Assessing physical activity with accelerometers in children and adolescents

Tips and tricks

TNO | Knowledge for business

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Background

- Increasing interest in assessing physical activity in children

metro - 15 sept 05

Een op drie kinderen in stadswijk te dik

BIJNA EEN OP de drie kinderen (31 procent) die in stadsvernieuwingswijken wonen, is te dik. Bijna één op de tien (9 procent) heeft ernstig overgewicht. Dat is aanzienlijk meer dan het landelijk gemiddelde. Toch eten ze niet meer dan nodig. Het komt omdat ze te weinig bewegen. Tot nu toe werd ervan uitgegaan dat ongeveer 80 procent van alle basisschoolleerlingen aan de norm voldoet. **ANP**

Het stadskind moet weer de straat op

VK 14/11

■ Als de straat goed is ingericht, bewegen kinderen meer.
■ Winst is vooral te halen in 'krachtwijken'.

Van onze verslaggeefster
Anneke Stoffelen

AMSTERDAM Een sportveldje aanleggen om kinderen meer te laten bewegen? Als gemeente kun je beter langs alle wegen parkeerstroken aanleggen in de strijd tegen overgewicht. Onderzoekster Sanne de Vries van TNO analyseerde het beweeggedrag van kinderen en de buurtindeling in tien achterstandswijken in onder meer Rotterdam, Amersfoort en Hengelo.

En dan blijkt: een veilige verkeerssituatie in de buurt heeft meer invloed op beweging dan het aantal speelplekken. Op 26 november promoveert De Vries aan de Vrije Universiteit in Amsterdam.

Van de onderzochte stadskinderen lijdt 1 op de 3 aan overgewicht (het landelijk gemiddelde is 16 procent). De onderzoekster liet 500 kinderen een beweegdagboekje bijhouden en stuurde een deel van hen een week lang met een geavanceerde stappenteller op pad. De Vries: 'Minder dan 20 procent van deze kinderen haalde de norm van 1 uur matig intensief bewegen per dag.'

Hoe meer rotondes, oversteekplaatsen en fietspaden in de wijk, hoe groter het aantal kinderen dat per fiets of lopend naar school gaat. Maar opvallender nog was de invloed van parkeerstroken parallel aan de straat op het beweeggedrag. De Vries: 'Dat vond ik zelf eerst nogal een vreemde bevinding. Maar zo'n parkeerstrook blijkt als een soort buffer te werken tussen het trottoir en de weg. Bovendien gaat de gemiddelde snelheid omlaag als er aan beide kanten van de weg rijen auto's staan. Ouders en kinderen zeiden in kringgesprekken dat parkeerstroken een veilig gevoel geven.' En hoe veiliger, hoe vaker kinderen lopen en spelen op de stoep.

Volgens De Vries zouden gemeenten bij herinrichting of nieuwbouw eerder moeten stilstaan bij de effecten op kinderen van de wijkindeling. 'Nu wordt er vaak pas een gezondheidsdeskundige geraadpleegd als het wijkplan al helemaal vastligt.' Terwijl er juist in de 'krachtwijken' een slag is te slaan, stelt de onderzoekster. 'Juist armere gezinnen ontbreekt het vaak aan geld om hun kind naar de sportclub te sturen. Die kinderen zijn dus erg afhankelijk van de situatie in eigen buurt.'

Het onderzoek krijgt nog een vervolg: vijf van de tien wijken zijn inmiddels deels geherstructureerd. Nieuwe metingen moeten aan het licht brengen wat de effecten daarvan zijn op het beweeggedrag van de kinderen.

Background

- Accurate assessment of physical activity is important

Physical activity

- Definition of physical activity: any bodily movement produced by skeletal muscles that result in energy expenditure

- Physical activity can be expressed in terms of:
  - energy expenditure (kcal)
  - external workload (Watt)
  - units of movement (counts)
  - frequency (days per week)
  - intensity (metabolic equivalents)
  - duration (minutes)
  - type of activity

Assessing physical activity

- Numerous methods to assess physical activity

Method	Advantages	Disadvantages
Calorimetry	Calibration	Expensive
Doubly labeled water	Free-living physical activity, gold standard for energy expenditure	Expensive, no information about frequency, intensity, duration and type of activity
Heart rate monitor	Monitoring for several days, memory capacity	Influence of stress, time of day, smoking etc. on heart rate
Motion sensor	User-friendly, monitoring for several days, memory capacity	Can not be worn during swimming, not/ less sensitive to certain activities such as cycling, walking stairs, upper body activities

