UNIVERSITÉ DE NANTES

INSEP
Terre de Champions

FÉDÉRATION FRANÇAISE DE CYCLISME

Laboratoire
Motricité - Interactions - Performance
EA 4334 Nantes - Le Mans

RELATION BETWEEN MAXIMAL POWER IN SPRINT CYCLING, PEDAL FORCE ORIENTATION AND STRENGTH OF THE LOWER-LIMB MUSCLES IN ELITE SPRINT CYCLISTS

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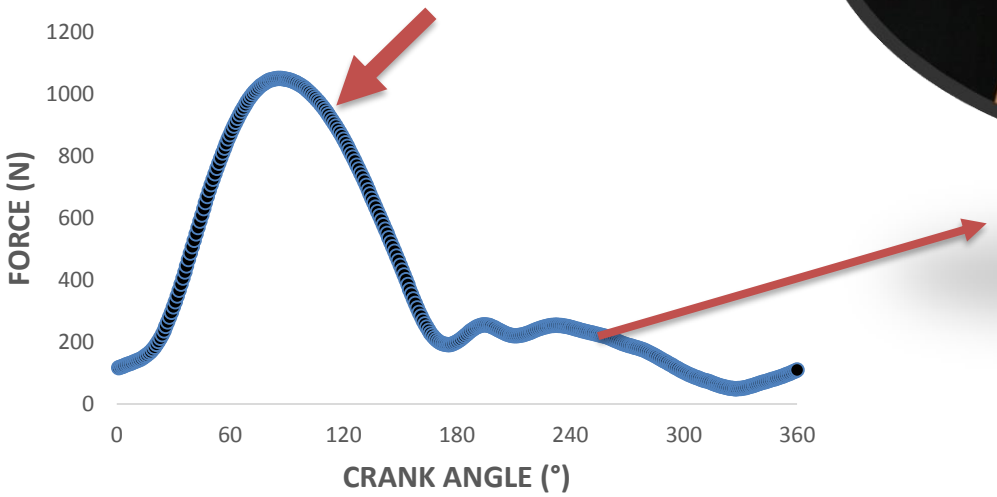
Knee extensors strength is strongly correlated with maximal power (Pmax)

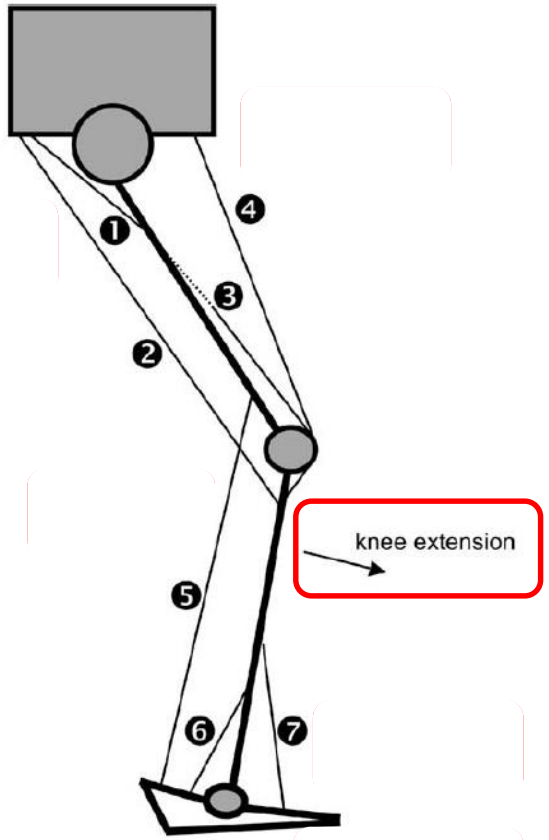
– Driss *et al.*, 2002 ; Kordi *et al.*, 2017

Hip extensors are the strongest muscular group (Ranamma *et al.*, 2012)

