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

Friday 23/11/2018 8:30÷10

Luca P. Ardigò Ph.D.

A class within an eight-class module

Smartphone inclinometer

2018 study example 4

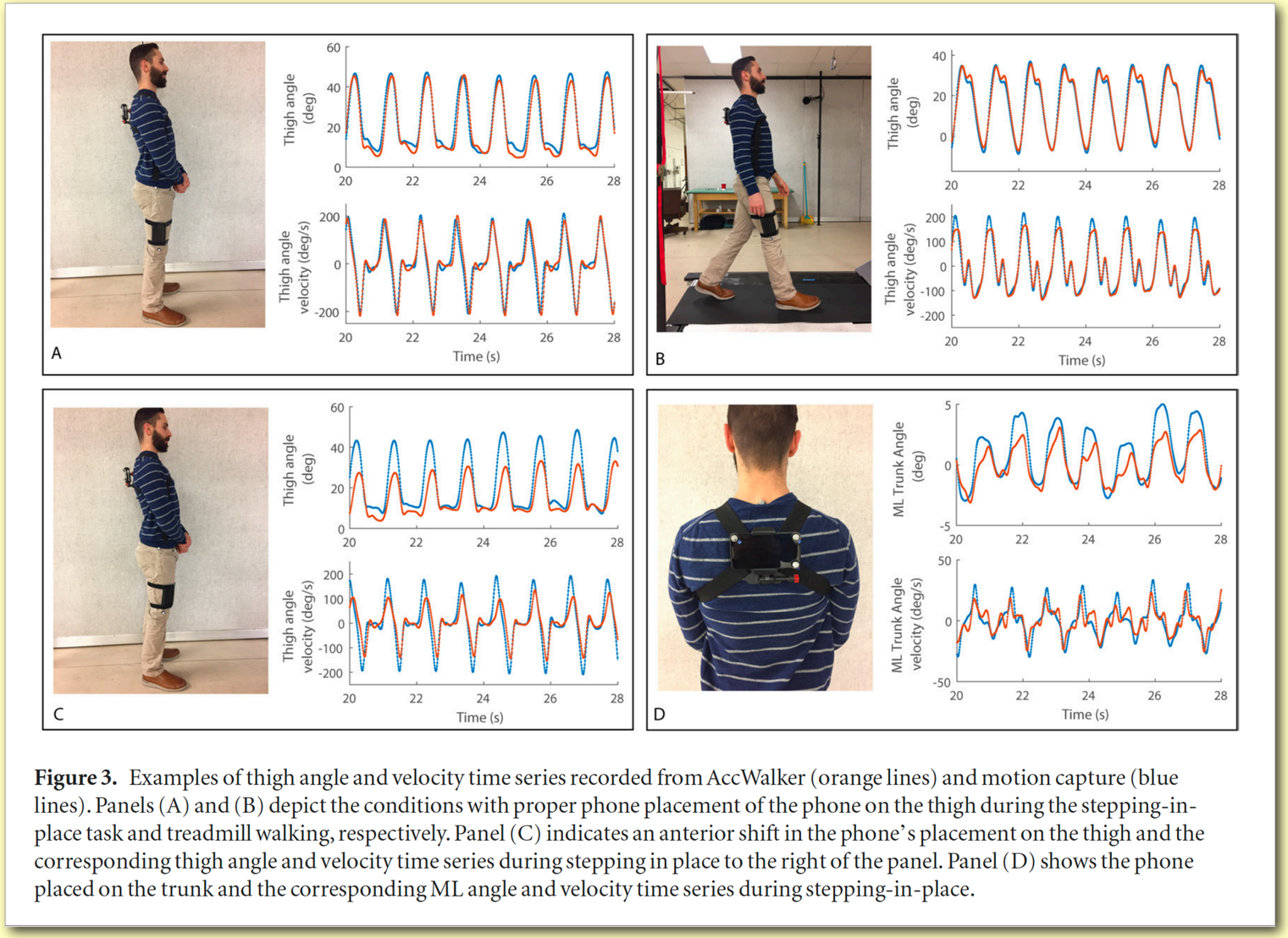

Figure 3. Examples of thigh angle and velocity time series recorded from AccWalker (orange lines) and motion capture (blue lines). Panels (A) and (B) depict the conditions with proper phone placement of the phone on the thigh during the stepping-in-place task and treadmill walking, respectively. Panel (C) indicates an anterior shift in the phone's placement on the thigh and the corresponding thigh angle and velocity time series during stepping in place to the right of the panel. Panel (D) shows the phone placed on the trunk and the corresponding ML angle and velocity time series during stepping-in-place.

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Table 1. Thigh and trunk metrics calculated from 3D motion capture and AccWalker during stepping in place when the phone was properly placed on the thigh (see figure 3(A)).

		Motion capture		AccWalker		Bland–Altman LOA						
	Unit	Mean	SD	Mean	SD	Bias	Bias *p*-value	Bias Effect Size	SD	Lower 95% CI	Upper 95% CI	ICC (3,k)
Temporal metrics												
Mean stride time	s	1.14	0.04	1.14	0.04	0.000	0.18	0.00	0.001	−0.001	0.001	1.00
CV stride time	%	2.06	0.32	2.07	0.32	0.01	0.31	−0.04	0.07	−0.11	0.15	1.00
ACF1	a.u.	0.31	0.16	0.30	0.15	−0.01	0.57	0.04	0.06	−0.13	0.11	0.98
Pace drift	s	0.04	0.02	0.04	0.02	0.00	0.48	0.01	0.00	0.00	0.00	1.00
Spatial metrics												
Peak thigh SD	deg	1.99	0.57	2.11	0.55	0.12	0.00	−0.15	0.08	−0.05	0.28	1.00
Thigh ROM	deg	44.03	8.54	46.63	8.57	2.65	<.001	−0.22	1.36	−0.07	5.37	0.99
Peak lift vel SD	deg/s	11.90	2.95	10.91	2.30	−0.99	0.02	0.27	1.21	−3.41	1.43	0.96
Peak return vel SD	deg/s	12.23	2.69	13.98	3.63	1.76	0.00	−0.39	1.32	−0.88	4.39	0.96
Trunk												
ML SD	deg	1.41	0.43	1.61	0.50	0.20	0.14	−0.30	0.39	−0.57	0.97	0.83
ML velocity SD	deg/s	8.24	2.53	9.88	2.57	1.64	0.03	−0.46	1.93	−2.20	5.48	0.85

Note. SD—standard deviation, bias—average difference between the 3D motion capture and AccWalker, SD LOA—standard deviation of the difference between the 3D motion capture and AccWalker, bias *p*-value—*t*-test comparison of the AccWalker to motion capture. Effect size was calculated using Cohen's pooled variance formula.

Smartphone inclinometer

2018 study example 4

Table 2. Average thigh and trunk metrics calculated from 3D motion capture and AccWalker, and the results of Bland–Altman LOA test when the phone was placed more anteriorly on the leg (see figure 3(C)).

		Motion capture		AccWalker		Bland–Altman LOA						
	Unit	Mean	SD	Mean	SD	Bias	Bias *p*-value	Bias effect size	SD	Lower 95% CI	Upper 95% CI	ICC (3,1)
Temporal metrics												
Mean stride time	s	1.13	0.04	1.13	0.04	0.000	0.56	−0.002	0.001	−0.001	0.001	1.00
CV stride time	%	1.88	0.30	1.98	0.33	0.10	0.05	−0.23	0.13	−0.16	0.37	0.91
ACF1	a.u.	0.18	0.14	0.11	0.11	−0.07	0.08	0.37	0.10	−0.26	0.13	0.71
Pace drift	s	0.02	0.01	0.02	0.01	0.00	0.34	0.02	0.00	0.00	0.00	1.00
Spatial metrics												
Peak thigh SD	deg	1.98	0.57	1.91	0.60	−0.08	0.31	0.09	0.21	−0.49	0.33	0.94
Thigh ROM	deg	40.56	6.85	29.09	7.15	−11.47	0.00	1.16	4.68	−20.64	−2.30	0.78
Peak lift vel SD	deg/s	12.52	3.19	10.78	2.53	−1.74	0.01	0.43	1.66	−5.00	1.52	0.83
Peak return vel SD	deg/s	11.31	3.49	11.27	4.48	−0.04	0.93	0.01	1.44	−2.86	2.78	0.94

Note. SD—standard deviation, bias—average difference between the 3D motion capture and AccWalker, SD LOA—standard deviation of the difference between the 3D motion capture and AccWalker, SD LOA/SD—ratio of the SD LOA to SD of the 3D motion capture (expressed as percentage).

Smartphone pedometer

2018 study example 5

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Walk this way: validity evidence of iphone health application step count in laboratory and free-living conditions

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Smartphone pedometer

2018 study example 5

Table 2. Summary of step data.

