University of Verona,

School of Exercise and Sport Science,

Laurea magistrale in Scienze motorie preventive ed adattate

(Laurea magistrale in Scienze dello sport e della prestazione fisica)

Metodologia delle misure delle attività sportive

Monday 20/11/2017 8:30÷10

Luca P. Ardigò Ph.D.

A class within a six-class module

50

Portable devices for measuring physical activity and metabolic expenditure

A HUGE topic!

(18/11/2017) 741 items!!!

Elite athletes' off-training PA

frontiers in Physiology

ORIGINAL RESEARCH
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Sedentary Behavior among National Elite Rowers during Off-Training—A Pilot Study

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The aim of this pilot study was to analyze the off-training physical activity (PA) profile in national elite German U23 rowers during 31 days of their preparation period. The hours spent in each PA category (i.e., sedentary: <1.5 metabolic equivalents (MET); light physical activity: 1.5–3 MET; moderate physical activity: 3–6 MET and vigorous intense physical activity: >6 MET) were calculated for every valid day (i.e., >480 min of wear time). The off-training PA during 21 weekdays and 10 weekend days of the final 11-week preparation period was assessed by the wrist-worn multisensory device Microsoft Band II (MSBII). A total of 11 rowers provided valid data (i.e., >480 min/day) for 11.6 week days and 4.8 weekend days during the 31 days observation period. The average sedentary time was 11.63 ± 1.25 h per day during the week and 12.49 ± 1.10 h per day on the weekend, with a tendency to be higher on the weekend compared to weekdays ($p = 0.06$; $d = 0.73$). The average time in light, moderate and vigorous PA during the weekdays was 1.27 ± 1.15, 0.76 ± 0.37, 0.51 ± 0.44 h per day, and 0.67 ± 0.43, 0.59 ± 0.37, 0.53 ± 0.32 h per weekend day. Light physical activity was higher during weekdays compared to the weekend ($p = 0.04$; $d = 0.69$). Based on our pilot study of 11 national elite rowers we conclude that rowers display a considerable sedentary off-training behavior of more than 11.5 h/day.

Keywords: accelerometer, microsoft band 2, multi-sensor, recovery, sedentary behavior, wearable

OPEN ACCESS

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Used device

Band Material	Thermal plastic elastomer silicone vulcanate (TPSiV)
Display Type	AMOLED
Battery Life	48 hours of normal use; advanced functionality like GPS use will impact battery performance
Battery Type	Li-Polymer
Maximum Operating Altitude	-300m to +4877m
Sensors	Optical heart rate sensor 3-axis accelerometer/gyro Gyrometer GPS Ambient light sensor Skin temperature sensor UV sensor Capactive sensor Galvanic skin response Microphone Barometer
Connectivity	Bluetooth 4.0 (Low Energy)
Charge Cable Connector	Custom charge cable