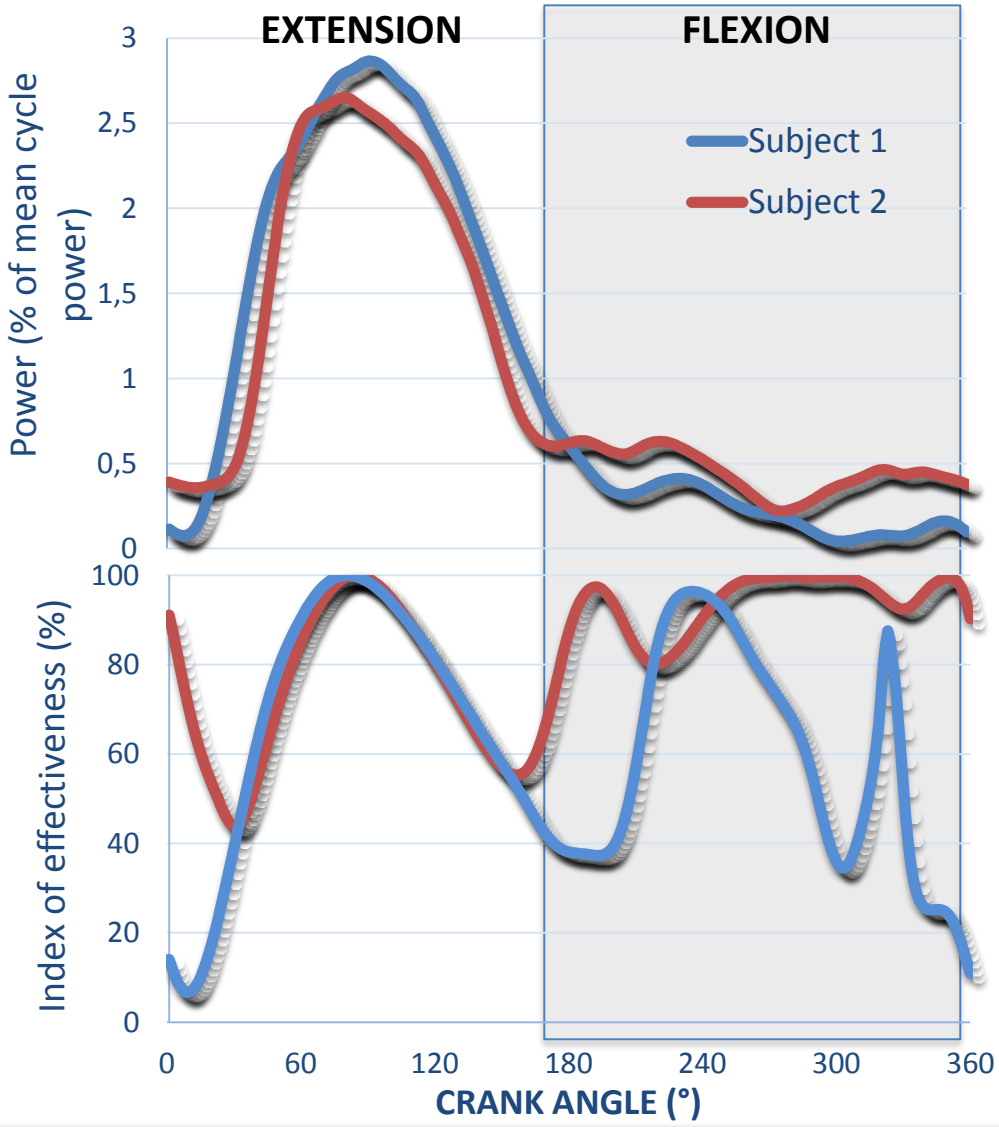
→ **RELEVANCE OF SPECIFIC STRENGTH ASSESSMENT (ISOKINETIC TORQUES)**



Force produced during the flexion phase account for ~20% of the total power (Dorel *et al.*, 2010)

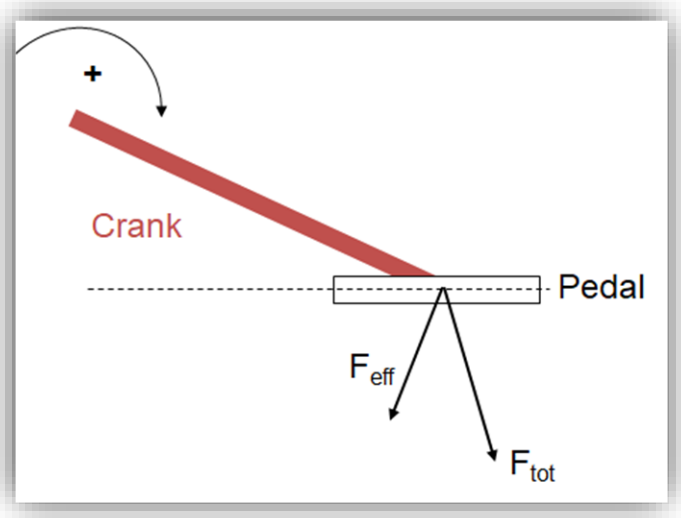


However, interindividual variability exists…



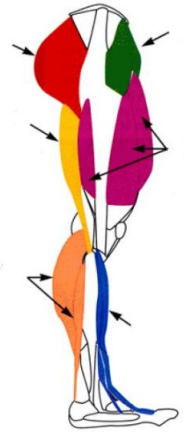
Role of index of effectiveness (IE)

