University of Verona,

School of Exercise and Sport Science,

Laurea magistrale in Scienze motorie preventive ed adattate

Metodologia delle misure delle attività sportive

Thursday 24/10/2013

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A class within a four classes module

16

PA & ME

V’O2, DLW issues
- ->ME;
- (mass?);
- specific activity efficiency? (PA/[ME-rME])

Luckily eff≈constant
- human species;
- walking main activity

HR issues
- ->ME (=kHR);
- <-external factors (e.g., stress, activity kind);
- latency

Specific measures

Observation issues

- simple, immediate;
- operator, video shooting;
- privacy?
- time taking (post-processing)

Self-report diaries, questionnaires issues

- cheap;
- time taking (post-processing)
- correlation w/DLW higher than HR

Specific measures

Common questionnaires

- Physical Activity Scale for the Elderly (PASE);
- Baecke questionnaire;
- Five-City questionnaire;
- Tecumseh questionnaire;
- Minnesota Leisure Time Physical Activity Questionnaire (MLTPA);
- Framingham questionnaire;
- Yale Physical Activity Survey (YPAS)

Ainslie et al., 2003

Specific measures

Pedometry features

- waist;
- ->steps

Pedometer kinds

- electromechanical circuit based;
- electromagnetic circuit based;
- uniaxially accelerometric;
- ankle, shoe 1, 2 uni-, biaxially accelerometric

Pedometry issues

- steps (i.e., most common PA kind m.u.) number;
- Japan standard Max e 3%

Specific measures

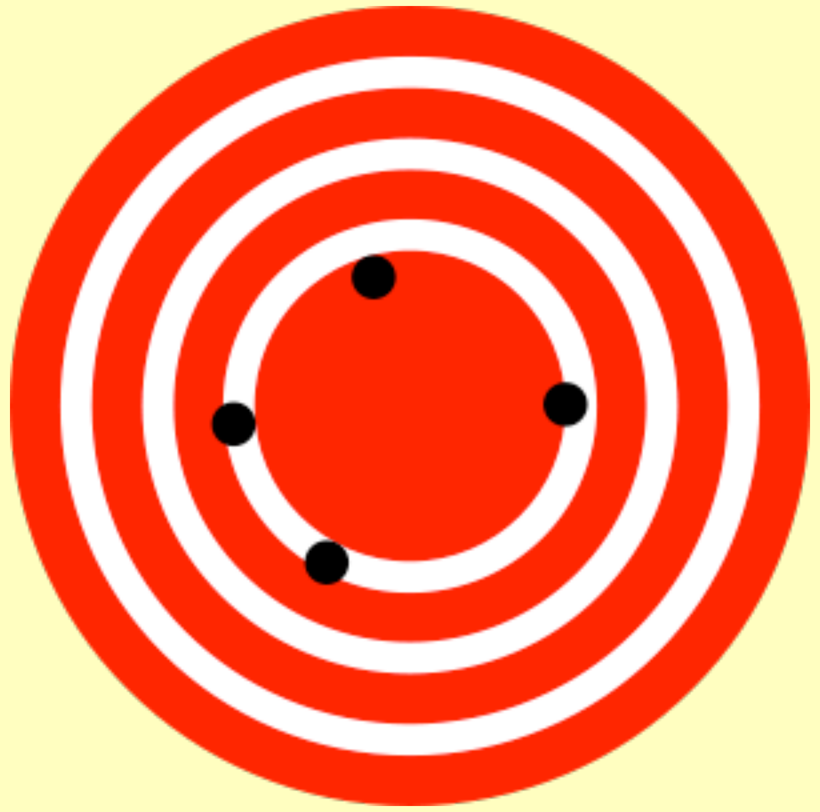
How many steps/day are enough?

- 10,000 (Hatano, 1993);
- Tudor-Locke et al., 2004:

- <5,000 sedentary lifestyle;
- 5,000 ÷ 7,499 typical daily activity that does not include exercise or sports and can be defined poorly active;
- 7,500 ÷ 9,999 includes a bit of extra-work (and/or fatiguing work) and can be defined a little active;

-> 10,000 active lifestyle;
-> 12,500 very active lifestyle

Accuracy and precision



Good accuracy,
poor trueness,
poor precision

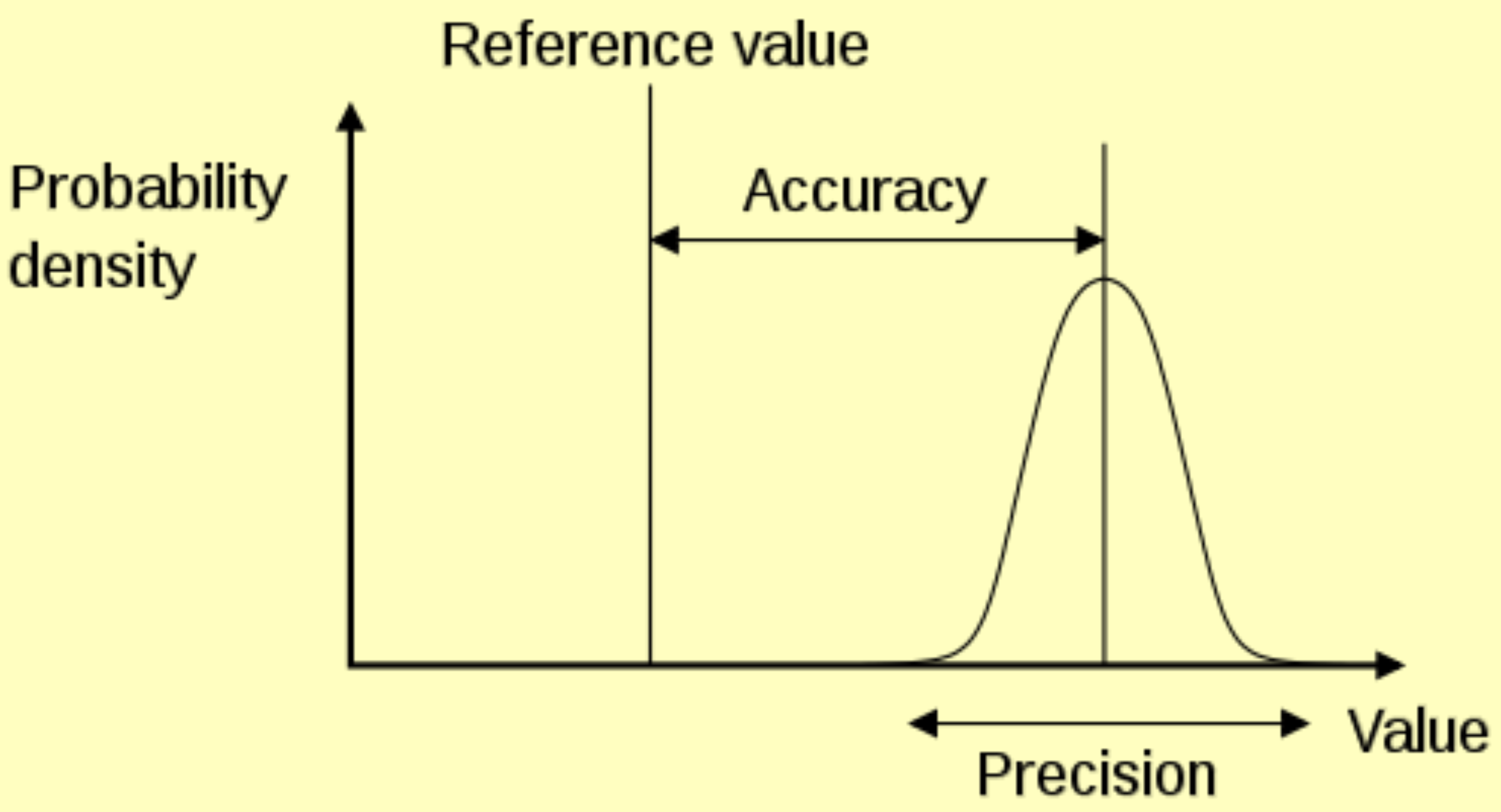
Low accuracy,
poor trueness,
good precision

