University of Verona,

School of Exercise and Sport Science,

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

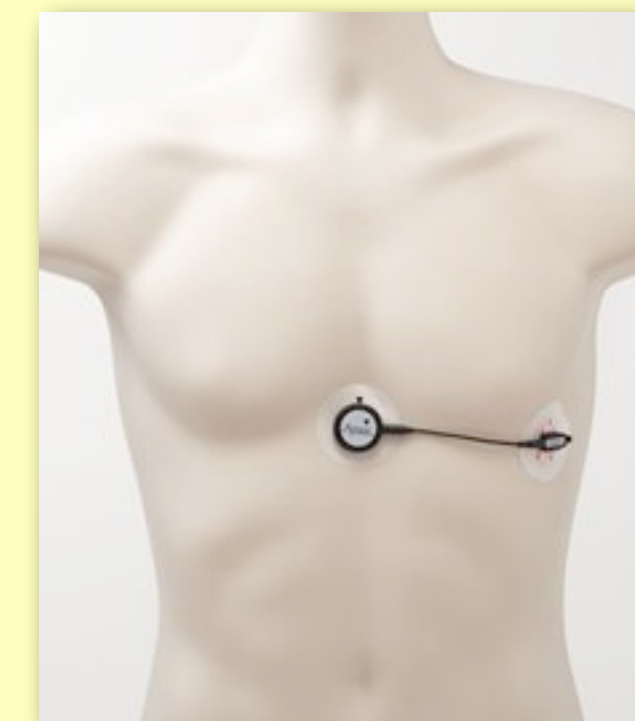Wednesday 23/10/2019 15:45÷17:15

Luca P. Ardigò Ph.D.