$$IE = \frac{\text{EFFECTIVE FORCE (Feff)}}{\text{TOTAL FORCE (Ftot)}}$$



CAPACITY TO EFFECTIVELY ORIENTATE THE FORCE ON THE PEDALS DETERMINANT IN FLEXION POWER PRODUCTION
(Bini *et al.*, 2013)

1 To determine if the force-generating capacity of the six main muscle groups of the lower limb are related to maximal power



To determine if fhe capacity to orientate the pedal force is related to maximal power

2 To investigate if these relationships are improved by using specific velocity conditions during single-joint strength measurements

HIGH-LEVEL POPULATION

9 HIGH-LEVEL SPRINT CYCLISTS (8 ♀ ; 11 ♂)

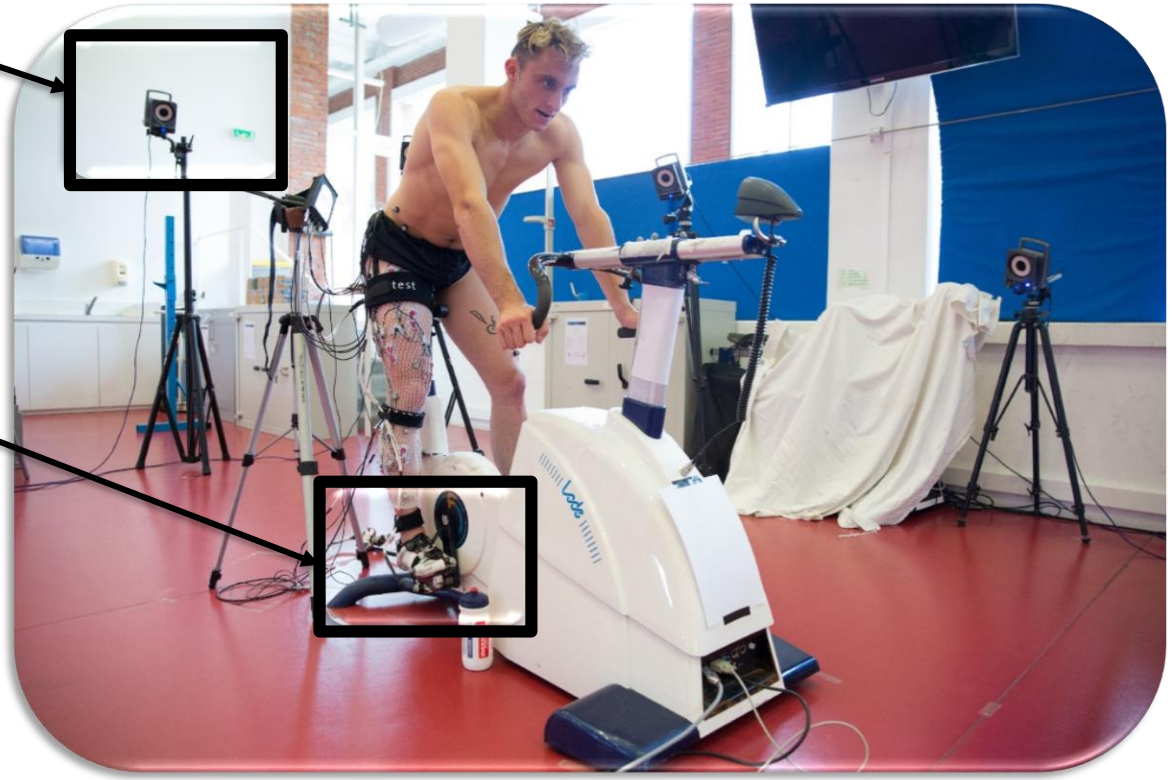
SESSIONS (AT LEAST 24H REST)

MOTION CAPTURE (VICON, MEASURE JOINT VELOCITY & FLEXION AND EXTENSION PHASES)