Assessment	Mean steps (SD)/n
Lab Test	
2.5km/h (n = 32)	
Manual Count	92.6 (9.6)
Criterion iPhone	85.5 (16.0)
Personal iPhone	84.2 (17.0)
5km/h (n = 33)	
Manual Count	123.2 (9.4)
Criterion iPhone	120.0 (9.3)
Personal iPhone	119.3 (10.3)
7.5km/h (n = 33)	
Manual Count	158.9 (13.9)
Criterion iPhone	151.9 (15.6)
Personal iPhone	152.5 (15.5)
10km/h (n = 33)	
Manual Count	171.4 (14.2)
Criterion iPhone	165.4 (16.6)
Personal iPhone	166.2 (16.9)
Free-Living Test (n = 31)	
Best Day	
iPhone	7314.6 (4201.3)
Accelerometer	8297.0 (4016.3)
Average Day	
iPhone	6701.5 (2629.6)
Accelerometer	8043.2 (2503.8)
Accelerometer Wear	
3 Valid Days	26
2 Valid Days	3
1 Valid Day	2
Total Valid Days	86
Mean Wear Time (h per Valid Day per person)	12.6 (2.2)

Smartphone pedometer

2018 study example 5

Table 3. Lab test analyses.

		Bland-Altman Analysis			Paired T-test				
Comparison	n	Mean (SD) Bias %	Lower Limit of Agreement (95% CI)	Upper Limit of Agreement (95% CI)	t	df	p	Rank	BH correction (α)
2.5km/h									
Criterion vs Manual	32	−7.6 (14.8)	−36.7 (−41.2 to −32.1)	21.5 (16.9 to 26.0)	2.95	31	0.006*	8	0.033
Personal vs Manual	32	−9.4 (16.2)	−41.2 (−46.2 to −36.2)	22.4 (17.4 to 27.4)	3.28	31	0.003*	6	0.025
Personal vs Criterion	32	−1.3 (15.9)	−32.5 (−37.4 to −27.6)	30.0 (25.1 to 34.8)	0.45	31	0.654	12	0.050
5km/h									
Criterion vs Manual	33	−2.8 (2.4)	−7.6 (−8.4 to −6.9)	2.0 (1.2 to 2.7)	6.66	32	<0.001*	1	0.004
Personal vs Manual	33	−3.2 (2.8)	−8.7 (−9.5 to −7.8)	2.3 (1.4 to 3.1)	6.57	32	<0.001*	2	0.008
Personal vs Criterion	33	−0.4 (2.6)	−5.5 (−6.3 to −4.7)	4.8 (4.0 to 5.6)	0.80	32	0.431	10	0.042
7.5km/h									
Criterion vs Manual	33	−4.3 (6.7)	−17.4 (−19.5 to −15.4)	8.8 (6.8 to 10.8)	3.69	32	0.001*	4	0.017
Personal vs Manual	33	−4.1 (4.8)	−13.5 (−15.0 to −12.1)	5.4 (4.0 to 6.9)	4.82	32	<0.001*	3	0.013
Personal vs Criterion	33	0.4 (4.4)	−8.2 (−9.5 to −6.9)	9.0 (7.7 to 10.3)	0.52	32	0.606	11	0.046
10km/h									
Criterion vs Manual	33	−3.5 (6.1)	−15.4 (−17.2 to −13.6)	8.4 (6.6 to 10.2)	3.30	32	0.002*	5	0.021
Personal vs Manual	33	−3.1 (5.6)	−14.1 (−15.8 to −12.4)	8.0 (6.3 to 9.7)	3.11	32	0.004*	7	0.029
Personal vs Criterion	33	0.5 (2.8)	−5.0 (−5.9 to −4.2)	6.0 (5.1 to 6.8)	0.96	32	0.346	9	0.038

		Intraclass Correlation Coefficient				
Comparison	n	ICC	95% CI	p	Rank	BH correction (α)
2.5km/h						
Criterion vs Manual	32	0.46	0.13 to 0.70	0.001*	11	0.046
Personal vs Manual	32	0.34	0.004 to 0.61	0.024*	12	0.050
Personal vs Criterion	32	0.84	0.70 to 0.92	<0.001*	6	0.025
5km/h						
Criterion vs Manual	33	0.89	0.27 to 0.97	<0.001*	4	0.017
Personal vs Manual	33	0.87	0.76 to 0.93	<0.001*	5	0.021
Personal vs Criterion	33	0.95	0.90 to 0.97	<0.001*	2	0.008
7.5km/h						
Criterion vs Manual	33	0.65	0.29 to 0.83	<0.001*	10	0.042
Personal vs Manual	33	0.74	0.59 to 0.88	<0.001*	8	0.033
Personal vs Criterion	33	0.92	0.84 to 0.96	<0.001*	3	0.013
10km/h						
Criterion vs Manual	33	0.72	0.42 to 0.87	<0.001*	9	0.038
Personal vs Manual	33	0.77	0.58 to 0.88	<0.001*	7	0.029
Personal vs Criterion	33	0.96	0.92 to 0.98	<0.001*	1	0.004

*Significant with Benjamini-Hochberg (BH) correction

Smartphone pedometer

2018 study example 5

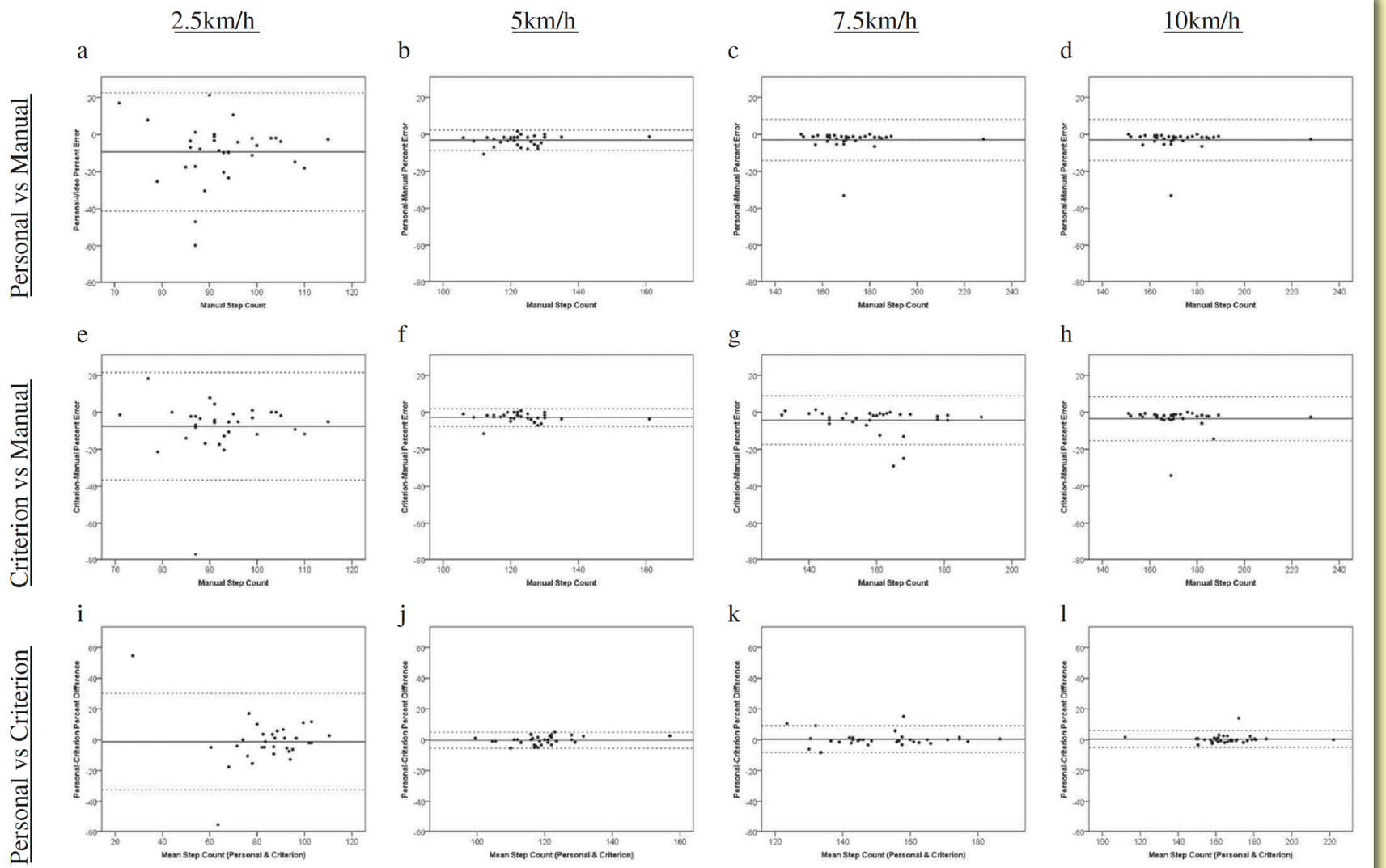


Figure 1. a–l. Laboratory test Bland-Altman plots at carying speeds.

Note: Solid lines indicate mean bias, dotted lines indicate 95% limits of agreement.

Smartphone pedometer

2018 study example 5

Table 4. Free-living test analyses.