Second generation accelerometers

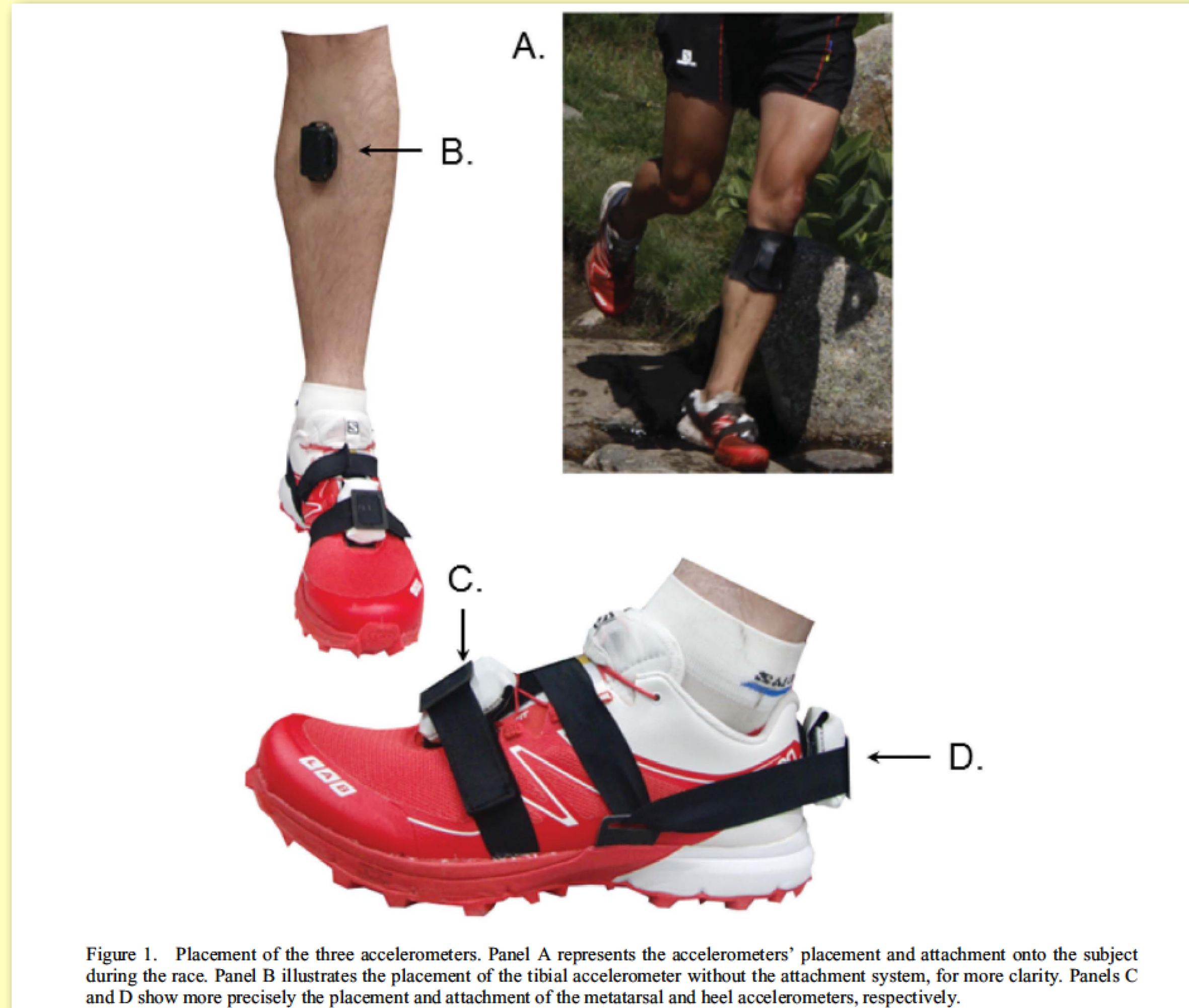– **Accelerometry + HR measure:**

. FitSense FS-1;

. Actiheart:

● @chest;

● each subject's calibration;

● OPEN ALGORITHM;

● user's models;

● accelerometer-, HR monitor-, accelerometer+HR

monitor-driven model;

Figure 1. Placement of the three accelerometers. Panel A represents the accelerometers' placement and attachment onto the subject during the race. Panel B illustrates the placement of the tibial accelerometer without the attachment system, for more clarity. Panels C and D show more precisely the placement and attachment of the metatarsal and heel accelerometers, respectively.
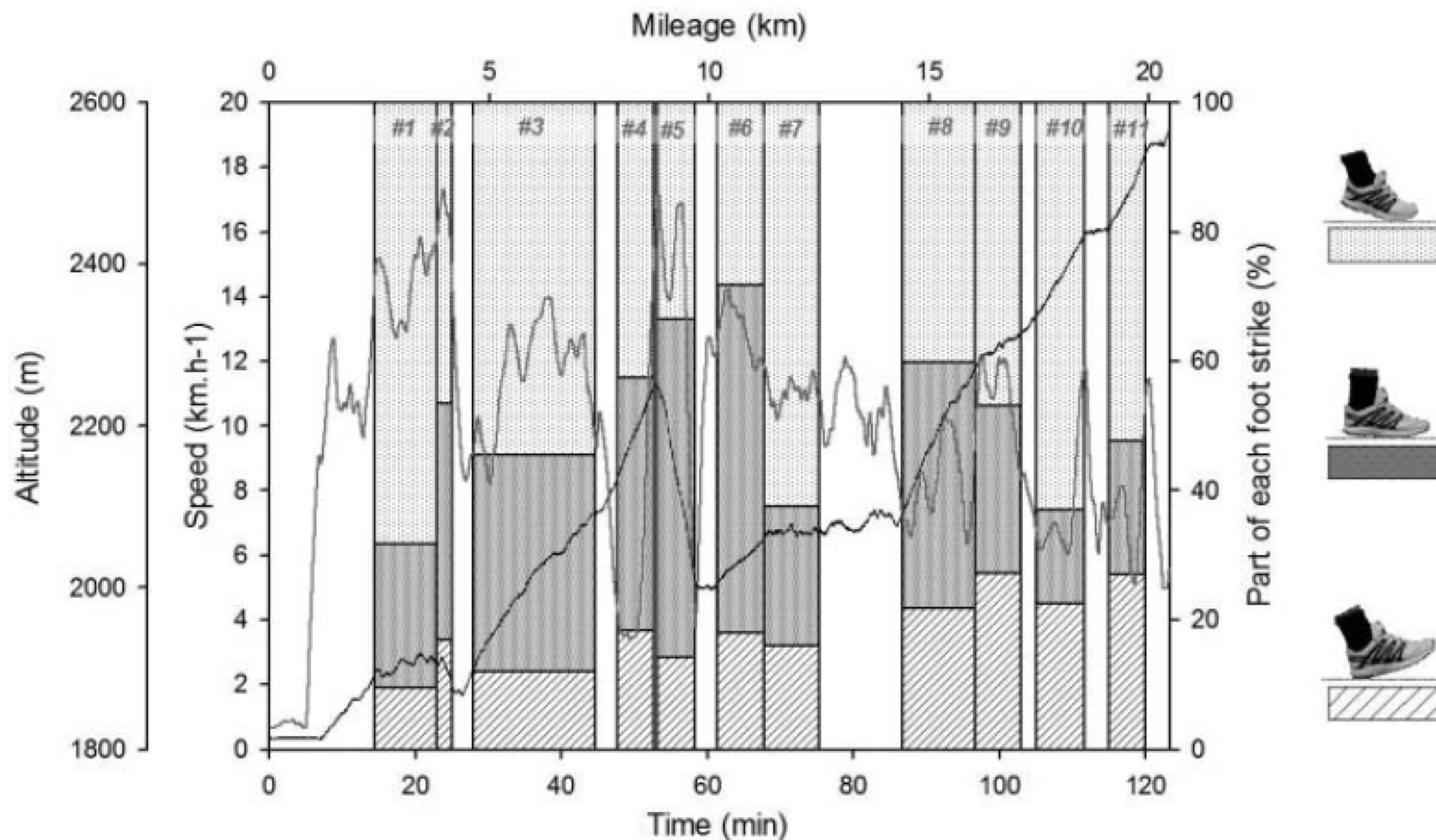
Giandolini et al., 2015

