Biomechanics in javelin throwing

with special reference to feedback for coaching

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Contents

1. Biomechanical background in javelin throwing

Bartlett and Best	The biomechanics of javelin throwing : a review J. Sp. Sci., 1988
Hay	Javelin throw in The Biomechanics of Sports Techniques, 1978
Hubbard	The throwing events in track and field in The Biomechanics of Sport II, 1987
Morris and Bartlett	Biomechanical factors critical for performance in the men's javelin throw Sports Med., 1996
Terauds	Biomechanics of the javelin throw A book, 1985

1. Biomechanical background in javelin throwing

Factors affecting the distance thrown

- Release speed
- Release angle
- Release angle of attack
- Release angle of yaw
- Release pitching moment
- Aerodynamic factors

Hay, 1993
Morris and Bartlett, 1996

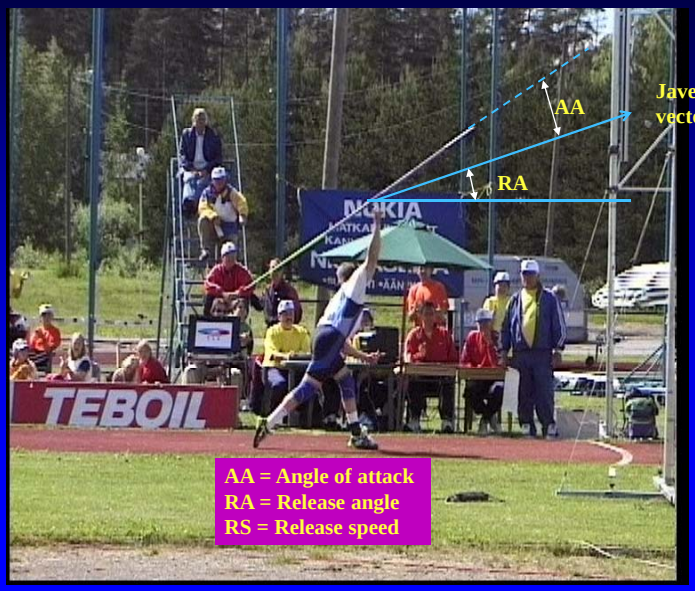
1. Biomechanical background in javelin throwing

Run-up

Crossover strides

Delivery stride

Final foot strike



Biomechanical service for the Finnish elite javelin throwers

Selection of methods and variables :

- Importance of the variable on throwing performance and javelin aerodynamics
- Demands of coaches and throwers
- Possibility to measure the variables

2. Cooperation between research and javelin throwing in Finland

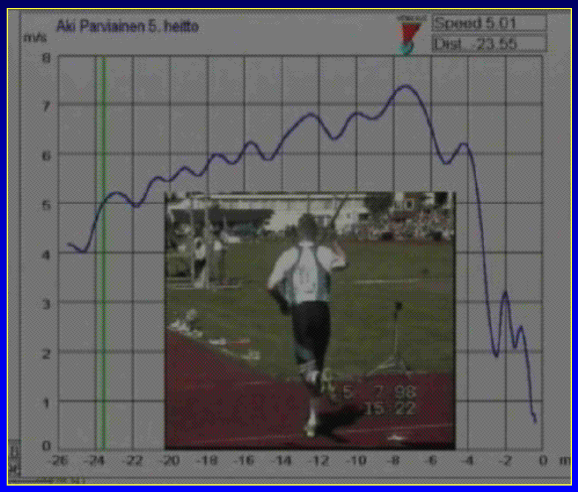
Variables selected and measured (throwers):

- run-up speed
- biomechanical parameters of the delivery stride
- biomechanical variables of the thrower during the final foot strike (between touch down of the left foot and release of the javelin)
- release speed, release angle, angle of attack, distance thrown

