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Laurea magistrale in Scienze motorie preventive ed adattate
(Laurea magistrale in Scienze dello sport individuali e squadra,
Laurea magistrale in Scienze dello sport e montagna)

Metodologia delle misure delle attività sportive

Thursday 17/10/2019 14÷15:30

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Accuracy and precision

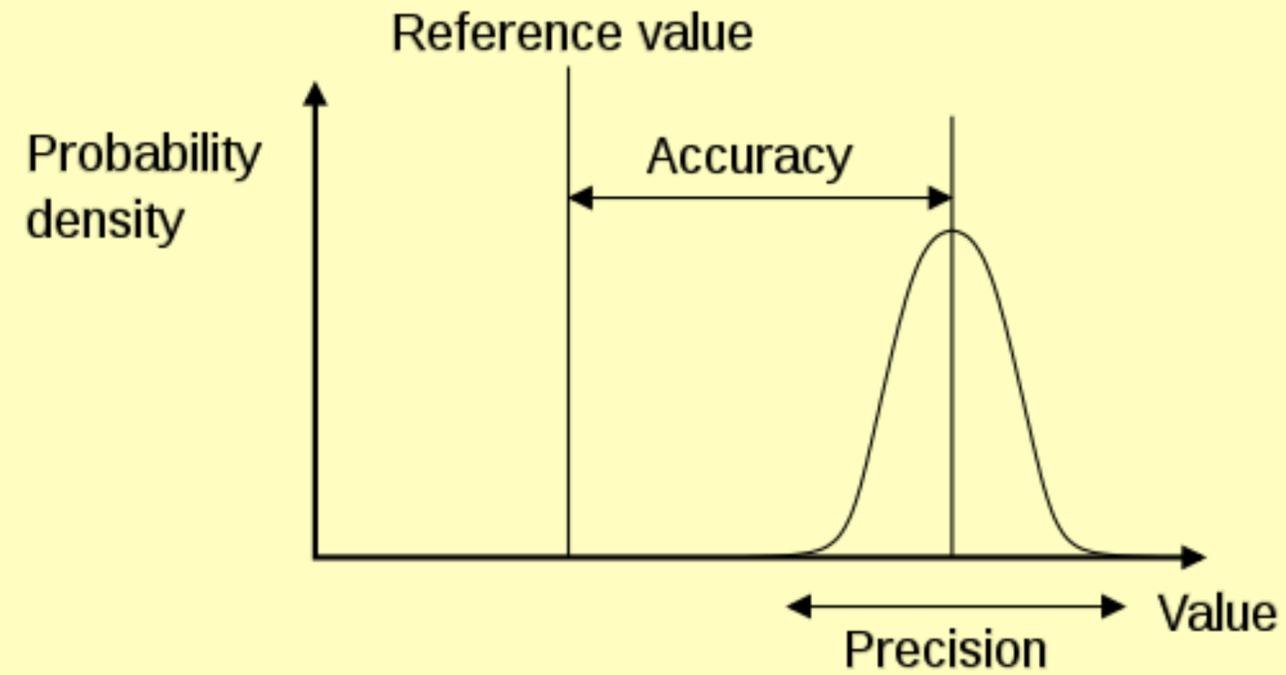


Good accuracy,
poor trueness,
poor precision



Low accuracy,
poor trueness,
good precision

Accuracy and precision



accuracy + precision = trueness

Accuracy, sensitivity, and specificity

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).

$$1. \text{ Accuracy} = \frac{TP+TN}{TP+FP+TN+FN}$$

$$2. \text{ Sensitivity} = \frac{TP}{TP+FN}$$

$$3. \text{ Specificity} = \frac{TN}{TN+FP}$$

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, sensitivity, and specificity

measures

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

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	
		Condition positive	Condition negative
Predicted condition	Total population		
	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.

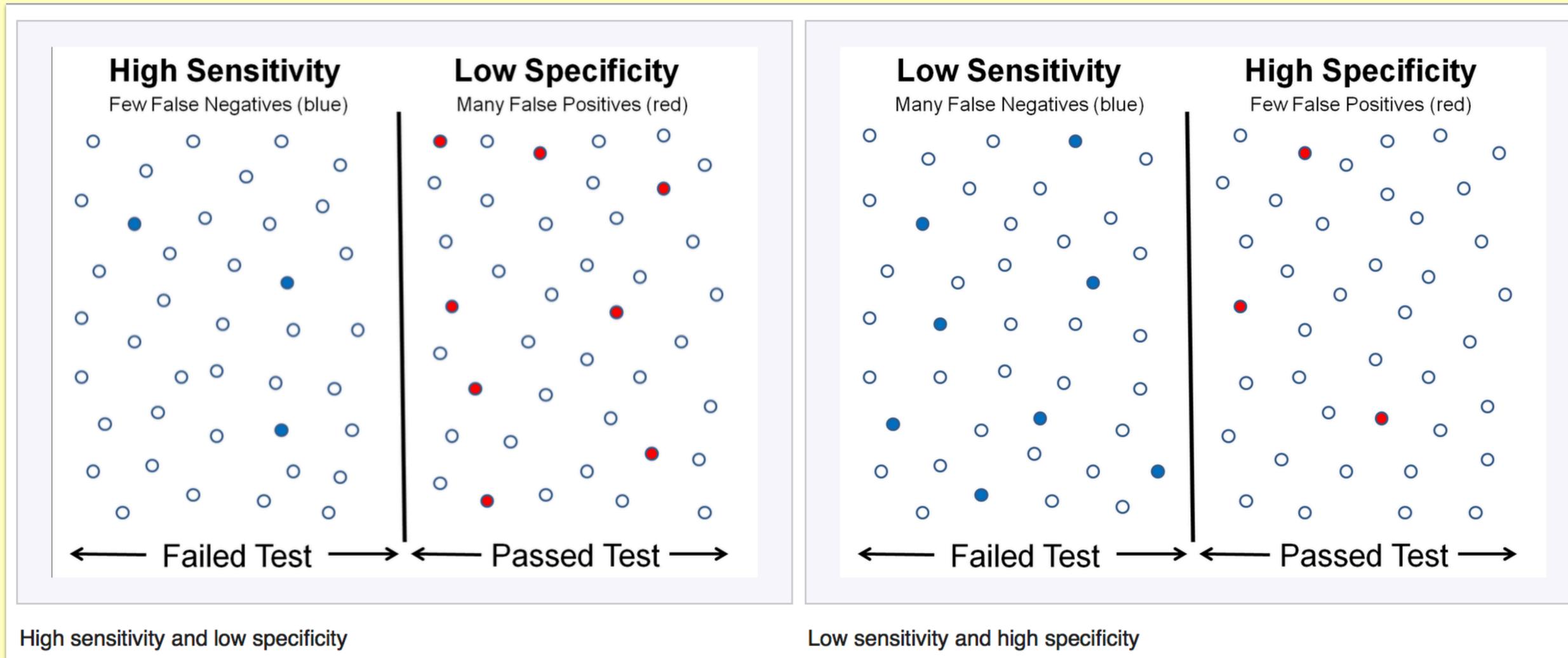
Example 4 [\[edit \]](#)

