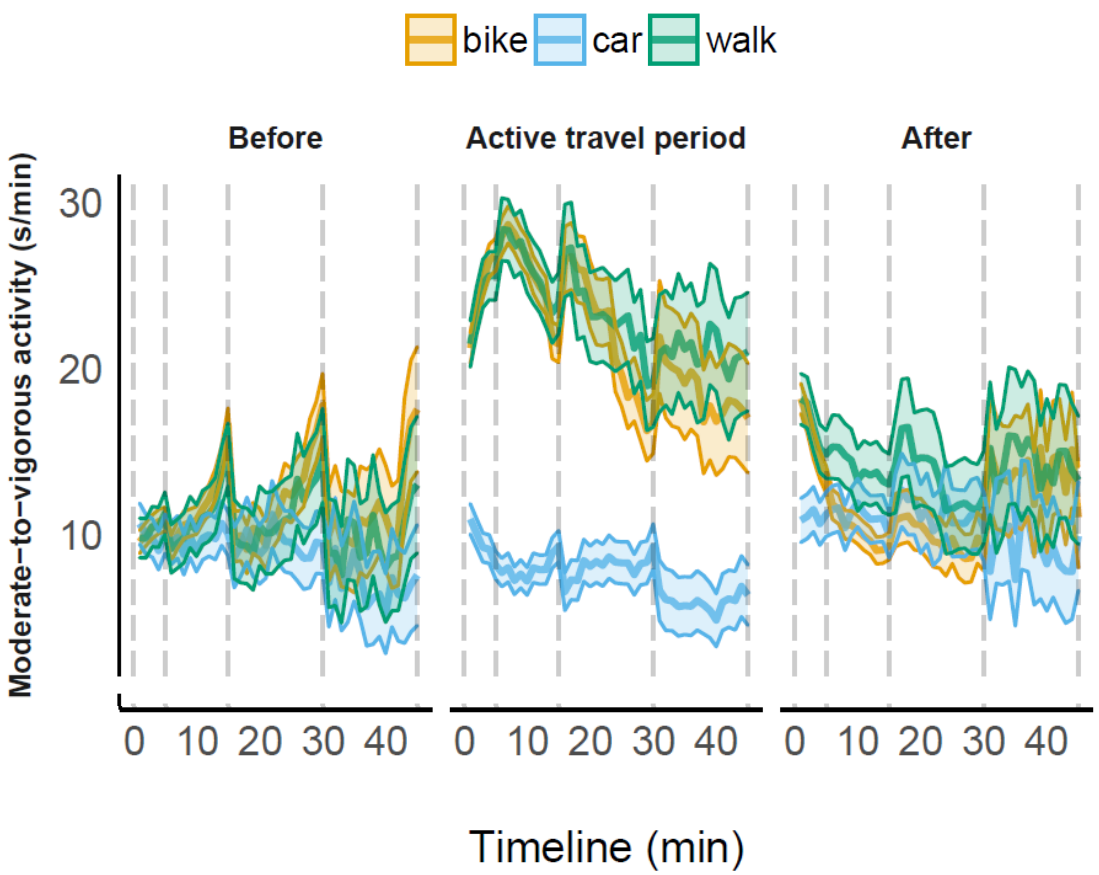
- Pesola et al. Under preparation
- n=160, 2182 trips

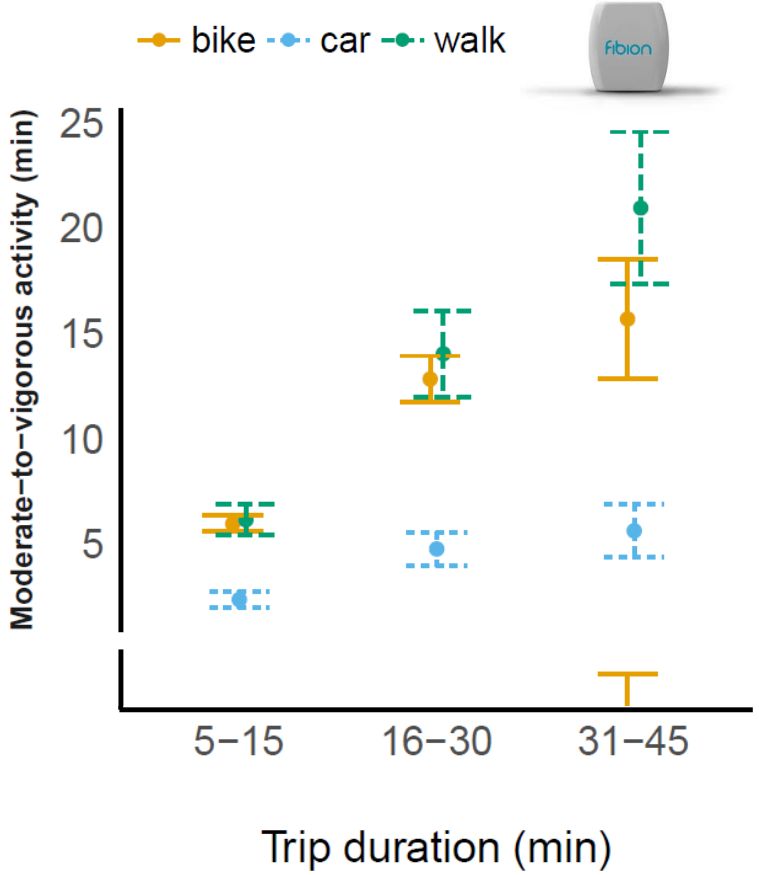




MVPA during actual cycling trips

- Pesola et al. Under preparation
- n=160, 2182 trips





Sensitivity & specificity with different duration required for ”cycling”