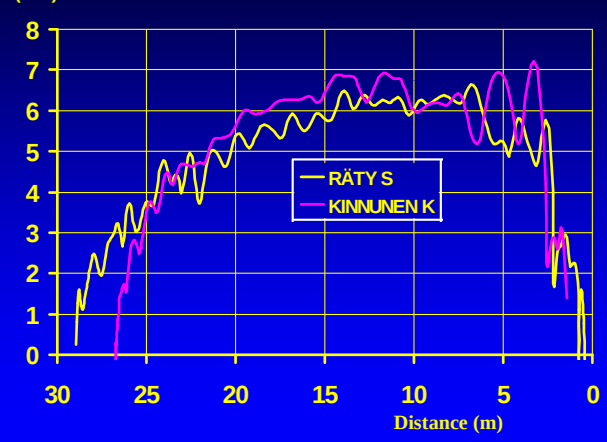
Variables selected and measured (javelin aerodynamics):

- release speed, angle and flight distance
- different javelin types, wind conditions, effects of rotation
- effects of the javelin's center of mass on flight distance and landing position

Run-up speed - radar



JAVELIN THROWING: Run-up speed



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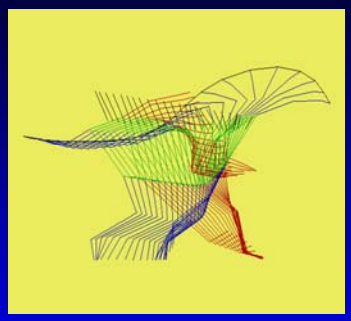
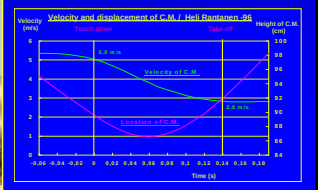
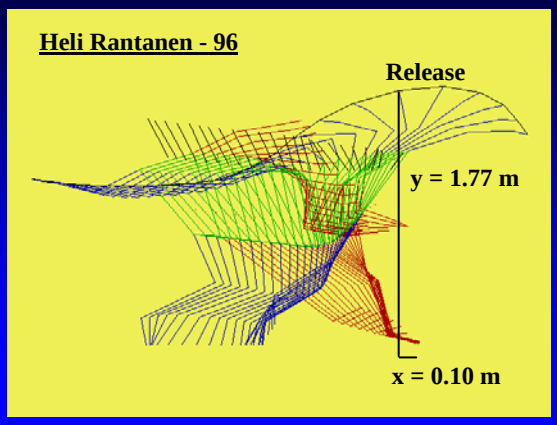
Throwing technique - video shooting and motion analysis