Assessing physical activity

Method	Advantages	Disadvantages
Direct observation	Information about frequency, intensity, duration, and type of activity	Time-consuming, reliability observers
Self-reports	Cheap	Validity, reliability, social desirable answers, relies on memory

- Each method has advantages and disadvantages

Selecting an appropriate physical activity assessment method

- Considerations:
  - Domain and purpose of physical activity research (e.g. screening versus evaluation)
  - Research question and hypotheses
  - Outcome measure for physical activity
  - Characteristics of the study population
  - Size of the study population
  - Feasibility, reliability, and validity of the assessment method
  - Budget of the study
  - Time frame of the study

- There is no gold standard to assess physical activity

Motion sensors

- Motion sensors are being used with increasing regularity to assess PA or to estimate EE
  - Pedometers
  - Accelerometers (uni-axial, two-axial, three-axial)

Steps to take

- I Selecting an appropriate motion sensor
- II Using motion sensors
- III Cleaning and analyzing motion sensor data
- IV Reporting motion sensor data

I Selecting an appropriate motion sensor

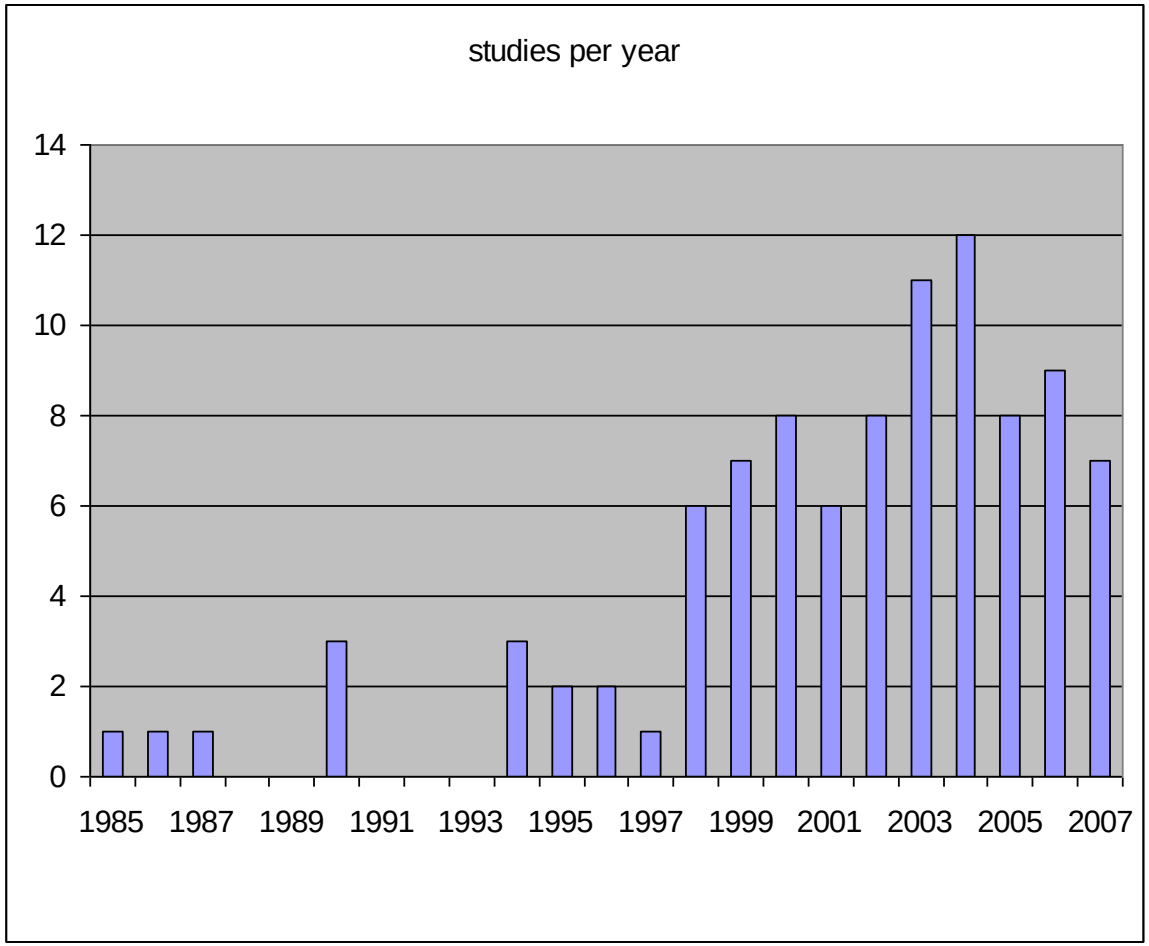
- Ideally a motion sensor is valid, reliable, sensitive, feasible, and cheap
- Does this ideal motion sensor exist?