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.

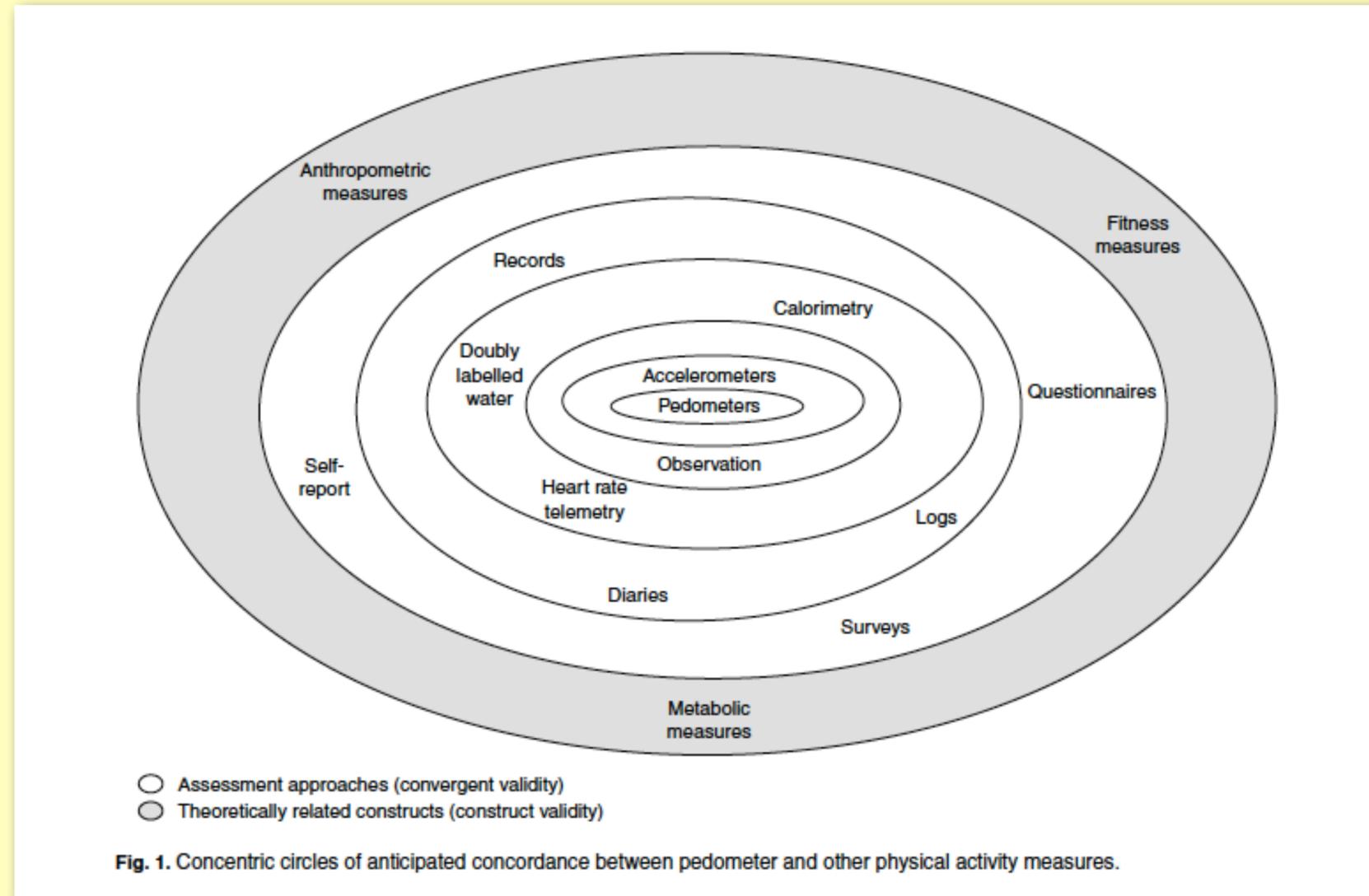
Sensitivity and specificity



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%

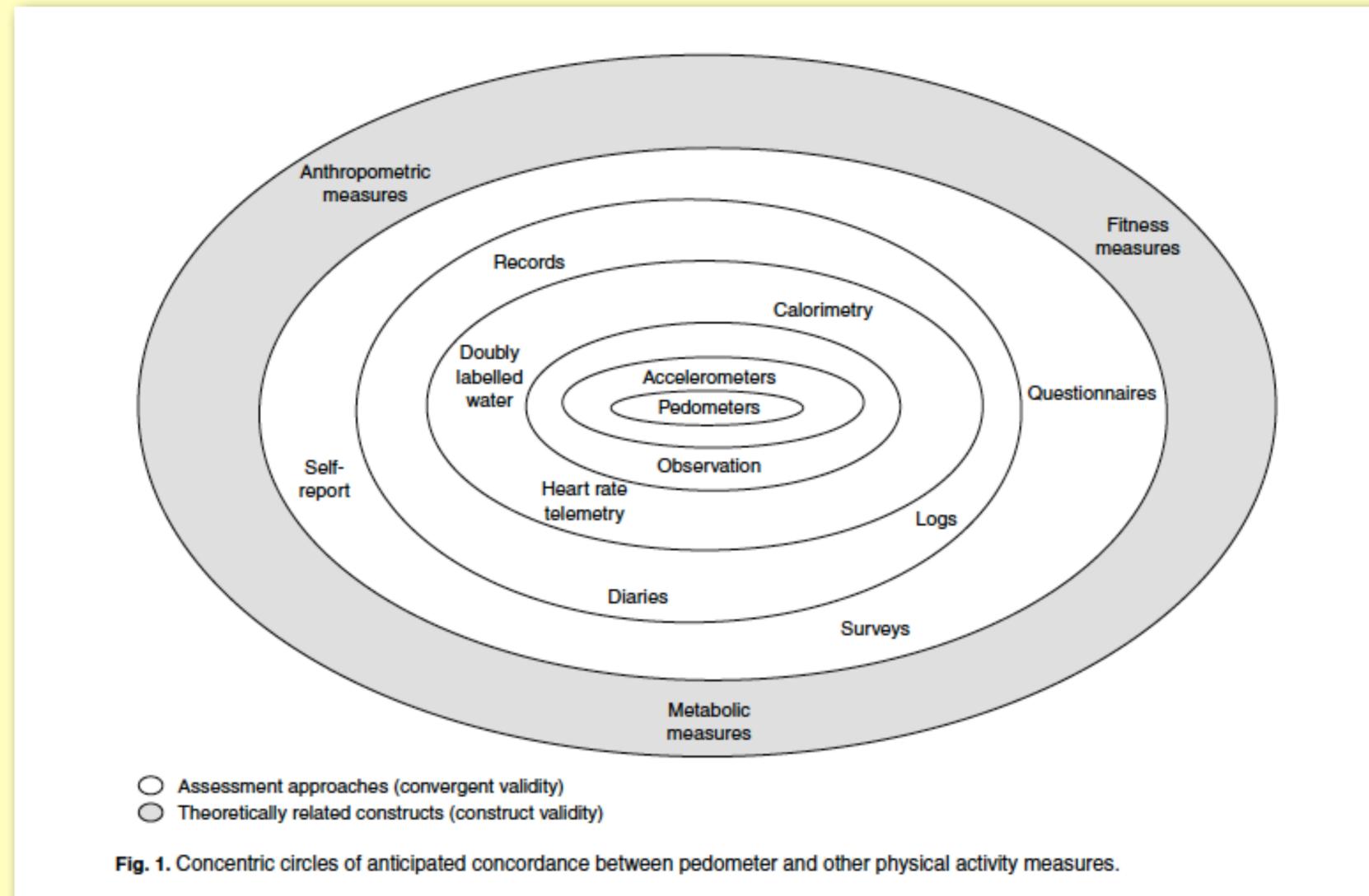
Convergent validity



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

