Javelin Throwing Technique and Biomechanics

Riku Valleala

KIHU – Research Institute for Olympic Sports

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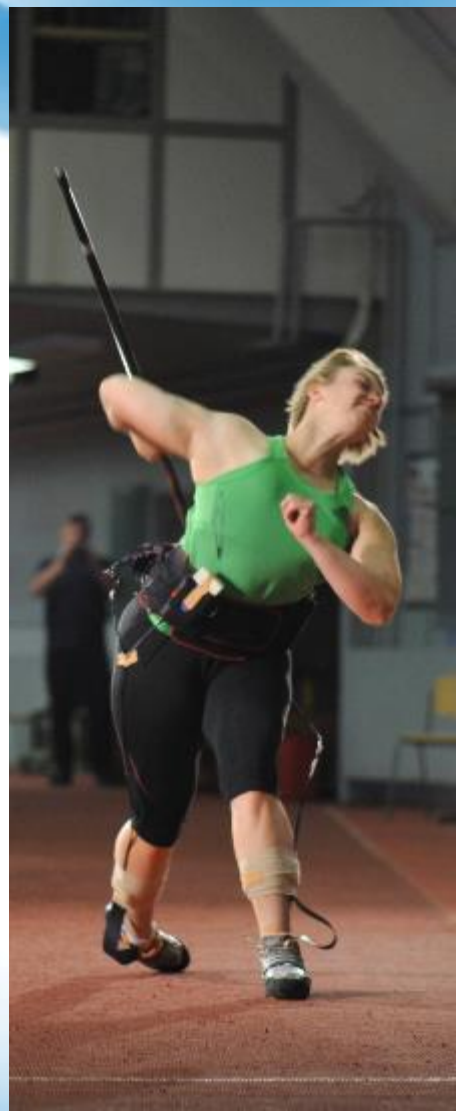
Contents of this presentation

- Basics of biomechanics in javelin throwing
- Importance of the release speed
- Factors affecting to release speed
  - Based on research findings
- Conclusions



Information based on…

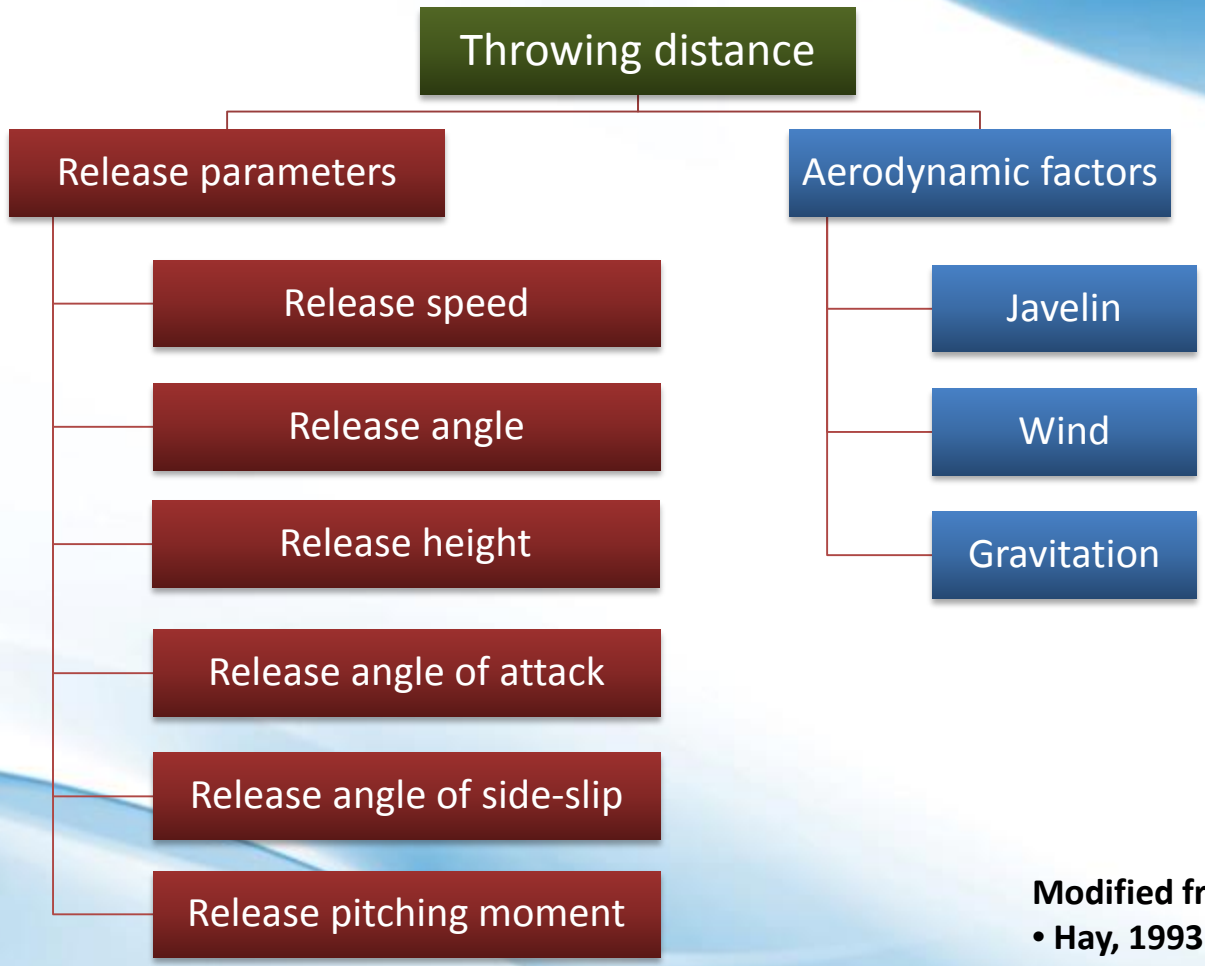
- KIHU 1991-1999 Finnish throwers
  - Around 250 throws analyzed
- KIHU 2006-2015 Finnish throwers
  - Totally 753 throws
- KIHU's analysis in Helsinki EC 2012
- Other competitions from 1984-
- A review from many studies, than just believing in one analysis!
- Not too many good competition analyses from latest years available.

Javelin throwing

- Very complex performance having several variables, which all affect to the throwing distance
- Same result can be achieved with many different techniques or styles

- https://www.youtube.com/watch?v=qVO89xE8o1I&list=PL9raFAO5De5SsNsDy1NyoDvaVBYmWKq9_

Factors affecting to throwing distance



Modified from:

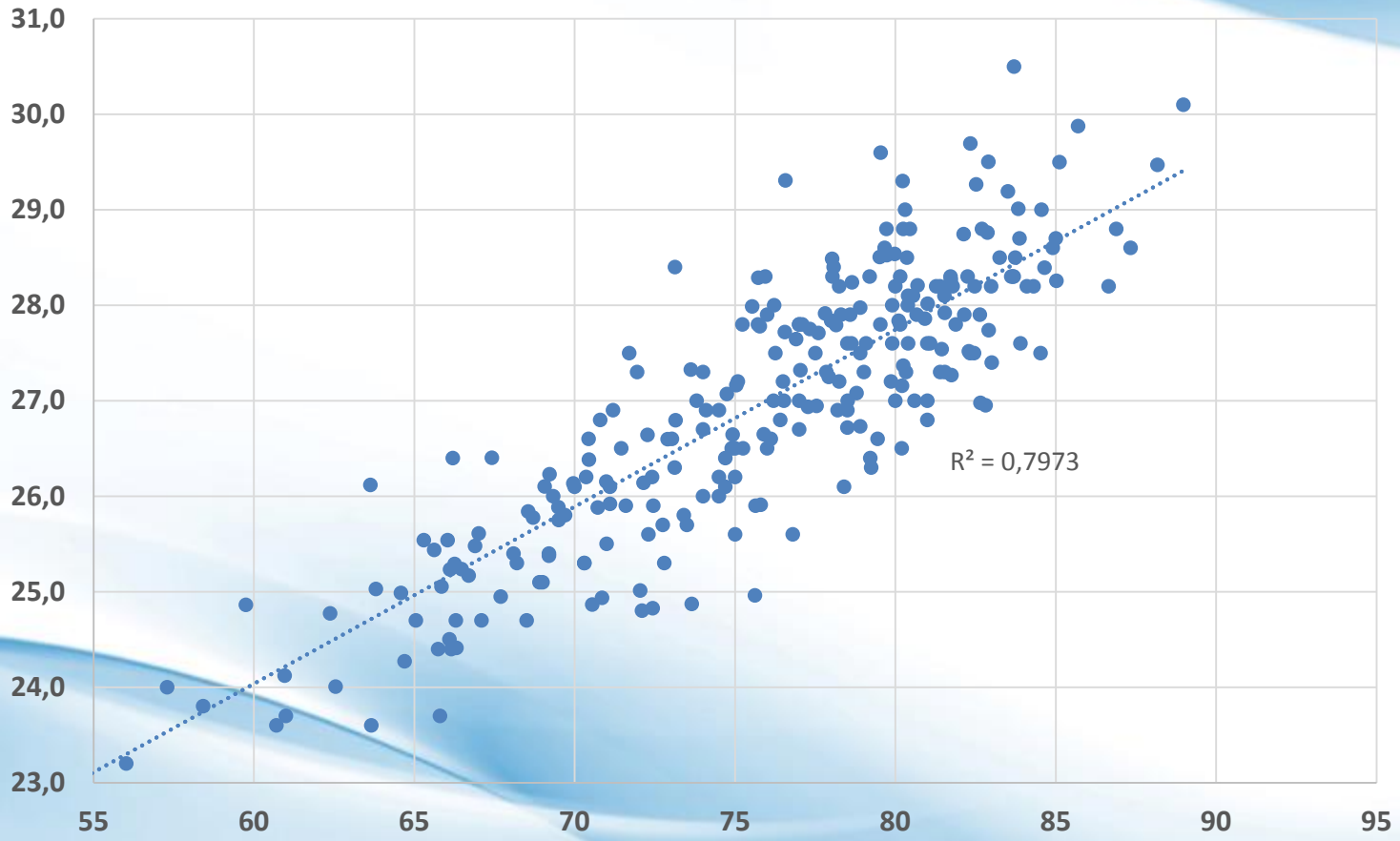
- **Hay, 1993**
- **Morriss and Bartlett, 1996**