		Bland-Altman Analysis			Paired T-test				
Comparison	n	Mean (SD) Bias	Lower Limit of Agreement (95% CI)	Upper Limit of Agreement (95% CI)	t	df	p	Rank	BH correction (α)
Steps									
Best Day	31	−982.4 (1153.0)	−3242.4 (−3601.1 to −2883.7)	1277.5 (918.8 to 1636.2)	4.74	30	<0.001*	3	0.038
Average Day	31	−1341.8 (1507.8)	−4297.1 (−4766.2 to −3828.0)	1613.6 (1144.5 to 2082.6)	4.96	30	<0.001*	2	0.025
Percent Difference									
Best Day	31	−18.2 (23.2)	−63.7 (−70.9 to −56.5)	27.27 (20.1 to 34.5)	4.37	30	<0.001*	4	0.050
Average Day	31	−21.5 (23.7)	−68.0 (−75.3 to −60.6)	24.88 (17.5 to 32.3)	5.06	30	<0.001*	1	0.013

		Intraclass Correlation Coefficient				
Comparison	n	ICC	95% CI	p	Rank	BH correction (α)
Steps						
Best Day	31	0.94	0.69 to 0.98	0.000*	1	0.025
Average Day	31	0.73	0.21 to 0.90	0.024*	2	0.050
Percent Difference						
Best Day		NA				
Average Day		NA				

*Significant with Benjamini-Hochberg (BH) correction, NA = Not applicable

Smartphone pedometer

2018 study example 5

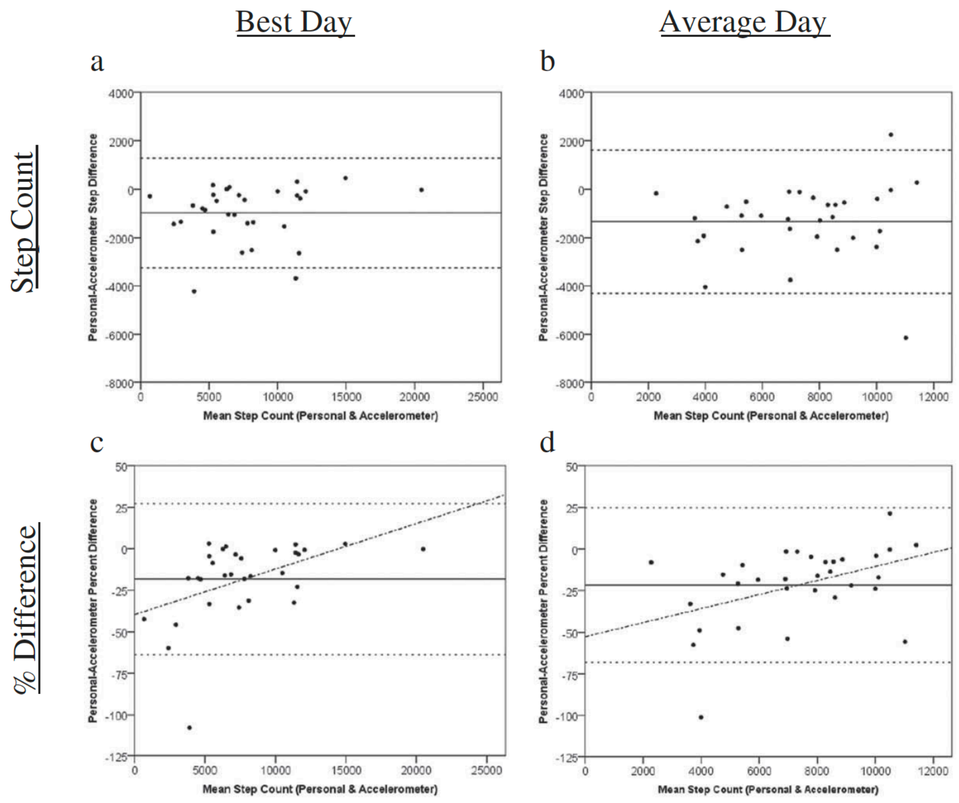


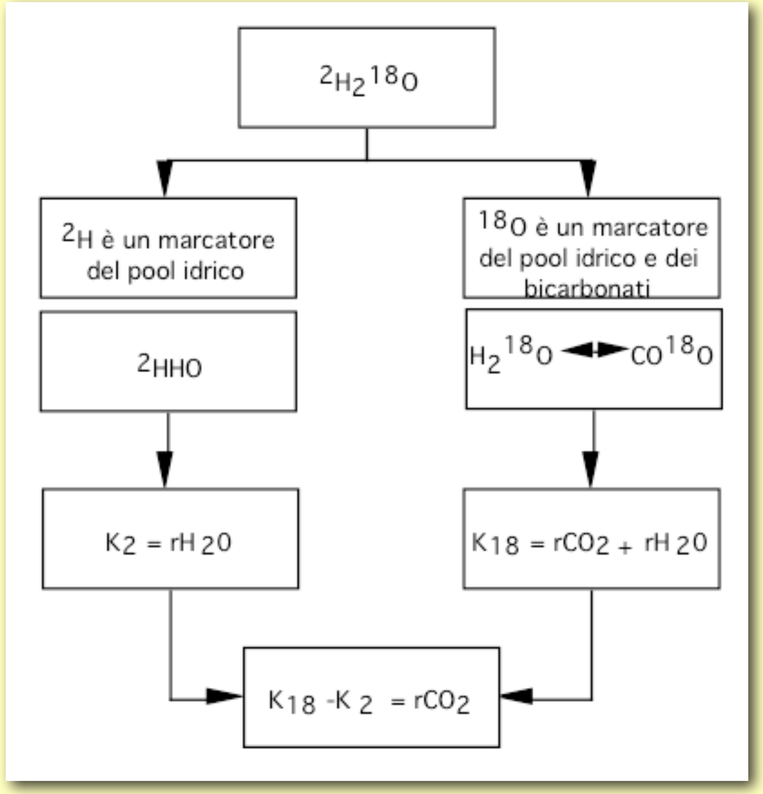
Figure 2. a–d. Free-Living Bland-Altman plots by method.

Note: Solid lines indicate mean bias, dotted lines indicate 95% limits of agreement, dashed lines indicate regression lines when significant.

DLW method

- Lifson et al., 1955;
- (small animals) 1975;
- validation by Scholler et al., 1982;
- (premature infants, children, pregnant and lactating women, elderly, obese people, hospitalized patients);
- subject is administered a dose of stable isotope $^{2}H_2{}^{18}O$, which (^{2}H, ^{18}O) equilibrates relatively quickly with body water (H, O);
- ^{2}H is eliminated as $^{2}H_2O$ (breath, urine, sweat, perspiratio insensibilis), while the ^{18}O is eliminated either as $H_2{}^{18}O$ (breath, ...) and as $C^{18}O_2$ (breathe only);
- difference between the two rates of elimination -> V'CO2 -> ME

DLW method


$^{2}H_2{}^{18}O$
^{2}H è un marcatore del pool idrico
^{18}O è un marcatore del pool idrico e dei bicarbonati
^{2}HHO
$H_2{}^{18}O \leftrightarrow CO^{18}O$
$K_2 = rH_2O$
$K_{18} = rCO_2 + rH_2O$
$K_{18} - K_2 = rCO_2$

measures

DLW method

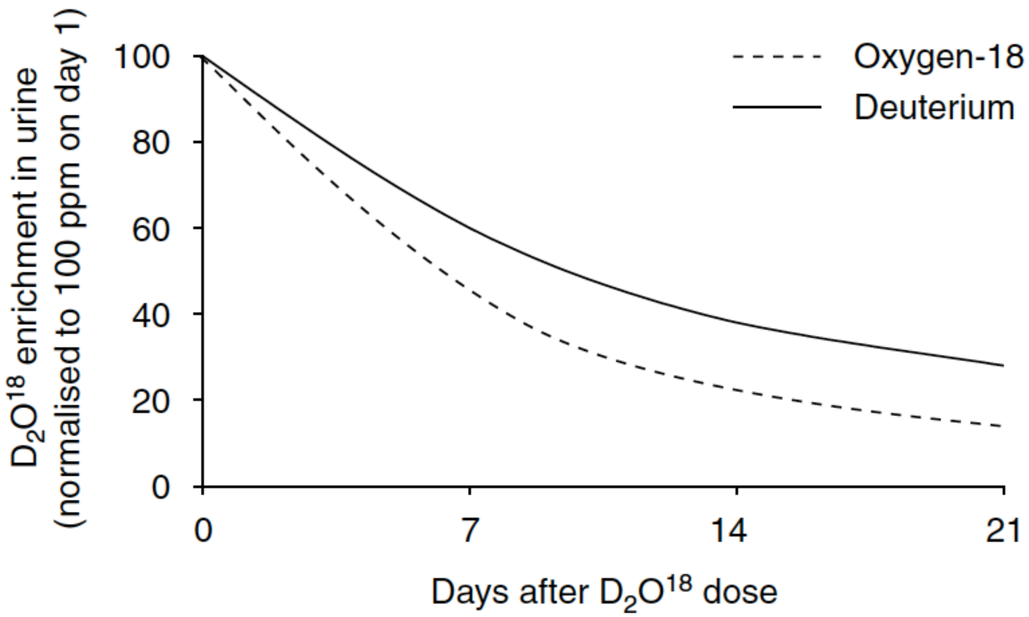


Fig. 1. Decline of ^{2}H (deuterium [D]) and ^{18}O in body fluids (urine, plasma or saliva) during a hypothetical doubly labelled water experiment.