Tudor-Locke et al., 2002

Construct validity

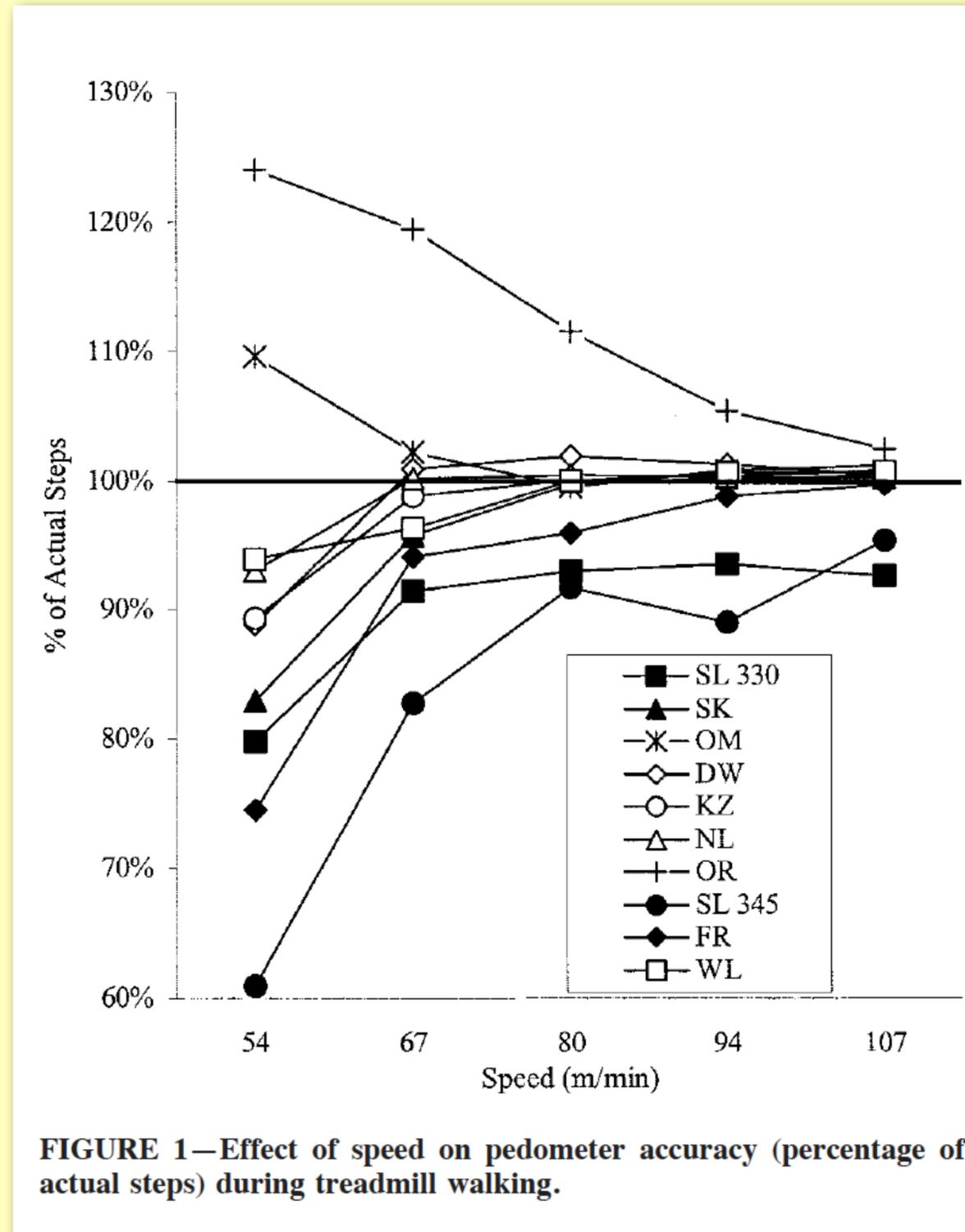


w/age;
w/anthropometry;
w/fitness measures

Tudor-Locke et al., 2004

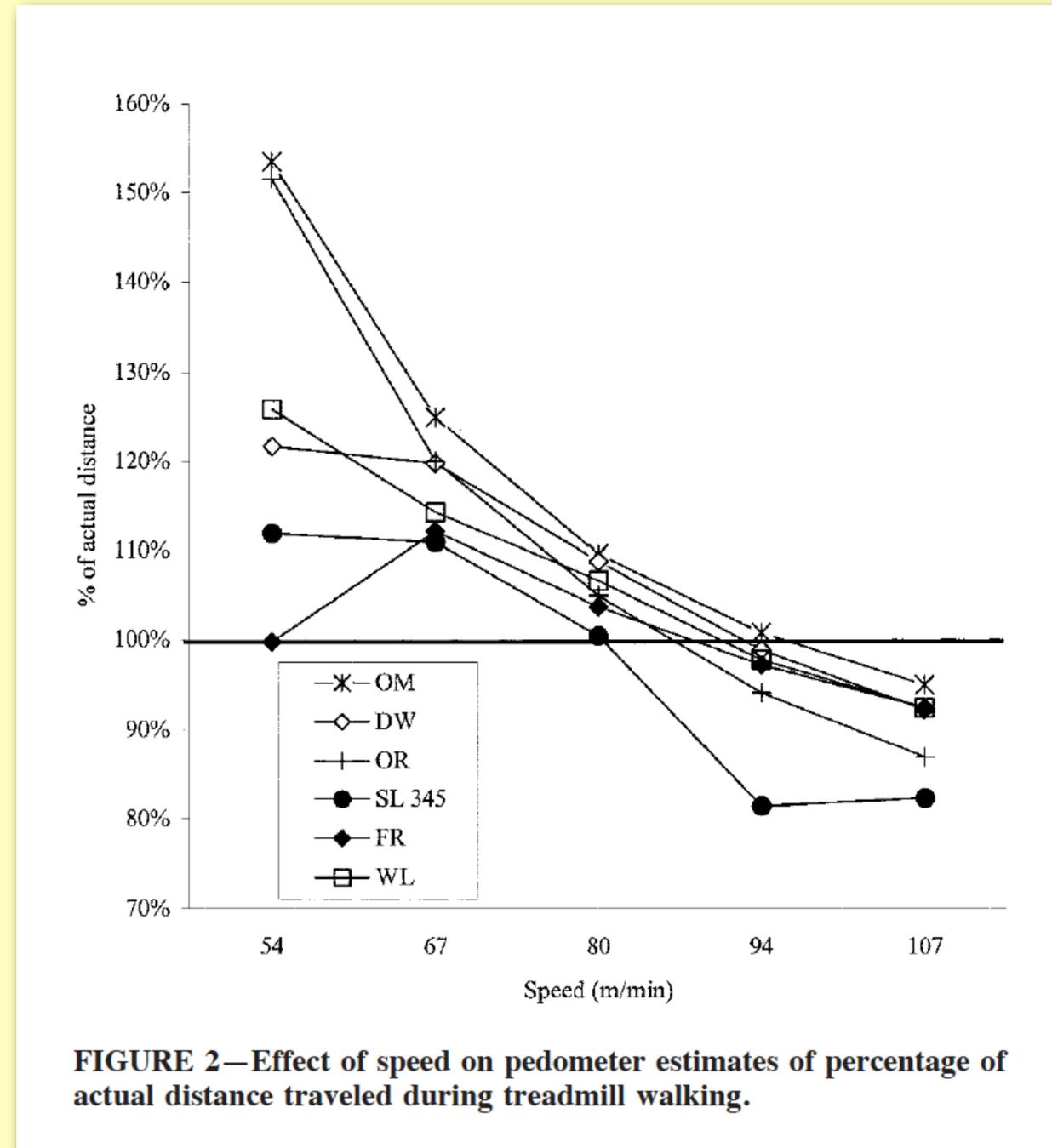
Pedometer accuracy/validity

measures