Release speed

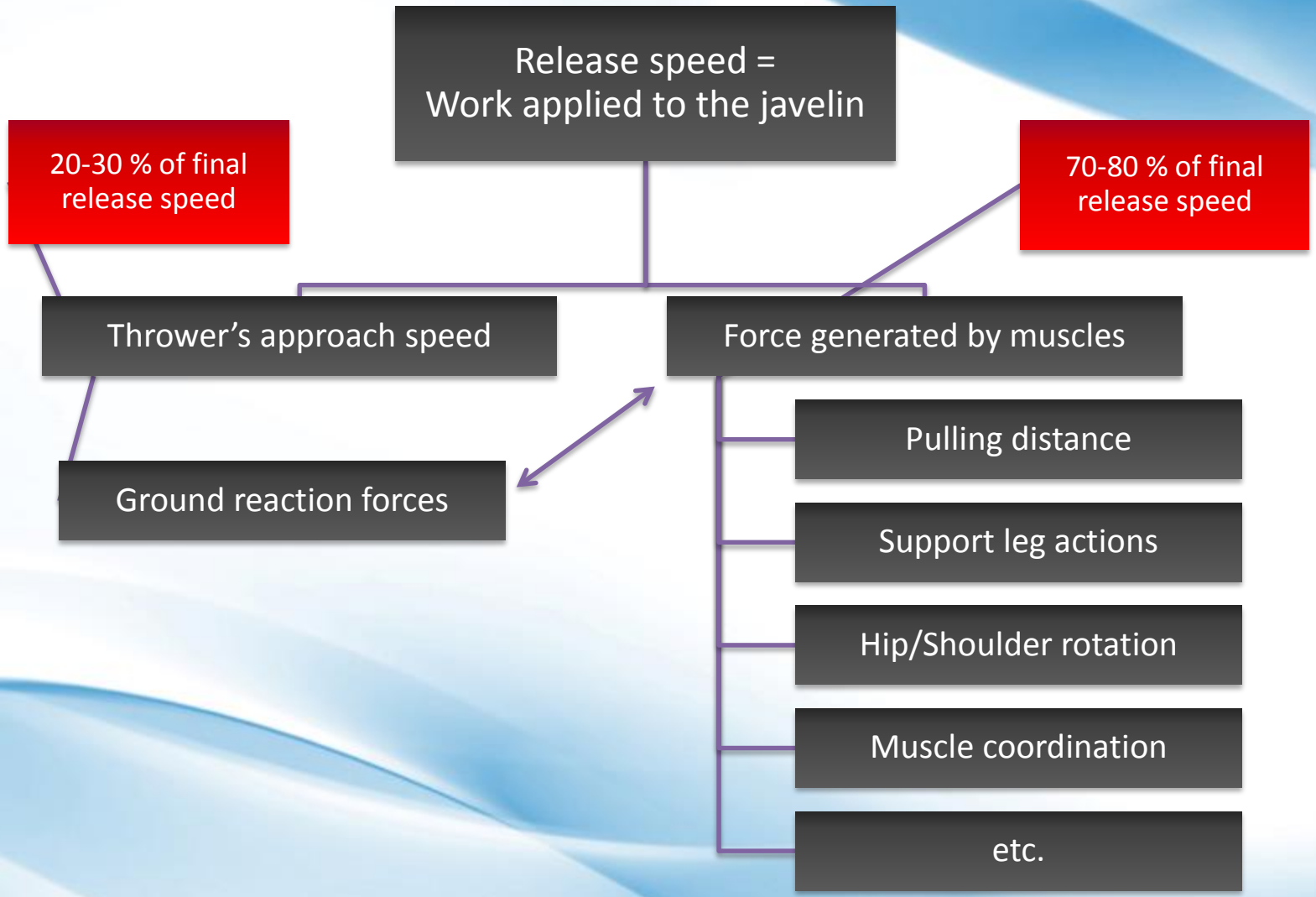
- Release speed is the strongest factor affecting to flight distance
- There are several results of high correlations between release speed and throwing distance
  - Viitasalo & Norvapalo 2003 r = .75
    Helsinki 2005 r = .89
    Osaka 2007 r = .94
    Berlin 2009 r = .67
    KIHU 2006-2015 r = .91

Release speed

Finnish throwers 2006-2015 (MEN, n=271)



Components of release speed



Components of release speed

- What is needed to accelerate javelin up to 30 m/s delivery phase?
  - about 20 kg average force to javelin
  - in 0,100 seconds
  - for distance of 1,80 m
  - with an average acceleration on 240 m/s
- Work about 350 J
- Power 3500-4000 W

Components of release speed

- Release speed is the strongest factor, so…
- It is reasonable to compare different variables to release speed instead of throwing result, because…
- There are many independent factors affecting to throwing result after javelin releases from the hand.

Run-up speed (approach speed)

Run-up speed (approach speed)

- Some values for MEN (at the final foot contact)
  - Los Angeles 1984 5,3 m/s (finalists)
    Barcelona 1992 5,2 m/s (finalists)
    Göteborg 1995 5,9 m/s (finalists)
    KIHU 1991-1999 5,7 m/s (mean ~81 m)
    Helsinki EC 2012 5,7 m/s (mean ~79 m)
    KIHU 2006-2015 5,9 m/s (mean ~79 m)

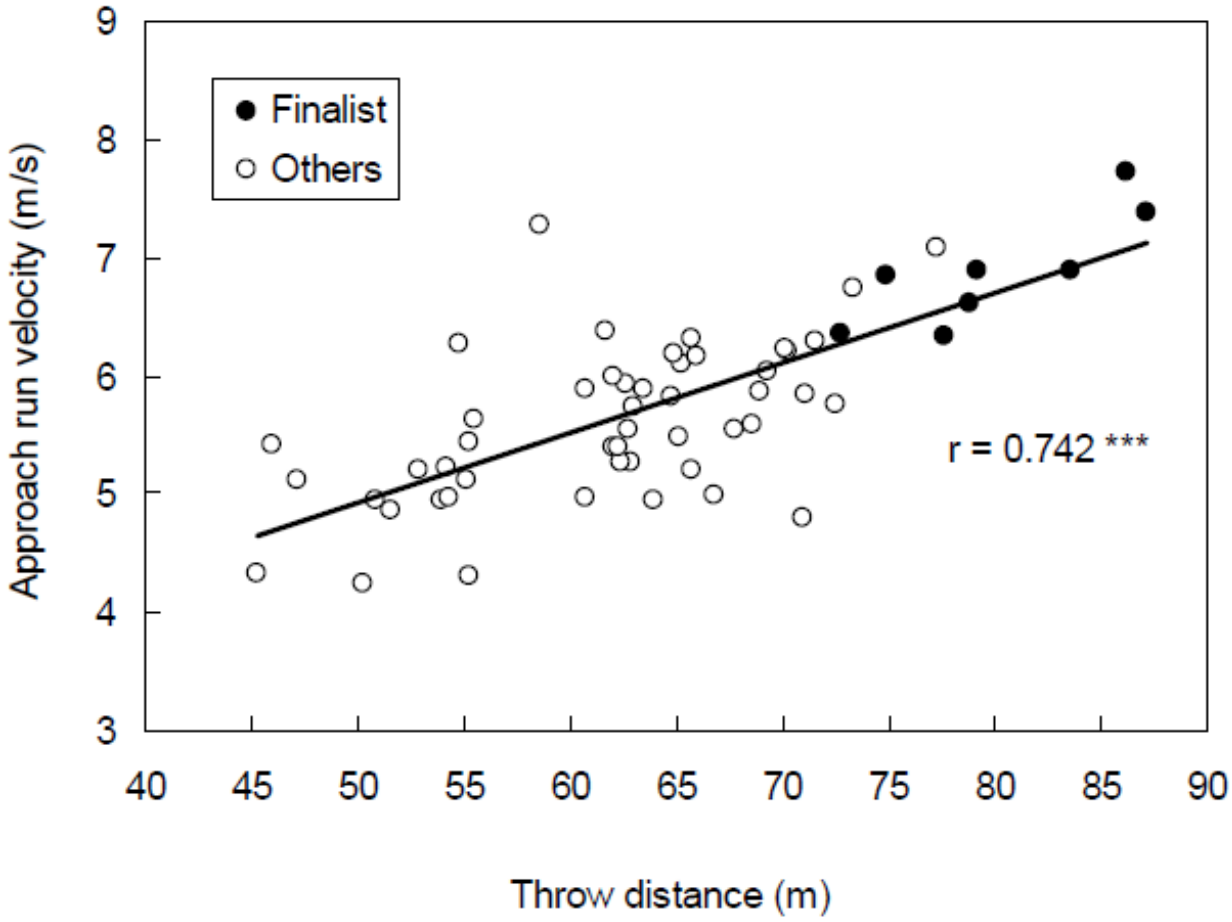
- …and for WOMEN (at the final foot contact)
  - Los Angeles1984 5,4 m/s (finalists)
    Barcelona 1992 5,6 m/s (finalists)
    KIHU 1991-1999 4,7 m/s (mean ~59 m)
    KIHU 2006-2015 5,0 m/s (mean ~54 m)

Run-up speed vs. throwing distance

- Connections to throwing result?
  - Igekami et al 1981 no correlation
    Lon Angeles 1984 no correlation
    Helsinki WC 2005 r = .74
    Osaka 2007 r = .59
    KIHU 2006-2015 no correlation
    Helsinki EC 2012 r = -.44

Run-up speed vs. throwing distance

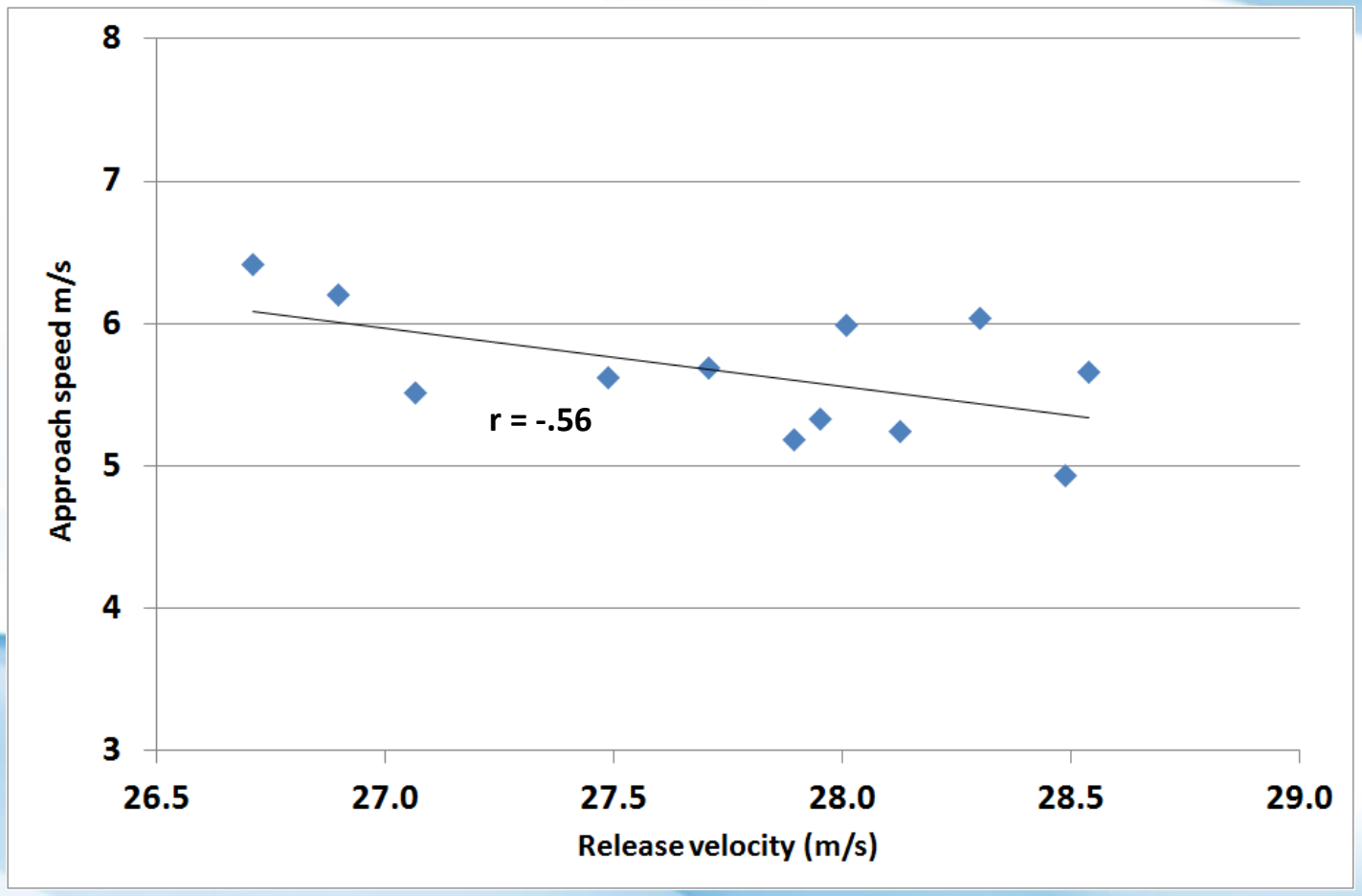
- Helsinki WC 2005 + (Japanese ones):