DLW method

- RQ (= V'CO2 / V'O2) estimate -> accuracy:
  - . standard Western diet -> RQ estimate;
  - . food intake diary -> RQ estimate (i.e., food quotient ≈ RQ);
  - . indirect calorimetry -> RQ

$$FQ = 1.0 \times CA + 0.7 \times F + 0.79 \times P + 0.66 \times A \quad (7)$$

where CA is the percent of energy in the diet consisting of carbohydrates, F is the percent that is fat, P is the percent protein, and A is the percent alcohol. Data on human macronutrient intake for the USA, based

DLW method

DLW method issues

- inability to discriminate the contribution of individual PAs (types, amount, intensity of each type) to ME;
- costs: isotopes and tools to detect them (i.e., mass spectrophotometers) still have considerable costs;
- -> only 3-4 ÷ 21 d ME;
- unknown RQ -> 5% e

measures

DLW method

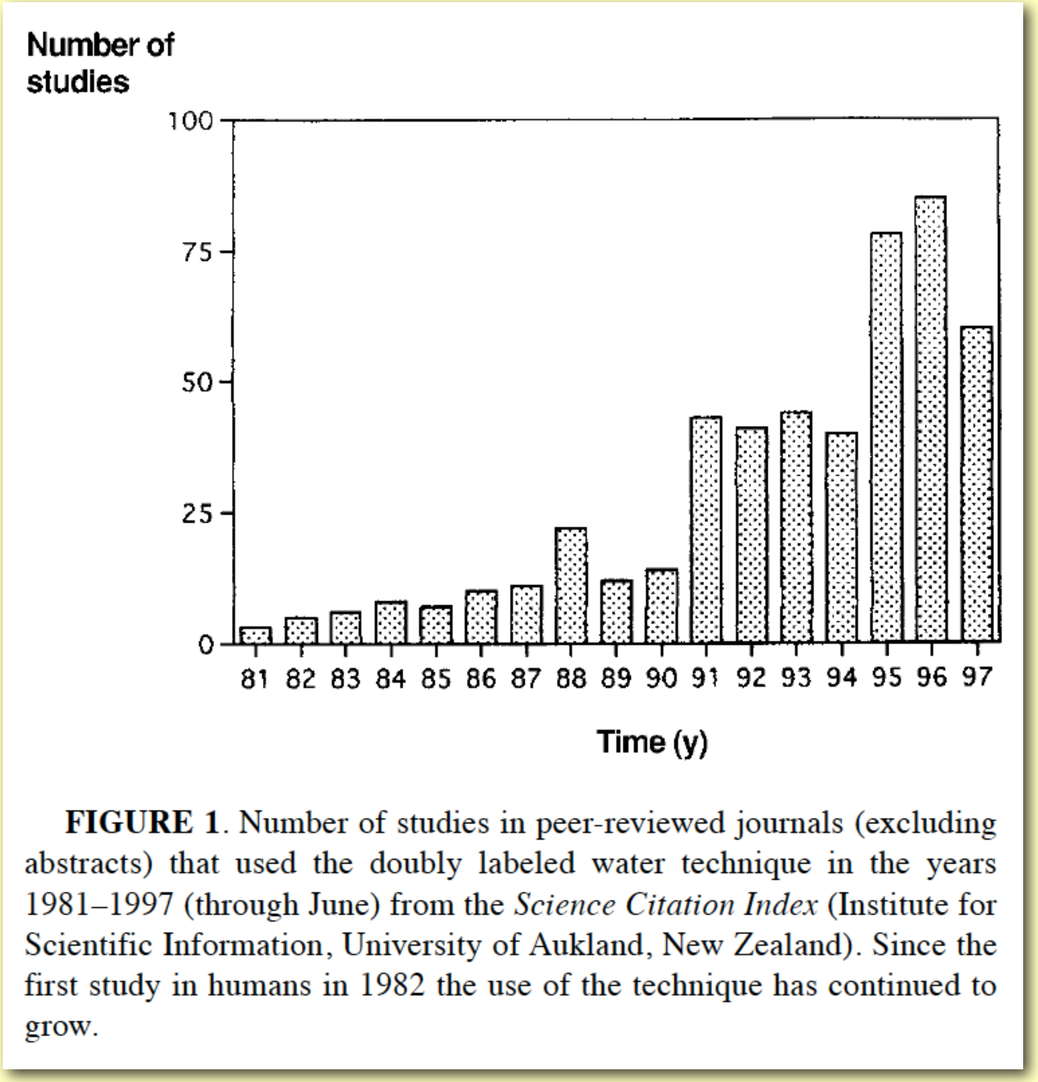


FIGURE 1. Number of studies in peer-reviewed journals (excluding abstracts) that used the doubly labeled water technique in the years 1981–1997 (through June) from the *Science Citation Index* (Institute for Scientific Information, University of Aukland, New Zealand). Since the first study in humans in 1982 the use of the technique has continued to grow.

Accelerometer & PAR vs. DLW

2018 study example 1

European Journal of Applied Physiology
https://doi.org/10.1007/s00421-018-3944-6

ORIGINAL ARTICLE

Validity of a triaxial accelerometer and simplified physical activity record in older adults aged 64–96 years: a doubly labeled water study

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Abstract

Background The aim was to examine the validity of a triaxial accelerometer (ACCTRI) and a simplified physical activity record (sPAR) in estimating total energy expenditure (TEE) and physical activity level (PAL) in older adults with the doubly labeled water (DLW) method.

Methods A total of 44 Japanese elderly individuals (64–96 years), of which 28 were community-dwelling healthy adults with or without sporting habits (S or NS group) and 16 were care home residents with frailty (F group), were included in the study. Basal metabolic rate (BMR) was measured by indirect calorimetry, TEE was obtained by the DLW method, and PAL was calculated as TEE/BMR. Daily step count was monitored by a pedometer (Lifecorder). The 24-h average metabolic

Accelerometer & PAR vs. DLW

2018 study example 1

Table 1 Physical characteristics, body composition, energy expenditure, and physical activity of the subjects ($n = 44$)

	Community-dwelling older adults with sporting habits $n = 9$ (M6/W3)	Community-dwelling older adults without sporting habits $n = 19$ (M6/W13)	Care home residents with frailty $n = 16$ (M8/W8)
Age (years)	71 ± 5	74 ± 7	84 ± 8
Height (cm)	162.8 ± 7.7	150.8 ± 6.9	150.9 ± 9.5
Weight (kg)	55.9 ± 10.1	51.3 ± 8.0	50.6 ± 9.5
BMI	21.0 ± 2.1	22.4 ± 2.5	22.4 ± 4.6
Percent fat (%)	26.7 ± 7.0	33.8 ± 5.7	27.9 ± 11.1
TBW (kg)	29.8 ± 4.9	24.8 ± 4.5	26.4 ± 4.3
FFM (kg)	40.8 ± 6.7	33.9 ± 6.2	36.0 ± 5.9
FM (kg)	15.2 ± 5.6	17.4 ± 4.0	14.6 ± 7.5
mBMR (kcal d^{-1})	1210 ± 154	1084 ± 169	1046 ± 192
eBMR (kcal d^{-1})	1188 ± 135	1067 ± 137	1036 ± 103
TEE_{DLW} (kcal d^{-1})	2556 ± 372	2044 ± 377	1608 ± 354
AEE_{DLW} (kcal d^{-1})	1091 ± 263	756 ± 258	401 ± 226
AEE_{DLW}/Wt (kcal kg^{-1} d^{-1})	19.7 ± 4.1	15.1 ± 6.3	8.2 ± 5.1
PAL_{DLW}	2.12 ± 0.23	1.90 ± 0.29	1.54 ± 0.24
24-h average METs of ACCTRI	1.80 ± 0.17	1.66 ± 0.14	1.27 ± 0.10
TEE of ACCTRI without DIT (kcal d^{-1})	2128 ± 258	1771 ± 251	1317 ± 377
$(TEE_{DLW} - TEE_{ACCTRI})/TEE_{DLW} \times 100$ (%)	− 16.2 ± 8.8	− 12.2 ± 10.5	− 15.6 ± 14.3
TEE of ACCTRI with DIT (kcal d^{-1})	2364 ± 287	1968 ± 279	1463 ± 173
PAL of ACCTRI corrected with DIT	2.00 ± 0.19	1.85 ± 0.15	1.41 ± 0.11
TEE of sPAR without DIT (kcal d^{-1})	2153 ± 359	1729 ± 319	1347 ± 185
$(TEE_{DLW} - TEE_{sPAR})/TEE_{DL} \times 100$ (%)	− 15.6 ± 8.2	− 14.6 ± 11.3	− 16.1 ± 16.4
TEE of sPAR with DIT (kcal d^{-1})	2393 ± 399	1921 ± 354	1497 ± 205
PAL of sPAR corrected with DIT	2.01 ± 0.21	1.80 ± 0.20	1.44 ± 0.09
Step count (d^{-1})	9568 ± 4496	8334 ± 3591	2130 ± 2075
Nd/No	1.037 ± 0.011	1.034 ± 0.012	1.038 ± 0.010