Calibration

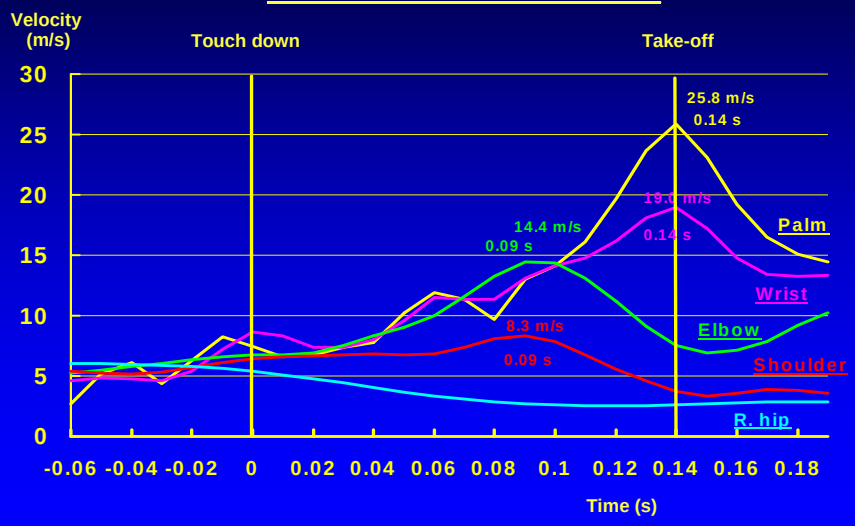


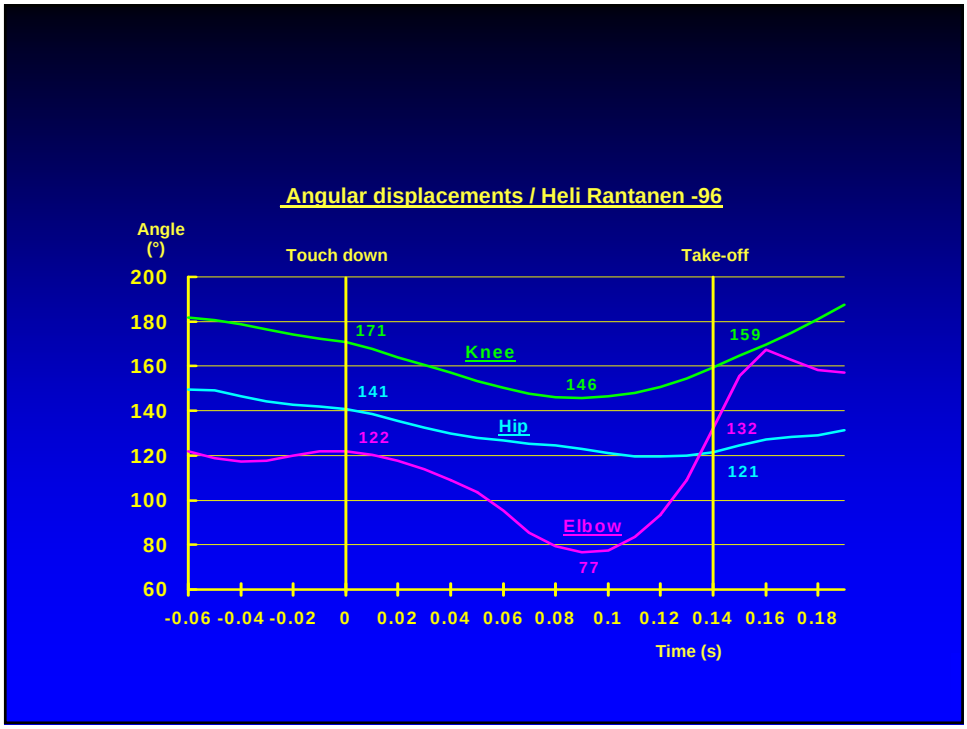


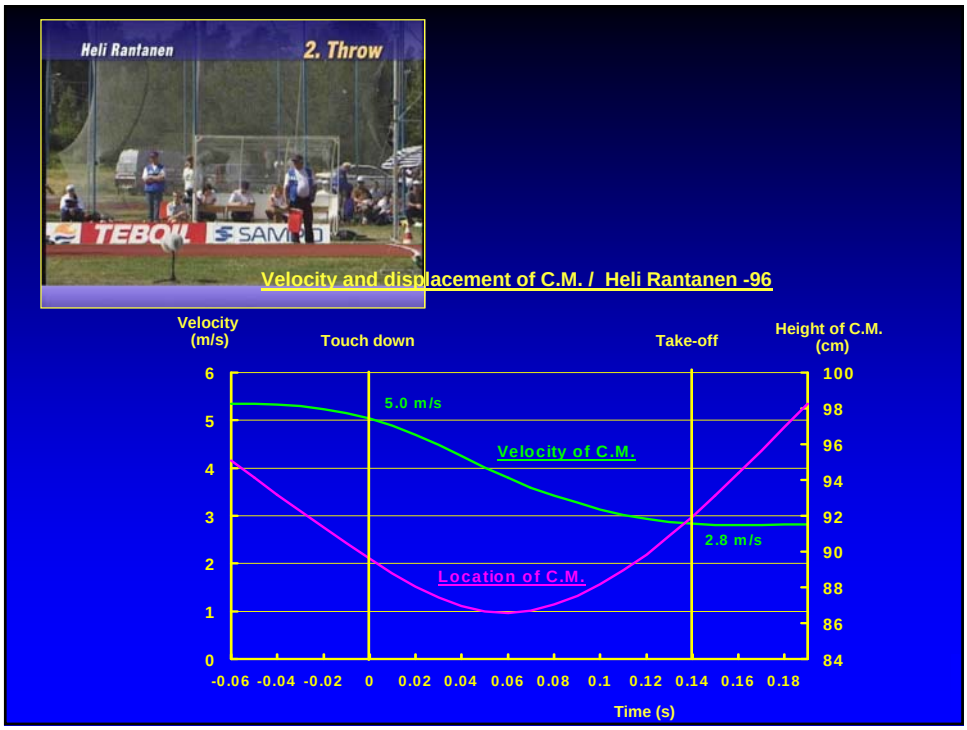
Heittokäden liikerata

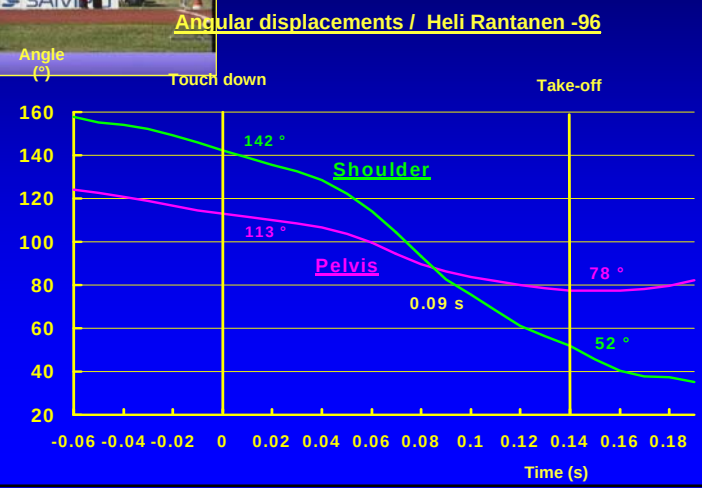


Linear velocities / Heli Rantanen -96




Angular displacements / Heli Rantanen -96
Angle (°)
Touch down
Take-off
200
180
160
140
120
100
80
60
171
Knee
146
159
141
Hip
122
132
121
Elbow
77
-0.06 -0.04 -0.02 0 0.02 0.04 0.06 0.08 0.1 0.12 0.14 0.16 0.18
Time (s)


Heli Rantanen
2. Throw
Velocity and displacement of C.M. / Heli Rantanen -96
Velocity (m/s)
Touch down
Take-off
Height of C.M. (cm)
6
5
4
3
2
1
0
100
98
96
