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ECSS LIVERPOOL 2011

Lumbo-pelvic lateral flexion biomechanics and quadratus lumborum asymmetry in junior cricket fast bowlers

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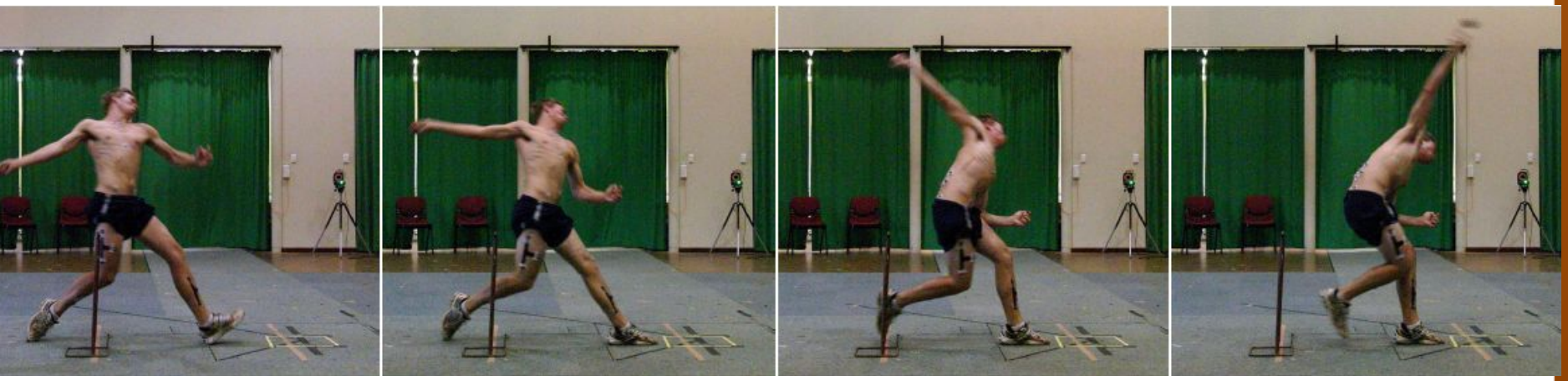
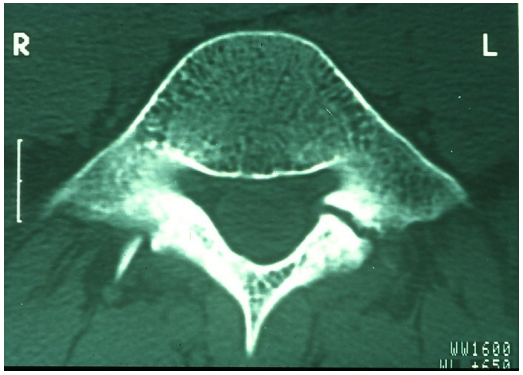
BACKGROUND

- Fast bowling: ground reaction force up to 9xBW; complex motion of the trunk *Hurrion et al., 2000*
- Amongst cricketers, fast bowlers are most affected by injury *Orchard et al.,2006*
- Juniors: low back most frequent site of injury *Stretch, 1995*

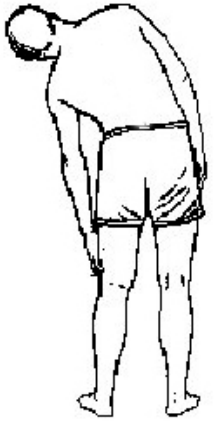


BACKGROUND

- Stress in the vertebra is increased by compression combined with extension / rotation / lateral flexion *Chosa et al.,2004*
- Spondylolysis
  - General population: 4%-6% *Frederickson et al., 1984*
  - Junior fast bowlers: 11% in one season *Foster et al., 1989*, 24% over 4 years *Engstrom et al., 2007*
- 80%-90% occur on the non-dominant side in fast bowlers *Hardcastle et al., 1992; Ranson et al.,2005; Engstrom et al., 2007*



LUMBAR RANGE OF MOTION



- Range of motion (ROM) during bowling relative to "available ROM"