BMI body mass index, *TBW* total body water, *FFM* fat-free mass, *FM* fat mass, *BMR* measured basal metabolic rate, *eBMR* estimated BMR by the fifth Japanese recommended dietary allowance equation, *TEE* total energy expenditure, *AEE* activity energy expenditure, *AEE/Wt* AEE divided by weight, *PAL* physical activity level, *ACCTRI* triaxial accelerometer, *DIT* diet-induced thermogenesis, *sPAR* simplified physical activity record, *Nd/No* stable isotope dilution space ratio of ^{2}H and ^{18}O

Accelerometer & PAR vs. DLW

2018 study example 1

Table 2 Physical characteristics, body composition, energy expenditure, and physical activity of men ($n=20$) and women ($n=24$)

	Men ($n=20$)			Women ($n=24$)		
	Community-dwelling older adults with sporting habits	Community-dwelling older adults without sporting habits	Care home residents with frailty	Community-dwelling older adults with sporting habits	Community-dwelling older adults without sporting habits	Care home residents with frailty
	$n=6$	$n=6$	$n=8$	$n=3$	$n=13$	$n=8$
Age (years)	73 ± 5	73 ± 9	82 ± 8	69 ± 4	75 ± 6	87 ± 7
Height (cm)	165.7 ± 7.3	157.2 ± 7.4	158.8 ± 4.9	157.0 ± 5.6	147.9 ± 4.4	143.0 ± 5.0
Weight (kg)	60.3 ± 9.8	58.4 ± 5.7	49.7 ± 9.2	47.2 ± 1.2	48.0 ± 6.8	51.5 ± 10.3
BMI	21.8 ± 2.0	23.6 ± 1.3	19.7 ± 3.4	19.2 ± 1.0	21.9 ± 2.8	25.1 ± 4.2
Percent fat (%)	27.2 ± 6.3	29.0 ± 2.3	20.4 ± 9.1	25.8 ± 9.7	36.0 ± 5.4	35.3 ± 7.4
TBW (kg)	31.9 ± 4.0	30.4 ± 3.6	28.6 ± 3.3	25.7 ± 4.1	22.3 ± 1.7	24.2 ± 4.2
FFM (kg)	43.6 ± 5.5	41.5 ± 4.9	39.0 ± 4.6	35.1 ± 5.5	30.4 ± 2.3	33.0 ± 5.7
FM (kg)	16.7 ± 5.8	16.9 ± 1.4	10.7 ± 6.3	12.1 ± 4.3	17.6 ± 4.8	18.5 ± 6.8
mBMR (kcal d^{-1})	1269 ± 145	1242 ± 167	1117 ± 144	1090 ± 103	1011 ± 114	975 ± 217
eBMR (kcal d^{-1})	1255 ± 112	1205 ± 124	1082 ± 90	1054 ± 36	1003 ± 88	990 ± 99
TEE_{DLW} (kcal d^{-1})	2704 ± 353	2308 ± 442	1795 ± 338	2260 ± 208	1922 ± 285	1421 ± 274
AEE_{DLW} (kcal d^{-1})	1165 ± 295	835 ± 281	498 ± 259	944 ± 97	719 ± 250	303 ± 144
AEE_{DLW}/Wt (kcal kg^{-1} d^{-1})	19.6 ± 5.1	14.2 ± 4.6	10.5 ± 6.0	20.0 ± 1.6	15.6 ± 7.0	5.8 ± 2.7
PAL_{DLW}	2.14 ± 0.29	1.85 ± 0.23	1.61 ± 0.26	2.07 ± 0.07	1.92 ± 0.32	1.47 ± 0.21
24-h average METs of ACCTRI	1.76 ± 0.19	1.59 ± 0.14	1.26 ± 0.10	1.87 ± 0.10	1.70 ± 0.12	1.29 ± 0.11
TEE of ACCTRI without DIT (kcal d^{-1})	2209 ± 286	1924 ± 323	1357 ± 132	1966 ± 57	1700 ± 184	1277 ± 176
$(TEE_{DLW} - TEE_{ACCTRI})/TEE_{DLW} \times 100$ (%)	−17.9 ± 9.9	−16.2 ± 5.2	−22.5 ± 13.4	−12.6 ± 6.2	−10.3 ± 11.9	−8.8 ± 12.4
TEE of ACCTRI with DIT (kcal d^{-1})	2454 ± 318	2138 ± 358	1508 ± 147	2185 ± 63	1889 ± 204	1418 ± 195
PAL of ACCTRI corrected with DIT	1.96 ± 0.21	1.76 ± 0.15	1.39 ± 0.11	2.07 ± 0.11	1.88 ± 0.14	1.43 ± 0.11
TEE of sPAR without DIT (kcal d^{-1})	2245 ± 388	1959 ± 448	1414 ± 180	1971 ± 250	1622 ± 173	1281 ± 176
$(TEE_{DLW} - TEE_{sPAR})/TEE_{DLW} \times 100$ (%)	−16.9 ± 9.5	−15.3 ± 9.6	−24.4 ± 17.9	−12.9 ± 5.4	−14.4 ± 12.3	−9.1 ± 12.2
TEE of sPAR with DIT (kcal d^{-1})	2494 ± 431	2177 ± 498	1571 ± 200	2409 ± 306	1983 ± 212	1565 ± 216
PAL of sPAR corrected with DIT	1.98 ± 0.22	1.79 ± 0.31	1.44 ± 0.09	20.7 ± 0.11	1.80 ± 0.13	1.44 ± 0.09
Step count (d^{-1})	9034 ± 5022	7925 ± 4625	3028 ± 2398	10637 ± 3903	8523 ± 3211	1231 ± 1276
Nd/no	1.035 ± 0.012	1.033 ± 0.011	1.038 ± 0.009	1.041 ± 0.009	1.034 ± 0.012	1.037 ± 0.011

BMI body mass index, *TBW* total body water, *FFM* fat-free mass, *FM* fat mass, *mBMR* measured basal metabolic rate, *eBMR* estimated BMR by the fifth Japanese recommended dietary allowance equation, *TEE* total energy expenditure, *AEE* activity energy expenditure, *AEE/Wt* AEE divided by weight, *PAL* physical activity level, *ACCTRI* triaxial accelerometer, *DIT* diet-induced thermogenesis, *sPAR* simplified physical activity record, *Nd/No* stable isotope dilution space ratio of ^{2}H and ^{18}O

Accelerometer & PAR vs. DLW

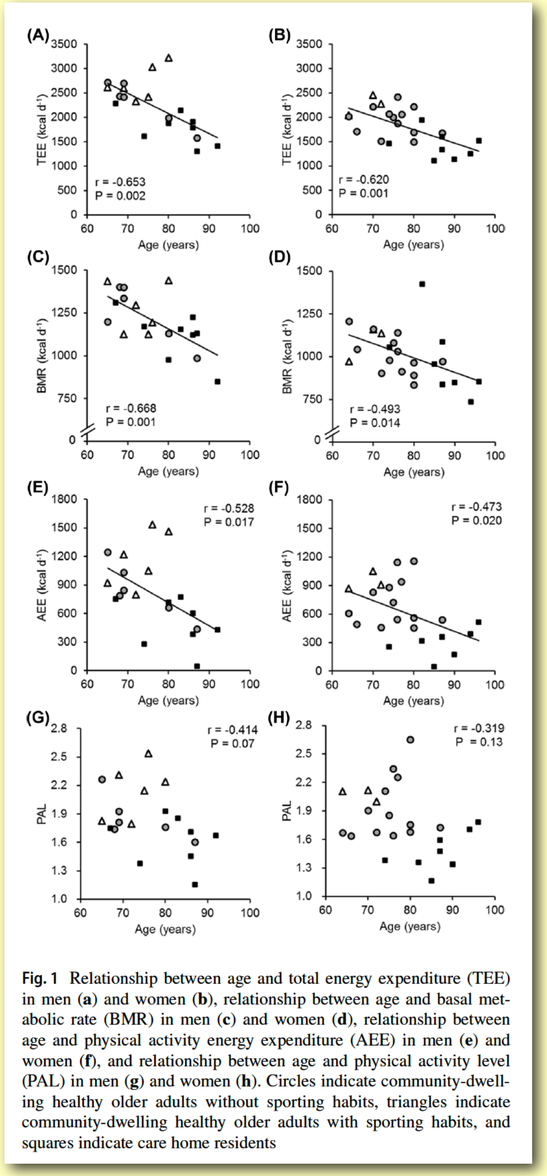


Fig. 1 Relationship between age and total energy expenditure (TEE) in men (**a**) and women (**b**), relationship between age and basal metabolic rate (BMR) in men (**c**) and women (**d**), relationship between age and physical activity energy expenditure (AEE) in men (**e**) and women (**f**), and relationship between age and physical activity level (PAL) in men (**g**) and women (**h**). Circles indicate community-dwelling healthy older adults without sporting habits, triangles indicate community-dwelling healthy older adults with sporting habits, and squares indicate care home residents