I Systematic reviews

2 systematic reviews on the reliability, validity, and feasibility of motion sensors used to assess physical activity in healthy children and adolescents (2-18 yr)
(*De Vries et al., 2006; De Vries et al., 2009*)

- Systematic literature search in PubMed, Embase, and PsychInfo
  - Written as full report
  - Main purpose clinimetric evaluation of a motion sensor
  - Published between 1980-2007
- Evaluation and comparison of studies using a 20-item checklist
  - 4 items on the study design
  - 6 items on the reliability of the motion sensor
  - 6 items on the validity of the motion sensor
  - 4 items on the feasibility of the motion sensor

I Number of clinimetric studies



I Results

- 2004: 35 articles on the clinimetric properties of 9 motion sensors (De Vries et al., 2006)
- 2007: 32 new articles on the clinimetric properties of 12 motion sensors (De Vries et al., 2009)

I Results reliability

	2-4 yr	4-8 yr	8-12 yr	12-18 yr
Digi-Walker	?	++	++	++
Walk4Life	?	++	++	?
Sun TrekLINQ	?	++	++	?
ActiGraph	+++	+++	+++	+++
BioTrainer	?	±	±	?
StepWatch	?	?	?	?
Actiwatch	?	?	?	?
Actical	?	?	?	?
RT3	?	?	?	?
Tracmor2	?	?	?	?
Tritrac-R3D	?	?	?	?

I Results validity

	2-4 yr	4-8 yr	8-12 yr	12-18 yr
Digi-Walker	++	+++		++
Walk4Life	?	++	++	?
Sun TrekLINQ	?			?
ActiGraph	+++		+++	+++
BioTrainer	?	++	++	++
StepWatch	?			
Actiwatch			++	++
Actical	++	++	++	++
RT3	?	++	++	?
Tracmor	++	++	++	?
Tritrac-R3D	?	++	+++	++

I Conclusions

- The Digi-Walker is the most studied pedometer (n = 15), the ActiGraph is the most studied accelerometer (n = 29)
- Although publication bias cannot be ruled out, most motion sensors seem to produce reliable and valid results when used to assess PA in children and adolescents
- The selection of an appropriate motion sensor remains an issue of cost per unit, monitor size, battery life, memory size, technical support, software packages, and comparability of findings with other studies