Pedometer accuracy/validity

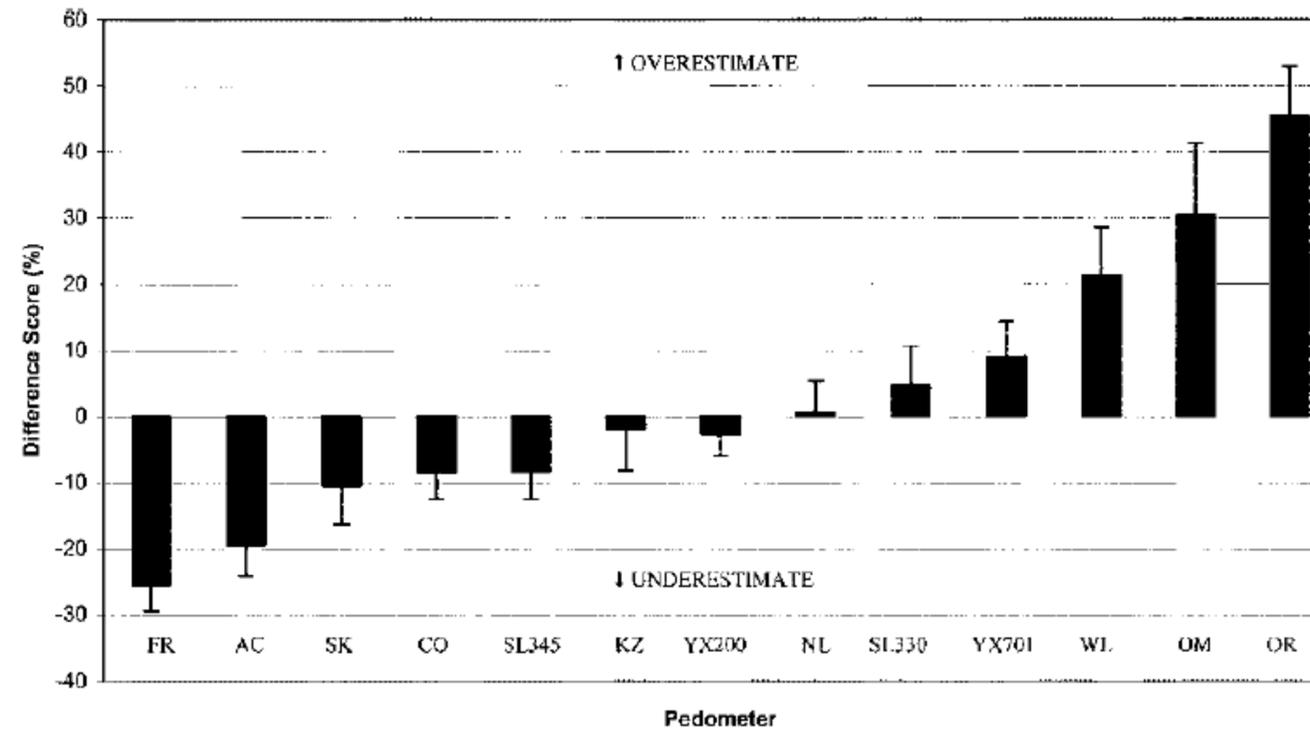
measures



(estimated) speed

Pedometer accuracy/validity

measures



step/day #

FIGURE 1—Mean difference scores [(comparison – criterion pedometer)/criterion] \pm 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.