Results

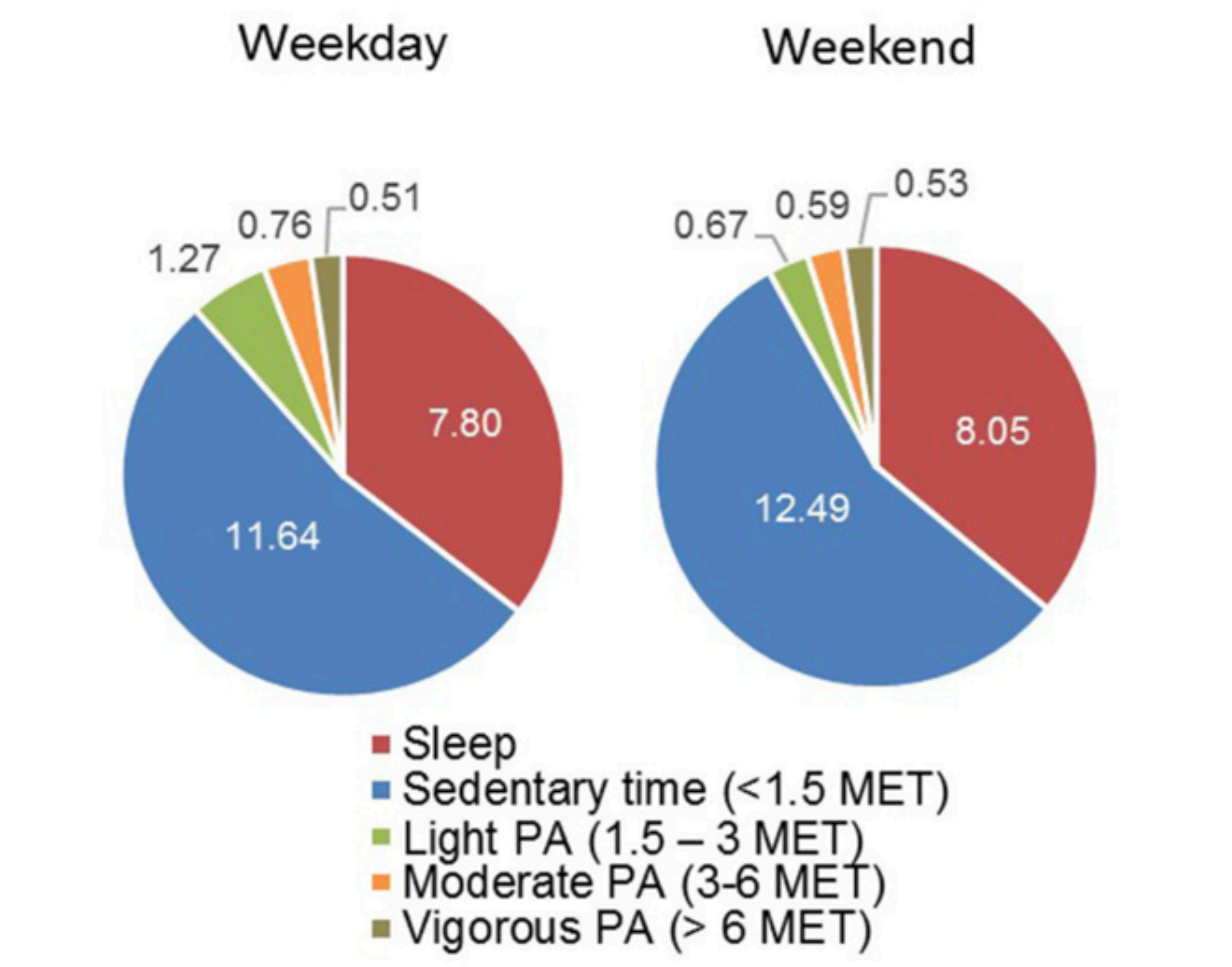


FIGURE 2 | Fraction of mean sedentary time [hours], light, moderate, and vigorous PA as well as sleep of total wear time during off-training periods.