INSTRUMENTED PEDALS

LODE EXCALIBUR

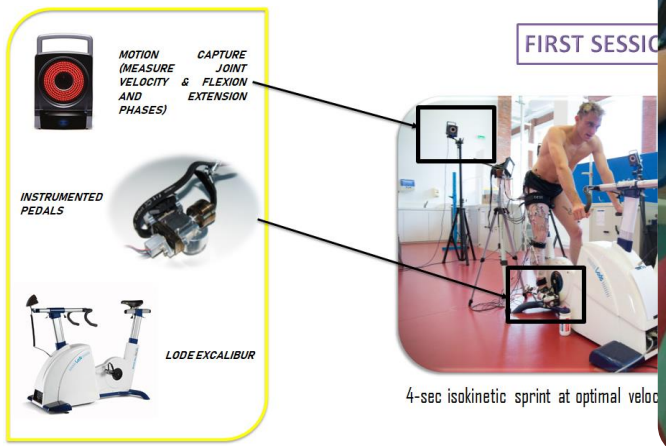
FIRST SESSION : PMAX in cycling



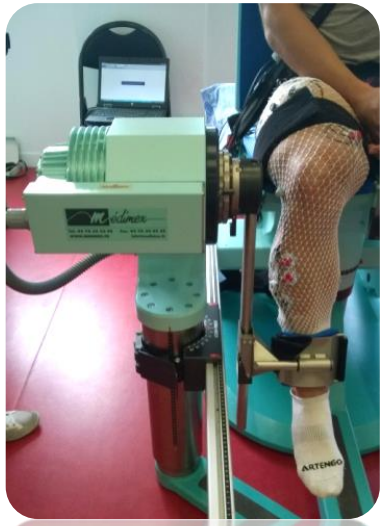
4-sec isokinetic sprint at optimal velocity (Dorel *et al.*, 2010)

- **19 HIGH-LEVEL SPRINT CYCLISTS (8 ♀ ; 11 ♂)**
- **2 SESSIONS (AT LEAST 24H REST)**

SECOND SESSION : STRENGTH ASSESSMENT



120 °/s



300 °/s

200 °/s

ISOMETRIC : 0 °/s

ISOKINETIC

Maximal isometric and isokinetic strengths of extensors and flexors at the three main joints of the right lower-limb were measured (Con-Trex ergometer)

TO RESPOND TO THE AIMS :

Linear regressions were performed between

ISOMETRIC + ISOKINETIC

- PMAX
- Sum of maximal extension and flexion torques from ankle, knee and hip joint

ISOKINETIC

- PMAX
- Maximal
  - Ankle EXT torque
  - Knee EXT torque
  - Hip EXT torque
  - Ankle FLEX torque
  - Knee FLEX torque
  - Hip FLEX torque

ISOKINETIC

- PMAX in Extension (EXT)
- Sum of maximal ankle extension, knee extension and hip extension torques

- PMAX in Flexion (FLEX)
- Sum of maximal ankle flexion, knee flexion and hip flexion torques

ISOMETRIC + ISOKINETIC

- PMAX
  - Sum of maximal extension and flexion torques from ankle, knee and hip joint

ISOKINETIC

- PMAX
  - Maximal
    - Ankle EXT torque
    - Knee EXT torque
    - Hip EXT torque
    - Ankle FLEX torque
    - Knee FLEX torque
    - Hip FLEX torque

ISOKINETIC

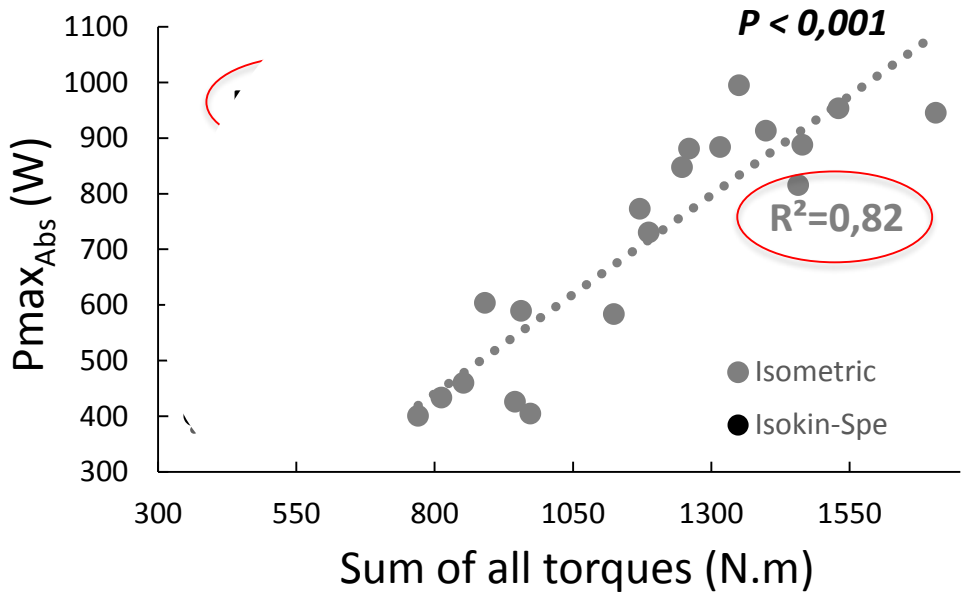
- PMAX in Extension (EXT)
  - Sum of maximal ankle extension, knee extension and hip extension torques
- PMAX in Flexion (FLEX)
  - Sum of maximal ankle flexion, knee flexion and hip flexion torques