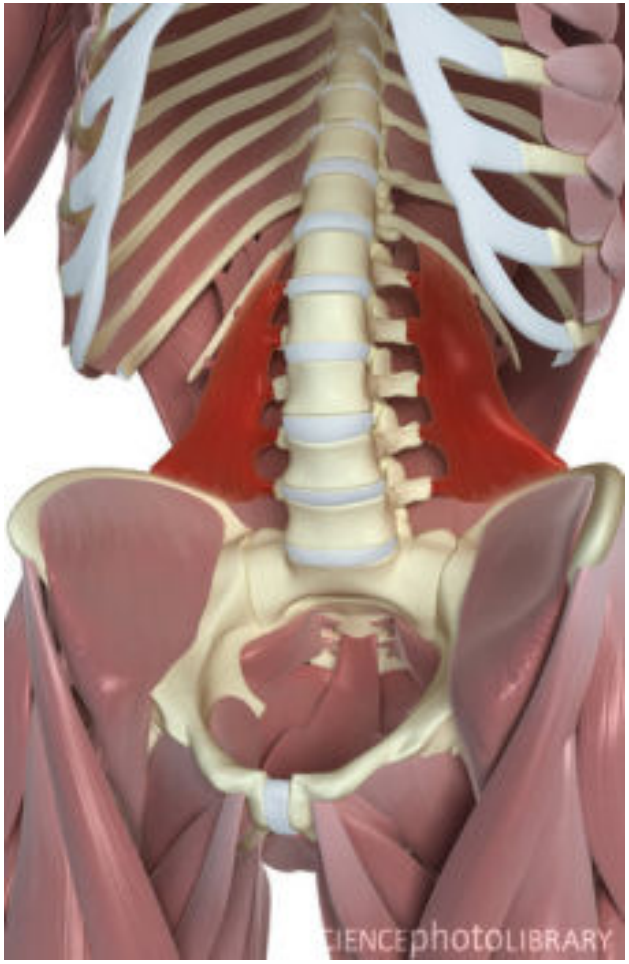
	Extension	Contralateral lateral flexion	Ipsilateral rotation
Lower trunk ROM during bowling, relative to available ROM, mean (SD)	26% (21)	129% (28)	79% (20)

Ranson et al., 2008

- Towards the non-dominant side, where stress fracture usually occurs
- Limitation: model not specific to lumbar region

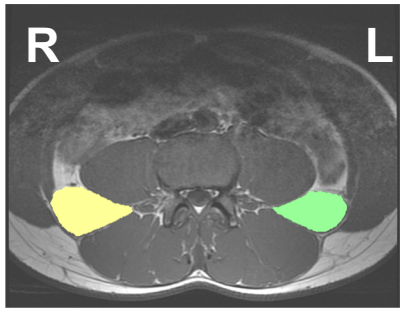
QUADRATUS LUMBORUM

- Quadratus lumborum (QL) laterally flexes the lumbar spine relative to the pelvis
- Found to be larger on the dominant side in many fast bowlers *Engstrom et al., 2007; Ranson et al., 2008*
- Correlation between dominant side QL and non-dominant side spondylolysis *Engstrom et al., 2007*
- Finite element model: no evidence that enlarged QL increases vertebral stress *de Visser et al., 2007*

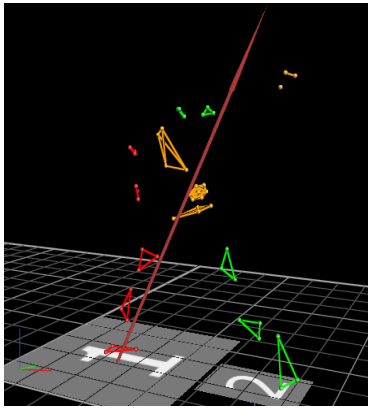


AIMS OF THE STUDY

1. QL cross-sectional area



2. Lumbo-pelvic lateral flexion kinematics and kinetics



3. Dominant vs. non-dominant side QL asymmetry – biomechanical comparison

METHODS

31 junior male right-arm fast bowlers, mean age 16.2 years ± 1.4

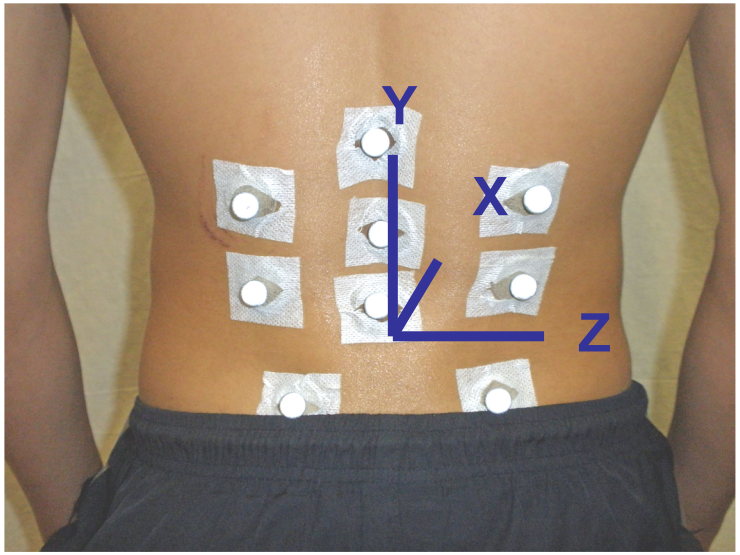
1. Lumbar MRI – QL cross-sectional area at L3/4
   Hides et al.,2010