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%

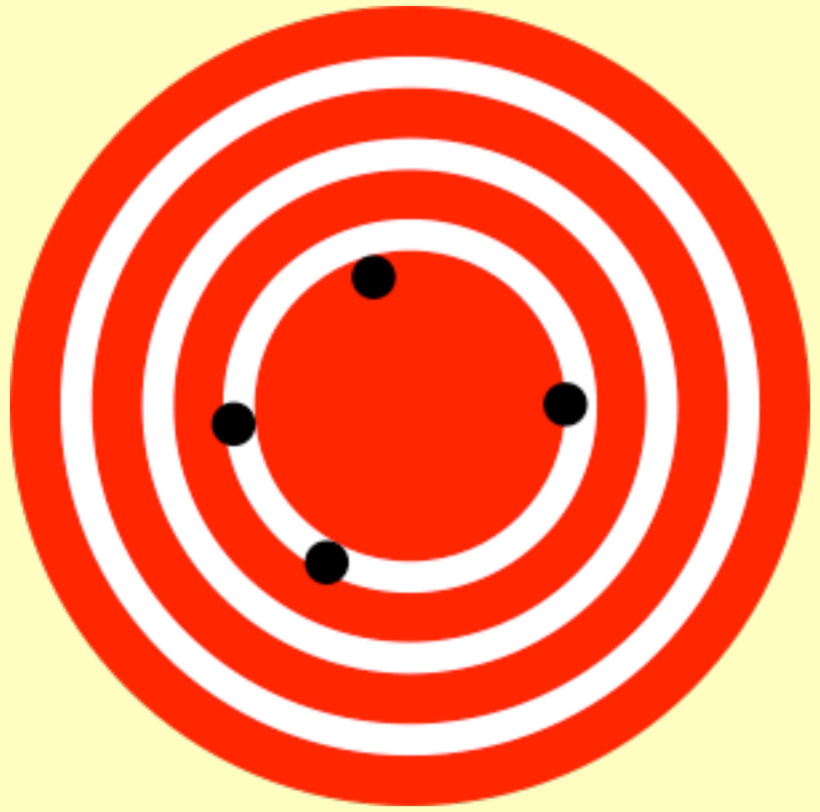
Specific measures

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

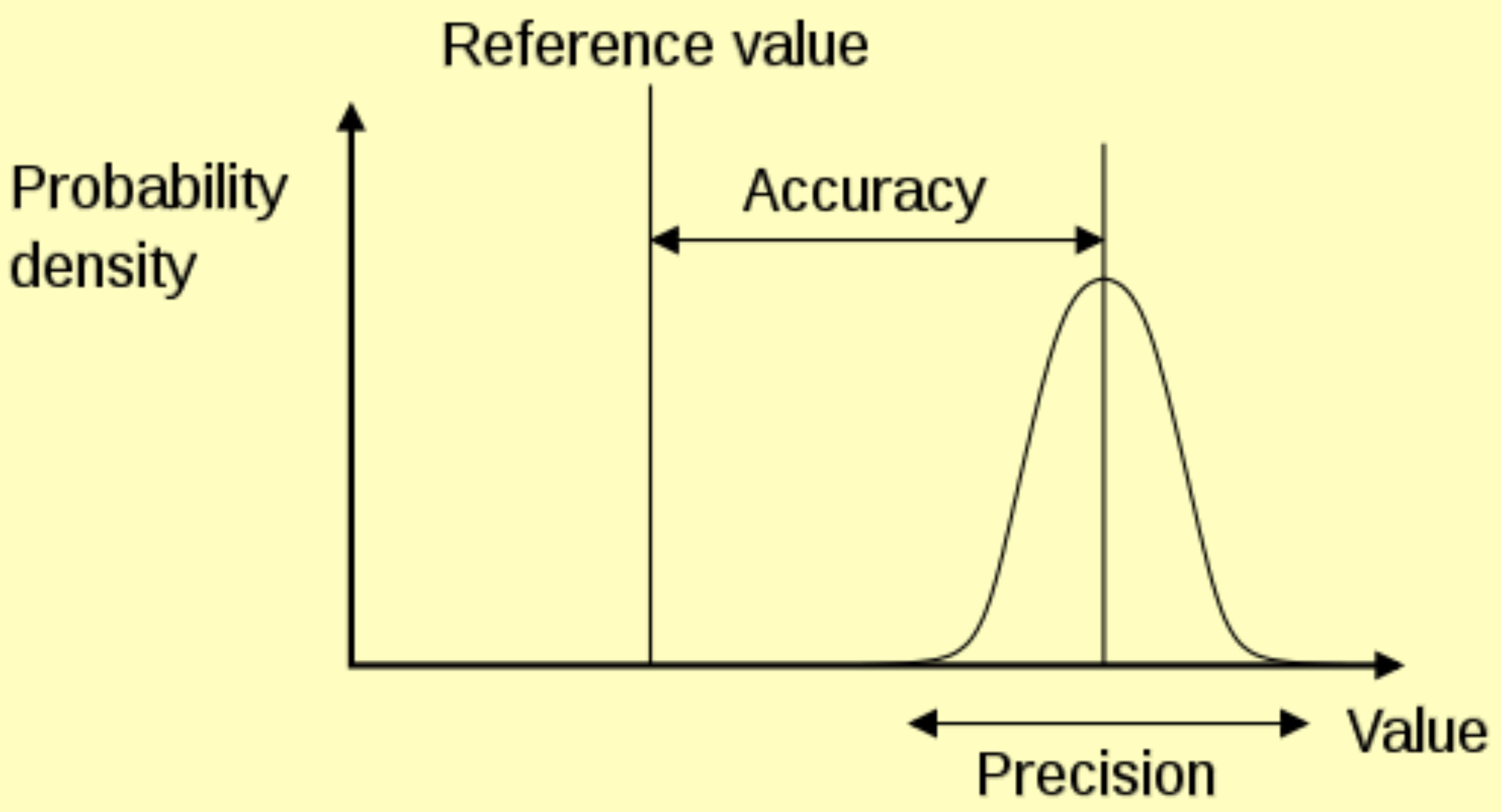
Low accuracy,
poor trueness,
good precision

Accuracy and precision

Good accuracy,
poor trueness,
poor precision

Low accuracy,
poor trueness,
good precision

Accuracy and precision



accuracy + precision = trueness

Accuracy, sensitivy, and specifity

The scores used to measure classification quality were accuracy, sensitivity and specificity computed according to the below formulae (TP = True Positive; TN = True Negative; FP = False Positive; FN = False Negative).

1. $Accuracy = \frac{TP+TN}{TP+FP+TN+FN}$
2. $Sensitivity = \frac{TP}{TP+FN}$
3. $Specificity = \frac{TN}{TN+FP}$

Sensitivity and specificity

Sensitivity and **specificity** are statistical measures of the performance of a binary classification test, also known in statistics as classification function:

- **Sensitivity** (also called the **true positive rate**, the recall, or **probability of detection**[1] in some fields) measures the proportion of positives that are correctly identified as such (e.g. the percentage of sick people who are correctly identified as having the condition).
- **Specificity** (also called the **true negative rate**) measures the proportion of negatives that are correctly identified as such (e.g. the percentage of healthy people who are correctly identified as not having the condition).

