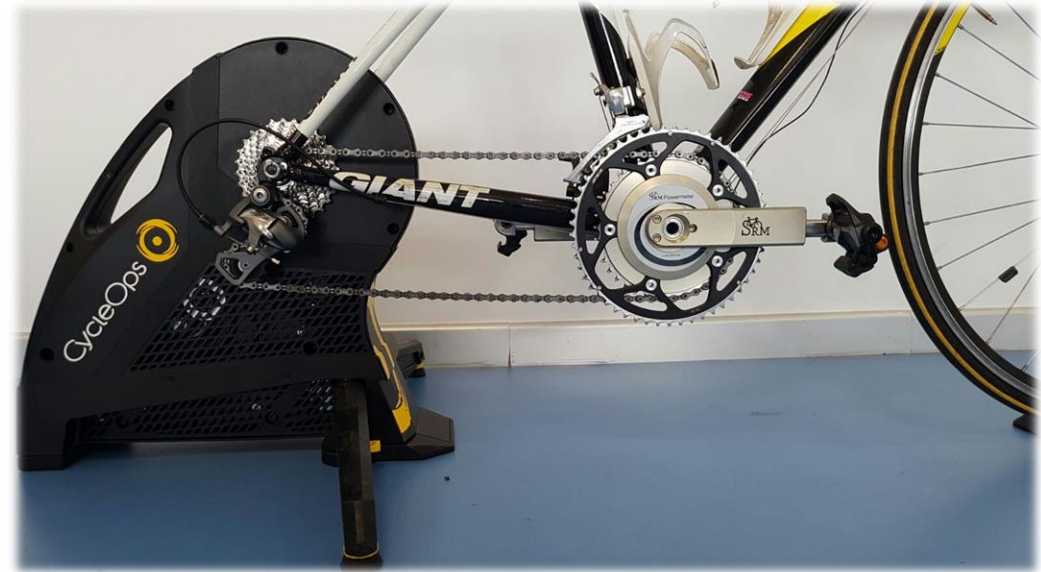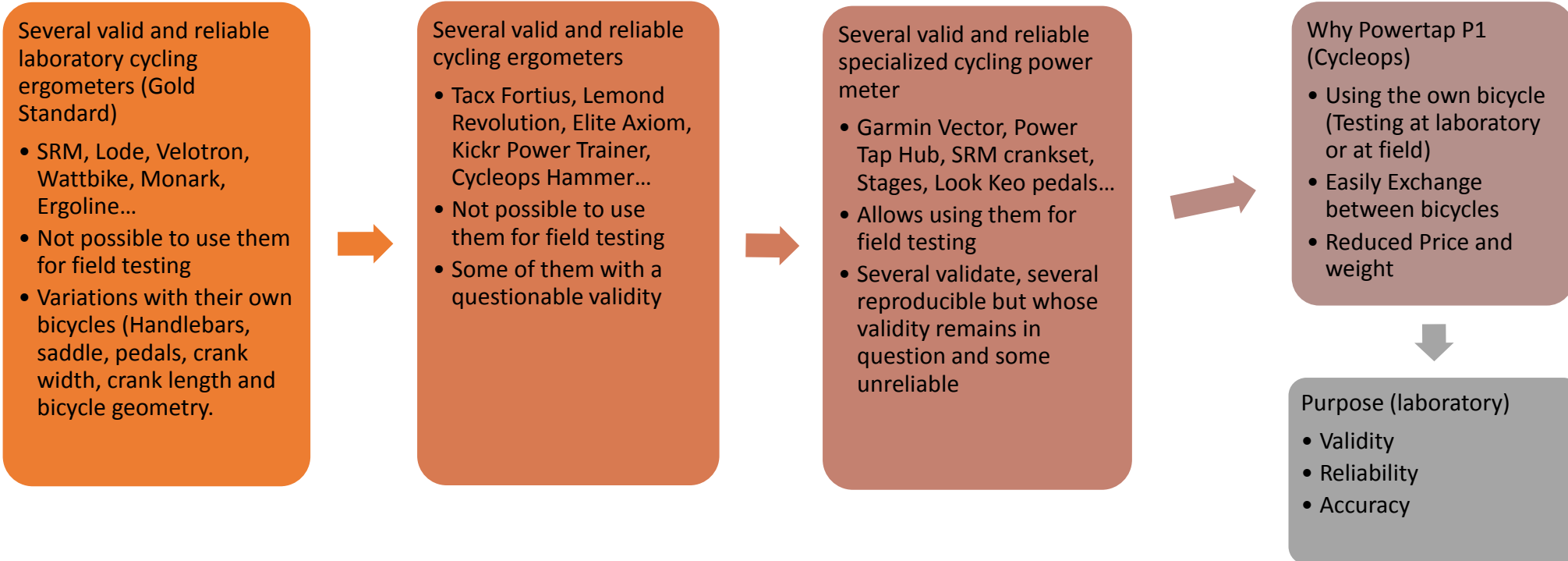**José R. Lillo Beviá**