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Figure 2. Altitude (black line) and speed (grey line) over the first 20 km of the race. Bar charts represent the repartition of foot strikes (RFS, MFS and FFS) within the eleven analysed sections.

Giandolini et al., 2015

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. SenseWear Armband:

- accelerometer + heat flow sensor (-> "internal heat produced") + skin galvanic response sensor (-> evaporation heat loss) + skin thermometer + instrument's shell (i.e., near–body) thermometer;
- gender, age, height, mass input;
- PROPRIETARY ALGORITHM (I.E., "HOW FROM EACH SENSOR'S OUTPUT TO ME?");

-> -18÷-7% walking, stairs climbing, cycling V'O2 ME;

-> -29% armergometer V'O2 ME;

<- investigators results driven new PROPRIETARY algorithm developed -> n.s. differences;

-> underestimate of rowing V'O2 ME;

arm cutaneous fat issue;

-> good precision of resting V'O2 ME;

-> good precision/low accuracy of cycloergometer V'O2 ME;

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-> +13÷+27% level walking V'O2 ME;

-> -22% uphill walking V'O2 ME;

-> overestimate of walking, running V'O2 ME;

-> overestimate of wheelchair users activities V'O2 ME;

-> underestimate of obese subjects resting V'O2 ME;

-> overestimate of obese subjects exercise V'O2 ME;

-> good accuracy of daily DLW ME;

-> underestimate of uphill walking, running V'O2 ME

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Validity of the Actiheart step test for the estimation of maximum oxygen consumption in endurance athletes and healthy controls

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ORIGINAL ARTICLE

ABSTRACT

Submaximal step tests are often used for estimation of maximum oxygen consumption (VO_2max) in

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Table 1: Participant characteristics of the men and women athletes (ATH) and controls (CON).