Precision, sensitivy, and specifty

Terminology and derivations from a confusion matrix

(number of) positive samples (P)

(number of) negative samples (N)

(number of) true positive (TP)

eqv. with hit

(number of) true negative (TN)

eqv. with correct rejection

(number of) false positive (FP)

eqv. with false alarm, Type I error

(number of) false negative (FN)

eqv. with miss, Type II error

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sensitivity or true positive rate (TPR)

eqv. with hit rate, recall

$$TPR = TP/P = TP/(TP + FN)$$

specificity (SPC) or true negative rate

$$SPC = TN/N = TN/(TN + FP)$$

precision or positive predictive value (PPV)

$$PPV = TP/(TP + FP)$$

Accuracy

accuracy (ACC)

$$ACC = (TP + TN)/(TP + FP + FN + TN)$$

Confusion matrix

		True condition	
	Total population	Condition positive	Condition negative
Predicted condition	Predicted condition positive	**True positive**	**False positive**, Type I error
	Predicted condition negative	**False negative**, Type II error	**True negative**

Table of error types

Table of error types		Null hypothesis (H_0) is	
		True	**False**
Decision About Null Hypothesis (H_0)	**Reject**	Type I error (False Positive)	Correct inference (True Positive)
	Fail to reject	Correct inference (True Negative)	Type II error (False Negative)

Examples

measures

Example 1 [edit]

Hypothesis: "Adding water to toothpaste protects against cavities."

Null hypothesis (H_0): "Adding water to toothpaste has no effect on cavities."

This null hypothesis is tested against experimental data with a view to nullifying it with evidence to the contrary.

A type I error occurs when detecting an effect (adding water to toothpaste protects against cavities) that is not present. The null hypothesis is true (i.e., it is true that adding water to toothpaste has no effect on cavities), but this null hypothesis is rejected based on bad experimental data.

Example 2 [edit]

Hypothesis: "Adding fluoride to toothpaste protects against cavities."

Null hypothesis (H_0): "Adding fluoride to toothpaste has no effect on cavities."

This null hypothesis is tested against experimental data with a view to nullifying it with evidence to the contrary.

A type II error occurs when failing to detect an effect (adding fluoride to toothpaste protects against cavities) that is present. The null hypothesis is false (i.e., adding fluoride is actually effective against cavities), but the experimental data is such that the null hypothesis cannot be rejected.

Example 3 [edit]

Hypothesis: "The evidence produced before the court proves that this man is guilty."

Null hypothesis (H_0): "This man is innocent."

A type I error occurs when convicting an innocent person (a miscarriage of justice). A type II error occurs when letting a guilty person go free (an error of impunity).

A positive correct outcome occurs when convicting a guilty person. A negative correct outcome occurs when letting an innocent person go free.

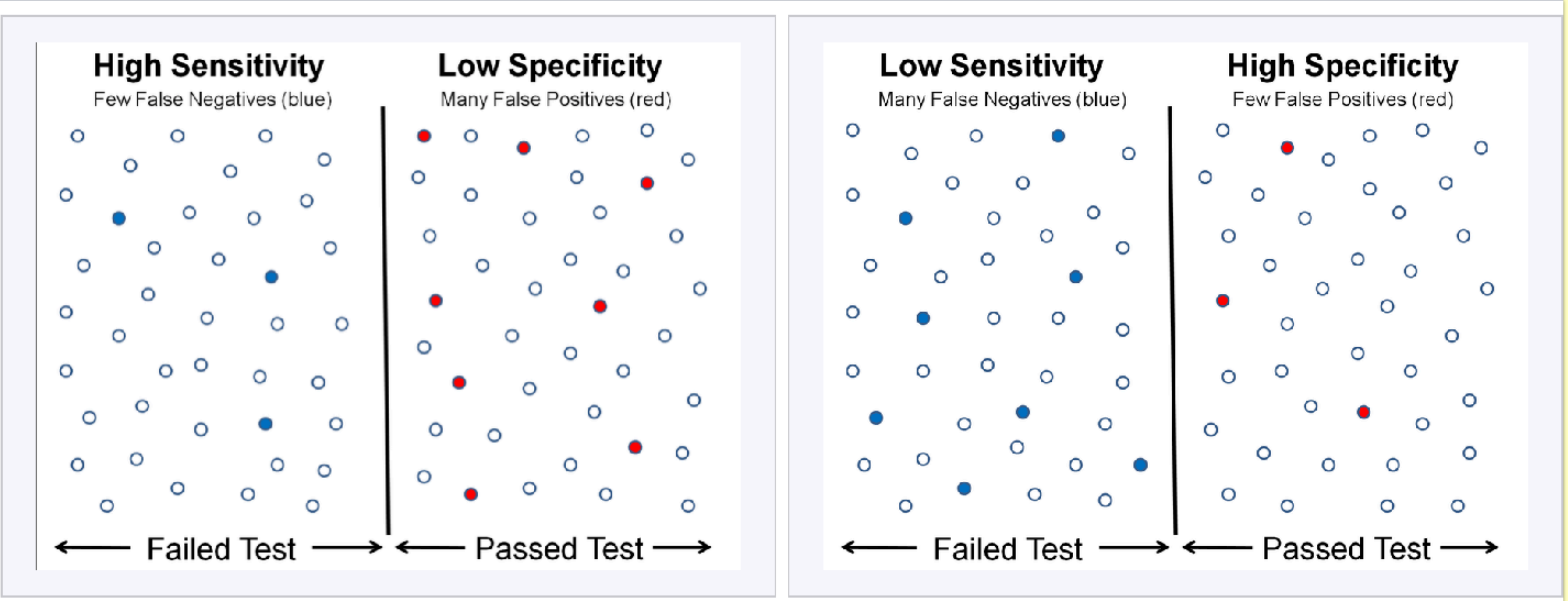
Example 4 [edit]