ISOKINETIC

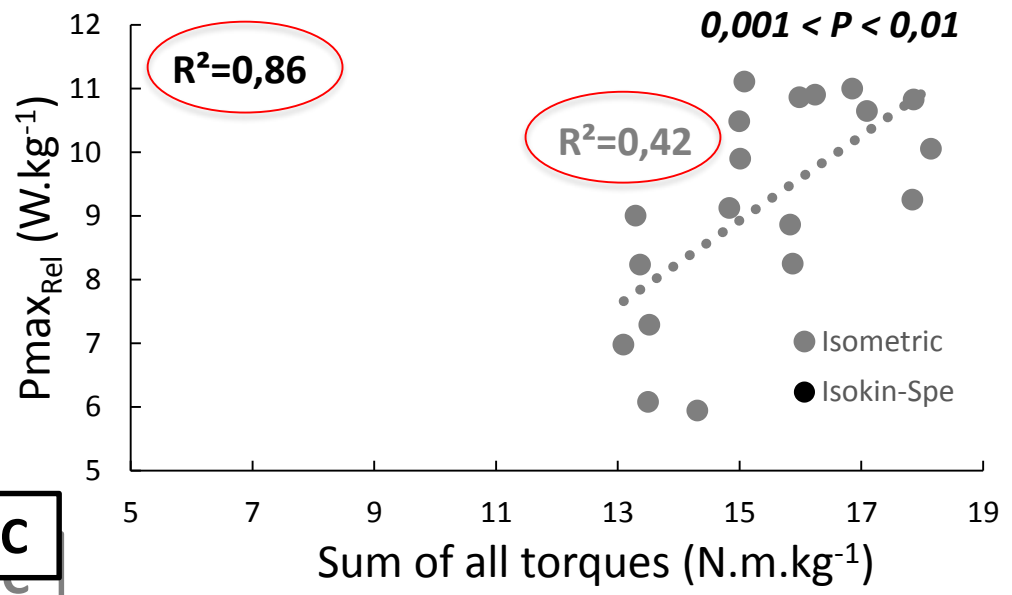
- PMAX in EXT
  - Index of effectiveness in the EXTENSION phase
- PMAX FLEX
  - Index of effectiveness in the FLEXION phase

TOTAL CYCLE : Relation between Pmax and sum of single-joint torques

ABSOLUTE



RELATIVE



ISOKINETIC

STRONGER CORRELATION FOR BOTH ABSOLUTE AND RELATIVE VALUES WITH ISOKINETIC SPECIFIC TORQUES

MORE SPECIFIC TO ASSESS TORQUES AT SPECIFIC VELOCITIES

TOTAL CYCLE : Relation between Pmax and each single-joint torque

R-values

	ABSOLUTE	RELATIVE
Ankle EXT	0,91	0,69
Ankle FLEX	0,86	0,65
Knee EXT	0,91	0,84
Knee FLEX	0,9	0,68
Hip EXT	0,94	0,82
Hip FLEX	0,84	0,63