94
92
90
88
86
84
5.0 m/s
Velocity of C.M.
2.8 m/s
Location of C.M.
-0.06 -0.04 -0.02 0 0.02 0.04 0.06 0.08 0.1 0.12 0.14 0.16 0.18
Time (s)



2. Cooperation between research and javelin throwing in Finland

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- **release speed, release angle, angle of attack, distance thrown**

Variables selected and measured (javelin aerodynamics):

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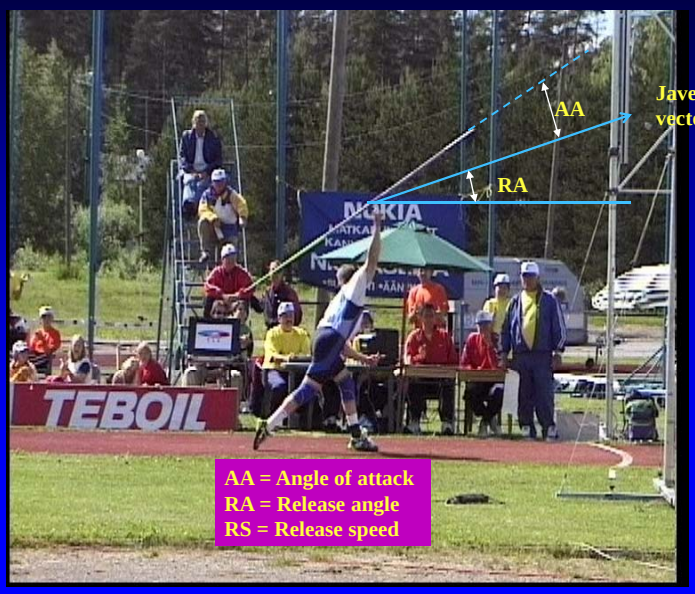
- different javelin types, wind conditions, effects of rotation
- effects of the javelin's center of mass on flight distnace and landing position