Accuracy and precision

Good accuracy,
poor trueness,
poor precision

Low accuracy,
poor trueness,
good precision

Accuracy and precision



accuracy + precision = reliability

Convergent validity

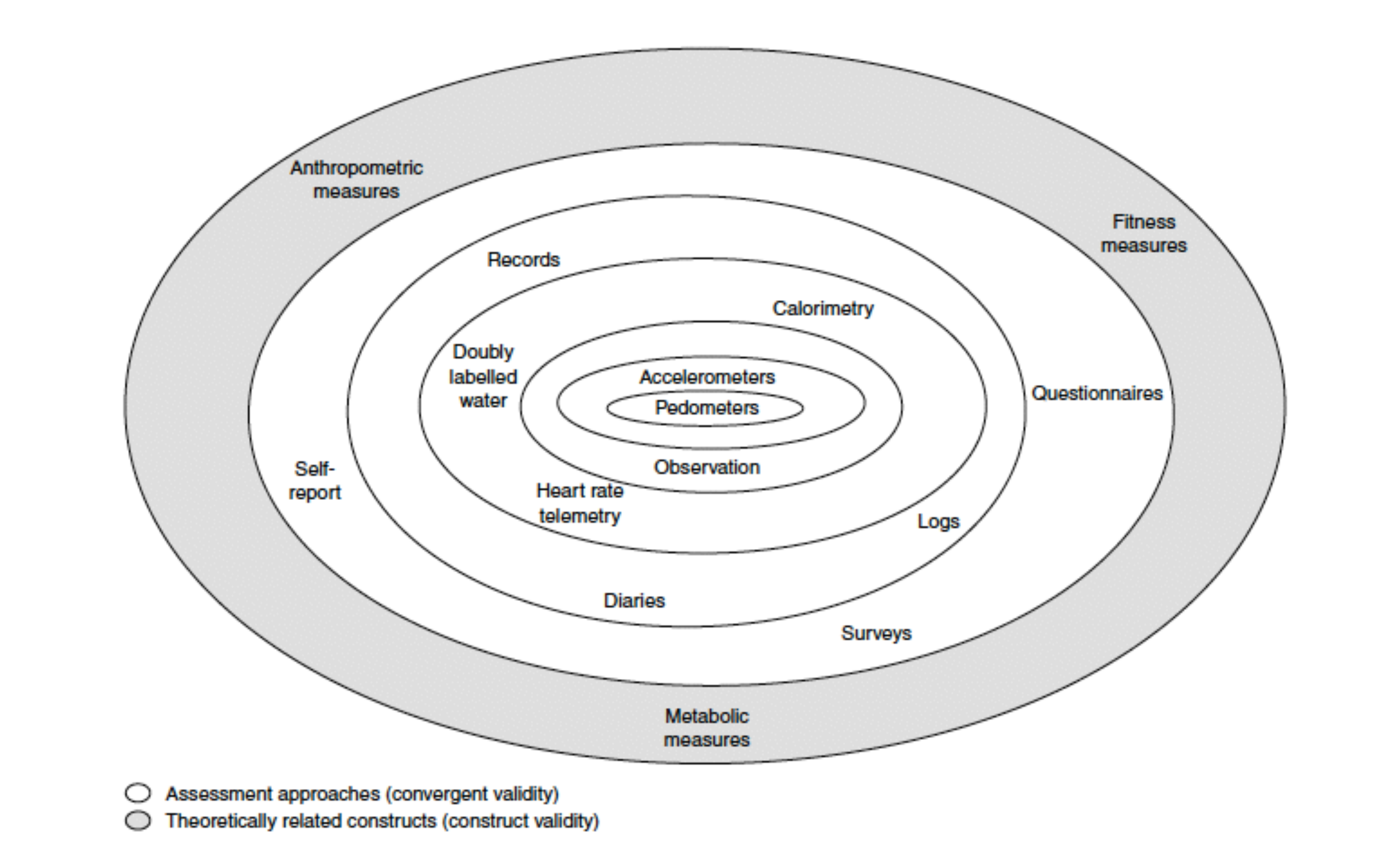


Fig. 1. Concentric circles of anticipated concordance between pedometer and other physical activity measures.

vs. accelerometer;
vs. observation;
vs. HR, V'O2, DLW;
vs. self-report diary

Tudor-Locke et al., 2002

Construct validity

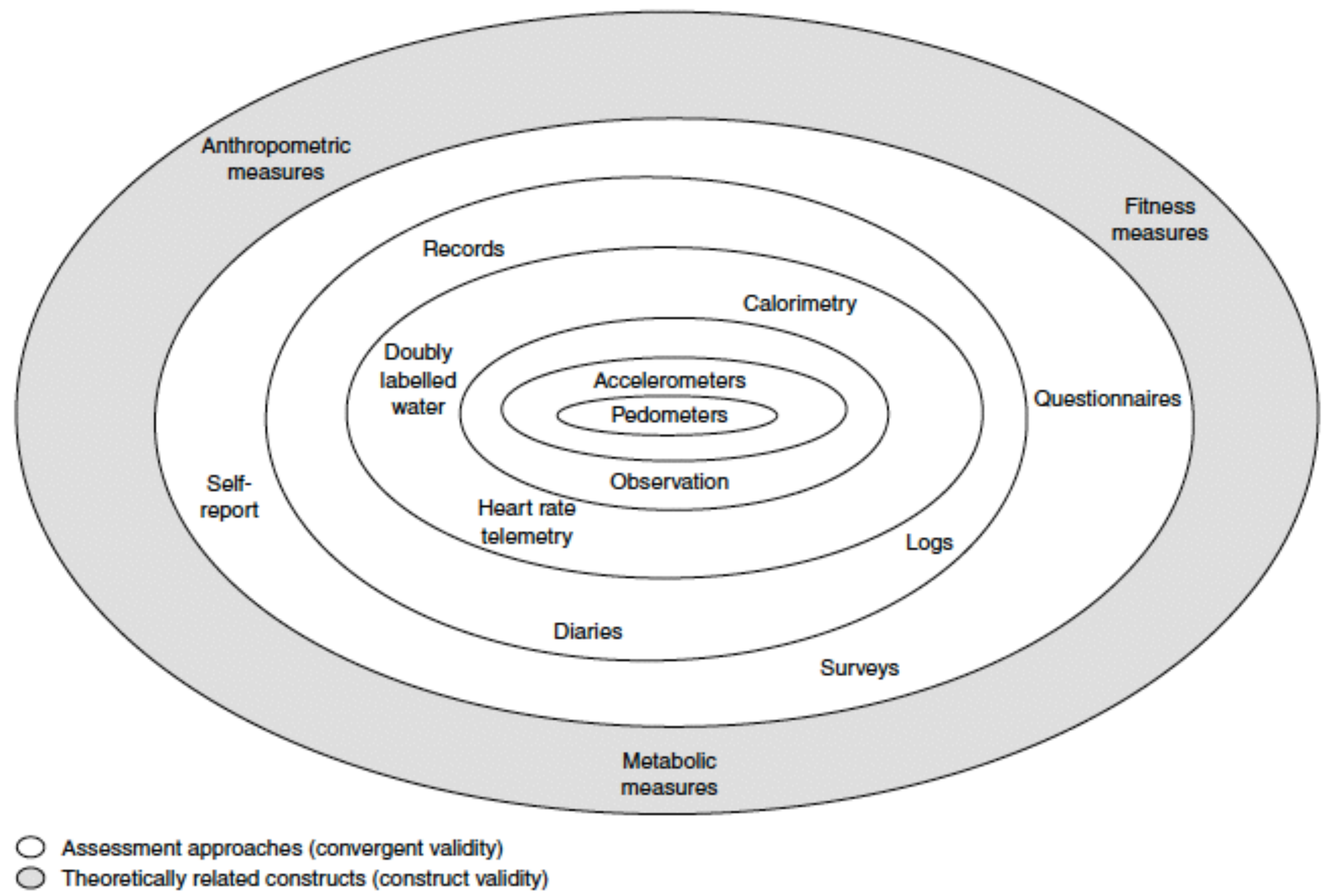


Fig. 1. Concentric circles of anticipated concordance between pedometer and other physical activity measures.