Murakami et al 2006

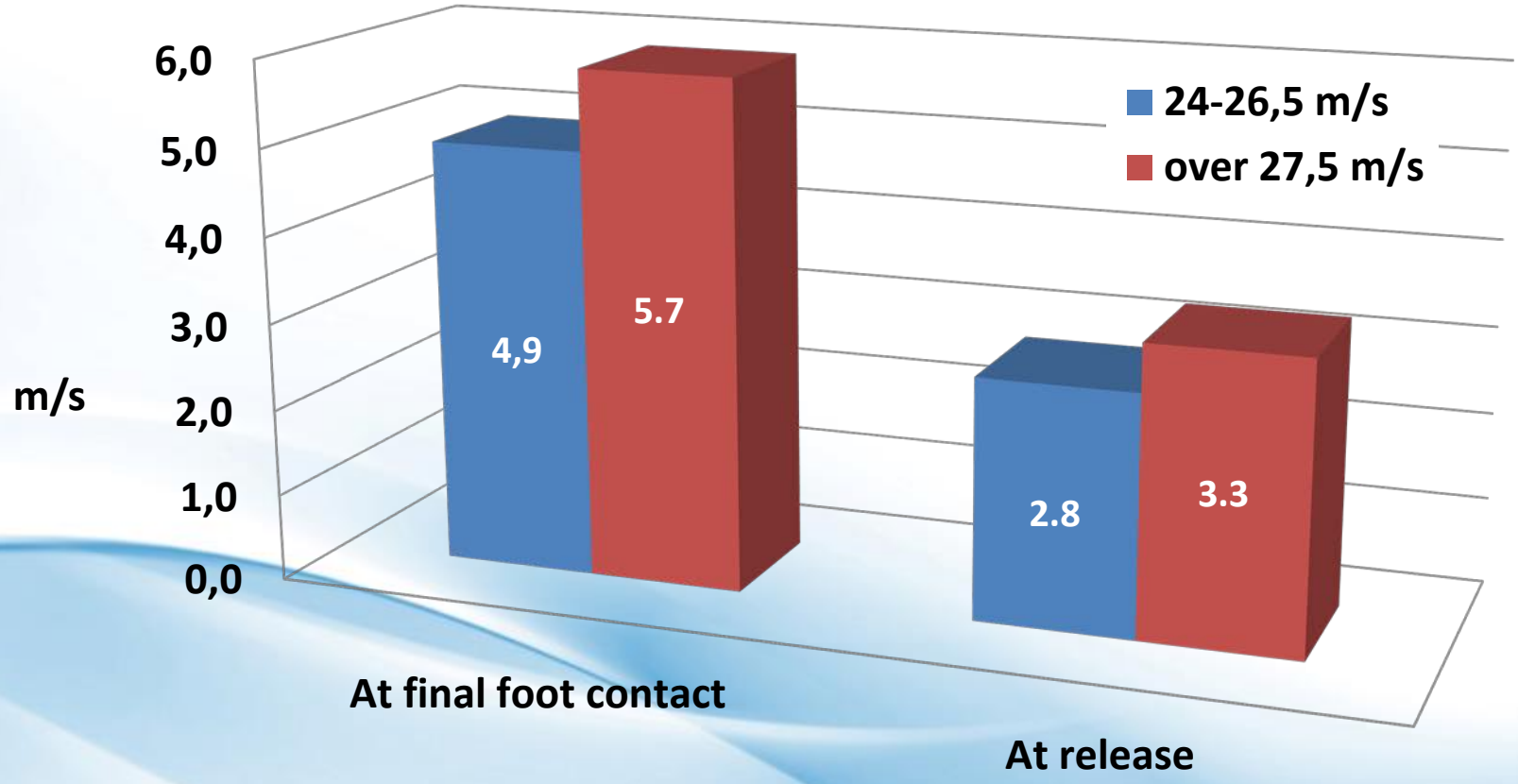
Run-up speed vs. release speed

- Helsinki EC 2012 men finalists:



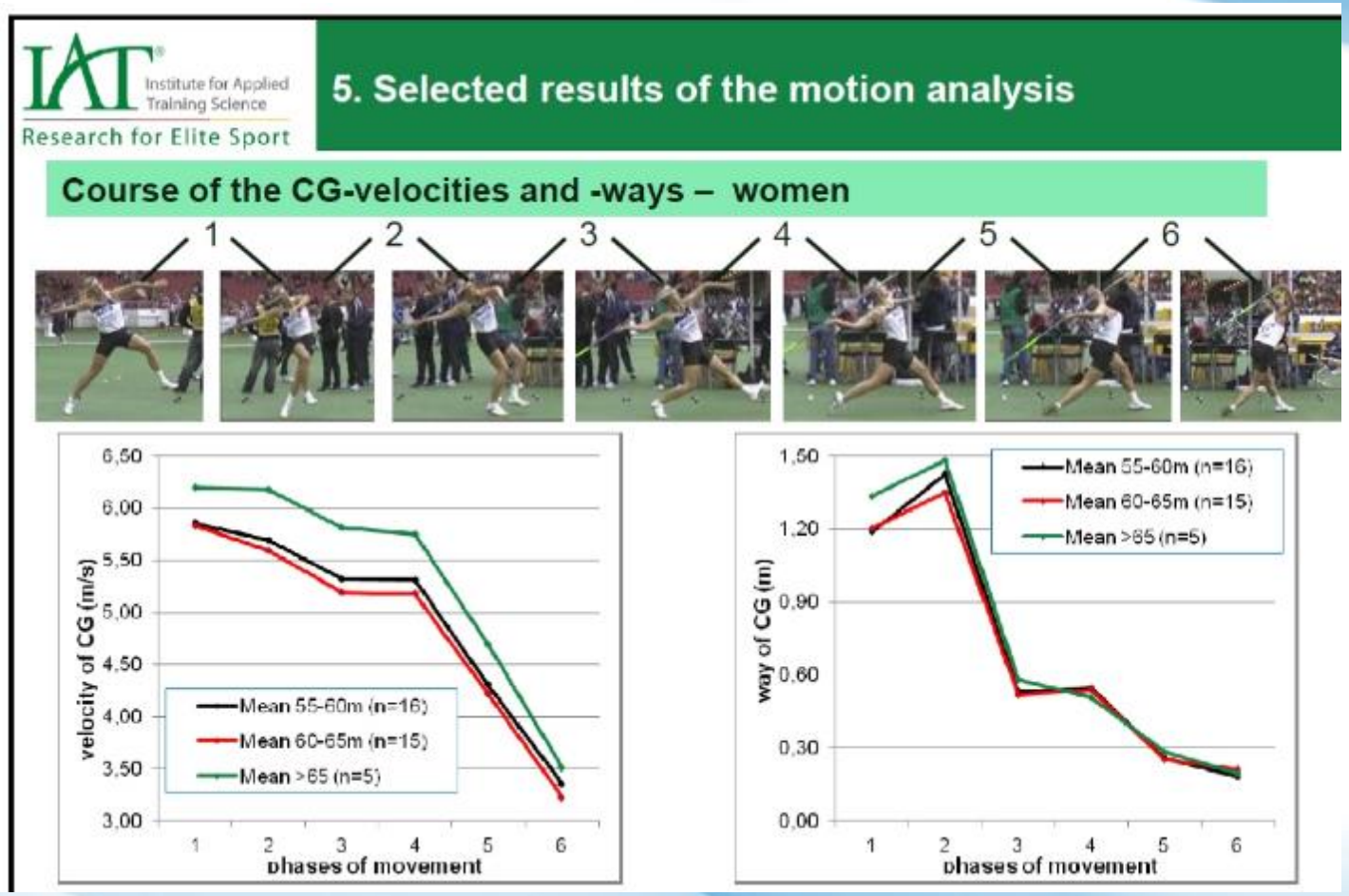
Run-up speed vs. release speed

- Finnish throwers 2006-2015, men



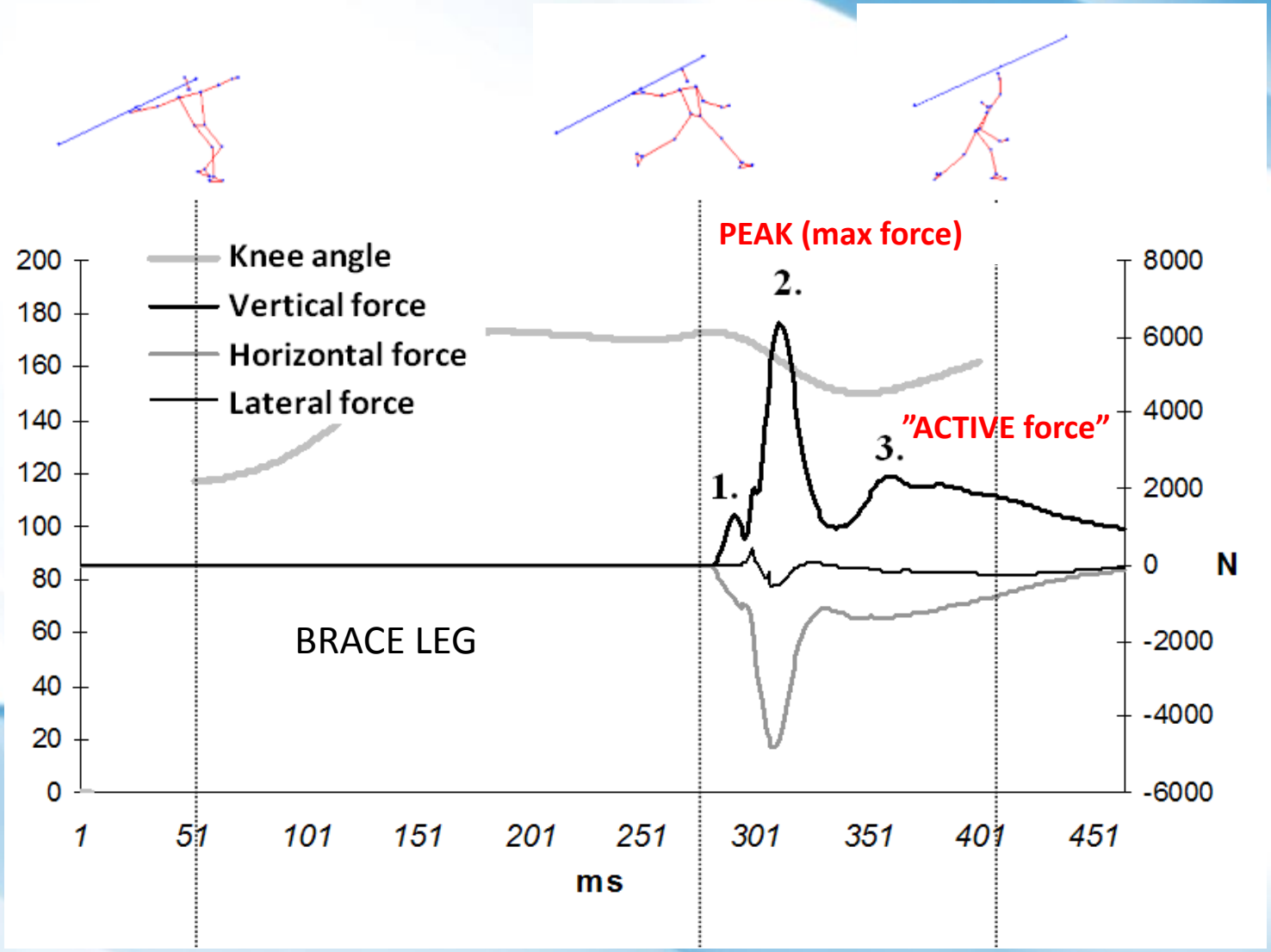
Run-up speed vs. release speed

- German analyses



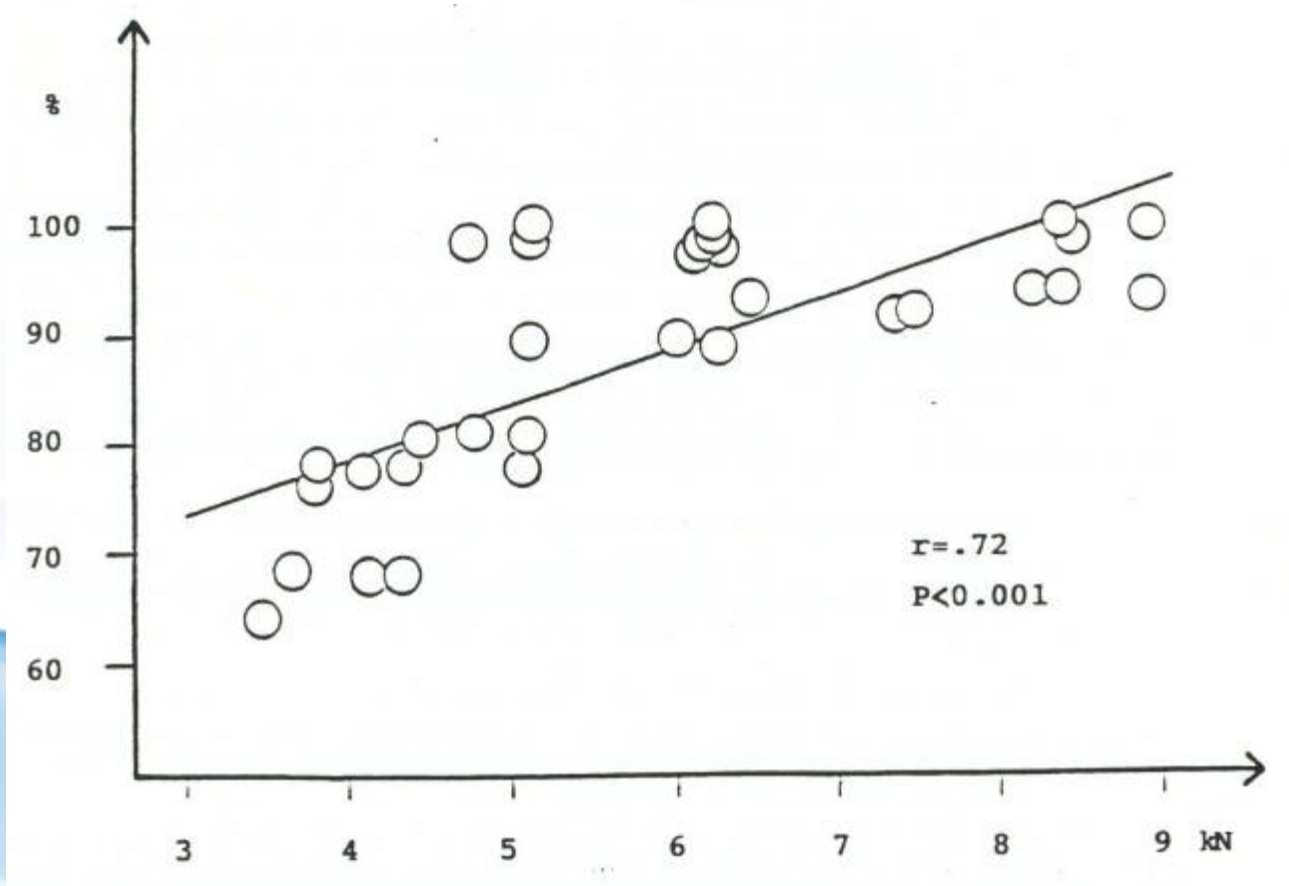
F. Lehmann, 2014

Ground reaction forces at delivery phase



Ground reaction forces and release speed

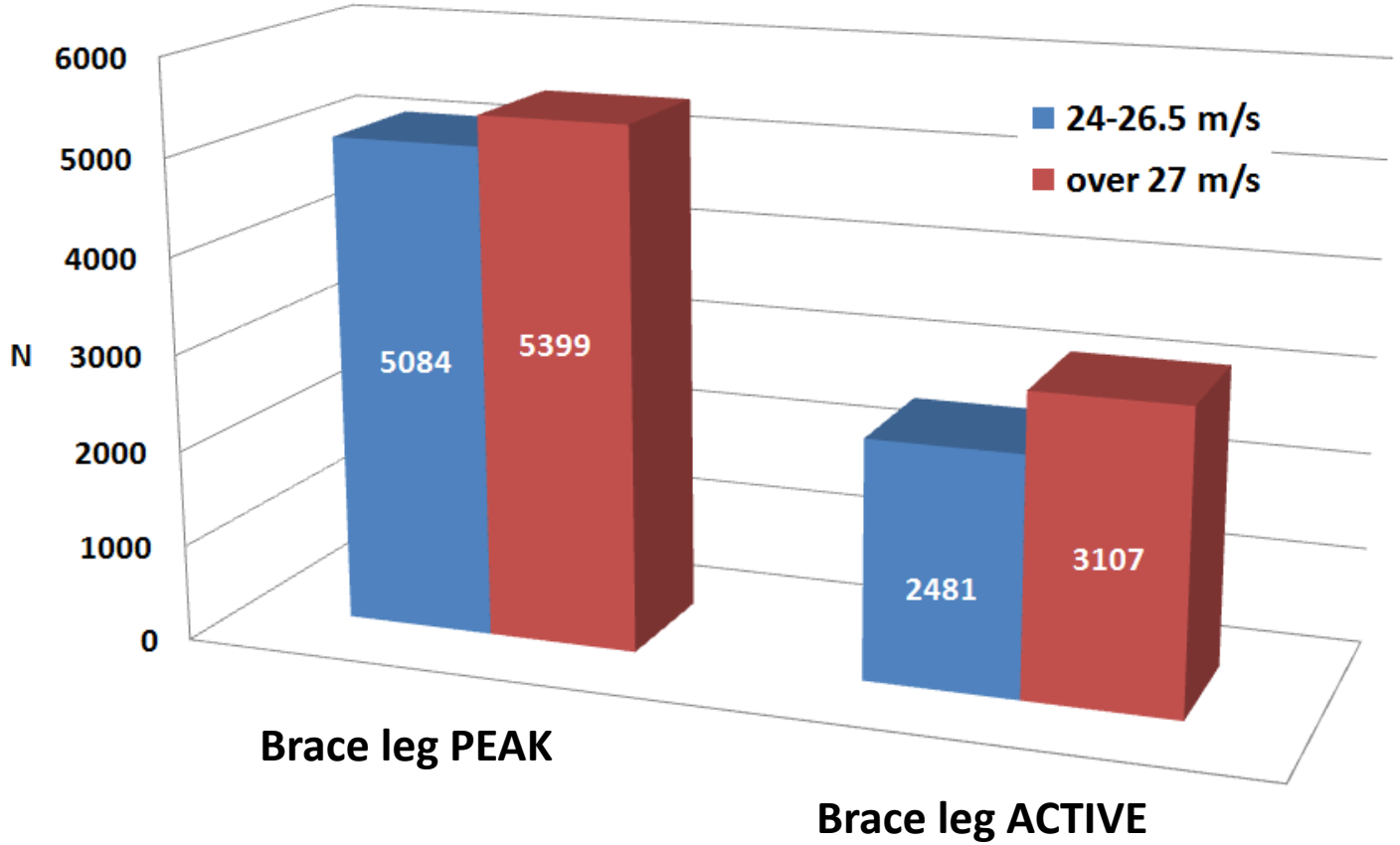
- Maximal vertical force vs. proportional release speed