Release parameters - photocell gate



Release parameters - photocell gate

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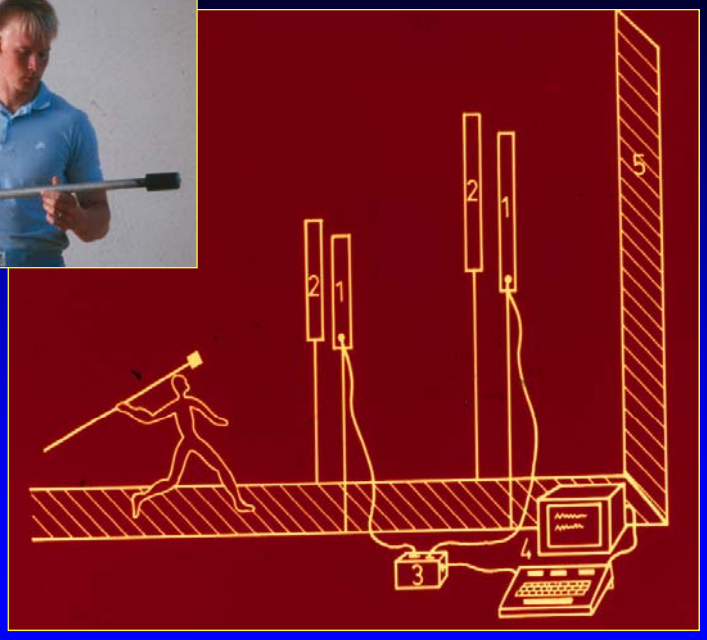
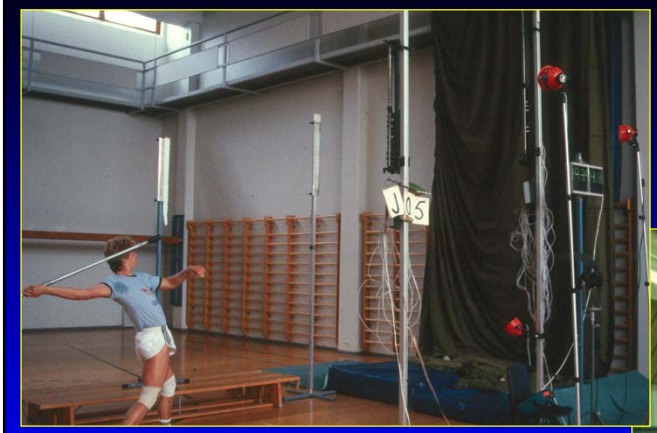


Release parameters - photocell gate



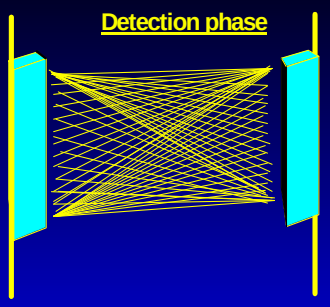
Release parameters - photocell gate

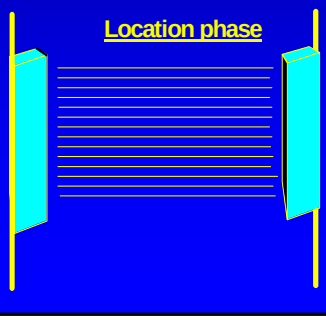
Release parameters - photocell gate

- two infrared walls ; 2.0 and 2.5 m height
- 300 photocells

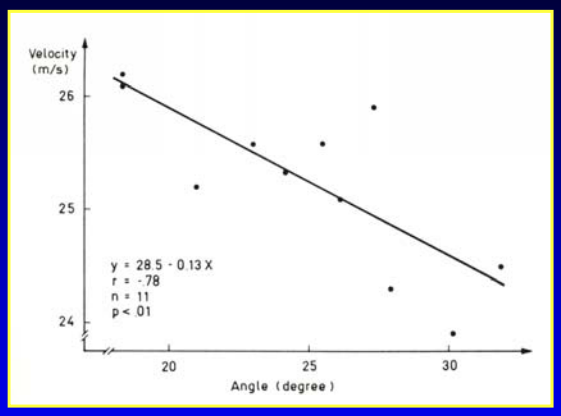
- detection phase :
  - 50 kHz, fan shape
  - resolution 1-3 mm