0,01 < P < 0,05

Significant relationship with Pmax for all single-joint torques

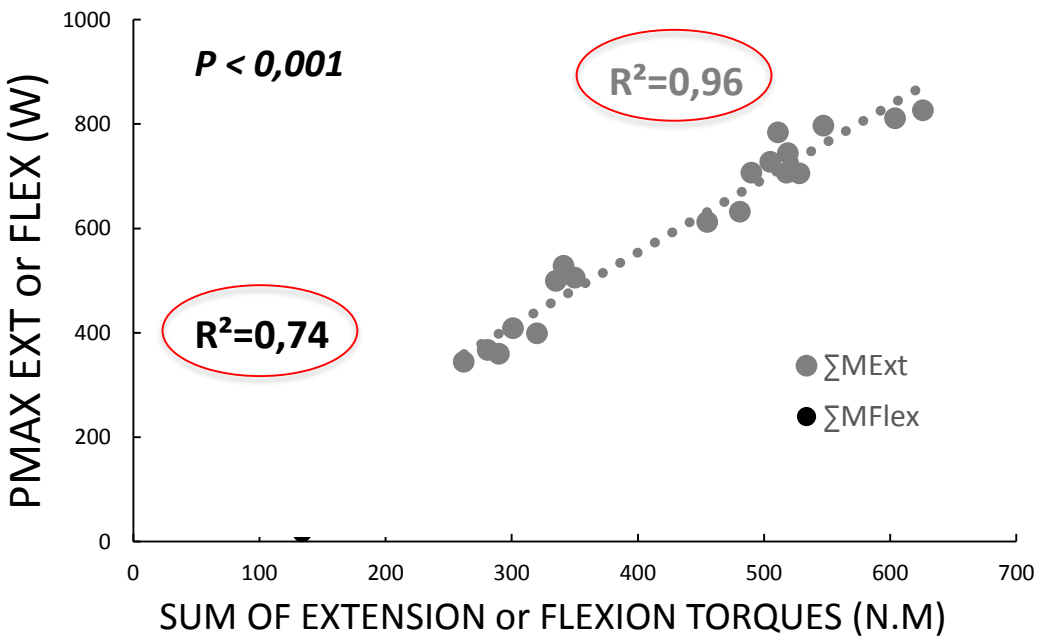
Hip extensor muscles are strongly correlated to Pmax (Ranamma *et al.*, 2012)

Variation of maximal power more explained by knee and hip extension abilities in this high-level population

KNEE AND HIP EXTENSION POWER ARE THE TWO MAIN JOINT-POWER PRODUCERS IN SPRINT CYCLING (MCDANIEL *et al.*, 2014)