Hypothesis: "A patient's symptoms improve after treatment A more rapidly than after a placebo treatment."

Null hypothesis (H_0): "A patient's symptoms after treatment A are indistinguishable from a placebo."

A Type I error would falsely indicate that treatment A is more effective than the placebo, whereas a Type II error would be a failure to demonstrate that treatment A is more effective than placebo even though it actually is more effective.

Sensitivity and specificity



High sensitivity and low specificity

Low sensitivity and high specificity

Worked example

		Patients with bowel cancer (as confirmed on endoscopy)	
		Condition positive	Condition negative
Fecal occult blood screen test outcome	Test outcome positive	**True positive** (TP) = 20	**False positive** (FP) = 180
	Test outcome negative	**False negative** (FN) = 10	**True negative** (TN) = 1820
		Sensitivity = TP / (TP + FN) = 20 / (20 + 10) ≈ **67%**	**Specificity** = TN / (FP + TN) = 1820 / (180 + 1820) = **91%**

Convergent validity

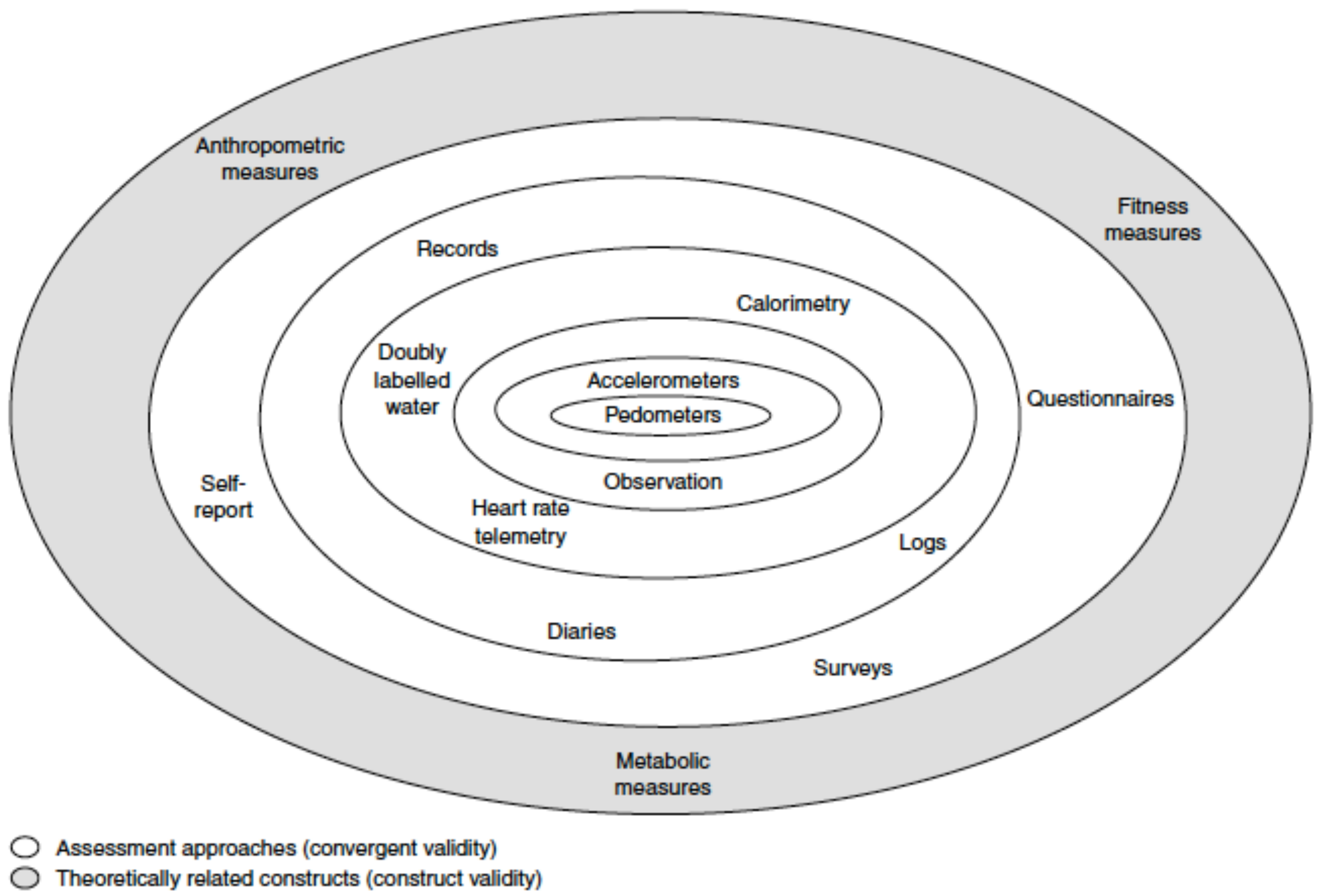


Fig. 1. Concentric circles of anticipated concordance between pedometer and other physical activity measures.