- location phase
  - 1 kHz
  - 15 mm resolution





Release speed vs. release angle



- 11 maximal throws
- male javelin thrower
- release angles between 18 and 32 deg

Viitasalo and Korjus, 1988

Optimum for neuromuscular functioning ≠

optimum for physics of throwing motion

RELEASE PARAMETERS AND THROW DISTANCE IN ELITE JAVELIN THROWING

K. Norvapalo , H. Mononen and J. Viitasalo

KIHU- Research Institute for Olympic Sports , Jyväskylä, Finland

PURPOSE

to investigate the relationship between

the release parameters and throw distance

among elite javelin throwers

METHODS / MEASUREMENTS

- 159 throws of 26 males

  98 throws of 15 females

- competitions in Finland

  during 1995-1998

- throw distance range for

  women 55.00 - 66.00 m

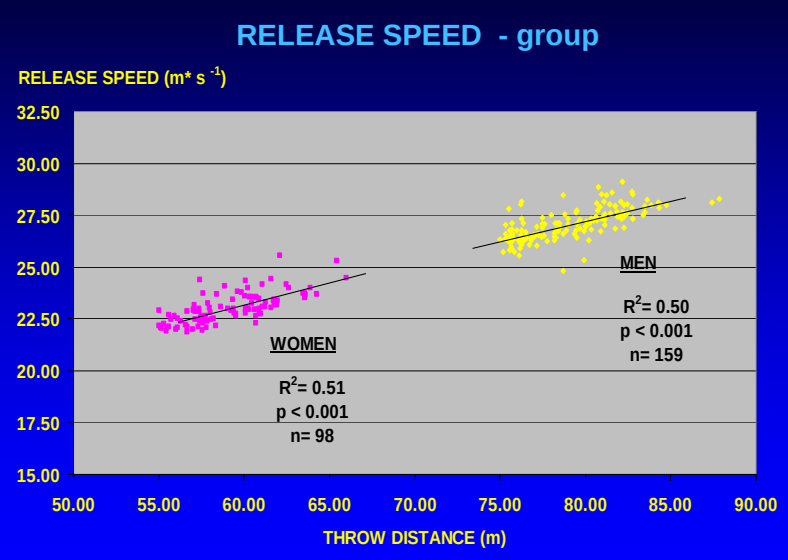
  men 75.00- 87.82 m

METHODS / PARAMETERS

- Release speed, (m * s^{-1})
- Release angle, (°)
- Angle of attack, (°)

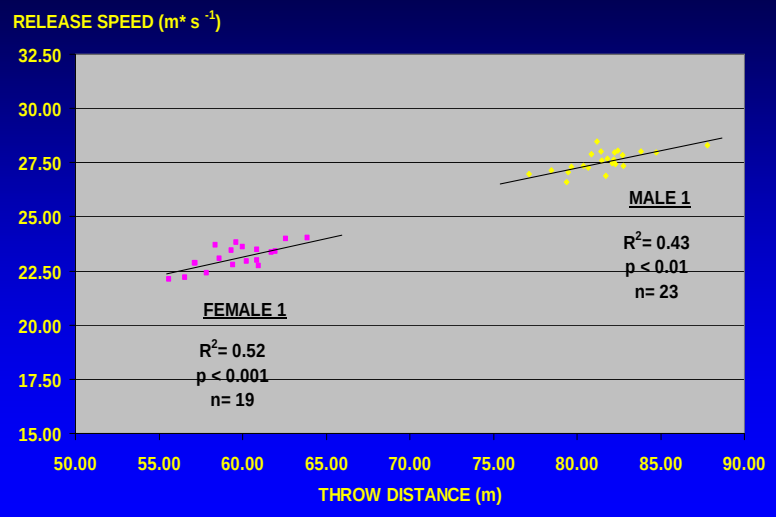
- Official throw distance (m)