(PhD student)

Human performance and Sports Science Laboratory
Faculty of Sports Sciences
University of Murcia
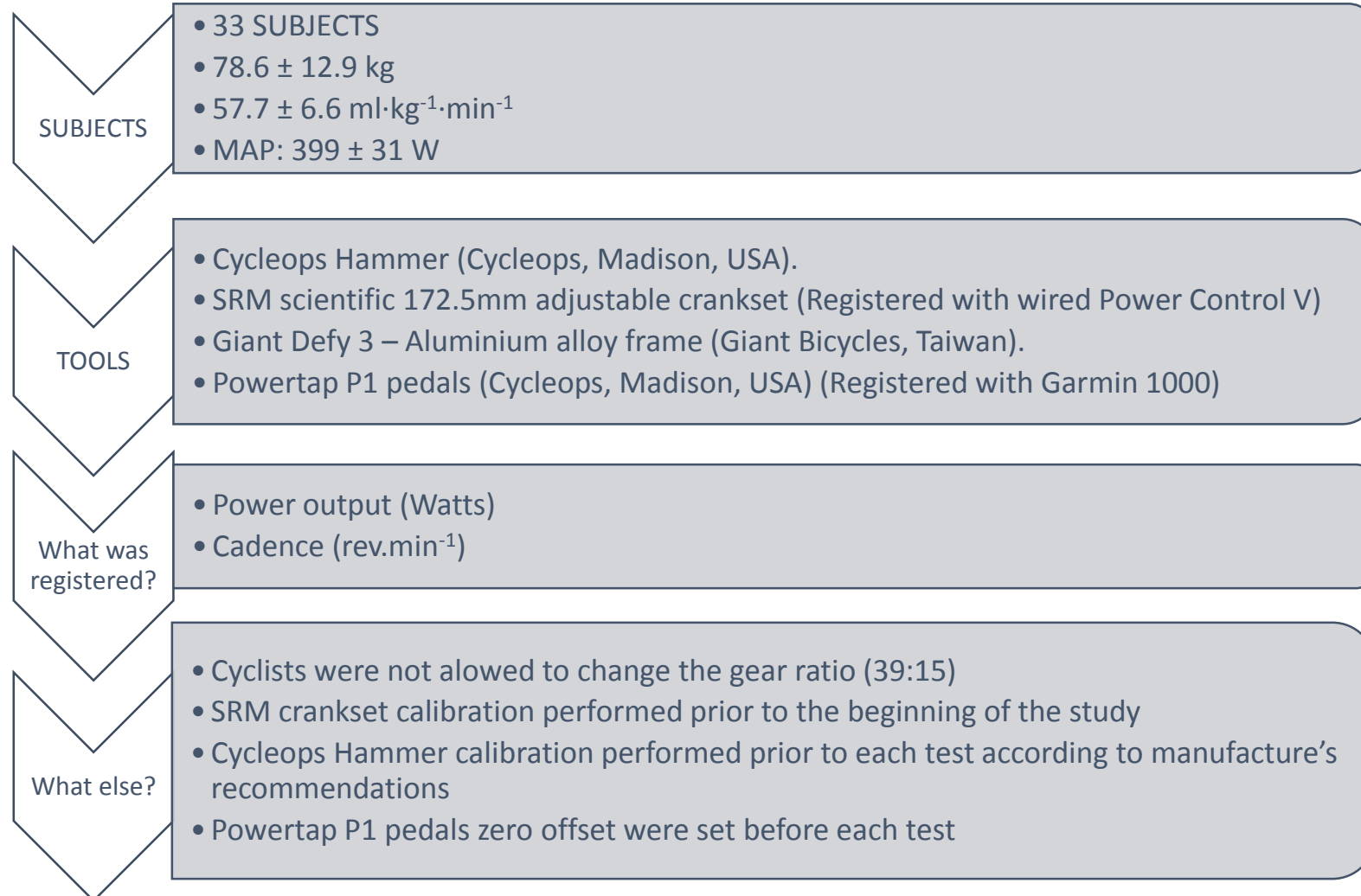**San Javier (Murcia)**
Spain