w/age;
w/anthropometry;
w/fitness measures

Tudor-Locke et al., 2004

Pedometer accuracy/reliability

measures

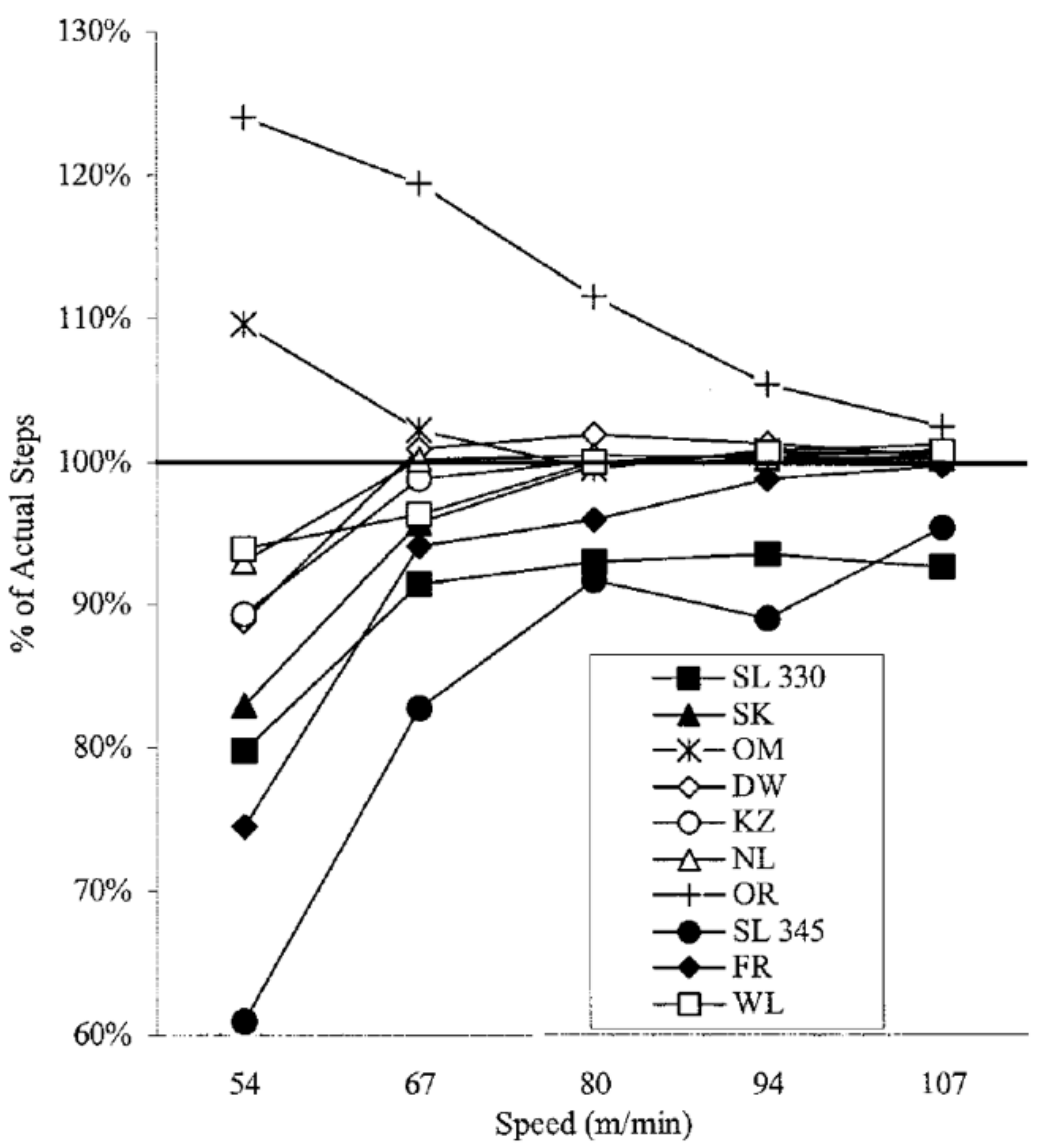


FIGURE 1—Effect of speed on pedometer accuracy (percentage of actual steps) during treadmill walking.

stride #

Crouter et al., 2003

Pedometer accuracy/reliability

measures

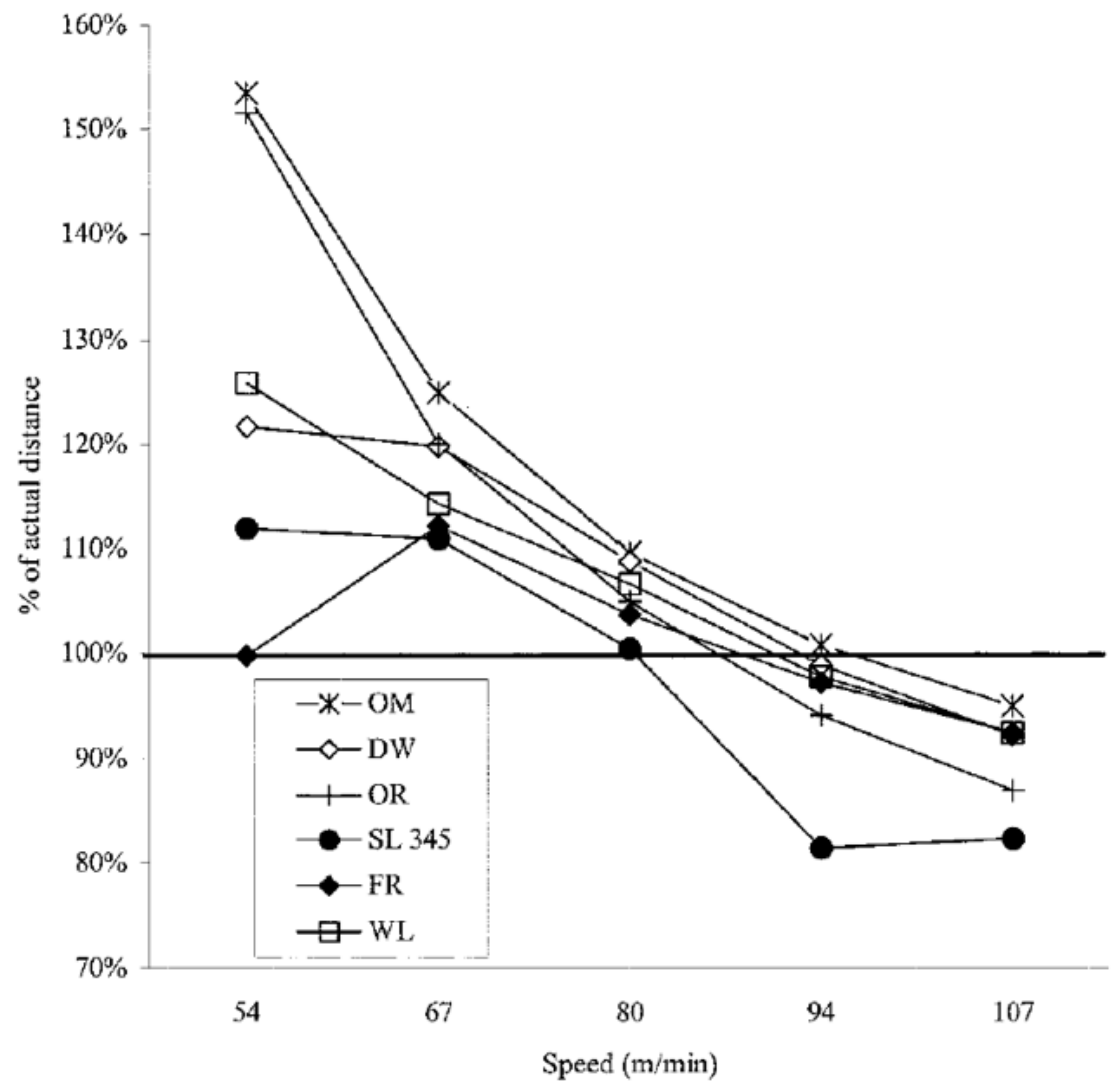


FIGURE 2—Effect of speed on pedometer estimates of percentage of actual distance traveled during treadmill walking.

(estimated) speed

Crouter et al., 2003

Pedometer accuracy/reliability

measures

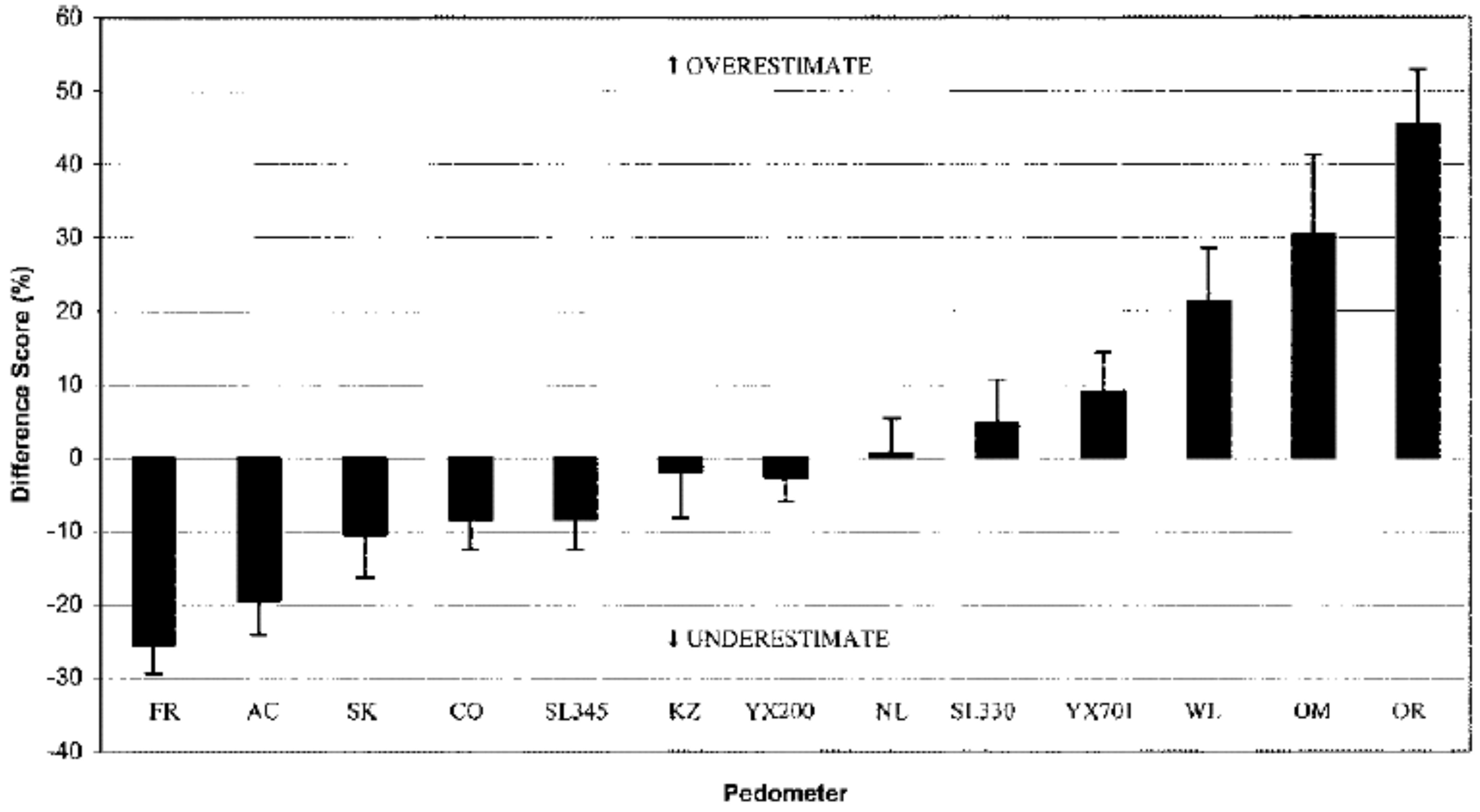


FIGURE 1—Mean difference scores [(comparison − criterion pedometer)/criterion] ± SE as a percentage of the criterion estimated steps over a 24-h period. Positive difference scores represent overestimations, and negative difference scores indicate underestimations of steps compared with the criterion pedometer.