Accelerometer & PAR vs. DLW

2018 study example 1

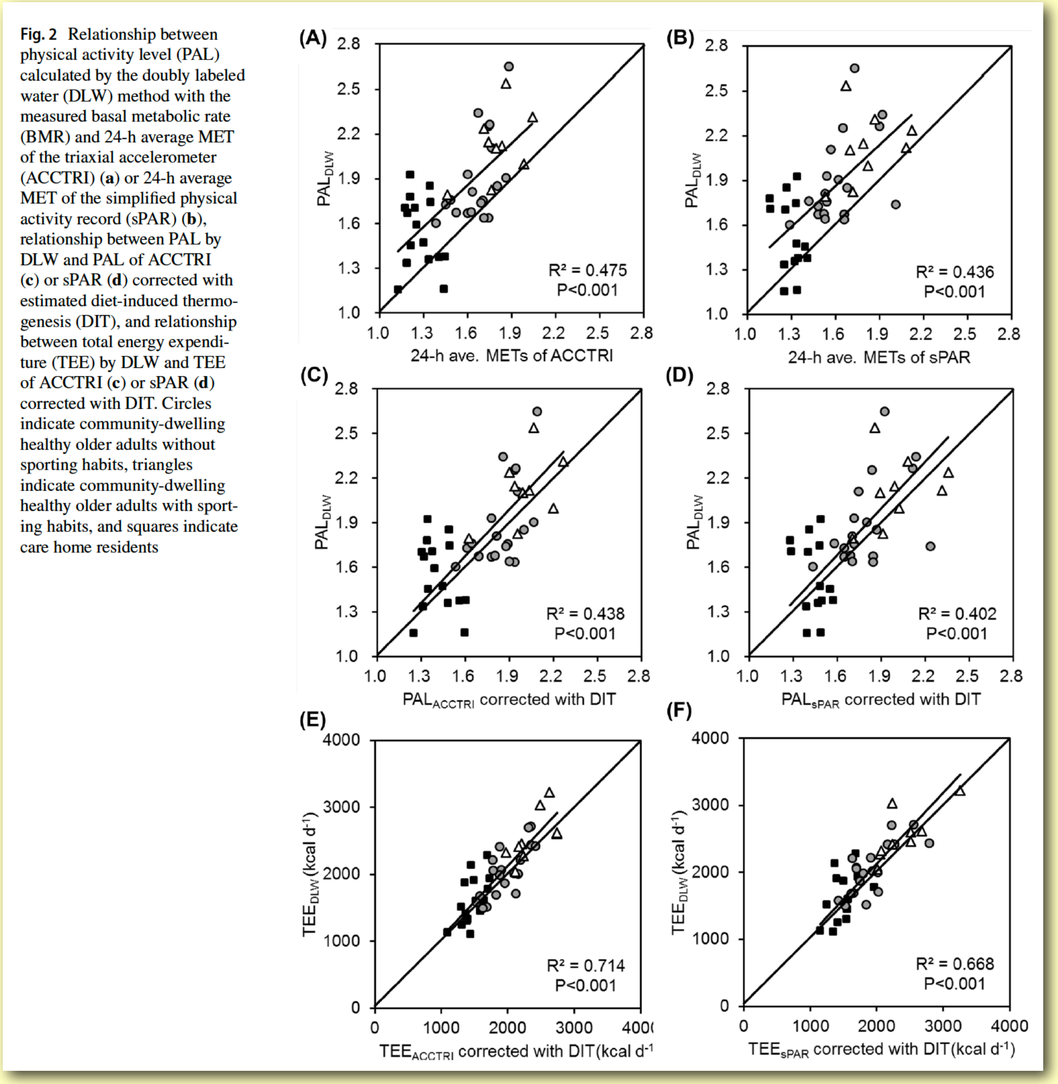


Fig. 2 Relationship between physical activity level (PAL) calculated by the doubly labeled water (DLW) method with the measured basal metabolic rate (BMR) and 24-h average MET of the triaxial accelerometer (ACCTRI) (**a**) or 24-h average MET of the simplified physical activity record (sPAR) (**b**), relationship between PAL by DLW and PAL of ACCTRI (**c**) or sPAR (**d**) corrected with estimated diet-induced thermogenesis (DIT), and relationship between total energy expenditure (TEE) by DLW and TEE of ACCTRI (**c**) or sPAR (**d**) corrected with DIT. Circles indicate community-dwelling healthy older adults without sporting habits, triangles indicate community-dwelling healthy older adults with sporting habits, and squares indicate care home residents

Accelerometer & PAR vs. DLW

2018 study example 1

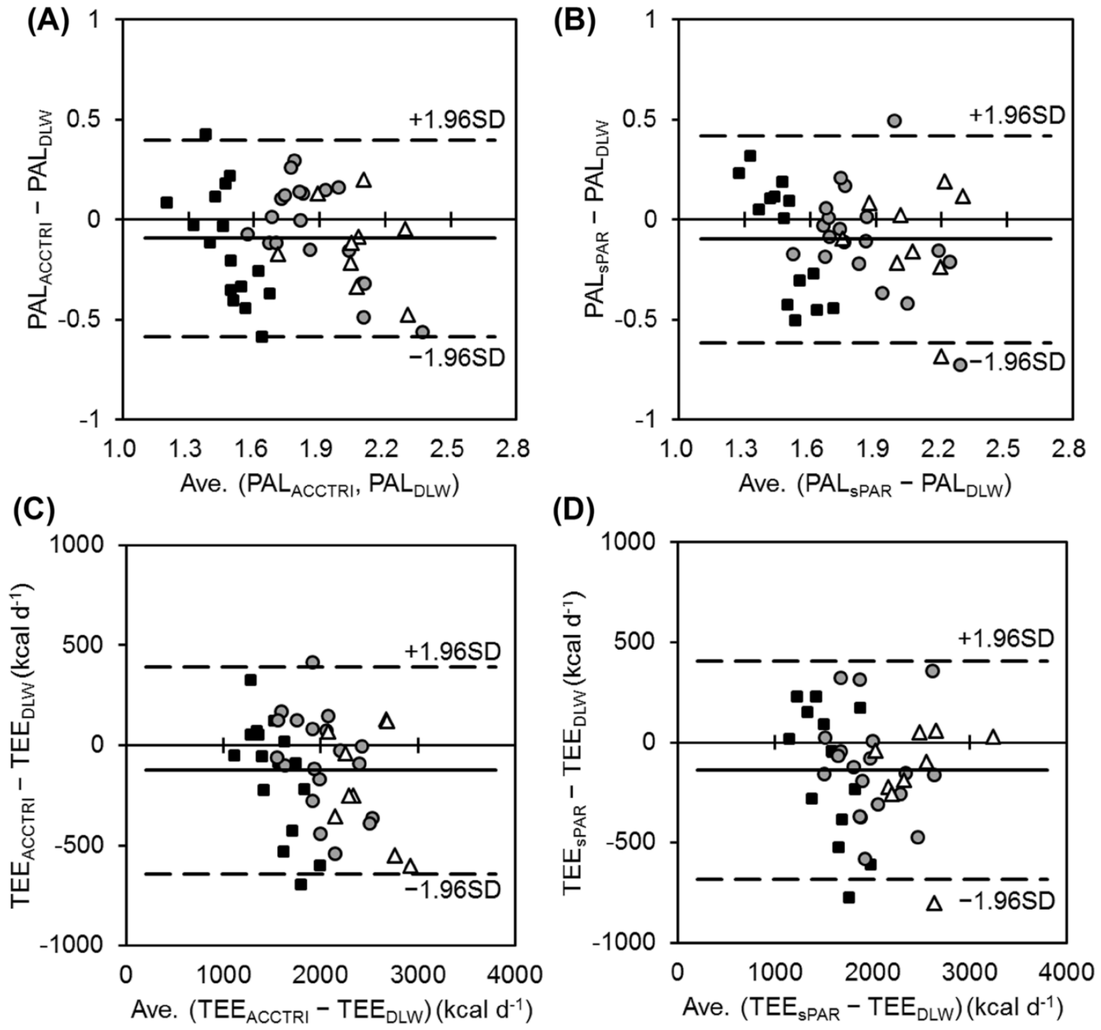


Fig. 3 Bland–Altman agreement plots showing the difference between the physical activity level (PAL_{DLW}) and total energy expenditure (TEE_{DLW}) measured using doubly labeled water and estimated by (**a** and **c**) a triaxial accelerometer (ACCTRI) and (**b** and **d**) simplified physical activity record (sPAR). A negative sign for the difference indicates an underestimation and a positive sign denotes an overestimation. No statistical differences were observed in the estimation error between ACCTRI and sPAR in both PAL and TEE. Circles indicate community-dwelling healthy older adults without sporting habits, triangles indicate community-dwelling healthy older adults with sporting habits, and squares indicate care home residents