Validity and Reliability of the Powertap P1 Pedals Power Meter

Several valid and reliable laboratory cycling ergometers (Gold Standard)

• SRM, Lode, Velotron, Wattbike, Monark, Ergoline…
• Not possible to use them for field testing
• Variations with their own bicycles (Handlebars, saddle, pedals, crank width, crank length and bicycle geometry.

Several valid and reliable cycling ergometers

• Tacx Fortius, Lemond Revolution, Elite Axiom, Kickr Power Trainer, Cycleops Hammer…
• Not possible to use them for field testing
• Some of them with a questionable validity

Several valid and reliable specialized cycling power meter

• Garmin Vector, Power Tap Hub, SRM crankset, Stages, Look Keo pedals…
• Allows using them for field testing
• Several validate, several reproducible but whose validity remains in question and some unreliable

Why Powertap P1 (Cycleops)

• Using the own bicycle (Testing at laboratory or at field)
• Easily Exchange between bicycles
• Reduced Price and weight

Purpose (laboratory)

• Validity
• Reliability
• Accuracy

Testing Procedures

SUBJECTS
- 33 SUBJECTS
- 78.6 ± 12.9 kg
- 57.7 ± 6.6 ml·kg^{-1}·min^{-1}
- MAP: 399 ± 31 W

TOOLS
- Cycleops Hammer (Cycleops, Madison, USA).
- SRM scientific 172.5mm adjustable crankset (Registered with wired Power Control V)
- Giant Defy 3 – Aluminium alloy frame (Giant Bicycles, Taiwan).
- Powertap P1 pedals (Cycleops, Madison, USA) (Registered with Garmin 1000)

What was registered?
- Power output (Watts)
- Cadence (rev.min^{-1})

What else?
- Cyclists were not alowed to change the gear ratio (39:15)
- SRM crankset calibration performed prior to the beginning of the study
- Cycleops Hammer calibration performed prior to each test according to manufacture's recommendations
- Powertap P1 pedals zero offset were set before each test