Korjus 1988

Ground reaction forces and release speed

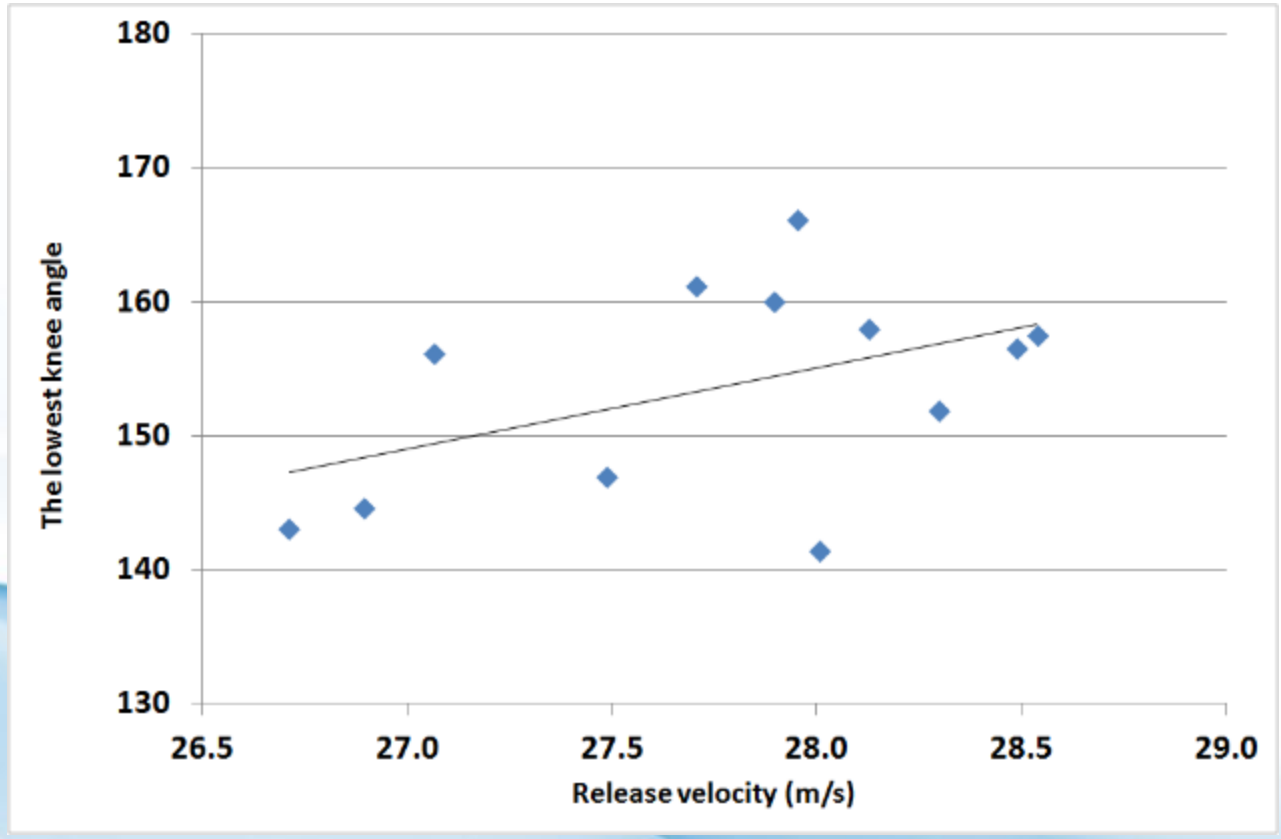
- Finnish throwers 2011-2012 (vertical force measured with pressure insoles, in trainings):



Knee angle of the support leg

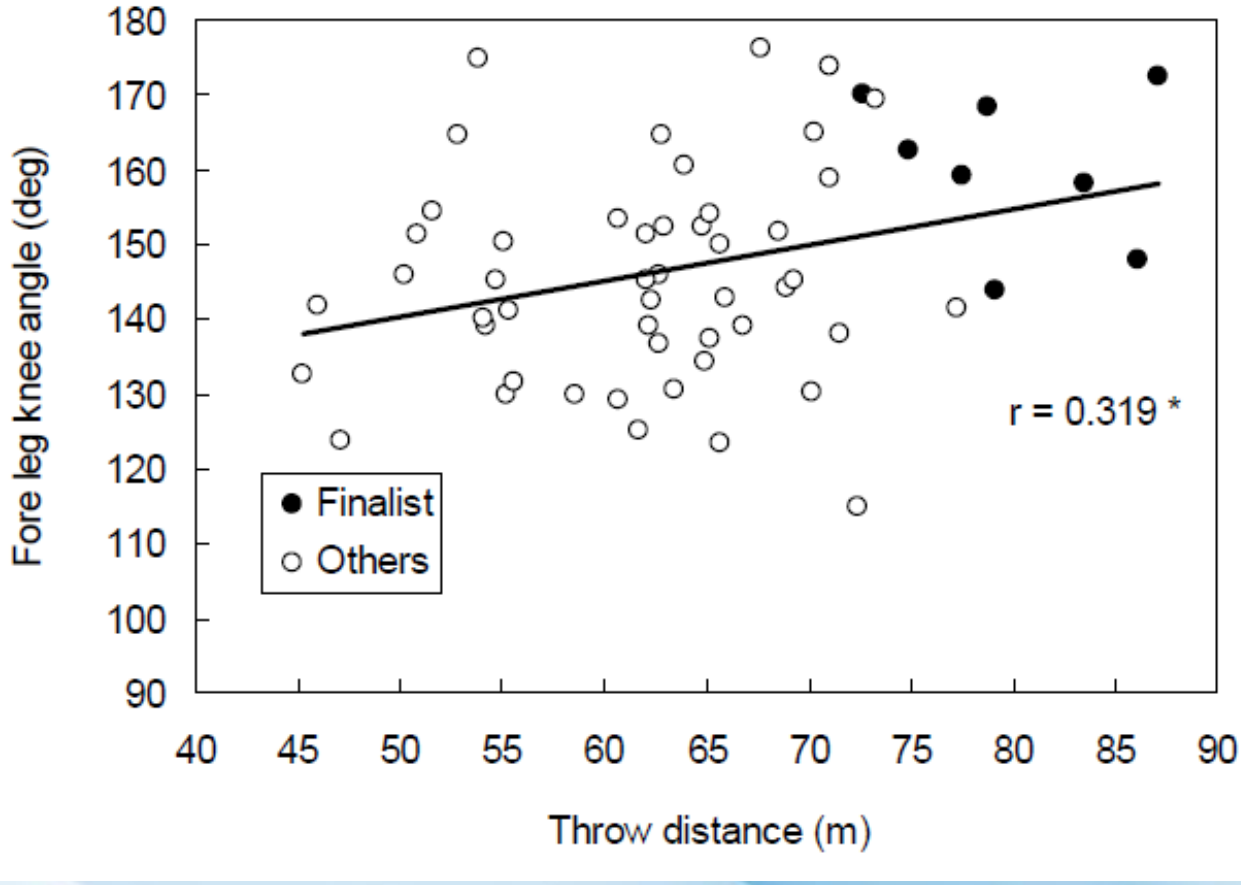
Knee angle of the brace leg

- Often considered as an important factor
- Helsinki EC 2012 men finalists (r = .46):



Knee angle of the brace leg

- Helsinki WC 2005 (+ Japanese throwers), men:



Murakami et al 2006

Knee angle of the brace leg

Berlin WC 2009

- Brace leg knee angle 0.06 s after the touch down for male throwers:
  - Average for places 1-3: 156 degrees
  - Average for places 4-11: 145 degrees

Sevilla WC 1999

- Brace leg knee angle for male throwers
  - 1 = at touch down
  - 2 = minimum
  - 3 = at release

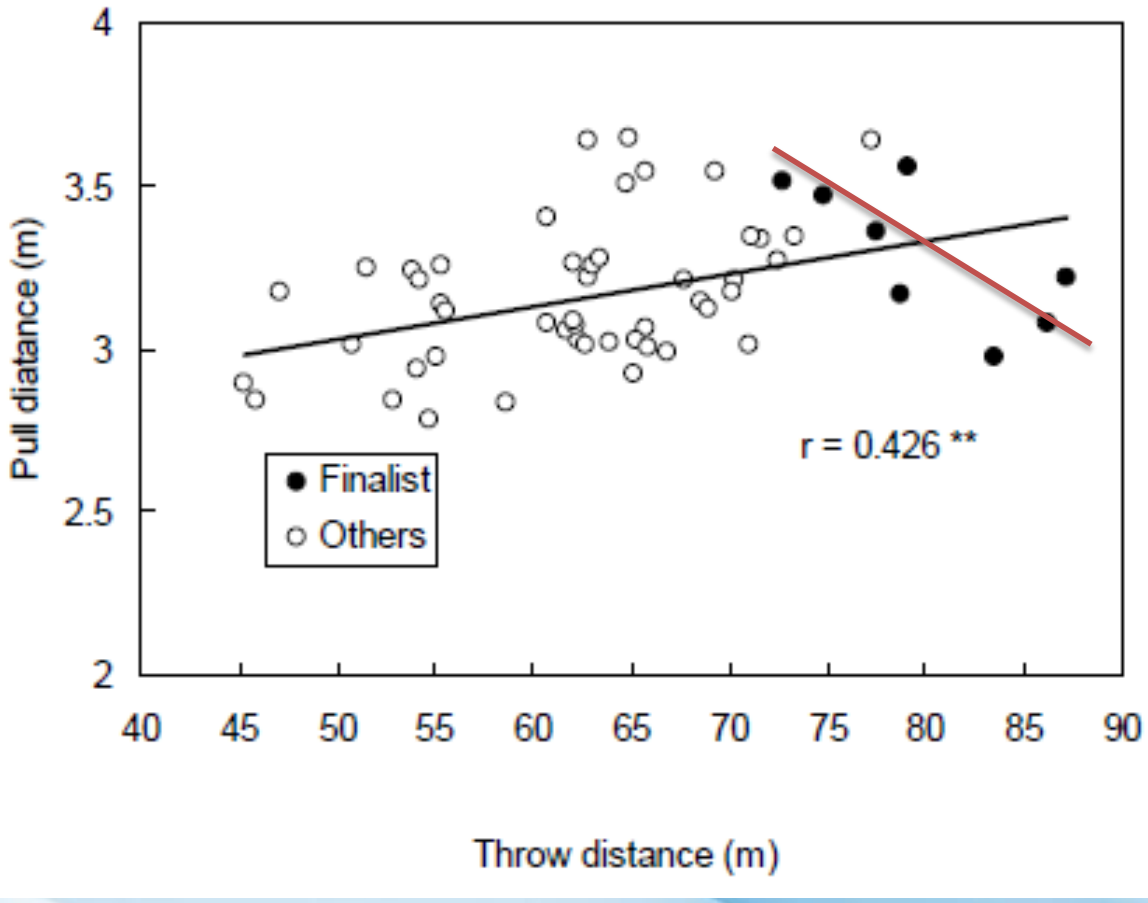
Pull distance

Pull distance

- Traditionally: longer pull distance –> higher release velocity
- Pull distance vs. throwing distance or release speed
  - Helsinki WC 2005, men — no correlation
    Osaka 2007, men — no correlation
    Helsinki 2012, men — r = .72 (release speed)
    KIHU 2006-2015 — no correlation
- Antropometrics will affect in some extend to this variable.