Dissociation of flexion & extension actions

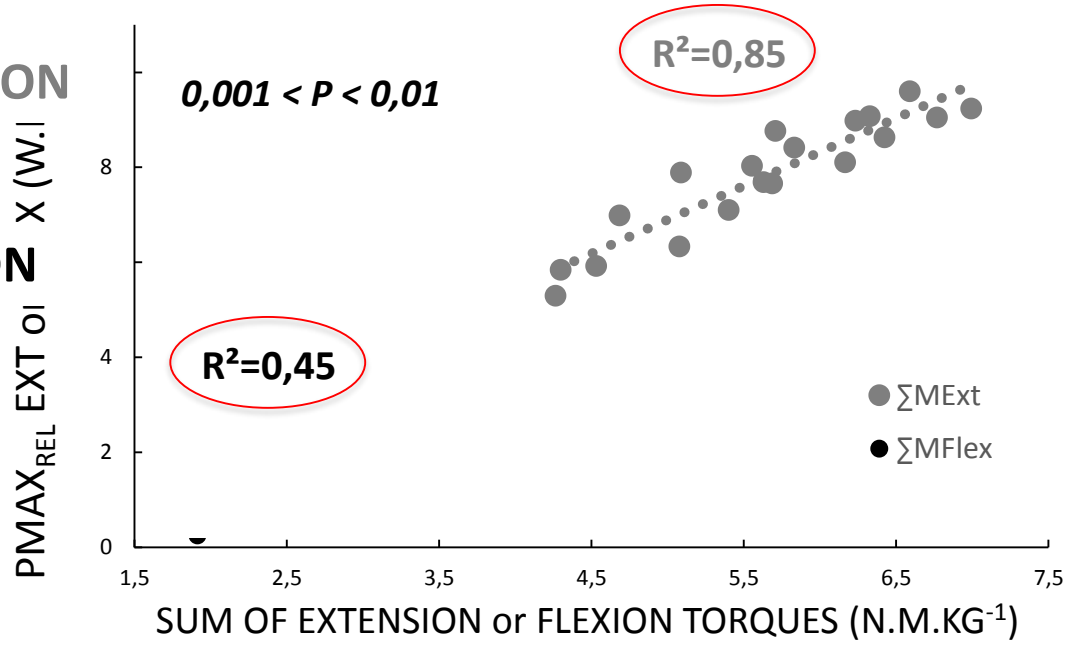
ABSOLUTE



RELATIVE

EXTENSION

FLEXION

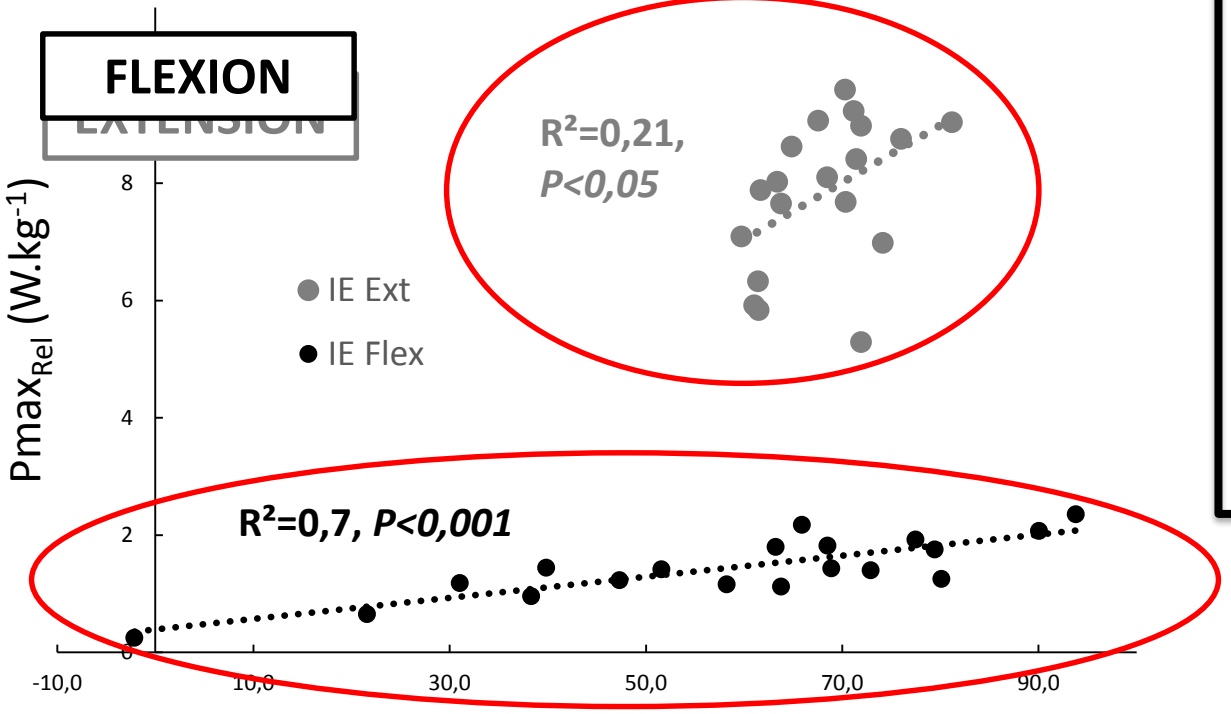


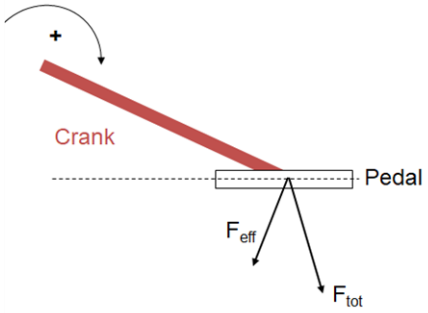
EXTENSION POWER IS STRONGLY RELATED TO EXTENSORS MUSCLES STRENGTH

ANOTHER PARAMETER IS ACTED WITHIN THE FLEXION PHASE

Role of index of effectiveness

RELATIVE





- **EXTENSION POWER MAINLY DETERMINED BY STRENGTH CAPACITIES**
- **CAPACITY TO EFFECTIVELY ORIENTATE THE FORCE IN THE FLEXION PHASE IS CRITICAL**

Interindividual variability in coordination within the flexion phase in sub-maximal condition (Hug *et al.*, 2008)

TO CONCLUDE…

- ✓ Maximal power is largely related to strength capacities
  - Isokinetic torque assessment is more relevant
- ✓ Mechanical effectiveness has to be taken into consideration, especially during the flexion phase

…AND GO FURTHER

NEXT STUDIES: WHAT ABOUT MUSCULAR COORDINATIONS ?

Same coordinations between subjects (e.g. activation levels) ?

SPECIFIC CONDITION : START

RELATIONSHIP BETWEEN STRENGTH CAPACITIES & PEAK OF FORCE IN CYCLING

SPECIFIC COORDINATION ON THE REAL FIELD ?