3 Randomized and counterbalanced sitting graded protocol 100-350 W plus 500W stages
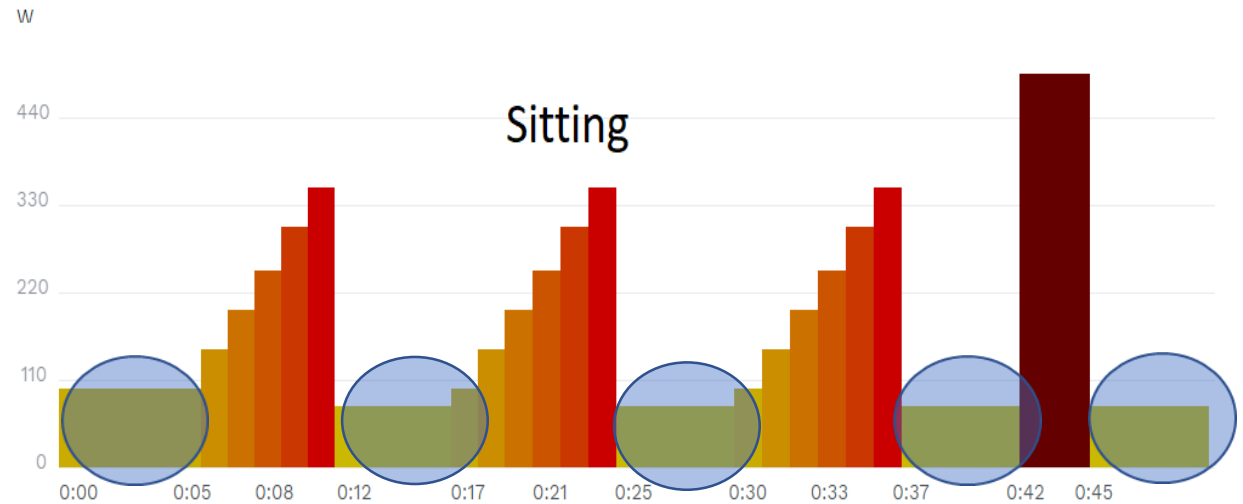
1 standing graded protocol from 250 to 450 W)