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

Tudor-Locke et al., 2002

Construct validity

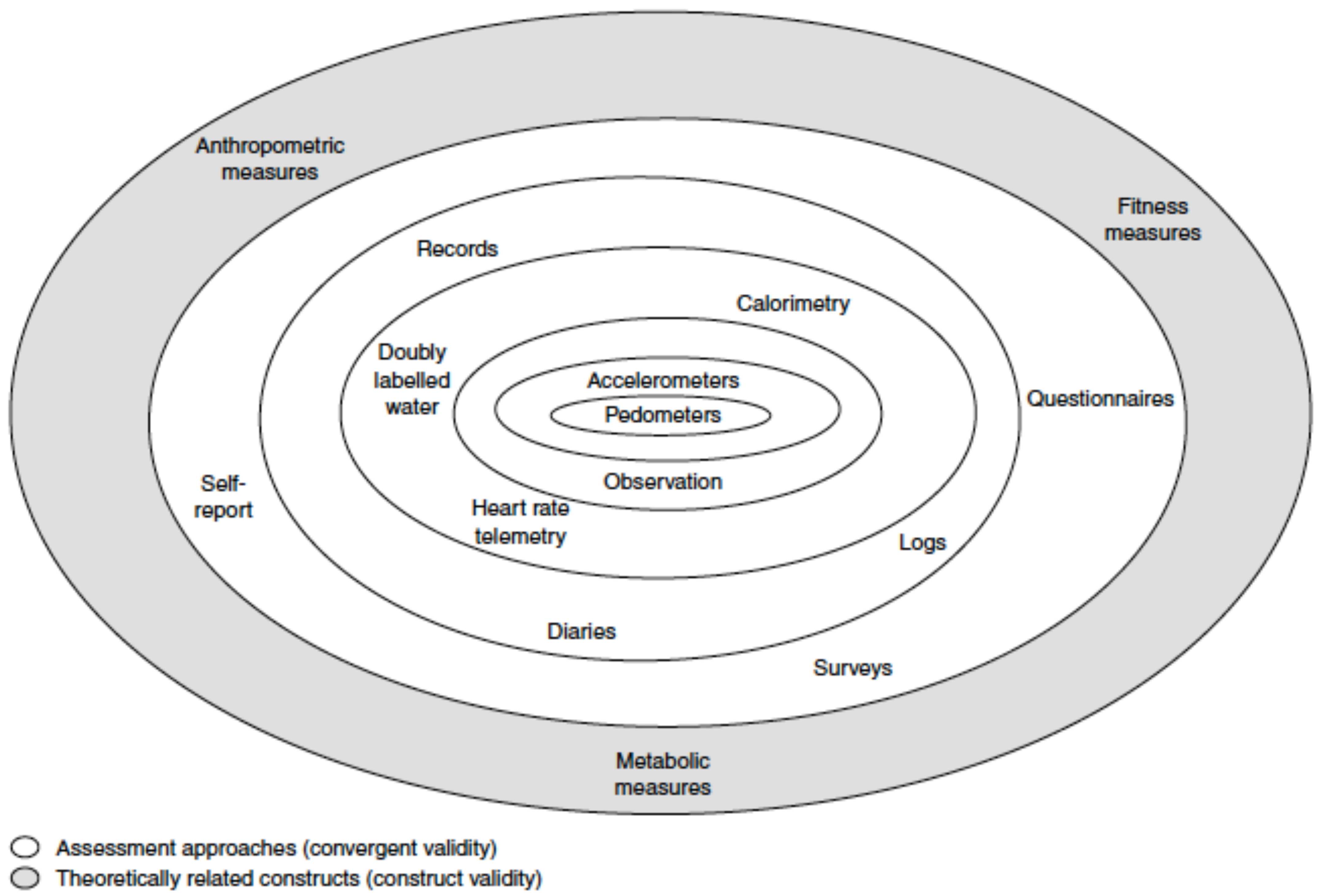


Fig. 1. Concentric circles of anticipated concordance between pedometer and other physical activity measures.