2. 3D motion analysis
   - VICON, 12 camera, 250 Hz
   - AMTI force plate, 2000 Hz
   - Lumbo-pelvic lateral flexion: angle / moment / power

3. DOM vs. NON-DOM, (>10% asymmetry)
   - Mann-Whitney / Independent Samples T-test

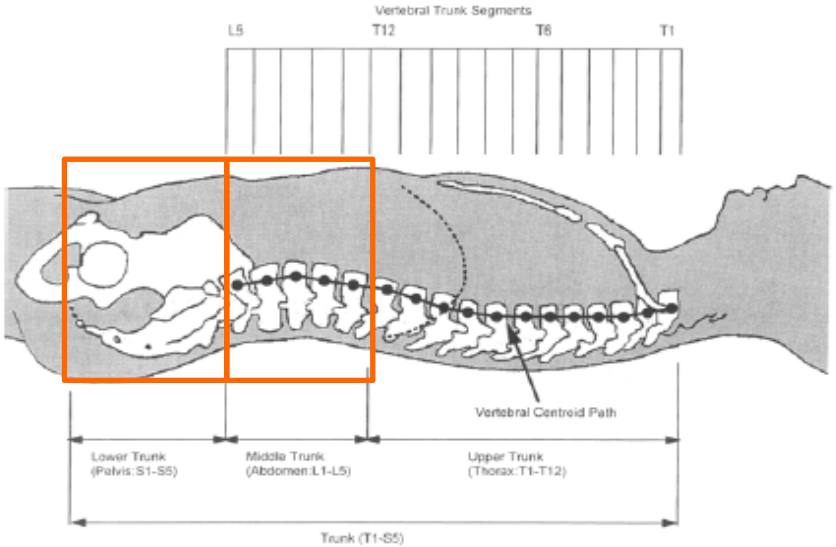
LUMBAR MODEL

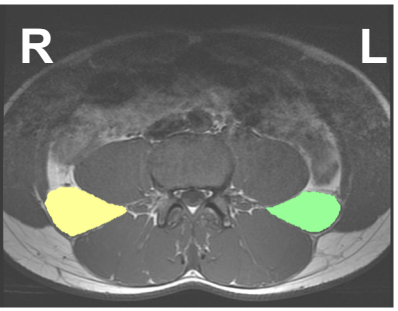
- Lumbar segment created using markers on
  - L1, L3, L5 spinous processes;
  - 5cm either side of L2 and L4 vertebrae



- Inverse dynamics model
- Inertial parameters for pelvis and lumbar segments

  Pearsall et al., 1996





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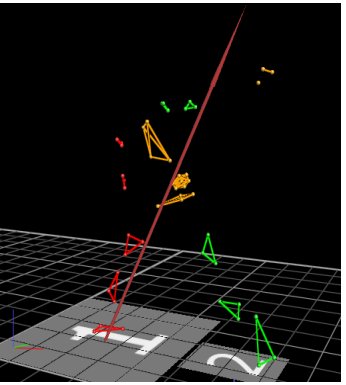
RESULTS:

1) Quadratus lumborum cross-sectional area

	Mean age of subjects, years (SD)	n	Percentage of subjects		
			<10% asymmetry	DOM larger	NON-DOM larger
Current study	16 (1)	31	39%	32%	29%
Kountouris et al (2011)	15	38	45%	26%	29%
Ranson et al (2008)	26 (1)	46	37%	41%	22%