5-min 100W Prior warm up, 5-min recovery between each graded stage and 5-min of cool down for each protocol
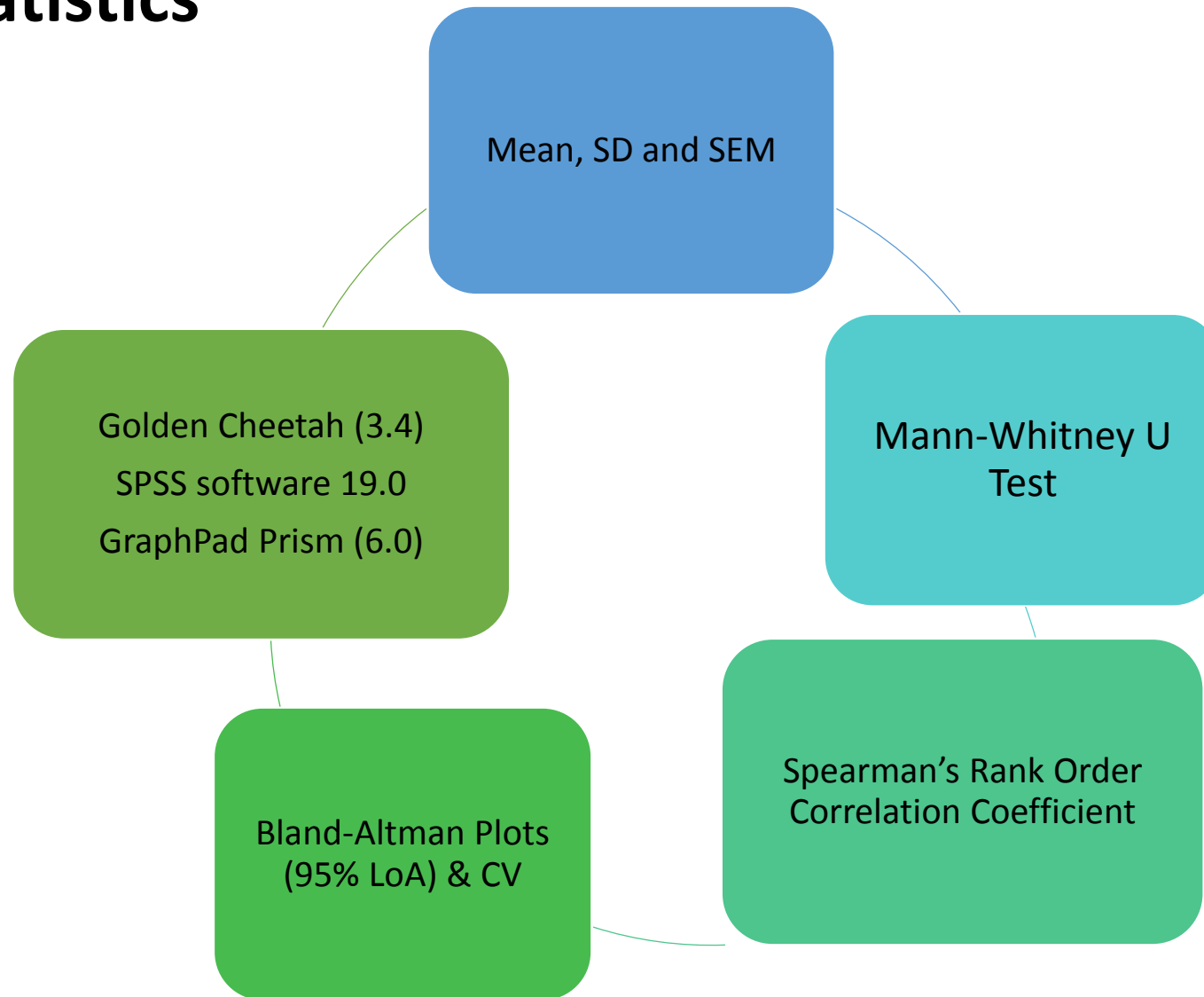
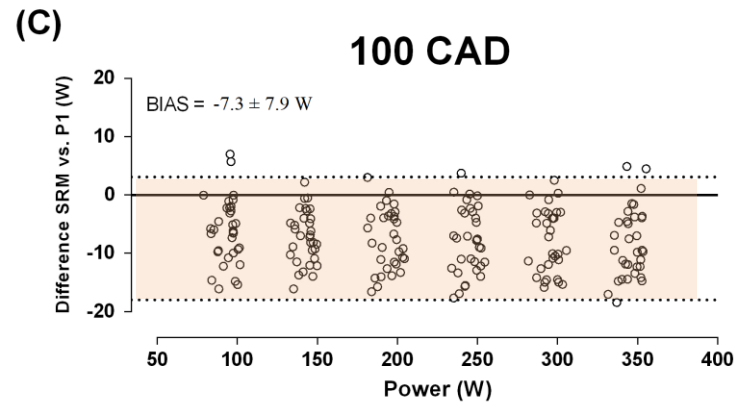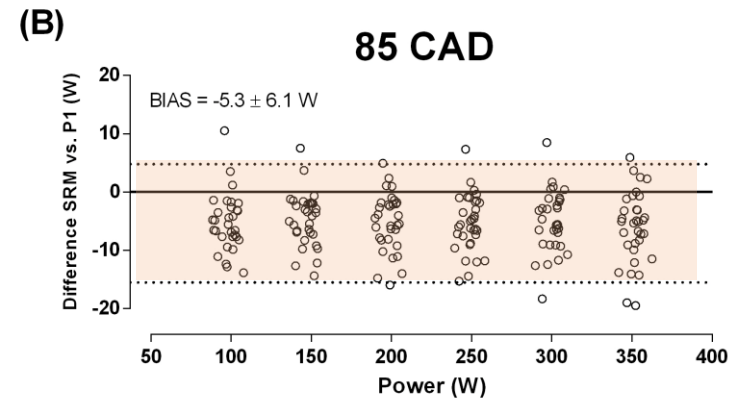75-second registered (10_{th} to 70_{th} second were analysed)
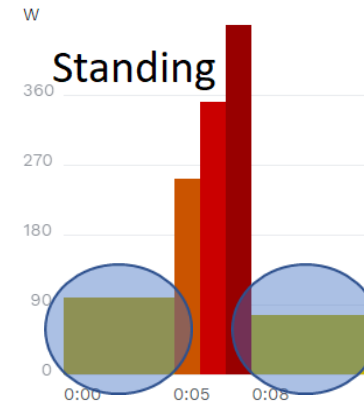
Testing Protocol