Schneider et al., 2004

Pedometer accuracy/validity

measures

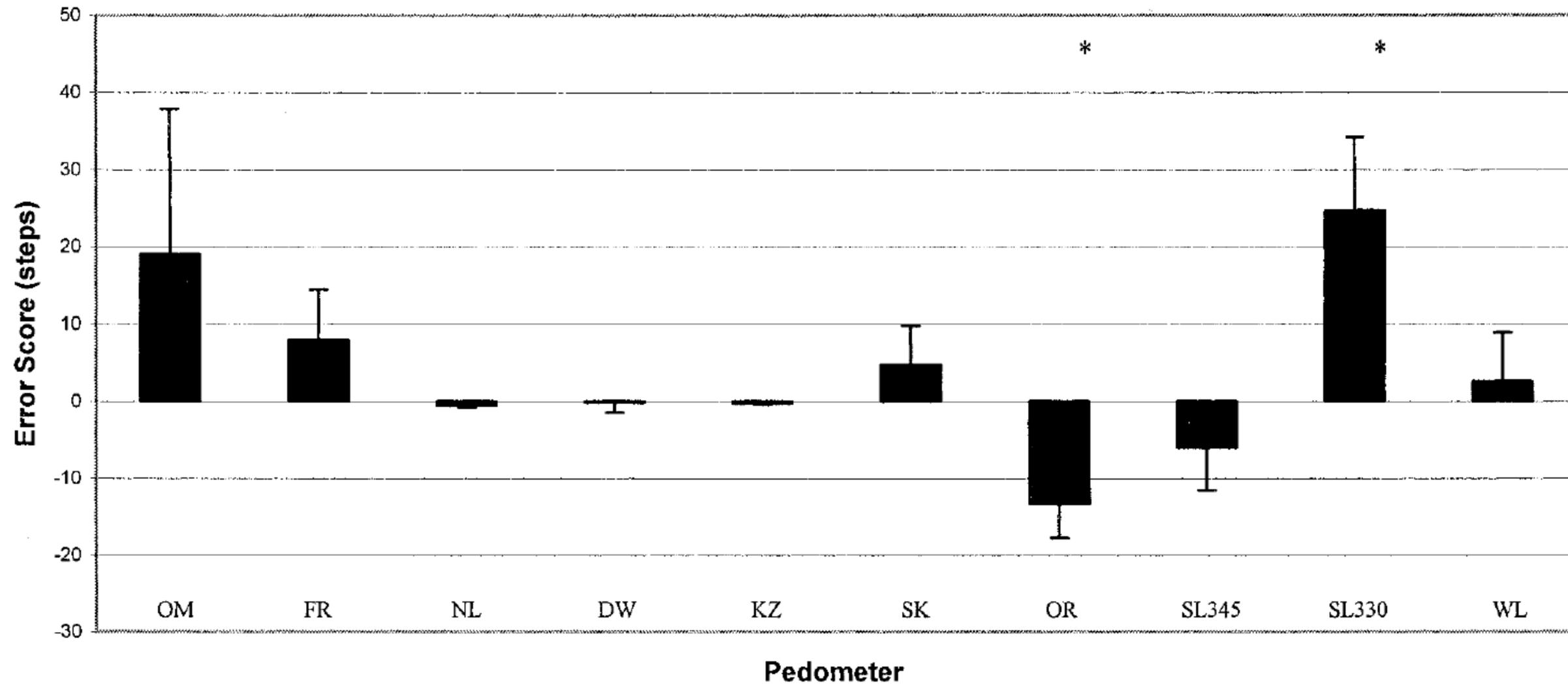


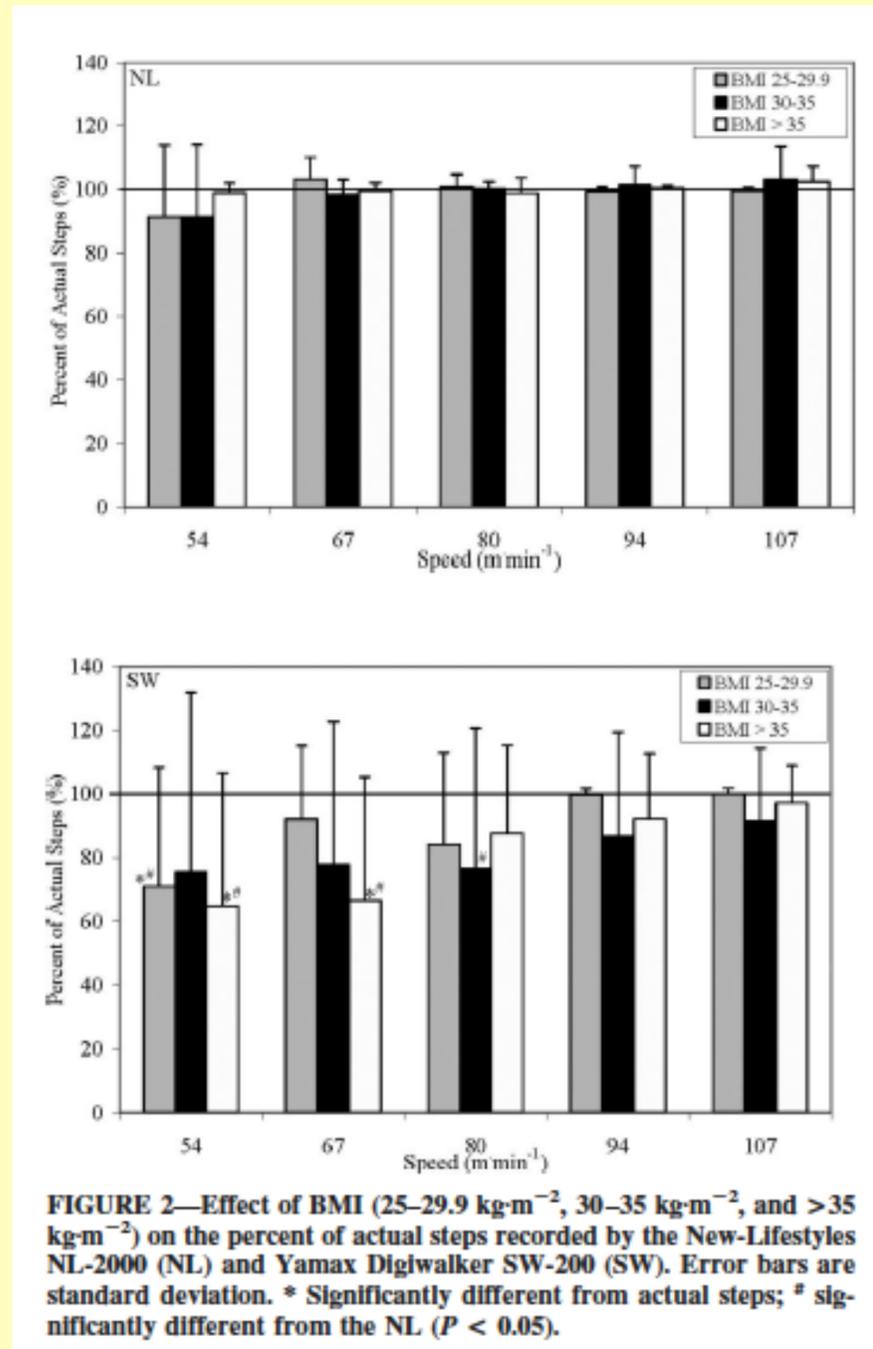
FIGURE 1—Mean error scores (actual – pedometer) \pm SE in number of steps during a 400-m track walk at self-selected speeds. * $P < 0.05$.

400-m step #

Schneider et al., 2003

Pedometer accuracy/validity

measures



(uniaxially accelerometric)

step #

(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 #

Vetrovsky et al. *BMC Public Health* (2018) 18:635
<https://doi.org/10.1186/s12889-018-5520-8>

BMC Public Health

RESEARCH ARTICLE

Open Access



A pedometer-based walking intervention with and without email counseling in general practice: a pilot randomized controlled trial