step/day #

Schneider et al., 2004

Pedometer accuracy/reliability

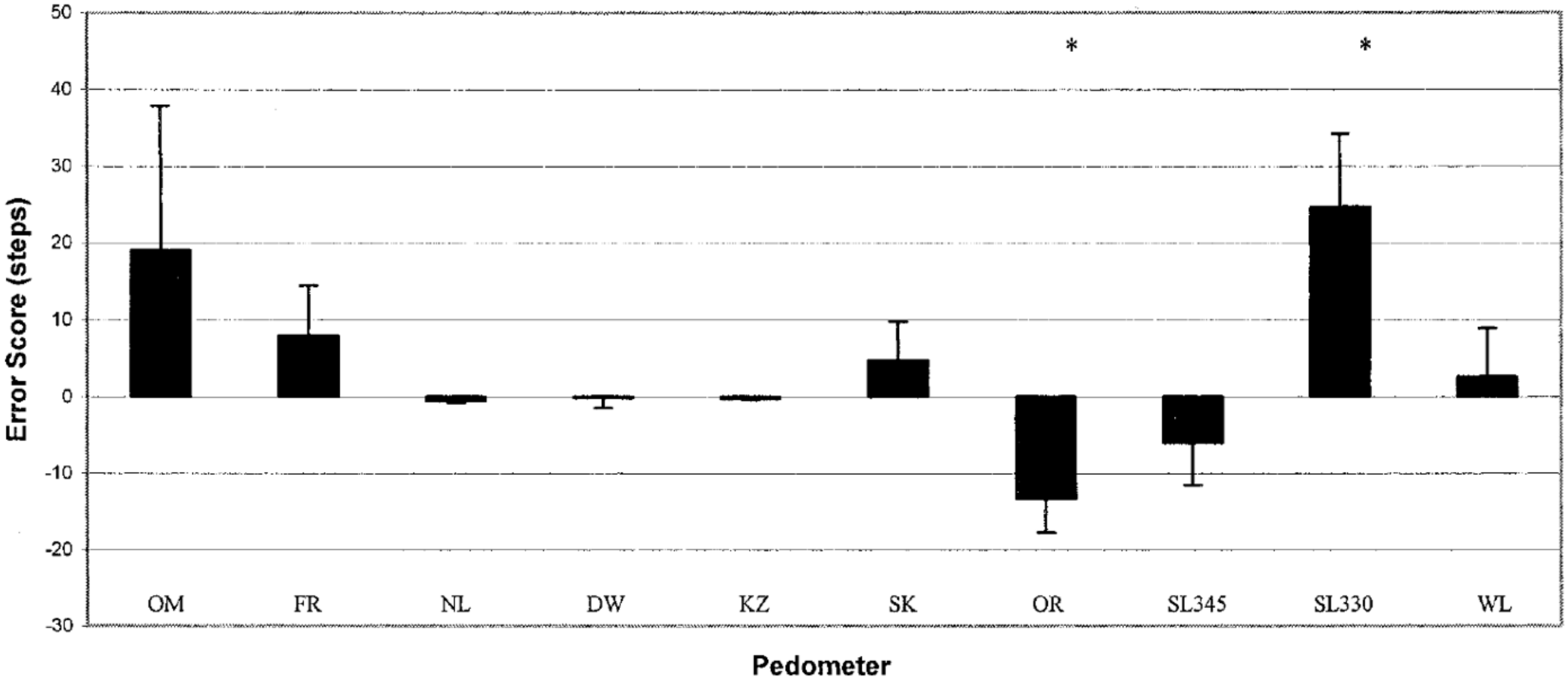


FIGURE 1—Mean error scores (actual − pedometer) ± SE in number of steps during a 400-m track walk at self-selected speeds. * $P < 0.05$.

400-m step #

Schneider et al., 2003

Pedometer accuracy/reliability

measures

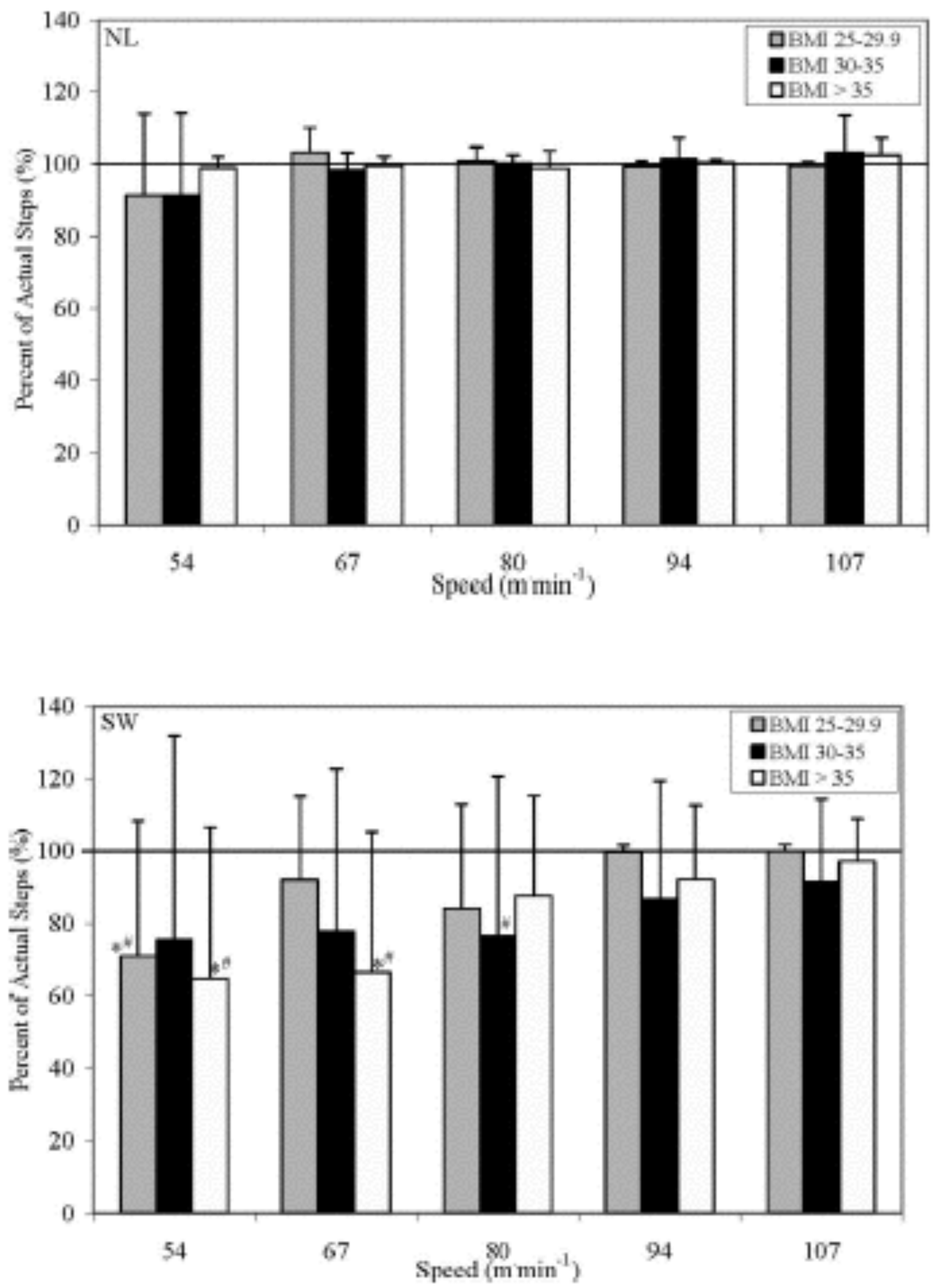


FIGURE 2—Effect of BMI (25–29.9 kg·m^{-2}, 30–35 kg·m^{-2}, and >35 kg·m^{-2}) on the percent of actual steps recorded by the New-Lifestyles NL-2000 (NL) and Yamax Digiwalker SW-200 (SW). Error bars are standard deviation. * Significantly different from actual steps; # significantly different from the NL ($P < 0.05$).