Accelerometer & PAR vs. DLW

2018 study example 1

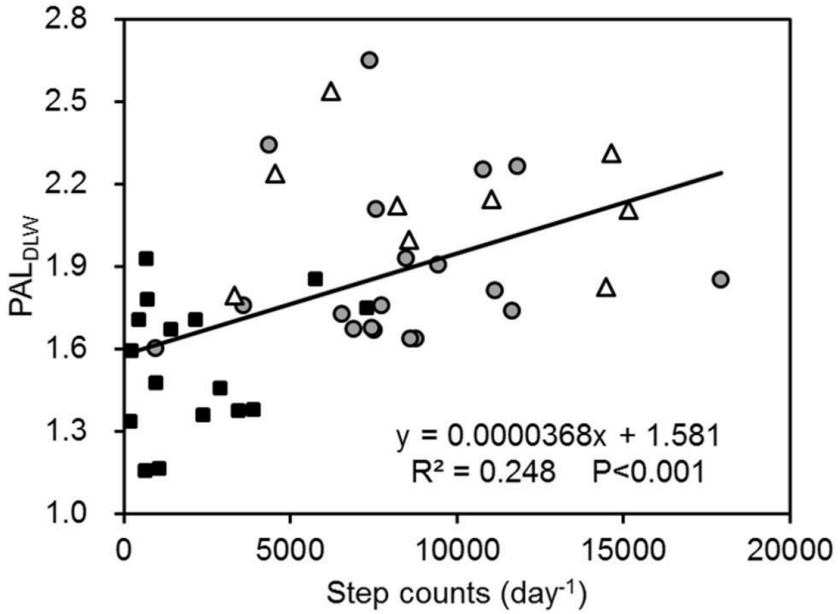


Fig. 4 Relationship between daily step counts by Lifecorder and physical activity level (PAL) calculated by the doubly labeled water (DLW) method with measured basal metabolic rate (mBMR). Circles indicate community-dwelling healthy older adults without sporting habits, triangles indicate community-dwelling healthy older adults with sporting habits, and squares indicate care home residents

Accelerometer & PAR vs. DLW

2018 study example 1

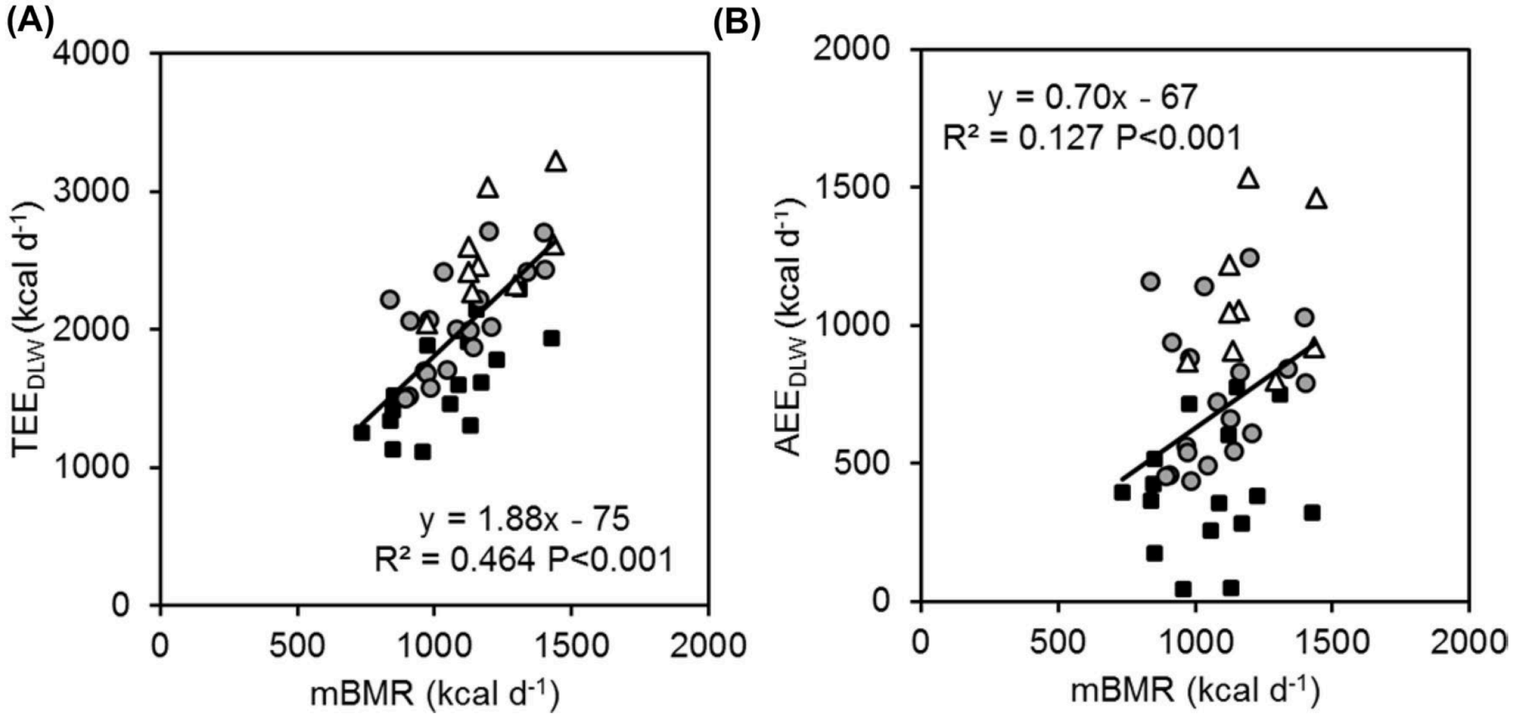
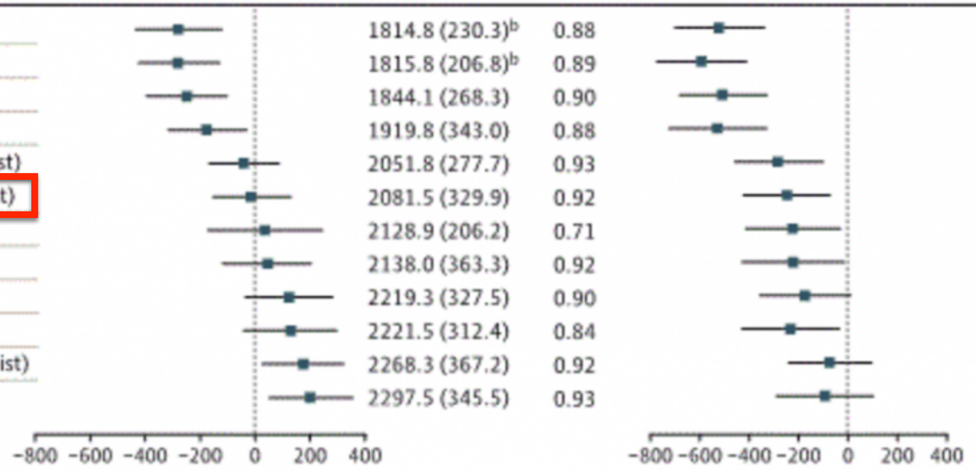


Fig. 5 Relationship between measured BMR (mBMR) and **a** total energy expenditure (TEE) and **b** physical activity energy expenditure (AEE). Circles indicate community-dwelling healthy older adults without sporting habits, triangles indicate community-dwelling healthy older adults with sporting habits, and squares indicate care home residents. The *Y*-intercept did not significantly differ from zero in both TEE and AEE

Wearables vs. DLW

Figure 1. Differences in Total Energy Expenditure in 19 Patients

Device Name (Wearing Position)	Standardized Day (Measured by Metabolic Chamber: 2093.0 ([304.0] kcal/day))			Free-living Days (Measured by DLW Method: 2314.4 ([312.6] kcal/day))		
	Difference in TEE Between Each Device and Metabolic Chamber (kcal/day), Mean (SD)	Estimated TEE by Each Device, Mean (SD)	Spearman Rank Correlation Coefficient[a]	Difference in TEE Between Each Device and DLW (kcal/day), Mean (SD)	Estimated TEE by Each Device, Mean (SD)	Spearman Rank Correlation Coefficient[a]
Withings Pulse O_2 (wrist)		1814.8 (230.3)[b]	0.88		1796.6 (246.5)[b]	0.82
Jawbone (UP24) (wrist)		1815.8 (206.8)[b]	0.89		1724.2 (229.7)[b]	0.81
Garmin Vivofit (wrist)		1844.1 (268.3)	0.90		1811.6 (274.8)[b]	0.85
ActiGraph GT3X (waist)[c]		1919.8 (343.0)	0.88		1789.5 (334.2)[b]	0.80
Suzuken Lifecorder EX (waist)		2051.8 (277.7)	0.93		2034.4 (298.3)	0.83
Panasonic Actimarker (waist)		2081.5 (329.9)	0.92		2069.8 (320.3)	0.85
Epson Pulsense (wrist)		2128.9 (206.2)	0.71		2097.4 (292.9)	0.82
Tanita AM-160 (pocket)		2138.0 (363.3)	0.92		2094.4 (402.3)	0.85
Fitbit Flex (wrist)		2219.3 (327.5)	0.90		2142.5 (354.4)	0.84
Misfit Shine (wrist)		2221.5 (312.4)	0.84		2084.1 (330.8)	0.85
Omron Active Style Pro (waist)		2268.3 (367.2)	0.92		2245.2 (359.5)	0.88
Omron CaloriScan (pocket)		2297.5 (345.5)	0.93		2221.3 (384.5)	0.88



Spearman rank correlation coefficients were obtained by interparticipant analysis. DLW indicates doubly labelled water; TEE, total energy expenditure.