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and Vaclav Bunc¹

Pedometer

2018 study example

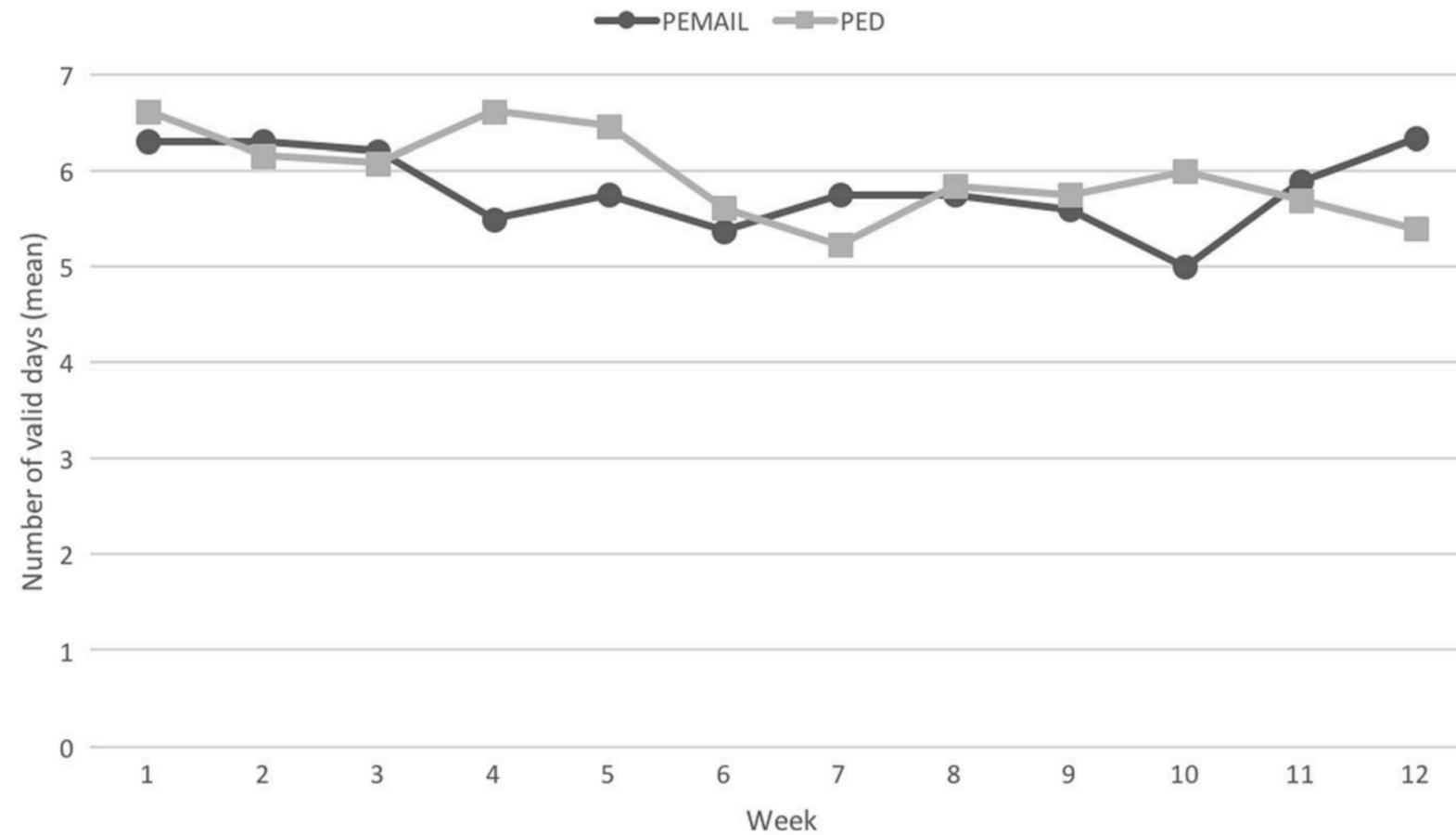


Fig. 2 Adherence to pedometer wear during the intervention period. The effect of time was significant ($P = 0.008$), whereas the effect of group was not

Pedometer

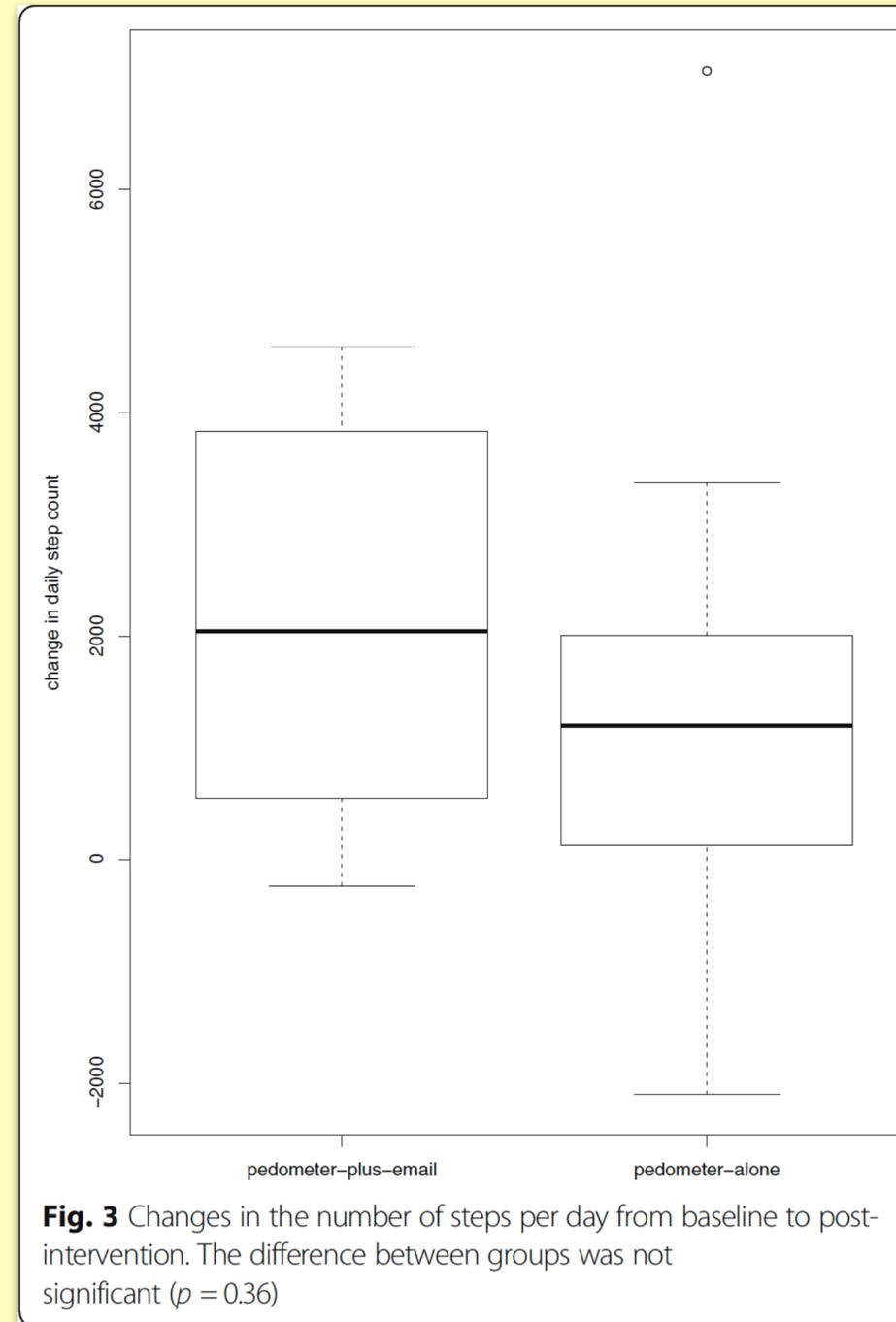
2018 study example

Table 1 Baseline characteristics of study participants, mean (SD)