(uniaxially accelerometric)

stride #

(electromechanical circuit based)

Crouter et al., 2005

Pedometer

Final pedometry issues

- no discrimination of weight lifting, gradient legged locomotion, cycling, swimming, rowing;
- shoe or ankle accelerometric pedometer -> stride #

Accelerometer

First generation

Rationale

a <- F (= m x a) <- by paying ME

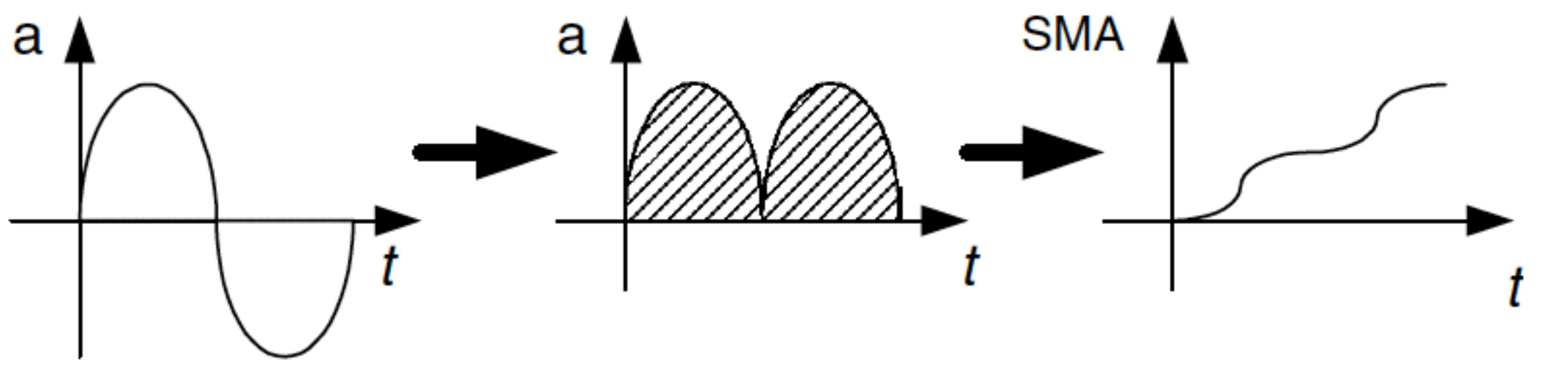


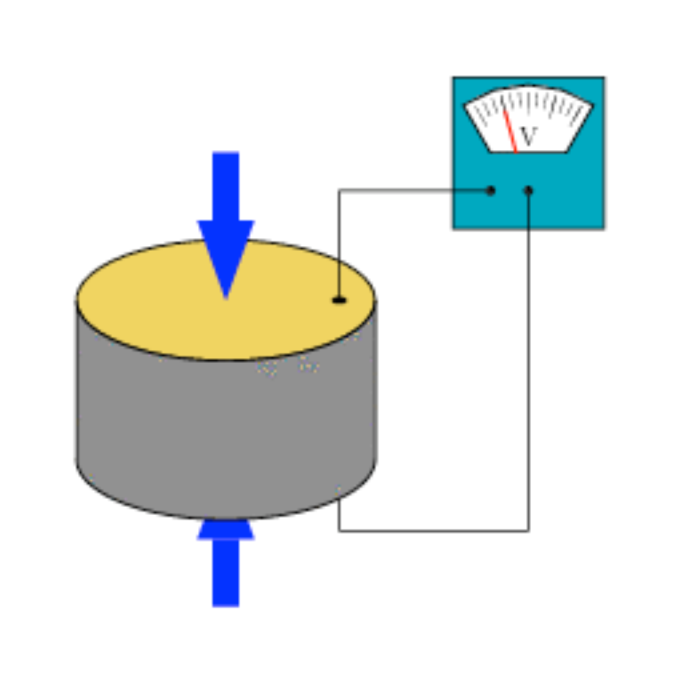
Figure 5. Metabolic energy expenditure (EE) is estimated by computing the signal magnitude area (SMA). The acceleration signal is rectified and then integrated. EE is then estimated by means of a linear regression.

Placement

waist but also chest, back, wrist, ankle

Accelerometer

- A piezo-electric or -resistive sensor;
- -> 'counts' number, intensity;
- no isometric force



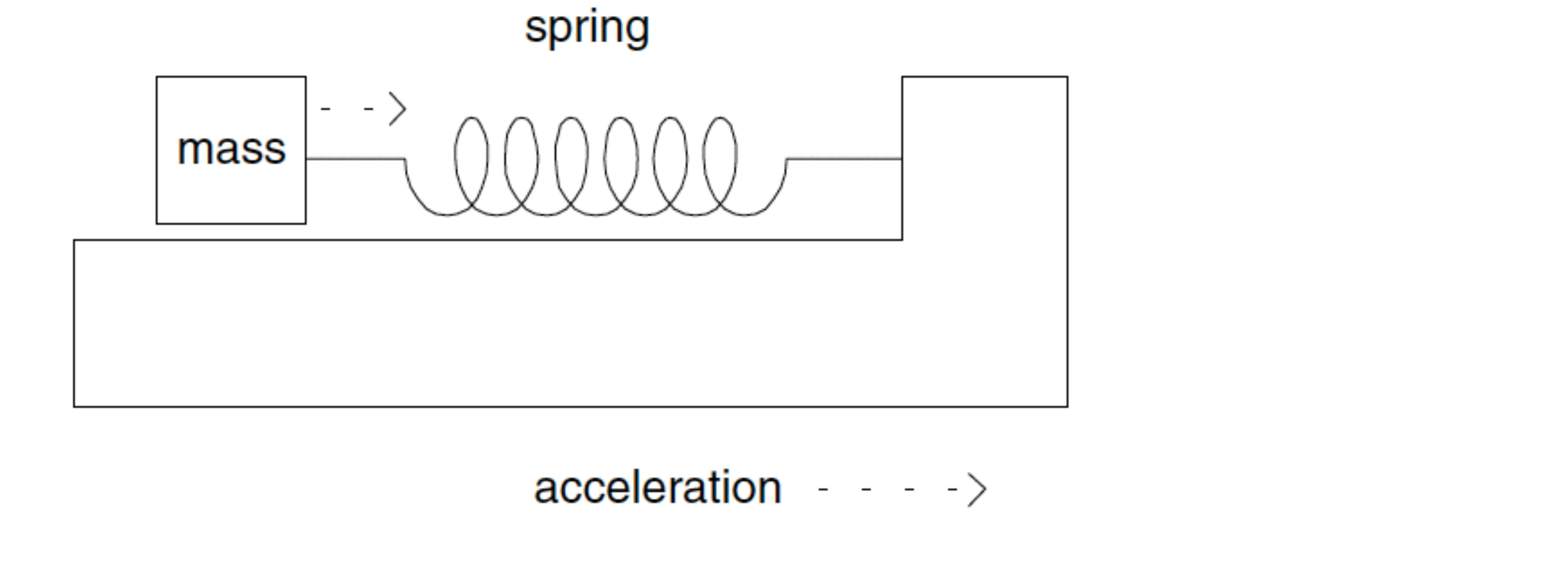
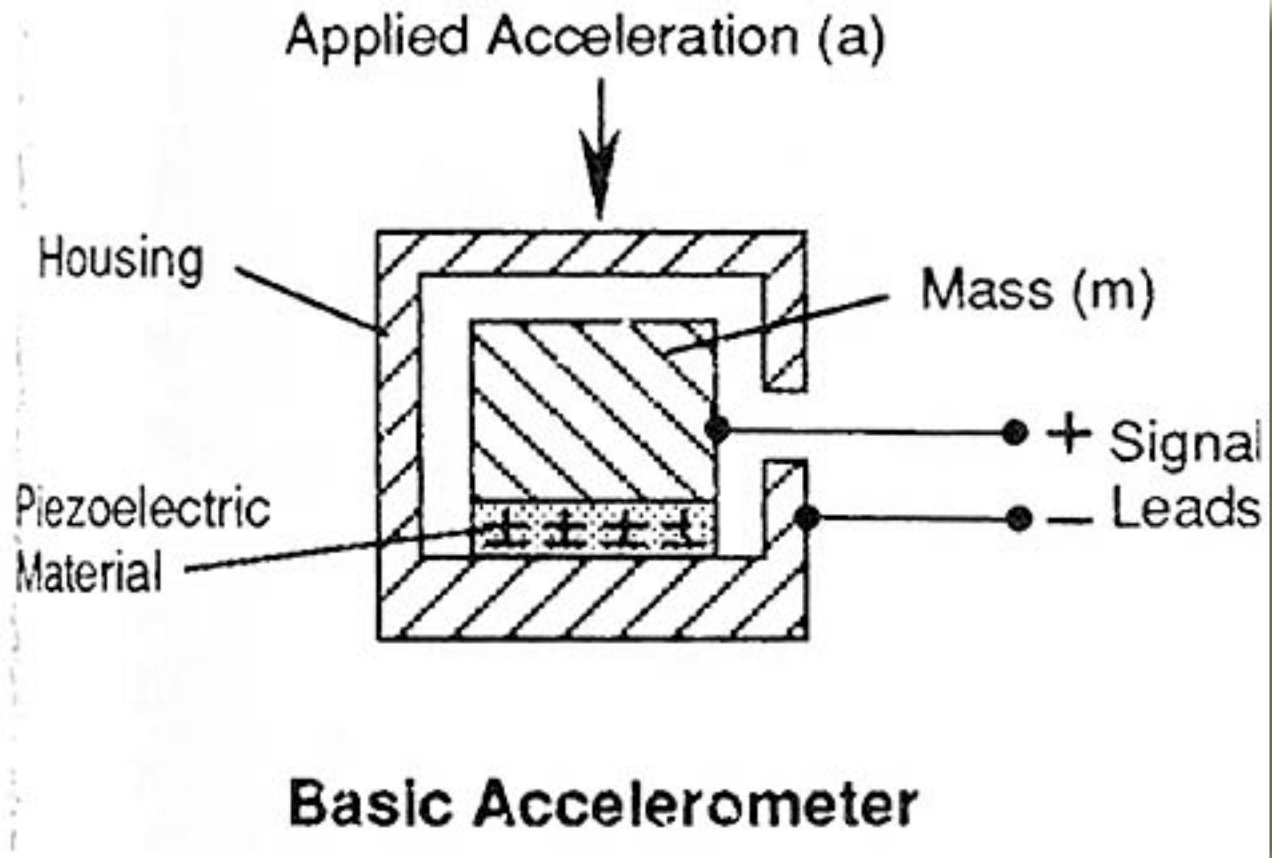