Statistics

Mean, SD and SEM

Mann-Whitney U Test

Spearman's Rank Order Correlation Coefficient

Bland-Altman Plots (95% LoA) & CV

Golden Cheetah (3.4)
SPSS software 19.0
GraphPad Prism (6.0)

Results

(A) **70 CAD**
BIAS = -2.4 ± 4.8 W

(B) **85 CAD**
BIAS = -5.3 ± 6.1 W

(C) **100 CAD**
BIAS = -7.3 ± 7.9 W
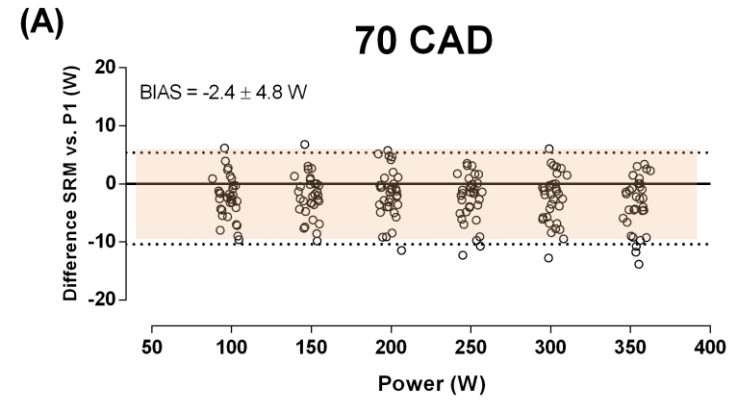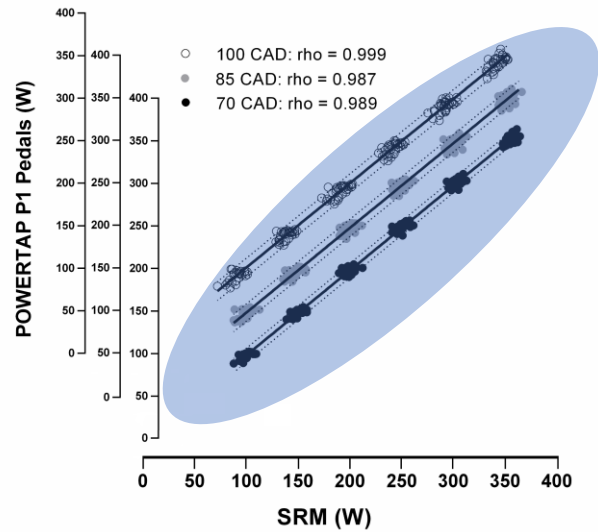
Results