	Pedometer-plus-email (<i>n</i> = 10)	Pedometer-alone (<i>n</i> = 13)
Age (yr)	44 (10)	39 (9)
BMI (kg/m ²)	33 (7)	33 (8)
Females (%)	30	62
Systolic blood pressure (mm Hg)	133 (9)	130 (18)
Diastolic blood pressure (mm Hg)	89 (10)	83 (15)
Waist circumference (cm)	114 (17)	102 (17)
Hip circumference (cm)	116 (10)	115 (17)
Steps per day	5034 (1431)	5050 (1393)

Pedometer

2018 study example



Pedometer

2018 study example

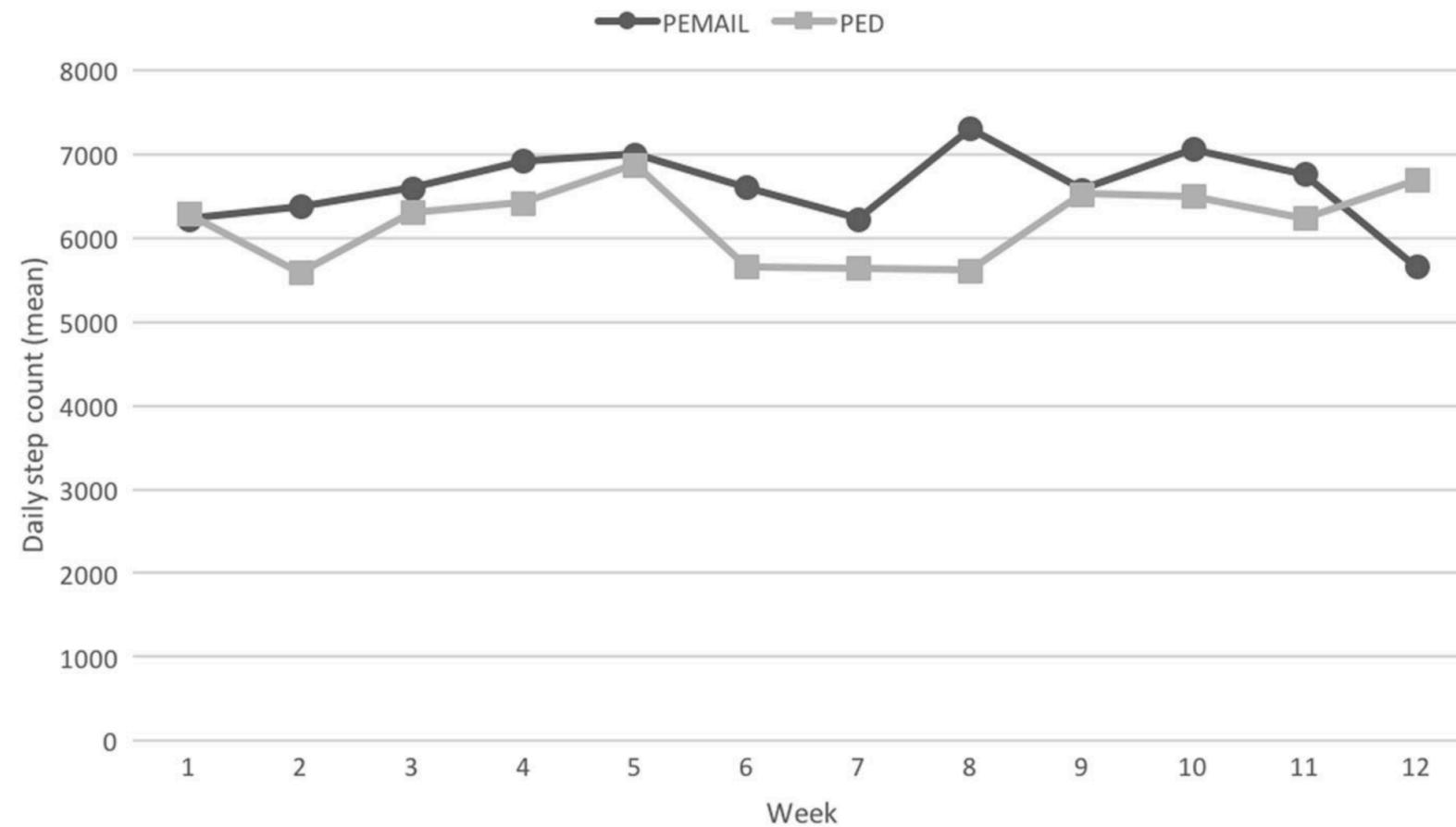


Fig. 4 Mean daily step count during the intervention period. No effect of group or time was observed

Pedometer

2018 study example

Table 2 Baseline (T0) and post-intervention (T12) values of both groups combined, mean (SD)

	T0	T12	Change	<i>p</i> value	Cohen's <i>d</i>
Steps per day	5043 (1377)	6719 (2359)	1676 (2066)	.0004	.87
Body mass (kg)	102.8 (21.7)	101.7 (21.6)	−0.7 (1.8)	.044	.05
Systolic blood pressure (mm Hg)	131.5 (14.3)	128.0 (12.4)	−3.5 (9.4)	.045	.26
Diastolic blood pressure (mm Hg)	85.5 (12.9)	83.7 (8.3)	−1.8 (9.7)	.193	.16
Waist circumference (cm)	107.2 (17.7)	105.4 (17.2)	−1.7 (4.0)	.029	.11
Hip circumference (cm)	115.4 (14.5)	114.8 (14.0)	−0.6 (5.0)	.292	.04