[a] Significant correlation for Spearman test between standard TEE and TEE estimated by each device.

[b] Significant difference from TEE obtained by the metabolic chamber or DLW method.

[c] TEE was calculated by adding resting metabolic ratio to physical activity energy expenditure provided by ActiGraph.

Wearables vs. DLW

JAMA Network™

From: **Accuracy of Wearable Devices for Estimating Total Energy ExpenditureComparison With Metabolic Chamber and Doubly Labeled Water Method**

JAMA Intern Med. 2016;176(5):702-703. doi:10.1001/jamainternmed.2016.0152

Figure Legend:

All 12 Wearable Devices on the BodyPhoto of all 12 wearable devices: Fitbit Flex, JAWBONE UP24, Misfit Shine, EPSON PULSENCE PS-100, Garmin Vivofit (wrist), TANITA AM-160, OMRON CaloriScan HJA-403C (hand-held), and Withings Pulse O2, OMRON Active style Pro HJA-350IT, Panasonic Actimarker EW4800, SUZUKEN Lifecorder EX, and ActiGraph GT3X (waist).

Second generation accelerometers

Accelerometer issues

- SINGLE-SITE PLACEMENT;
- waist placement -> PA underestimate during upper limb movement, standing, vertical activity (i.e., climbing stairs, uphill walking), pushing or pulling objects, carrying loads (e.g., books or laptops), body-supported exercise (e.g., cycling), water PA (e.g., swimming), running faster than 9 km/h, horizontal speed rapid changes activities (e.g., tennis)

Second generation accelerometers

measures

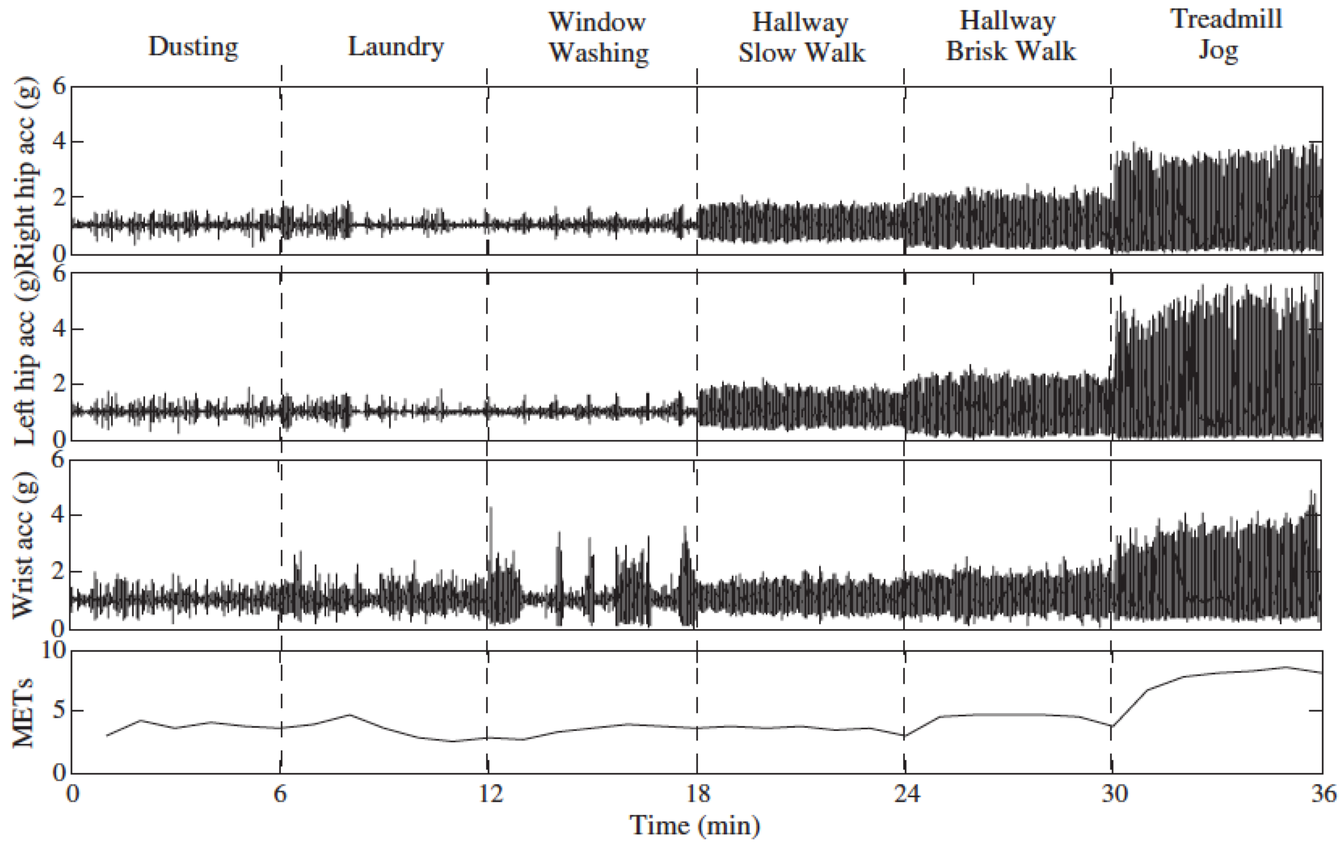


Figure 1. An example of accelerometer and MET measurements for one participant performing an activity routine. Data was not captured between activities.

Ellis et al., 2014

Second generation accelerometers

Solution?

- A combination of variables describing:
  1) upper limbs-focused high frequency components (upper limbs movements feature sedentary PA);
  2) a trunk-focused posture variable featuring locomotion;
  3) lower limbs-focused high intensity components (lower limbs have largest, most powerful muscles);

Second generation accelerometers

- More than ONE accelerometer together, as well (e.g., waist TriTrac-R3D + dominant arm wrist Actiwatch, Actiwatch + Actical, ...);
- accelerometers based activity logger:
  . two (@sternum, front thigh) biaxial accelerometers + analog data-logger;

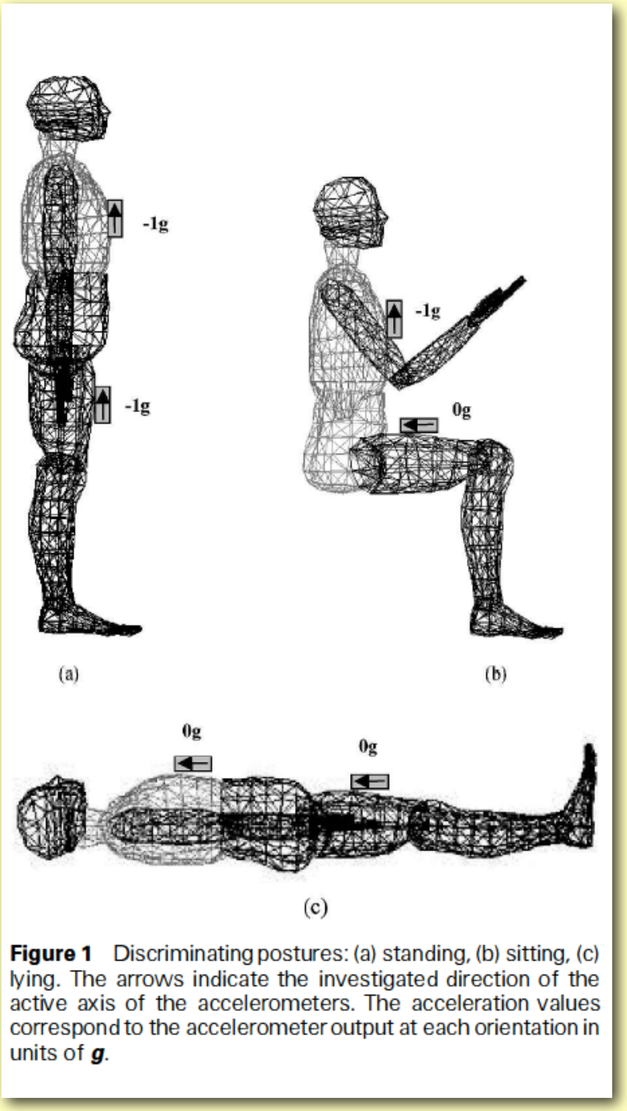


Figure 1 Discriminating postures: (a) standing, (b) sitting, (c) lying. The arrows indicate the investigated direction of the active axis of the accelerometers. The acceleration values correspond to the accelerometer output at each orientation in units of ***g***.

Culhane et al., 2004