Figure 1. A piezoelectric accelerometer works like a simple mass spring system.



Accelerometer

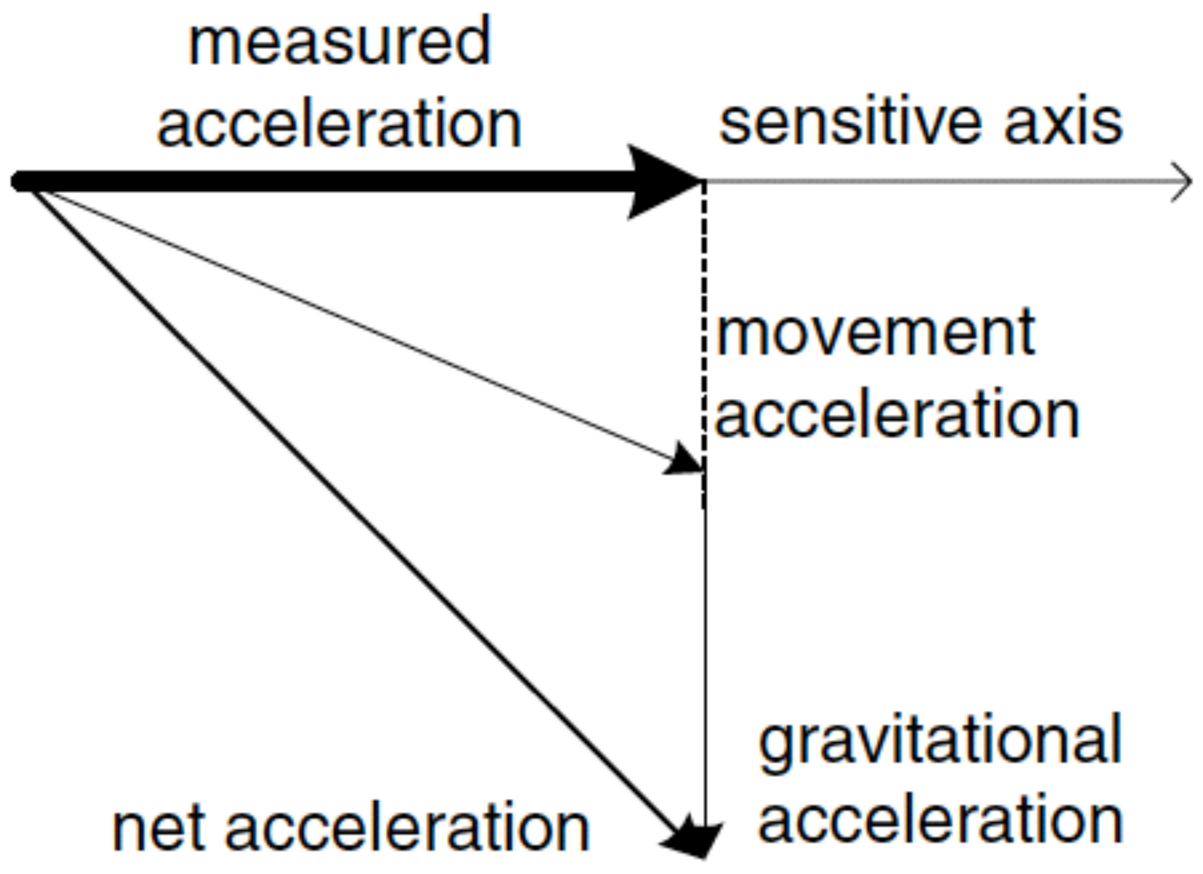


Figure 2. Piezoelectric accelerometers measure the sum of the acceleration due to movement and gravitational acceleration acting along the sensitive axis.

Mathiee et al., 2004

Accelerometer

measures

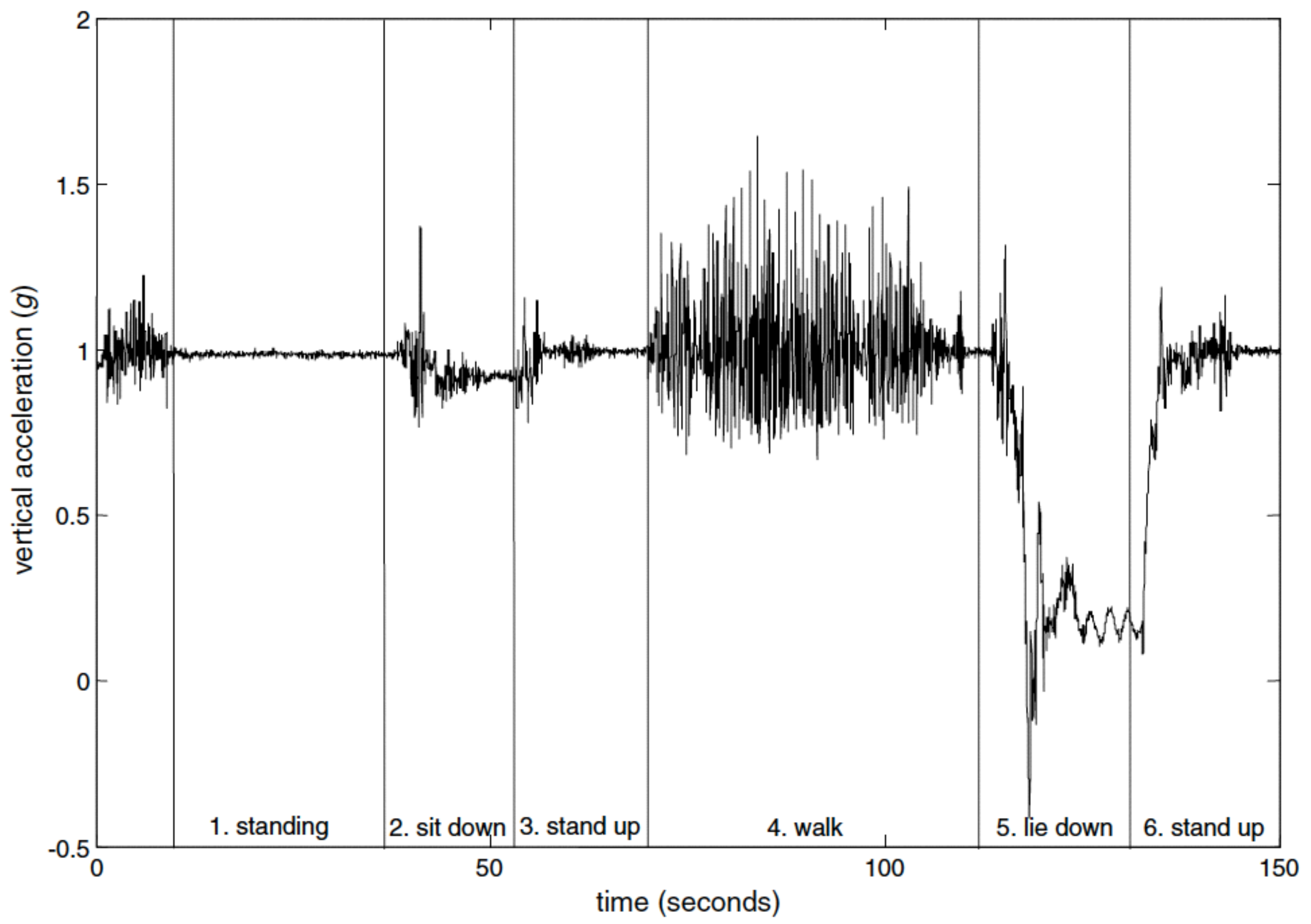


Figure 4. Acceleration signal produced by a waist-mounted accelerometer aligned in the vertical (gravitational) direction, during a selection of basic daily movements. The acceleration signal is composed of the gravitational acceleration due to the posture of the subject and the acceleration due to body movement. g is the acceleration due to gravity, approximately 9.81 m s^{-2}. The measured accelerations are dependent on the activity being performed. If the accelerometer was attached at a different point on the body, different acceleration signals would be recorded.