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Thank you for your attention

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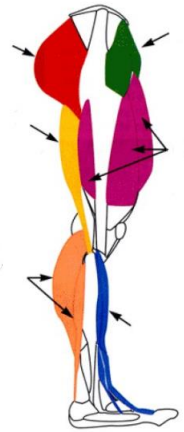

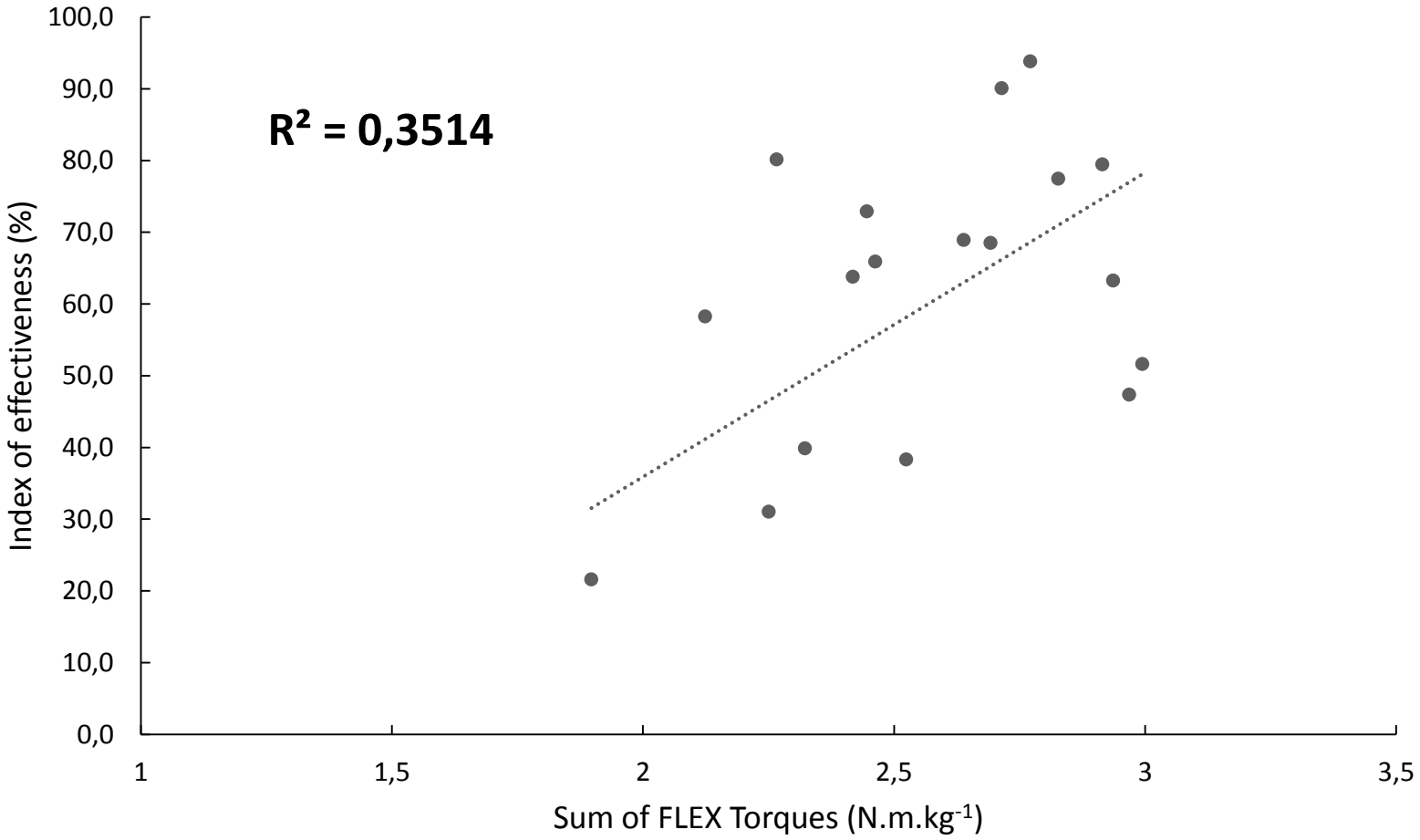
R² = 0,3514
Index of effectiveness (%)
100,0
90,0
80,0
70,0
60,0
50,0
40,0
30,0
20,0
10,0
0,0
1
1,5
2
2,5
3
3,5
Sum of FLEX Torques (N.m.kg-1)