RESULTS



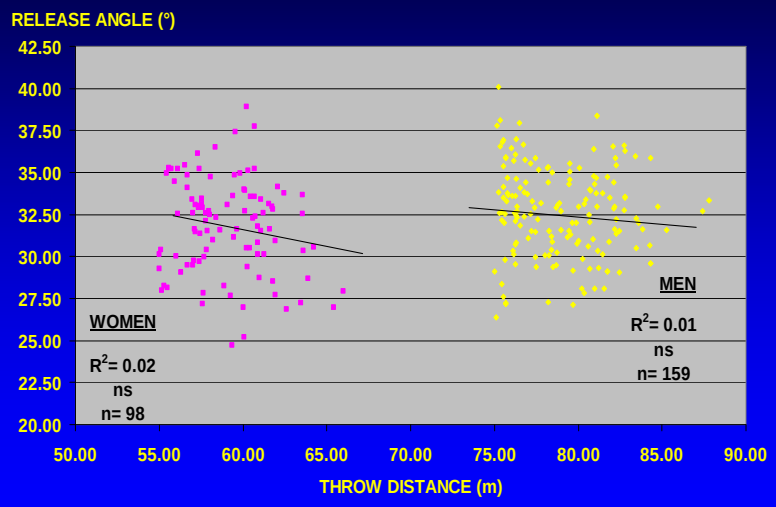
RESULTS

RELEASE SPEED - individual

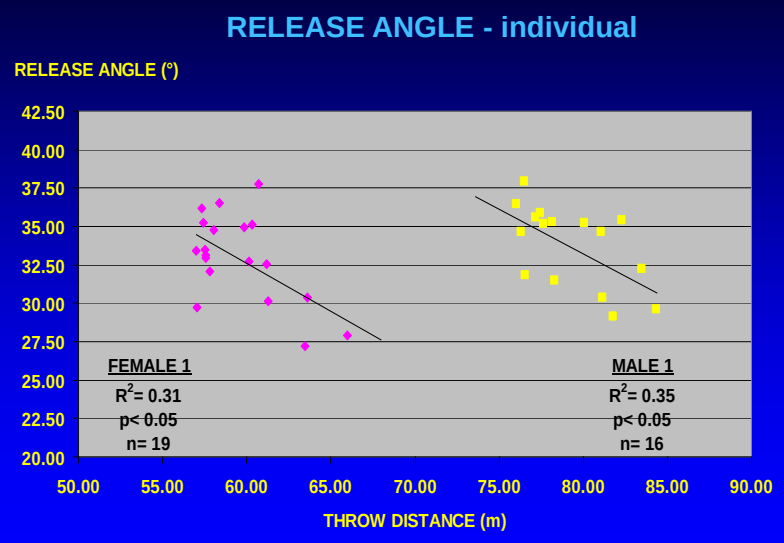


RESULTS

RELEASE ANGLE - group



RESULTS



Number of	Men	Women
Competitons	6	7
Trowers	63	40
Throws	184	133

Men

Result = 3.52*v + 0.39*ra - 0.14*aa – 29.45 R^2 = 0.66

Women

Result = 3.82*v + 0.08*ra - 0.11*aa – 31.23 R^2 = 0.80

v = release speed (m/s)
ra = release angle (deg.)
aa = angle of attack (deg.)