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

Tudor-Locke et al., 2004

Pedometer accuracy/validity

measures

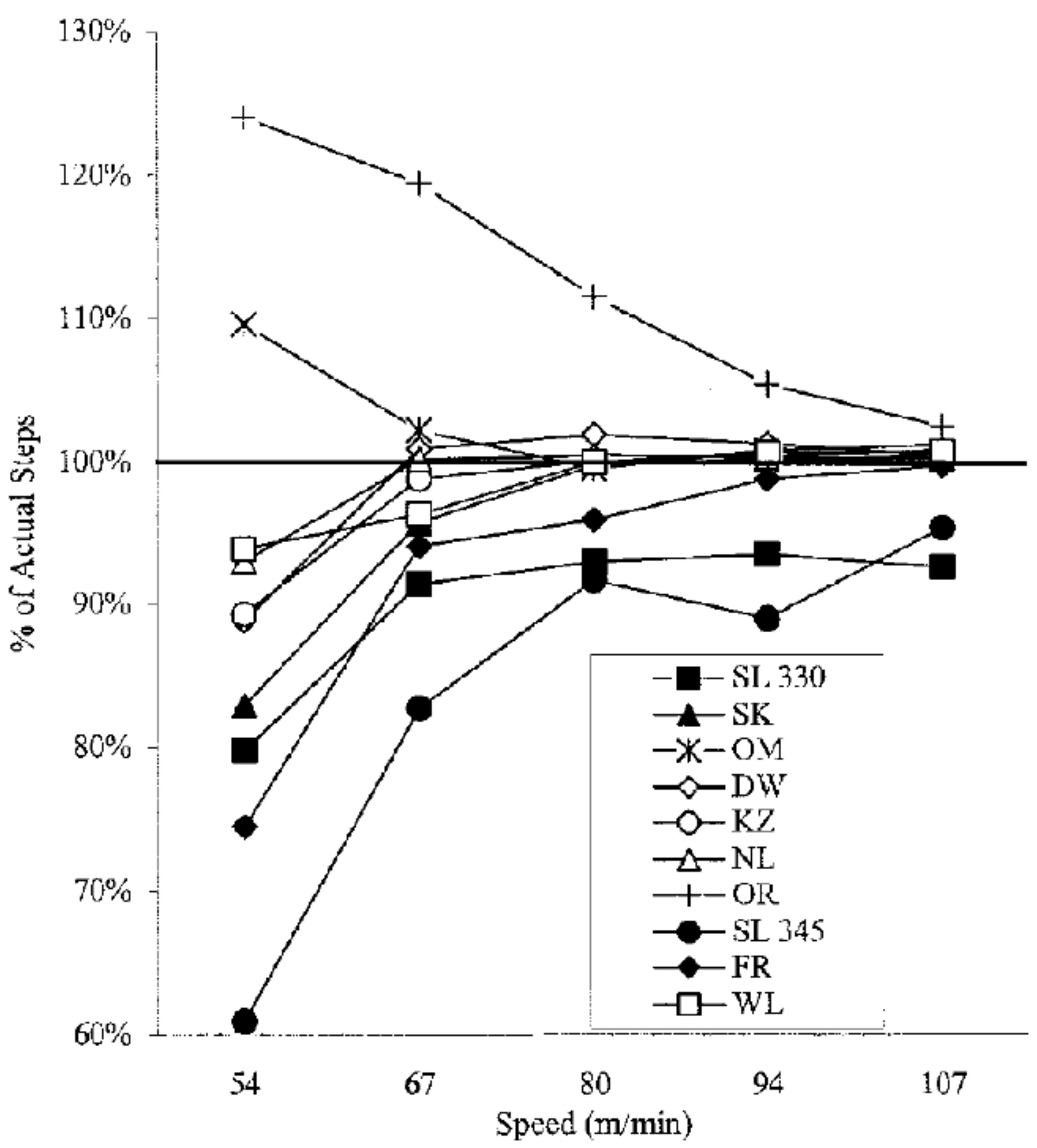


FIGURE 1—Effect of speed on pedometer accuracy (percentage of actual steps) during treadmill walking.