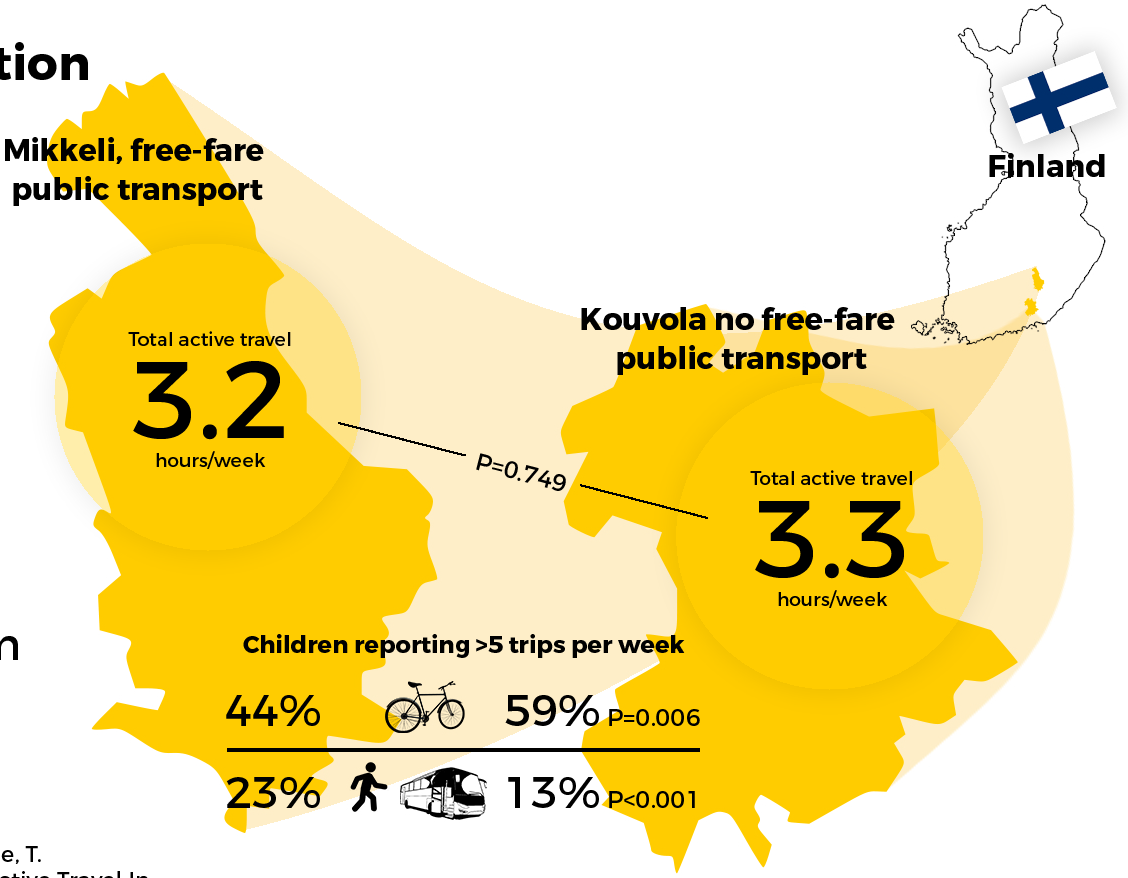
Table 3. Sensitivity and specificity of Fibion-measured cycling during reported cycling trips vs other trips

Time (s)	Sensitivity	Specificity	Accuracy
>0	0.82	0.72	0.77
>4	0.82	0.72	0.77
>9	0.82	0.72	0.77
>14	0.82	0.72	0.77
>19	0.82	0.72	0.77
>29	0.82	0.72	0.77
>34	0.84	0.69	0.77
>40	0.87	0.66	0.77
>50	0.91	0.63	0.77

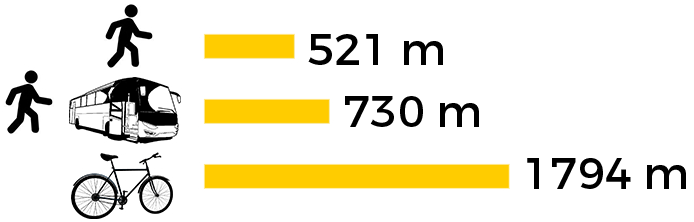
Diary = cycling
Fibion = cycling

Diary = walk or car
Fibion ≠ cycling

Free-fare public transportation is associated with less cycling, but more walking to bus stops



Median distance per one-way trip



Reference:
Pesola, AJ, Hakala, P, Berg, P, Ramezani, S, Villanueva, K, Rinne, T.
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

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Conclusions

PPGIS:

- Mikkeli free-fare public transport is associated with increased bus use, but not with a lower active travel duration in 10-12 year old children
- Children in Mikkeli were cycling less, but walking more to bus stops

Fibion:

- **MVPA during cycling trips is not different to MVPA during walking trips**
- No difference in total device-measured MVPA between cities (preliminary findings)

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