Mathiee et al., 2004

Accelerometer

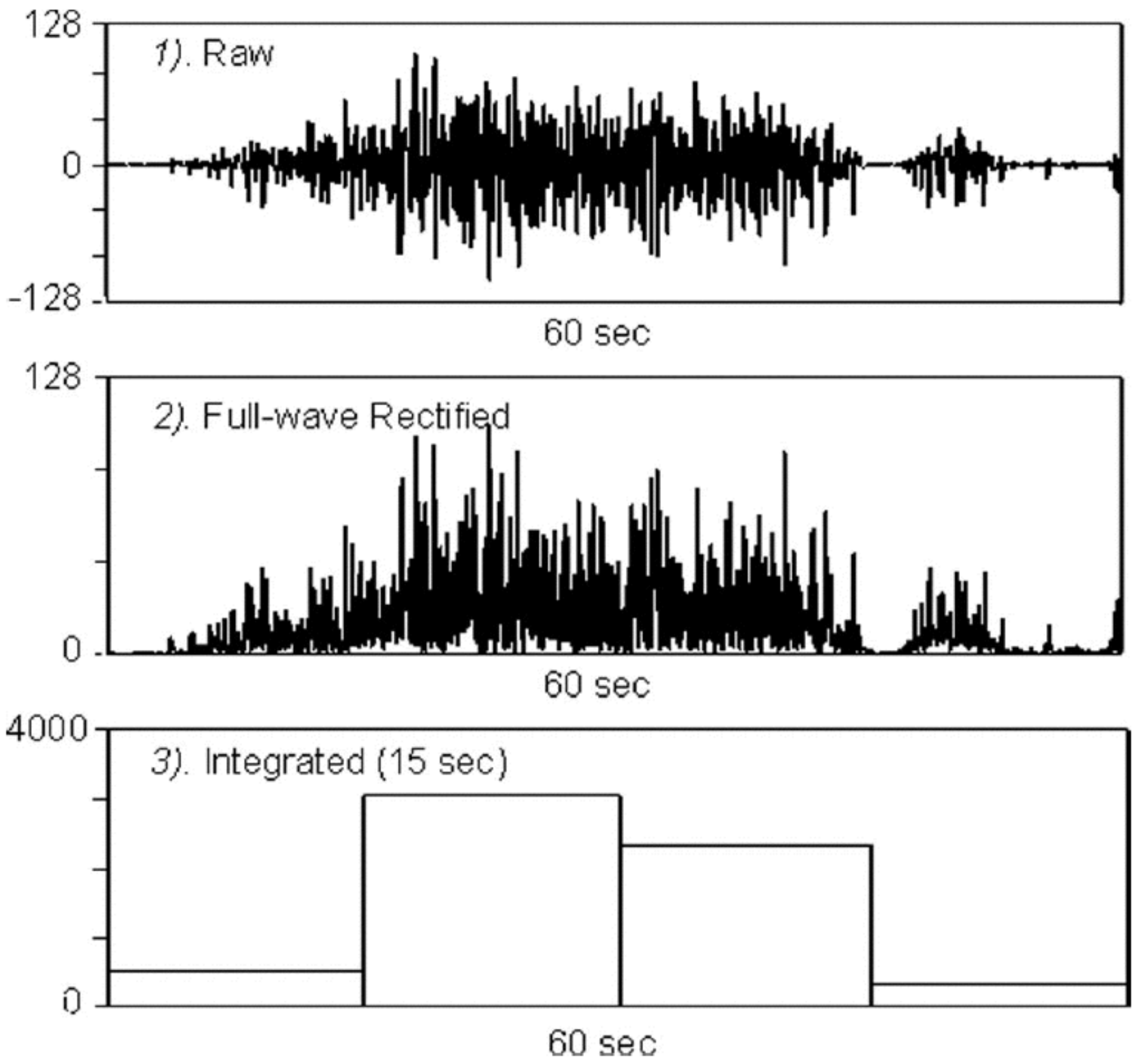


FIGURE 2—Analytical processing of the acceleration data. 1. Raw: a 60-s window of a digitized raw signal collected at 32 Hz and using a 8-bit A/D conversion. 2. Rectification: all negative signal from (1) was turned into positive. 3. Integration: 15-s epochs.

Chen et al., 2005

Accelerometer

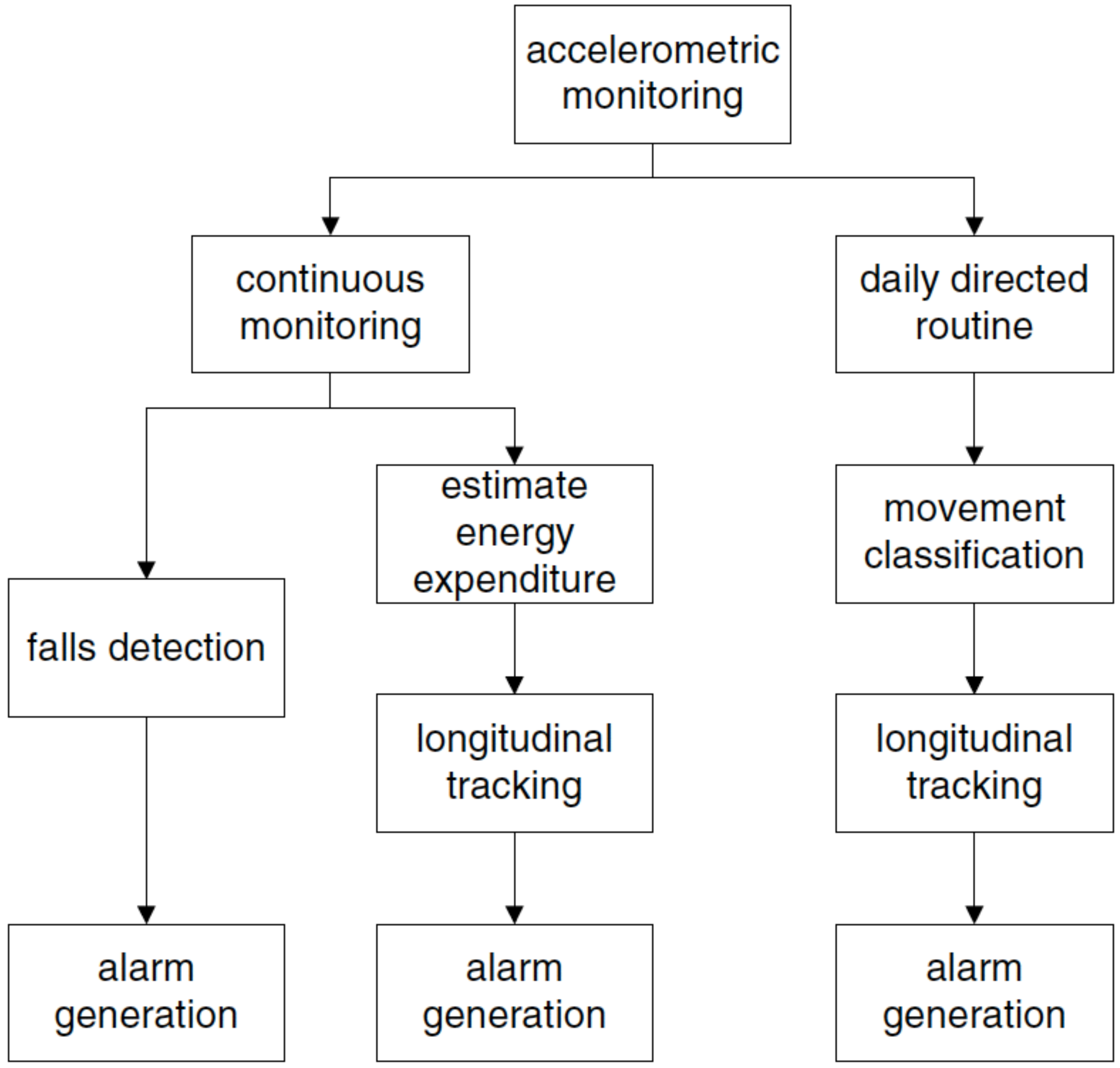


Figure 6. The three modes of monitoring.