step #

Crouter et al., 2003

Pedometer accuracy/validity

measures

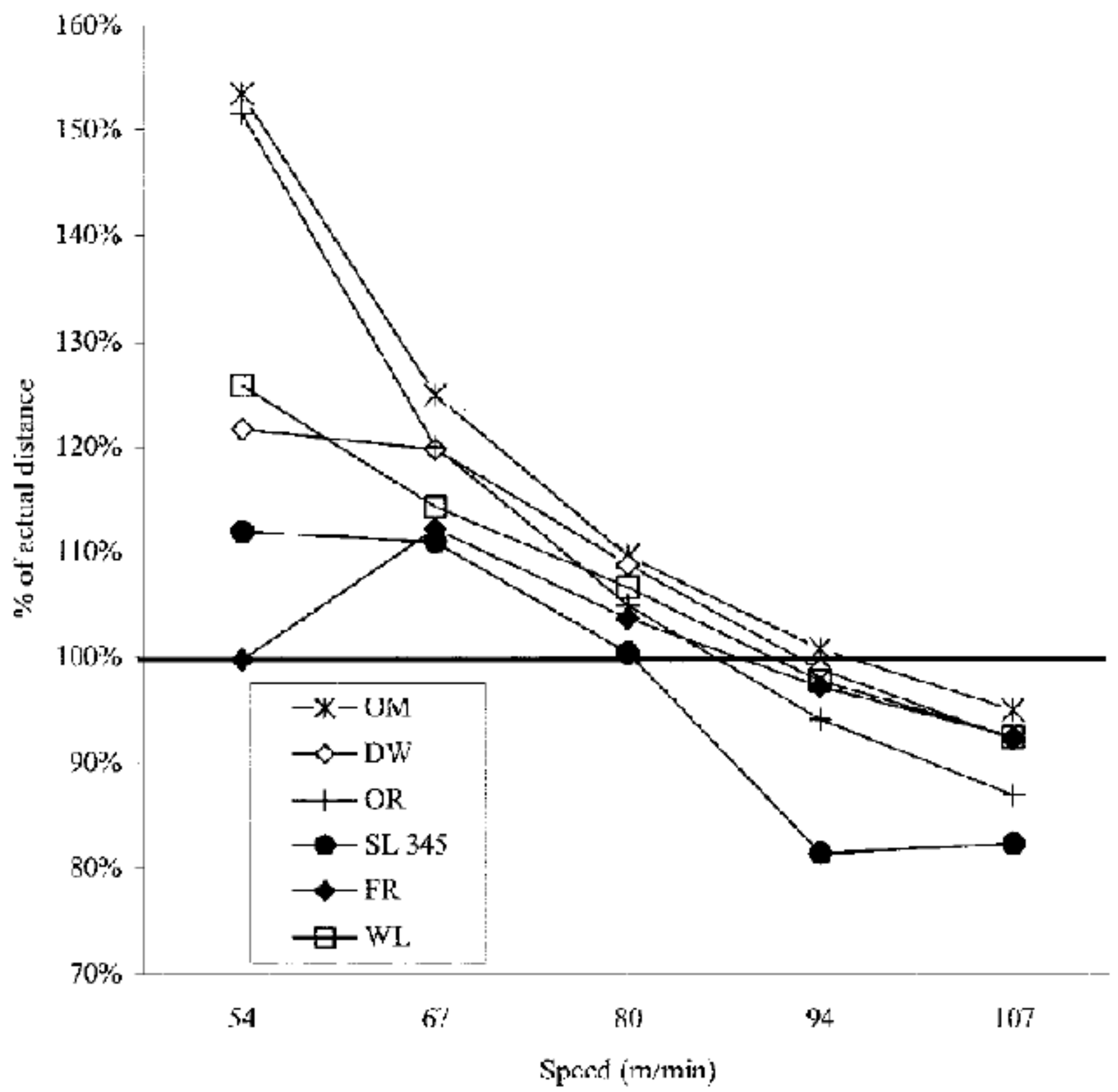


FIGURE 2—Effect of speed on pedometer estimates of percentage of actual distance traveled during treadmill walking.

(estimated) speed

Crouter et al., 2003