	Women		Men	
	ATH ($n = 24$)	CON ($n = 26$)	ATH ($n = 22$)	CON ($n = 19$)
Age (years)	30.0 ± 5.5	27.4 ± 4.9	25.8 ± 4.4	27.1 ± 5.4
Body mass (kg)	57.0 ± 5.9 [a]	61.6 ± 6.6	69.9 ± 6.8	72.4 ± 7.3
Height (cm)	168 ± 5	168 ± 7	180 ± 4	179 ± 7
BMI ($kg \cdot m^{-2}$)	20.3 ± 1.6 [b]	21.8 ± 1.6	21.6 ± 1.6	22.5 ± 1.7
Body fat (%)	23.3 ± 4.8 [a]	26.0 ± 4.8	14.1 ± 4.1 [a]	17.0 ± 5.0
Fat-free mass (kg)	44.4 ± 4.3	45.7 ± 5.2	60.9 ± 6.6	60.8 ± 6.7
RMR				
$\quad kcal \cdot d^{-1}$	1436 ± 121	1500 ± 153	1868 ± 162	1835 ± 257
$\quad kcal \cdot kg^{-1} \cdot d^{-1}$	25.4 ± 2.5	24.4 ± 1.4	26.8 ± 1.6 [a]	25.3 ± 2.5
$\quad kcal \cdot kg^{-1} \cdot h^{-1}$	1.06 ± 0.10	1.02 ± 0.06	1.12 ± 0.07 [a]	1.06 ± 0.10
VO_2max				
$\quad L \cdot min^{-1}$	3.2 ± 0.3 [a]	3.0 ± 0.4	4.5 ± 0.4 [a]	4.1 ± 0.6
$\quad ml \cdot kg^{-1} \cdot min^{-1}$	56.1 ± 4.5 [c]	48.4 ± 4.4	64.0 ± 6.2 [c]	56.6 ± 5.0
Maximum metabolic equivalent of task	15.2 ± 1.4 [c]	13.7 ± 1.2	16.3 ± 1.2 [a]	15.3 ± 1.4
HRmax (bpm)	181 ± 9 [a]	186 ± 7	189 ± 8	189 ± 7
SHR (bpm)	49 ± 7 [a]	53 ± 6	48 ± 6	50 ± 7
Recovery HR (bpm)	87 ± 14	90 ± 17	85 ± 11	85 ± 12
PAL	2.1 ± 0.3 [b]	1.9 ± 0.2	1.9 ± 0.3	1.7 ± 0.2

Legend: Results are expressed as mean ± standard deviation. [a] significantly different from CON of the same sex ($p < 0.05$), [b] significantly different from CON of the same sex ($p < 0.01$), [c] significantly different from CON of the same sex ($p < 0.0001$)

Second generation accelerometers

Table 2: Concurrent validity (tested mode vs. criterion measure) of the two Actiheart modes to estimate VO_2max in men and women athletes (ATH) and controls (CON).

	Women		Men	
	ATH (*n*=24)	CON (*n*=26)	ATH (*n*=22)	CON (*n*=19)
r value				
AHraw	0.225	0.463 [a]	-0.069	0.431
AHcomplete	0.410 [a]	0.488 [a]	0.235	0.480 [a]
MAE [ml · kg^{-1} · min^{-1}]				
AHraw	8.8 ± 9.2	2.5 ± 7.2	5.2 ± 10.0	1.0 ± 9.1
AHcomplete	3.0 ± 6.5	-1.2 ± 8.0	-1.5 ± 10.0	-5.4 ± 9.8
MAPE [%]				
AHraw	17.7 ± 13.7	11.4 ± 10.4	13.6 ± 8.6	11.4 ± 10.6
AHcomplete	10.8 ± 6.5	13.6 ± 8.9	11.1 ± 10.5	14.7 ± 12.2
SEE [ml · kg^{-1} · min^{-1}]				
AHraw	4.47	3.98	6.31	4.66
AHcomplete	4.19	3.91	6.15	4.53

Legend: Results are expressed as mean ± standard deviation. [a] correlations significant at $p < 0.05$

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Table 3: Parameters of linear regression for maximum oxygen consumption (VO$_2$max; ml · kg^{-1} · min^{-1}) in men and women athletes (ATH) and controls (CON). Measured VO$_2$max was entered as dependent variable and estimated VO$_2$max by Actiheart was the independent variable.

| | Women | | Men | |
	ATH (*n=24*)	CON (*n=26*)	ATH (*n=22*)	CON (*n=19*)
R^2				
AHraw	0.051	0.215	0.005	0.186
AHcomplete	0.168	0.238	0.055	0.230
p-value				
AHraw	0.291	**0.017**	0.760	0.065
AHcomplete	**0.047**	**0.011**	0.293	**0.038**
Slope				
AHraw	0.11	0.251	-0.057	0.216
AHcomplete	0.266	0.234	0.153	0.217
Intercept				
AHraw	50.914	36.881	67.394	44.632
AHcomplete	42.004	36.782	54.011	43.183