Mathiee et al., 2004

Accelerometer

- Uniaxial accelerometer -> -59% children DLW ME;
  -59÷-50% old men DLW ME;
  +50÷+60% old claudicants DLW ME;
  -59% young women weekly DLW nME;
- Triaxial accelerometer -> +12÷+49% V'O2 locomotion ME;
  -21÷-8% V'O2 gradient walking ME;
  -68÷-53% V'O2 cycling ME;
  -45÷-35% V'O2 daily activity ME;
  -35% young women weekly DLW nME

HR wrist monitor

HR wrist monitor

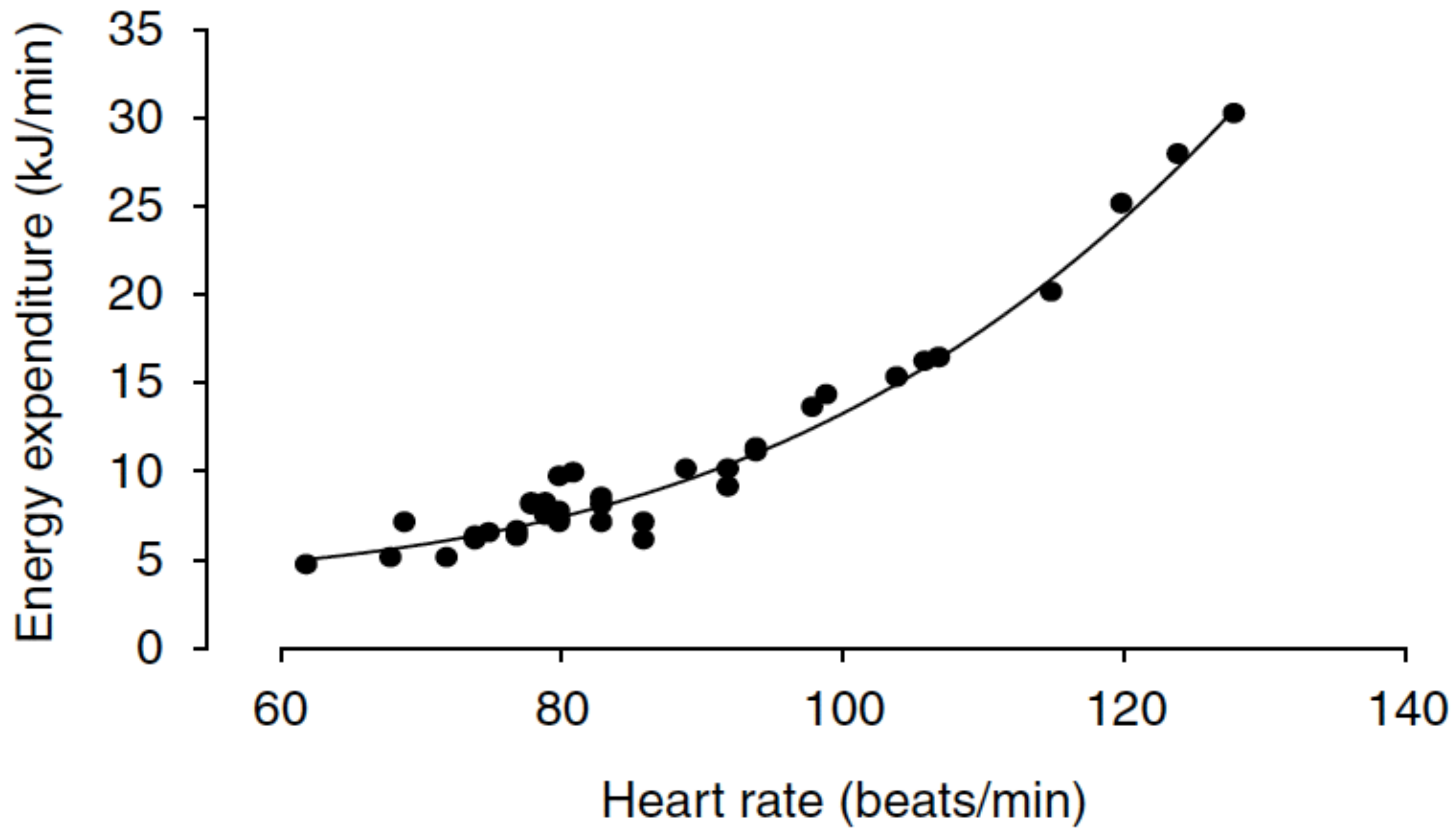


Fig. 2. The relationship between heart rate and energy expenditure in a healthy male study participant (unpublished data).

HR wrist monitor

HR measure issues

- HR <- environmental temperature and humidity, hydration status, posture, illness, stress, type of exercise (w/upper limbs or lower ones, continuous or intermittent), gender, age, body mass;
- w/≈3′ latency

but...

- pedometer/accelerometer -> level legged locomotion;
  no exercise with upper limbs, walking and running on soft ground or on slopes, cycling, swimming, rowing;
- pedometer/uniaxial accelerometer -> no over 9 km/h running

HR wrist monitor

HR measure issues

- (HR ≥ 90 bpm or ≥ 60% HRMax) ME = k HR;
- -30% daily ME;

(partial) answer:

- FLEX HR method (Spurr et al., 1988): ME = k HR (subject, activity specific) use only @external load/HR > FLEX HR, i.e., average between maximum value during rest or sedentary activity, and minimum value during light activity;
- i.e., (HR < FLEX HR) ME = rME, (HR > FLEX HR) ME = k HR;
- -17÷+20% daily DLW ME

HR wrist monitor

-> beat to beat recording -> HRV

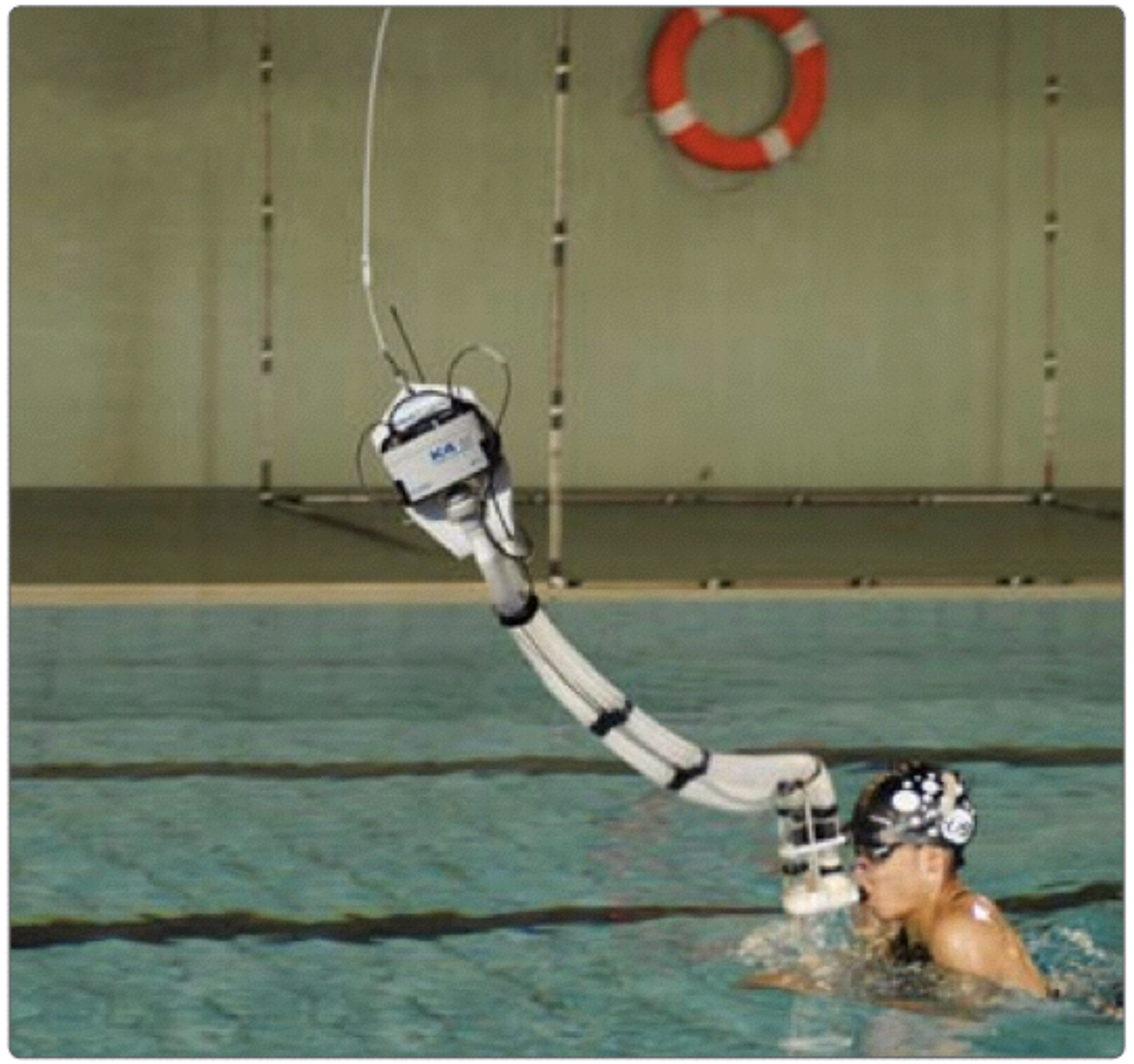
V'O2 measure

- direct calorimetry in metabolic chamber;
- indirect calorimetry, respirometry @closed/open circuit -> V'O2, V'CO2, ...;
- < 8h

V'O2 measure

V'O2 measure

Option 1:
An operator can follow the swimmer by holding the K4b2 using a special rod (rod and harness are included in the standard packaging)



Option 2:
The K4b2 can be hung on a cable to be placed above the swimming pool lane