Pull distance vs. release speed

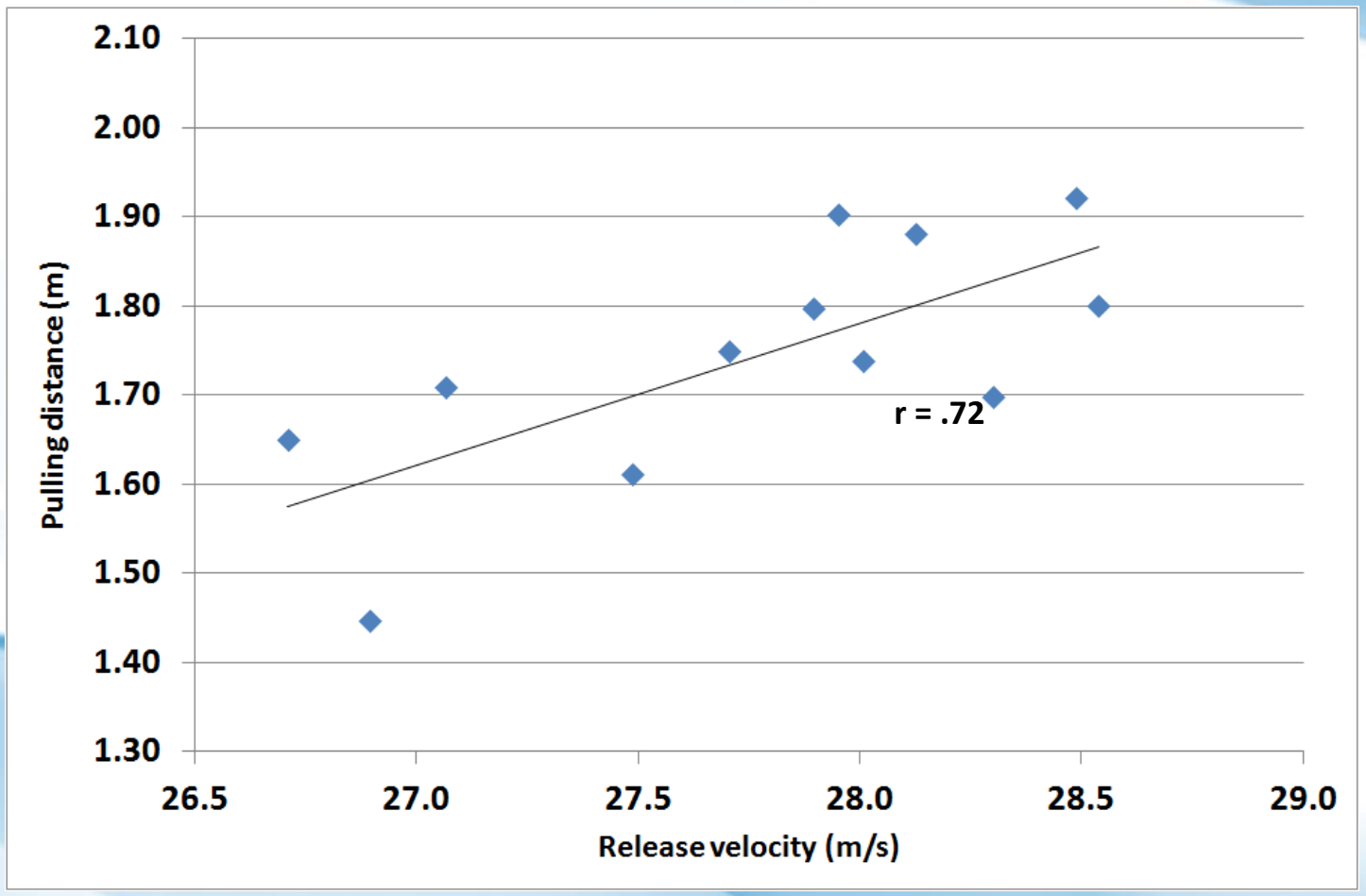
- Helsinki WC 2005 (+ Japanese throwers), men:



Murakami et al 2006

Pull distance vs. release speed

- Helsinki EC 2012 men finalists:

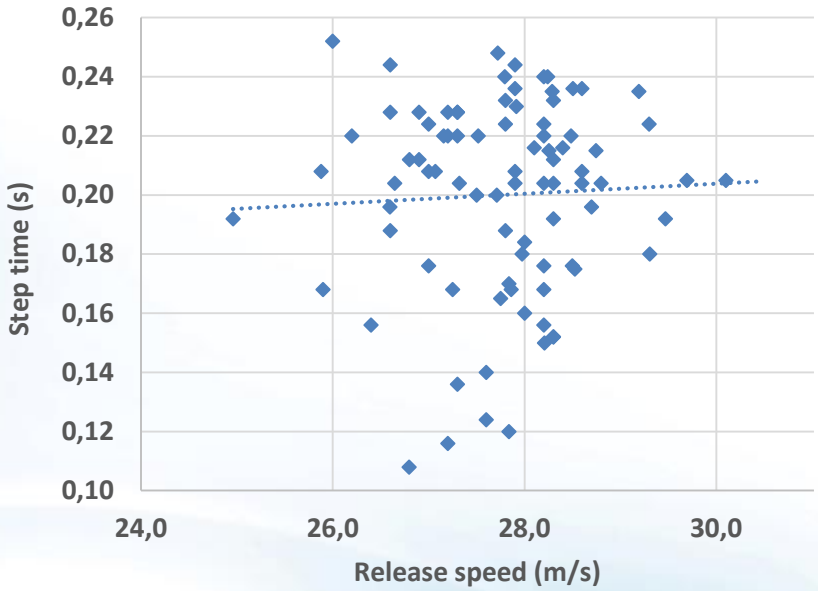


Duration of the final step

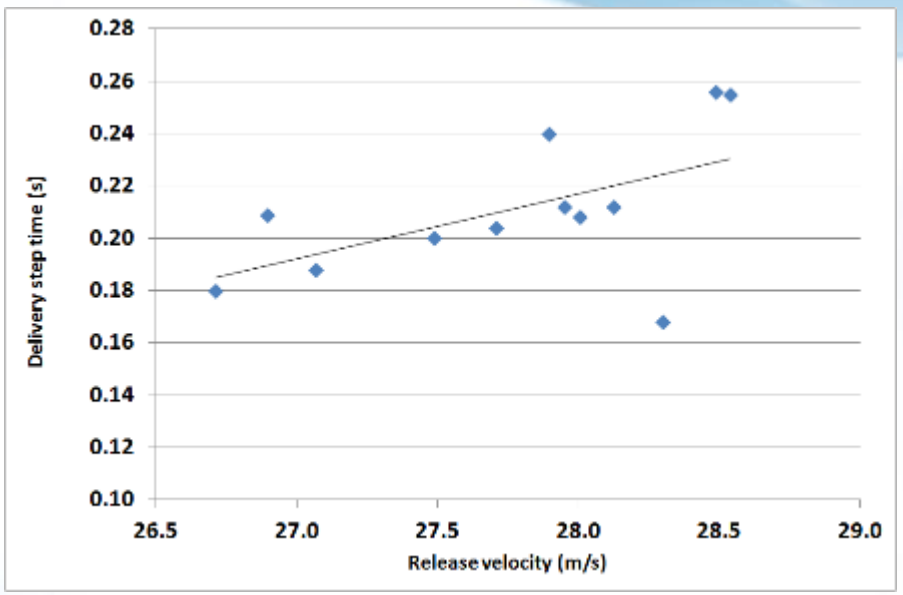
- Higher run-up velocity -> shorter duration
- ”Try to get your front leg to the ground as fast as possible”
- Correlations quite conflicting:
  - Osaka 2007, men — no correlation
    KIHU 2006-2015 — no correlation
    Helsinki EC 2012, men — r = .55

Duration of the final step and release speed

- Finnish throwers 2006-2015:

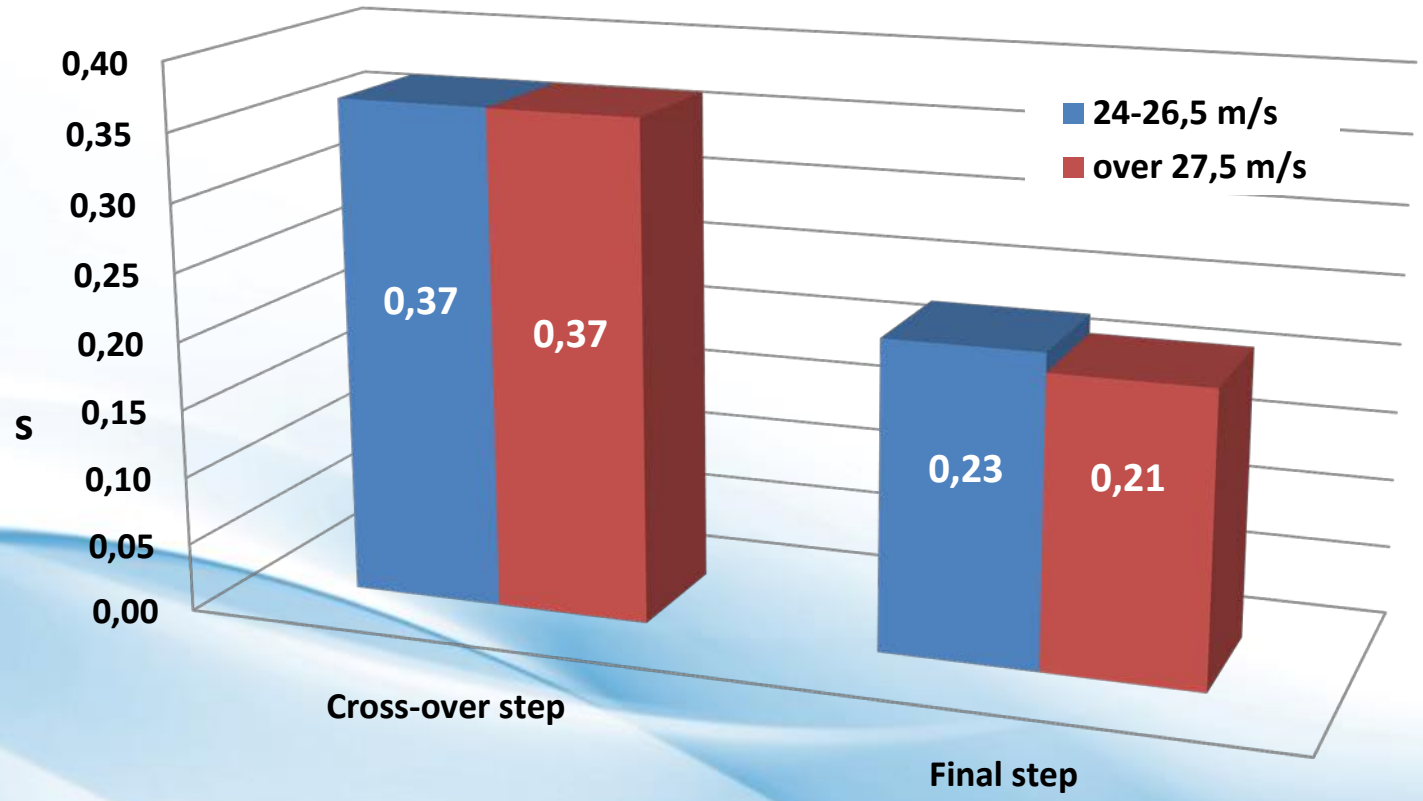


- Helsinki EC 2012:



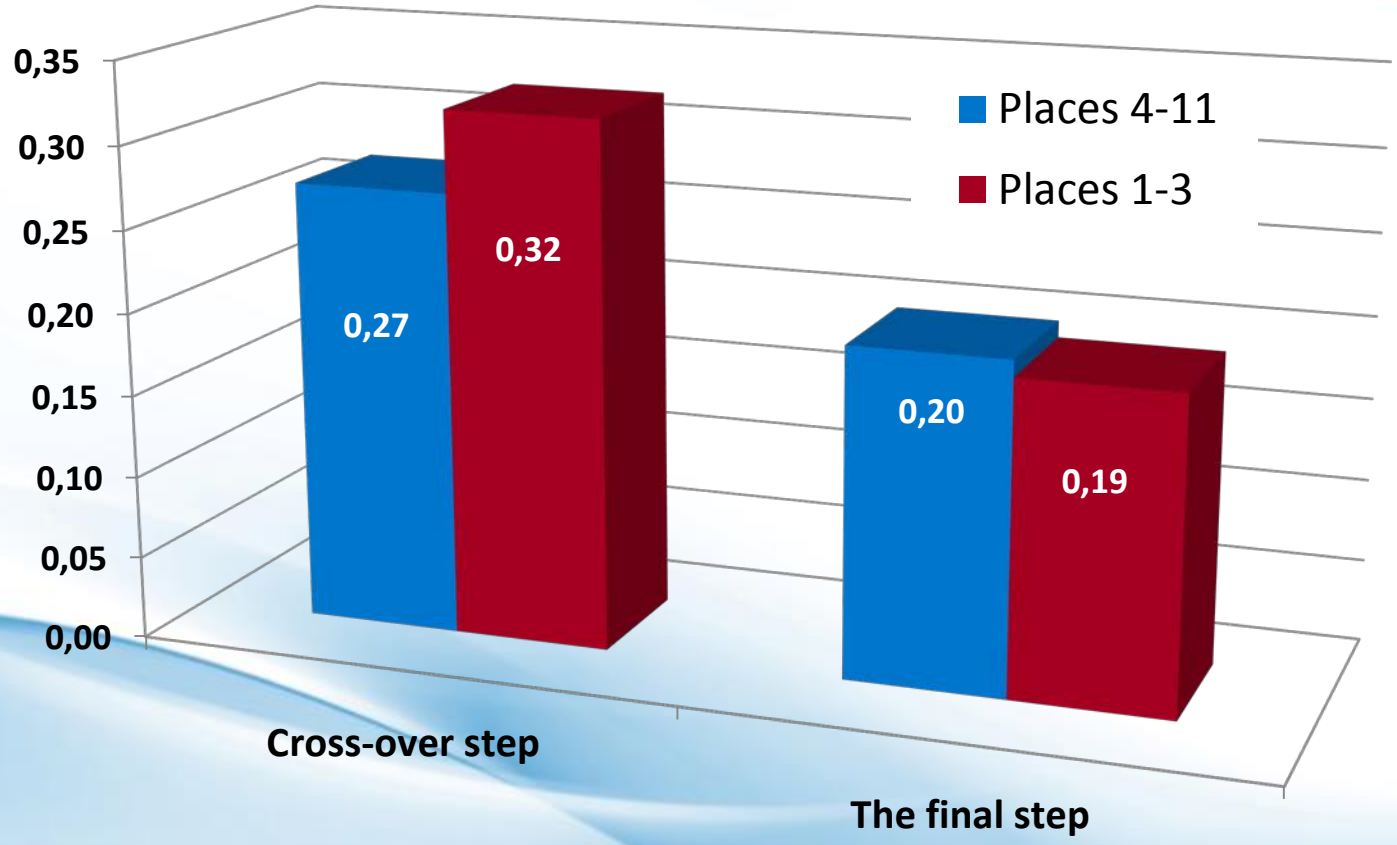
Duration of the two last steps

- Long cross-over + shorter final step
- Finnish throwers 2006-2015, men:



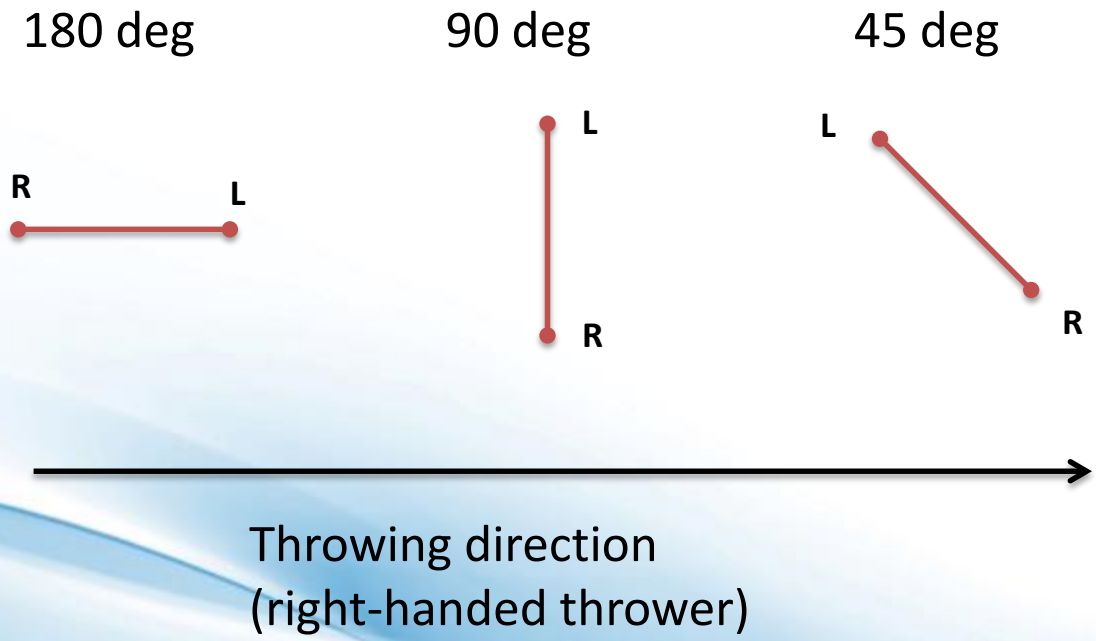
Duration of the two last step

- Berlin WC 2009 men finalists



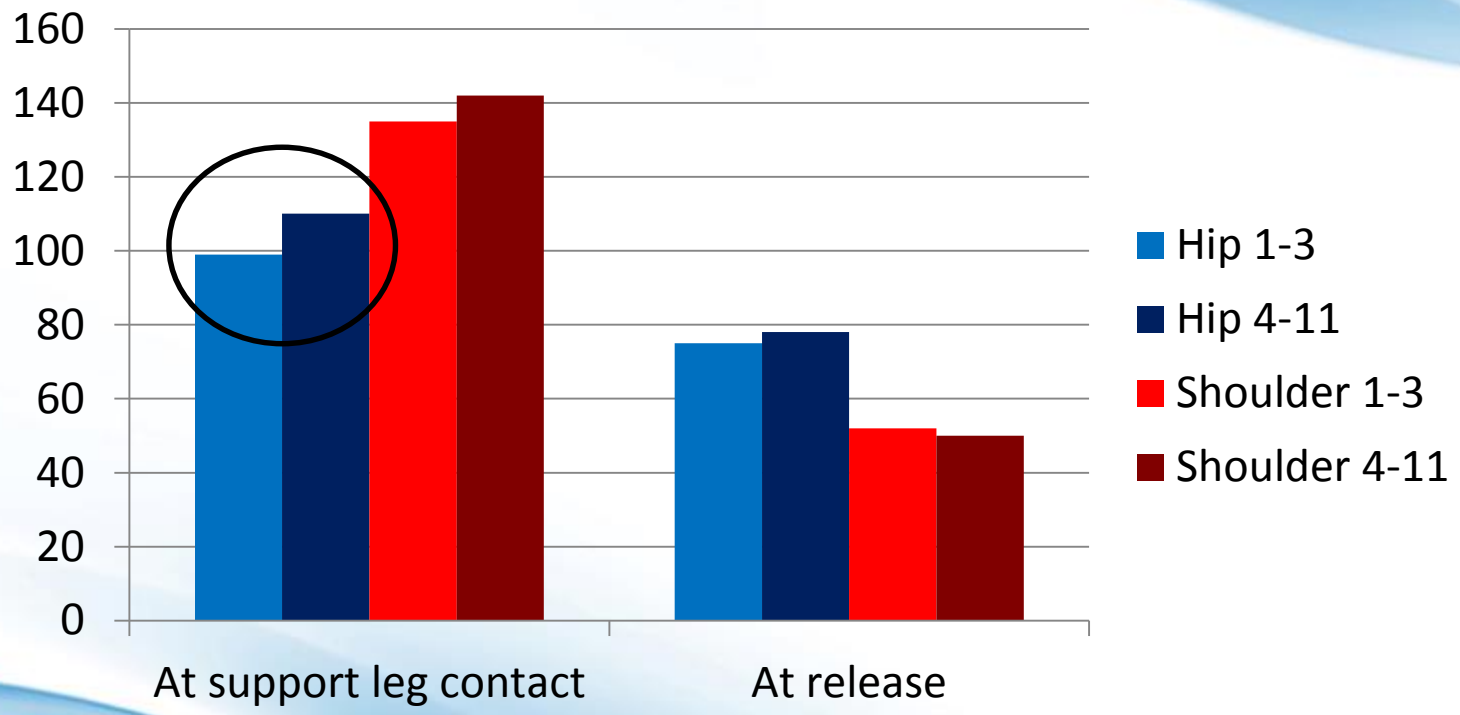
Hip and shoulder rotation angles

- Rotation of the hip axis and shoulder axis viewed from above



Hip and shoulder rotation angles

- Berlin WC 2009 men, places 1-3 vs. 4-11:

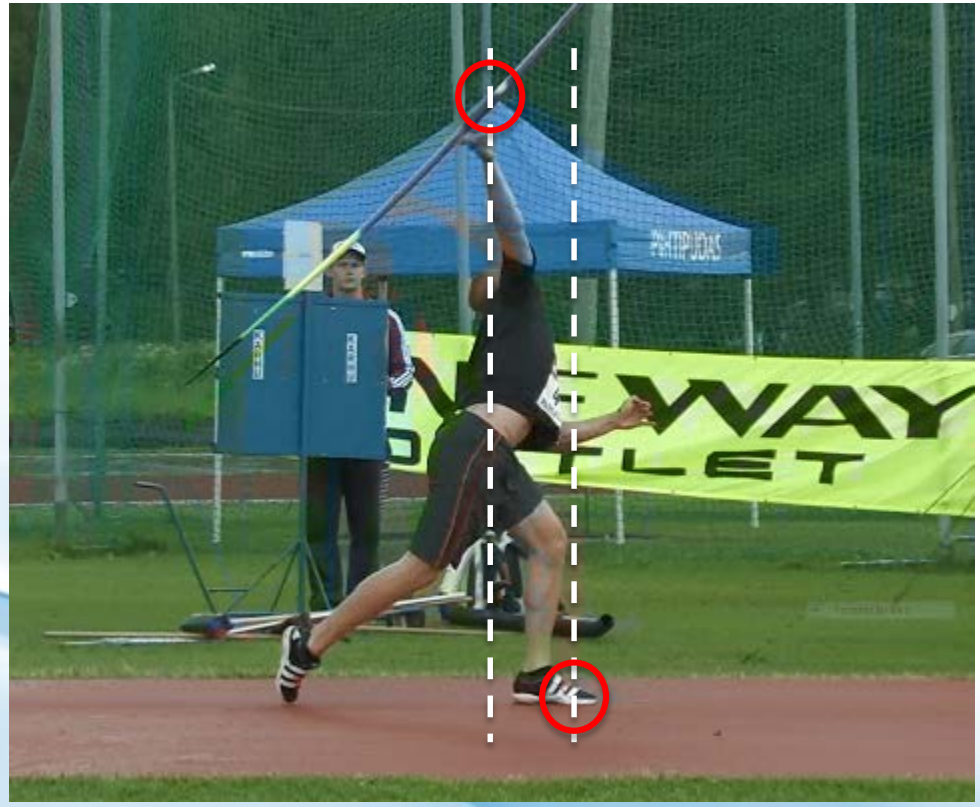


Hip rotations at final foot contact, places 1-3 vs. 4-11:

99 vs. 110 (men), 82 vs. 107 (women)

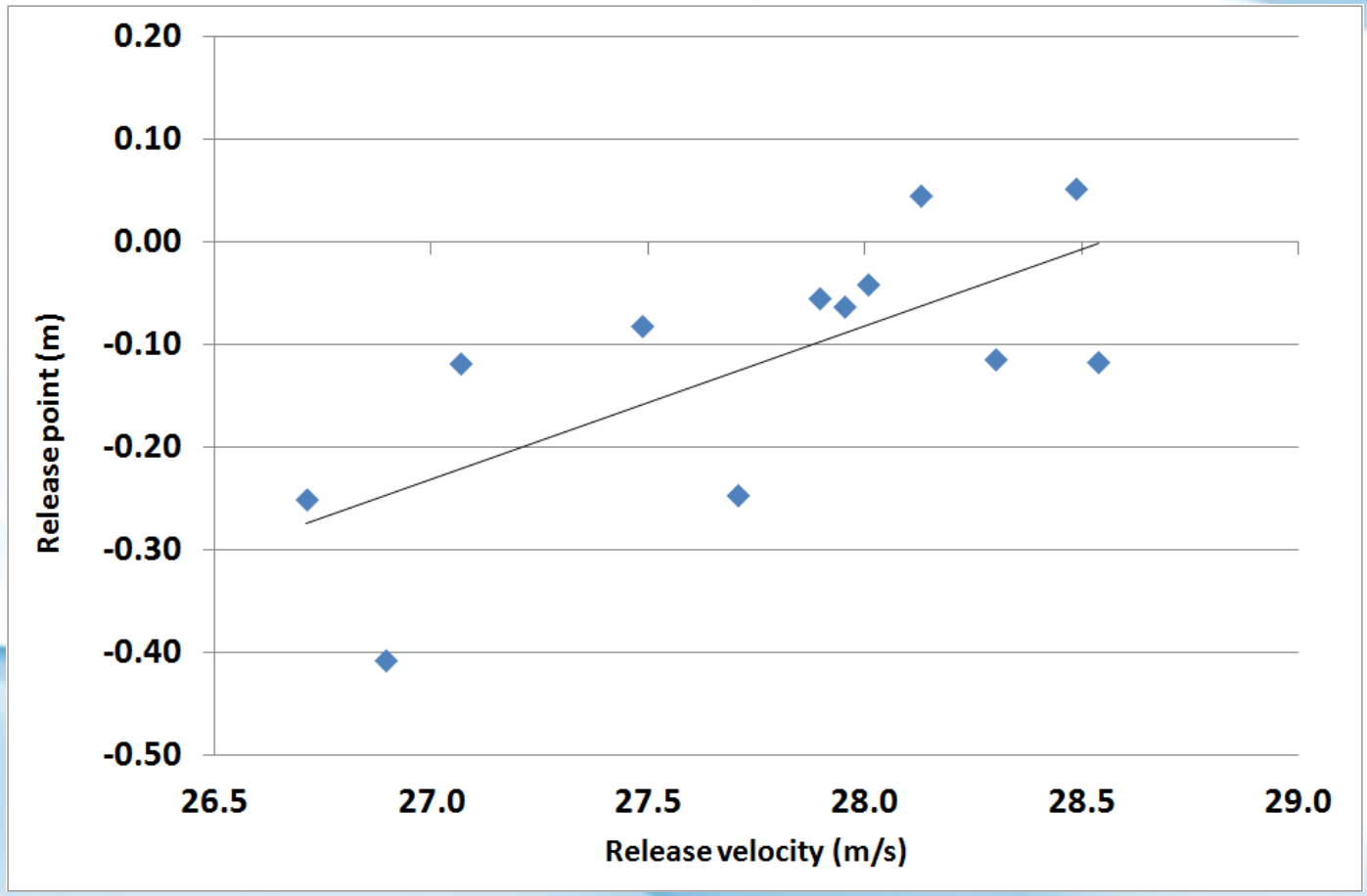
Release point of the javelin

- Distance between the release point and toes of the front leg in horizontal direction



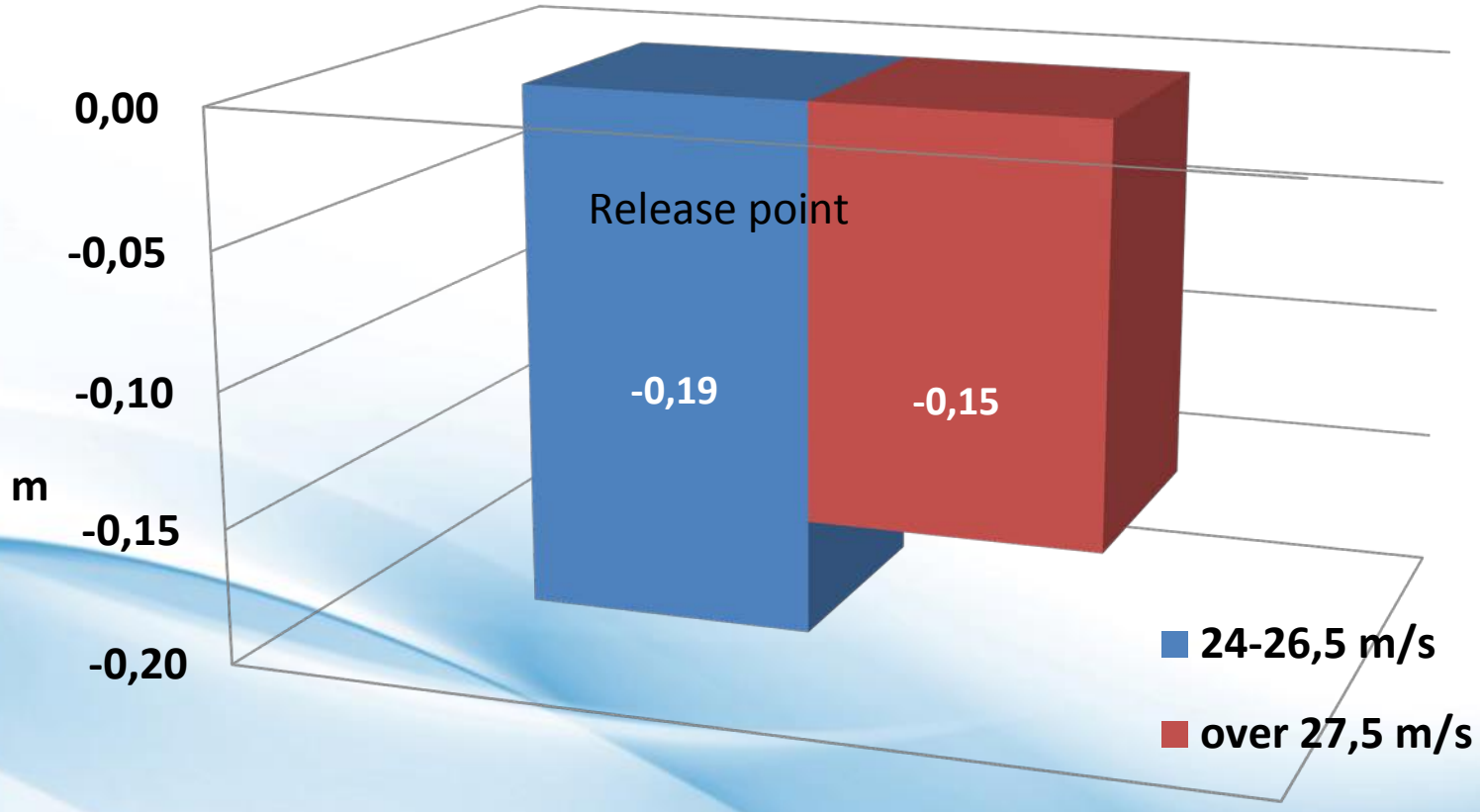
Release point of the javelin

- Helsinki EC 2012 men finalists:



Release point of the javelin

- Finnish male throwers 2004-2012:



Conclusions

- It can be proposed that better throwers
  - Have greater approach speed
  - Have longer cross-over step, but short final step
  - Have bigger pull distance
  - Have stiffer support leg
  - Produce higher ground reaction forces
  - Start hip rotation earlier and rotate their shoulder axis more at the end of pull phase
  - Release javelin further on the front (closer to the toes of support leg)

Conclusions

- Group-level correlations give some fundamentals for improving performance.
- BUT there are also other variables that may be important at individual level.
- And, the higher level of an athlete, the more individual based analysis should be.

Thank you!