Legend: Significant *p*-values are highlighted in bold.
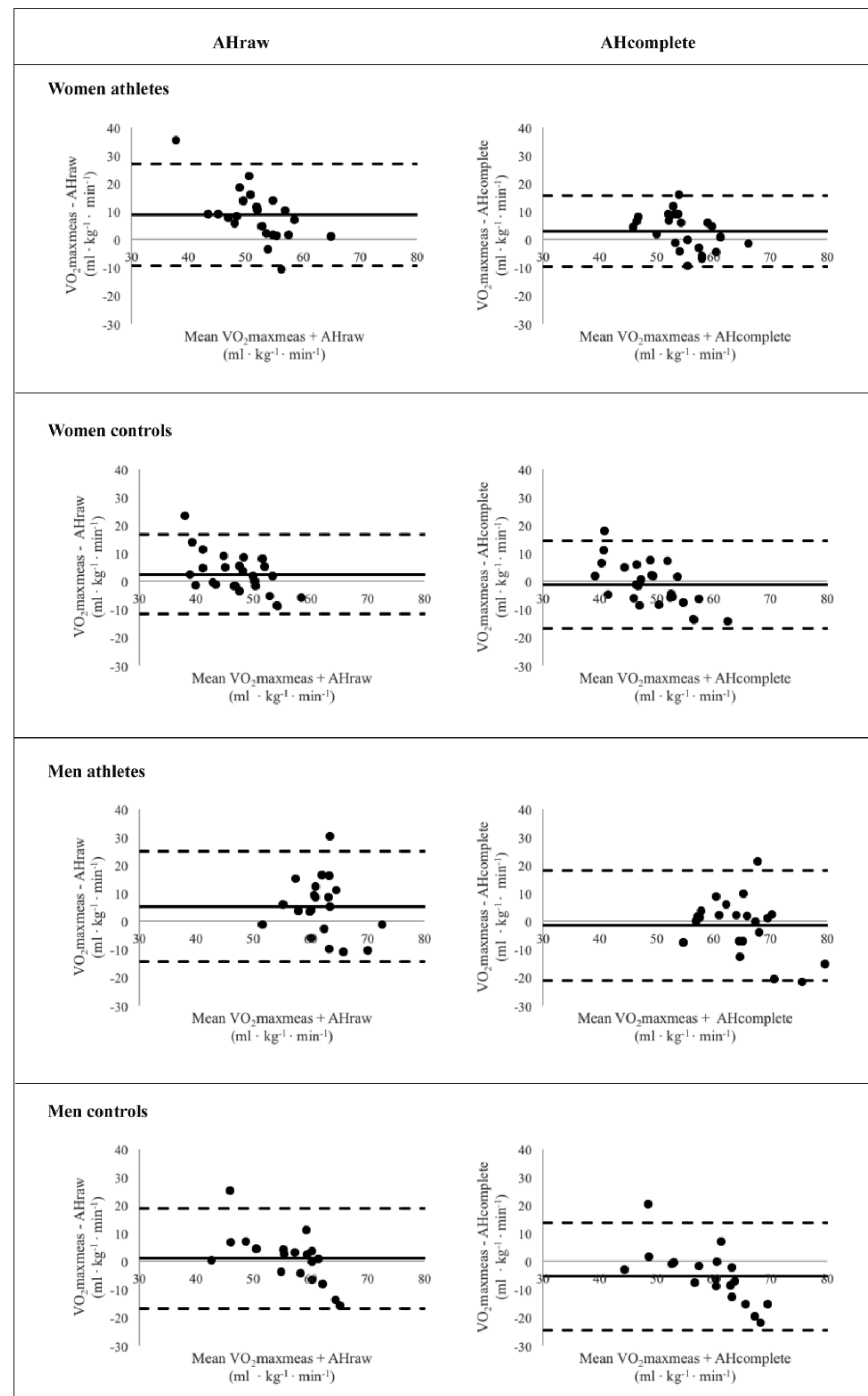
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Figure 1: Bland-Altman plots of AHraw and AHcomplete and the reference method (VO$_2$maxmeas) for men and women athletes and controls.

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