			SRM (W)		PT P1 (W)		SEM (W)	Rho Spearman value	Bias (W)	SD Bias (W)	SRM (rpm)		PT P1 (rpm)	
			Mean SD	CV	Mean SD	CV			Bland Altman		Mean SD	CV	Mean SD	CV
70 CAD	SITTING	100 W	99±6	5.6%	97±4*	4.2%	0.7				70.4±1.0	1.4%	71.7±1.1	1.5%
		150 W	150±5	3.4%	148±5	3.0%	0.8			4.8	70.7±0.9	1.3%	70.7±1.0	1.5%
		200 W	200±5	2.4%	198±4	2.1%	0.7	0.989#	-2.4	LoA (-12.1 to 7.3)	70.6±1.1	1.5%	70.9±1.1	1.5%
		250 W	251±5	2.0%	248±5	1.9%	0.8				70.7±1.0	1.4%	70.8±1.0	1.3%
		300 W	303±5	1.5%	300±5	1.6%	0.8				70.4±0.9	1.3%	70.9±0.9	1.3%
		350 W	356±4	1.2%	352±5*	1.4%	0.9				70.0±1.0	1.5%	70.6±1.0	1.5%
85 CAD	SITTING	100 W	101±6	5.9%	96±6*	5.7%	1.0				84.7±0.8	0.9%	85.0±0.8	0.9%
		150 W	149±6	4.0%	145±5*	3.7%	0.9			6.1	84.7±0.8	0.9%	84.8±0.8	0.9%
		200 W	201±6	2.7%	196±5*	2.7%	0.9	0.987#	-5.3	LoA (-17.6 to 7.0)	84.8±0.9	1.1%	85.0±0.9	1.1%
		250 W	252±5	1.9%	246±5*	2.2%	0.9				84.8±1.1	1.3%	85.0±1.1	1.8%
		300 W	303±6	1.8%	298±6*	2.0%	1.1				84.9±1.2	1.4%	85.1±1.2	1.4%
		350 W	355±5	1.5%	349±6*	1.7%	1.0				84.9±1.0	1.2%	85.1±1.0	1.7%
100 CAD	SITTING	100 W	96±8	8.6%	91±7*	7.2%	1.1				98.9±1.3	1.3%	99.7±1.2	1.3%
		150 W	145±7	4.9%	139±5*	3.9%	0.9			7.9	98.9±1.4	1.4%	99.2±1.5	1.5%
		200 W	197±8	4.1%	191±7*	3.7%	1.2	0.999#	-7.3	LoA (-23.1 to 8.4)	99.6±1.2	1.2%	99.1±1.2	1.3%
		250 W	248±7	2.9%	241±7*	2.8%	1.2				99.6±1.3	1.3%	99.7±1.3	1.3%
		300 W	298±7	2.4%	291±7*	2.4%	1.2				99.5±1.5	1.6%	99.8±1.6	1.6%
		350 W	352±5	1.9%	342±8*	2.3%	1.3				99.8±1.9	1.9%	99.7±1.9	1.9%
FC	STANDING	250 W	253±7	2.6%	241±5*	2.2%	0.9			5.3	75.9±6.1	8.0%	74.9±11.0	14.7%
		350 W	352±6	1.8%	345±5*	1.5%	0.9	0.927#	-9.0	LoA (-19.7 to 1.7)	74.8±9.1	12.1%	73.5±12.9	17.6%
		450 W	455±8	1.7%	446±6*	1.2%	1.0				69.6±7.7	11.1%	68.5±10.7	15.7%
FC	SITTING	500 W	499±9	1.8%	492±11*	2.2%	1.9		-7.0	3.5 LoA (-14.1 to 0.0)	90.0±10.1	11.2%	89.8±10.5	11.7%

POWER OUTPUT | CADENCE

CAD = Cadence; FC-S = Free cadence standing; SD = Standard Deviation; CV = Coefficient of variation; rho Spearman = Spearman correlation coefficient; LoA = Limits of Agreement; * Significant differences compared to the SRM device; # significant Spearman correlation coefficient; (p < 0.05).

Discussion

Similar bias and 95 LoA

(-2.4±4.8W to -7.3±7.9W)

- (Garmin Vector) 1.3±6.0W (Bouillod et al 2016)
- (Garmin Vector) -1.3±5.3W (Nimmerichter et al 2017)
- (Powertap hub) 2.9 ± 3.3W (Bertucci et al 2005)

Similar CV

(2.0, 2.5 and 3.0% from 150 to 350W sitting, 2.2% at 500W and 1.6% standing

- (Powertap hub) 1.7 to 2.7% and 1.2 to 2.0% (SRM crankset) (Bertucci et al 2005)
- (Garmin Vector) 2.82 and 0.95 (SRM crankset) (Nimmerichter et al 2017)

Conclusions and practical applications

Valid and reliable

- Near perfect relationship between 100 and 350W (Sitting) at 70, 85 and 100 rev.min^{-1}
- Low CV between SRM and Powertap P1 pedals

Small but significant differences between Powertap P1 and SRM

- Low bias for power (-2 ± 4.8 W to -7.3 ± 7.9 W) for sitting and standing position.

Accuracy

- Power Tap P1 pedals slightly underestimate the power output data in a consistent and direct proporcional manner to the pedalling cadence

The Powertap P1 pedals are an alternative to more expensive laboratory ergometers, allowing cyclists and thriatletes to use their own bicycle for testing, training or competición purposes.

Thank you very much for your attention!