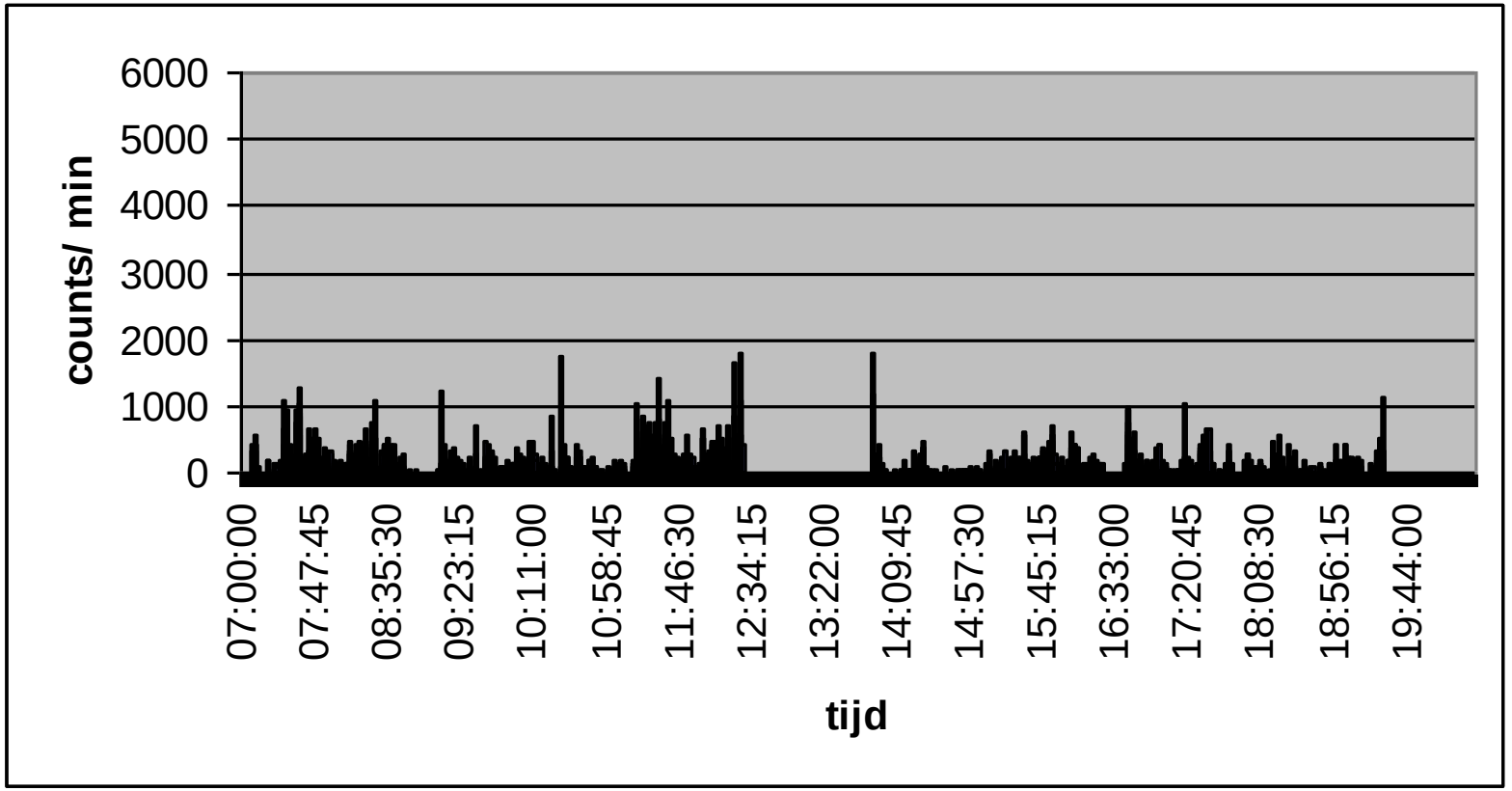
II Using accelerometers

- Oral and written instruction
- Site of placement: right hip
- Number of monitoring days: preferably 8 days *(Penpraze et al., 2006; Rowlands, 2007;Trost et al., 2000)*
- Reactivity
- Number of hours per day: preferably 24 hours per day (or all waking hours) *(Rowlands, 2007)*
- Time-sampling interval: as short as possible *(< 15 seconds) (Nilsson et al., 2002; Reilly et al., 2008)*

II Using accelerometers

- Reminders *(Trost et al., 2005)*
- Accelerometer diary (e.g. to note duration of cycling and swimming, non-wearing time, experience)
- Incentives *(Trost et al., 2005)*

III Cleaning and analyzing accelerometer data



III Cleaning and analyzing accelerometer data

- Consensus is lacking! *(De Vries, 2009)*
- Definition of a valid day
- Definition of non-wearing time
- Cleaning and reducing extreme values (outliers?)
- Application of count cut-offs for sedentary, light, moderate, and vigorous intensity physical activity
- Application of equations to convert counts into EE estimates
- Application of correction factors for certain activities that are not (accurately) measured with accelerometers, such as cycling and swimming

III Valid day and number of days

- Number of days:
  Reported in the literature: 1-14 days *(Masse et al., 2005)*

  The ICC of 4 days of monitoring ranged between 0.64-0.77 in children and adolescents *(Trost et al., 2000)*

  Difference between weekdays and weekend days may be age- and country specific (*Rowlands, 2007)*

  > at least 3 week days and 1 weekend day

- Number of hours per day:
  Reported in the literature: 1 – 16.6 hours (*Masse et al., 2005)*

  > 70% of waking time (400-500 minutes)

III Non-wearing time

- Not usually reported
- 10, 15, 20 and 30 minutes have been used *(Masse et al., 2005)*

  > 10 minutes of consecutive zeros

III Outliers

- Based on minute epochs: normal range: 0 - 20.000 counts
  Note: Be aware of 32670

- Based on mean counts/min over entire measurement period:
  normal range: 100-1500 counts/min