RESULTS

THROW DISTANCE vs RELEASE PARAMETERS - MEN
(Regression analyses, R^2)

	Release speed	Release speed and angle	Release speed, angle and angle of attack
Ath 1 (n=11)	0.29	0.50	0.73
Ath 2 (n=13)	0.64	0.76	0.80
Ath 3 (n=15)	0.80	0.80	0.80
Ath 4 (n=16)	0.82	0.82	0.88
Ath 5 (n=18)	0.55	0.55	0.59
Ath 6 (n=23)	0.43	0.57	0.66

CONCLUSIONS

- among elite javelin throwers the release speed was the best parameter to predict the throw distance both at group and individual level
- the release angle had significant relationship with throw distance only at individual level
- the angle of attack did not alone significantly affect on the throw distance
- the explanatory power of various release parameters on the official throw distance differed in individual and group levels

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Aerodynamics of the javelin - pneumatic javelin gun

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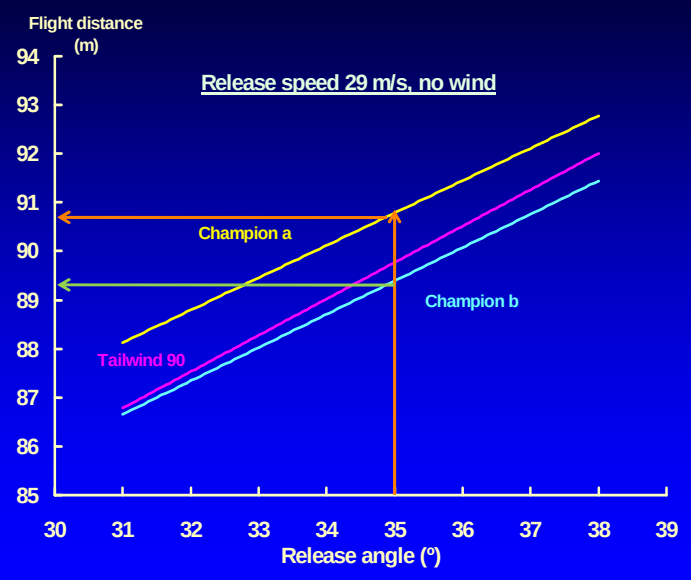
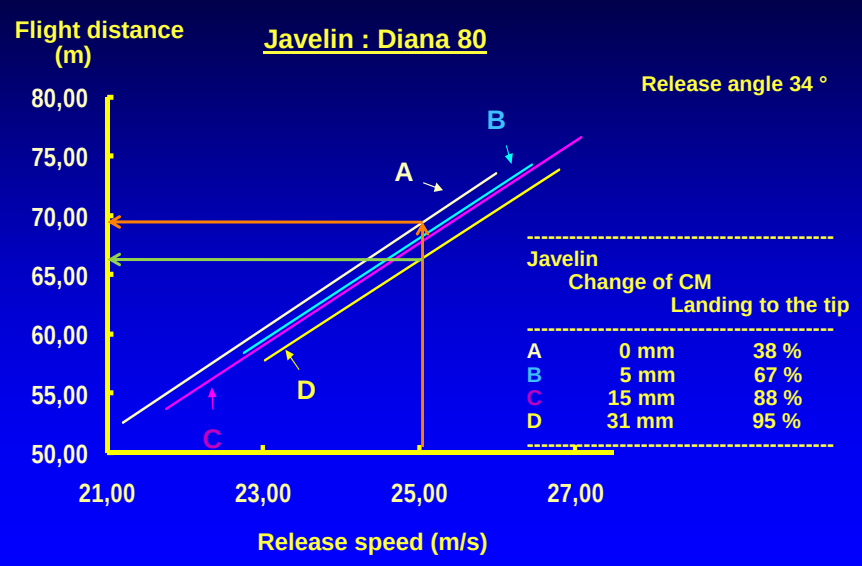


Aerodynamics of the javelin - pneumatic javelin gun



Javelin	Change of CM	Landing to the tip
A	0 mm	38 %
B	5 mm	67 %
C	15 mm	88 %
D	31 mm	95 %

Some conclusions

There is only one optimal technique for any particular thrower but it varies considerably between individuals

Best et al., 1993

What is optimal in respect of throwing physics is not necessarily optimal in respect of the neuromuscular functioning

The aerodynamic characteristics differ between javelin models/manufacturers as well as between individual javelins

Thank You

Jukka Viitasalo