III Count cut offs and EE equations

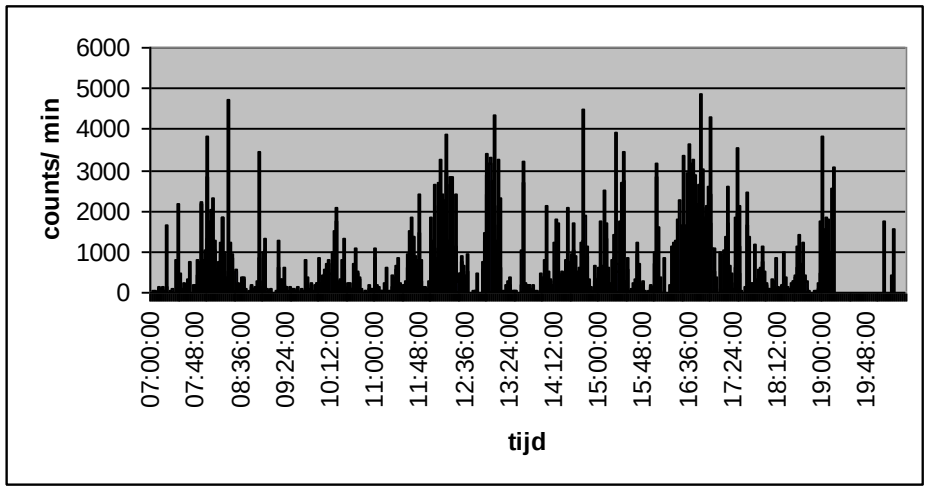
- Time spent at different intensity levels is derived from the relationship between activity counts and EE *(Matthews et al., 2005; Freedson et al., 2005; Tros et al., 2006)*

- Main issues:
  - Effect of calibration activities
  - Effect of age, weight and other subject characteristics

Reference	Activities	Sedentary	MVPA
Eston et al.	Mixed	< 200	➢4000
Puyau et al.	Mixed	< 800	➢8200
Treuth et al.	Mixed	< 100	➢3000

III Count cut offs and EE equations

- Pragmatic approach:
  - Acknowledge the limitations of accelerometry
  - Use an equation established from activities and within a population that resembles your study
  - Use counts/measured time (counts/min) as the primary outcome variable in association analyses



III Application of correction factors

- As far as I know correction factors are not used yet for cycling or other activities

IV Reporting motion sensor data

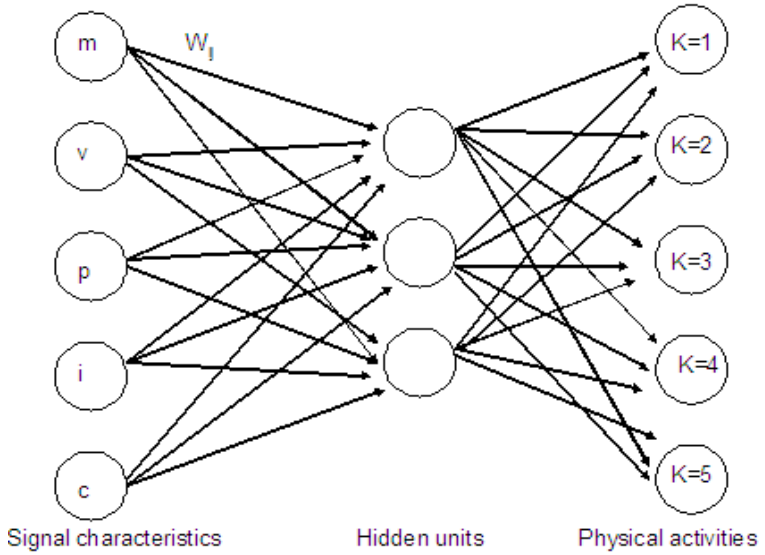
- Report step II and step III in the methods: i.e. instruction, site of placement, time-sampling interval, number of monitoring days, reminders, incentives, definition of a valid day, outliers, imputation, count cut- offs, EE equations, correction factors, etc

- Report the amount of data lost (due to e.g., refusal, monitor loss, software problems, data handling decisions etc) (usually up to 25%!), average wearing time (days and hours per day)

- Always report the mean counts per minute

V Work in progress

- Use of pattern-recognition based approaches to identify the type of activity from accelerometer data *(De Vries, Galindo-Garre et al.)*
- With artificial neural network models we are able to correctly classify about 80% of the activities of adults
- In 2010 we will build an ANN model for use in children



Thank you for your attention!

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