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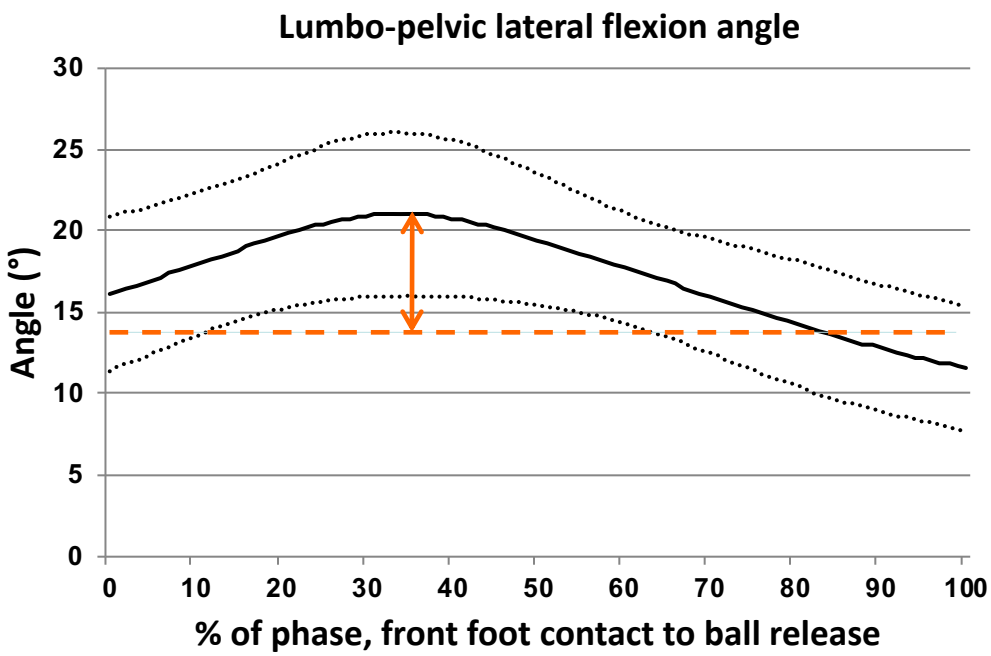
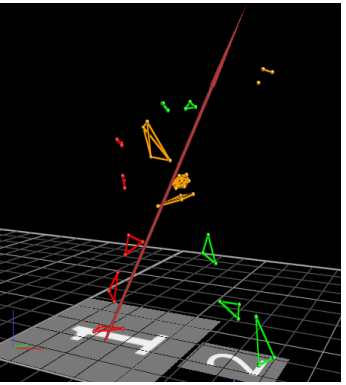
RESULTS:
2a) Lumbo-pelvic kinematics



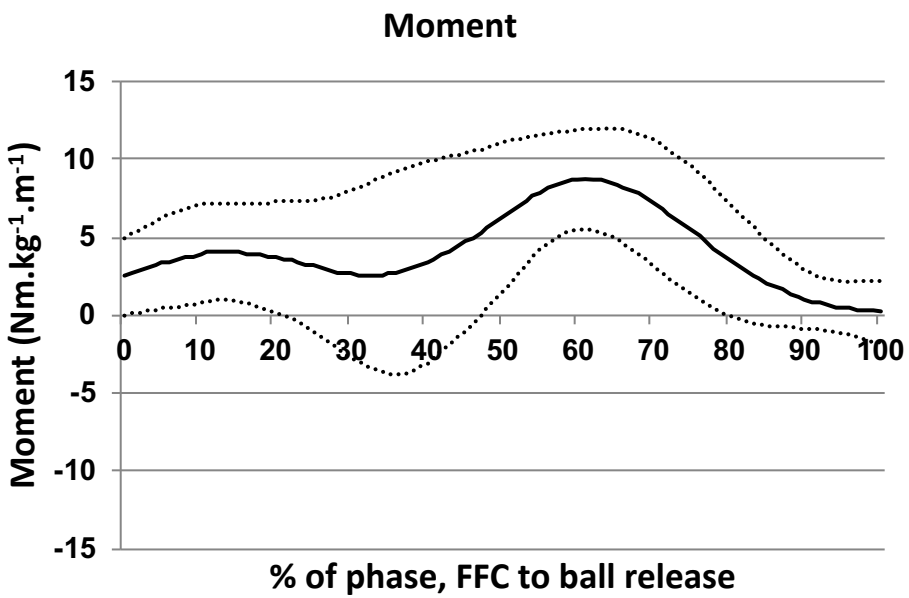
Solid line, mean; dotted lines, SD

Lumbo-pelvic lateral flexion relative to dynamic ROM trial	
Range for all subjects	+ 1.8°-13.7°
Angle, mean (SD)	+ 7.9° (3.1)
Percentage, mean (SD)	166% (41)



RESULTS:

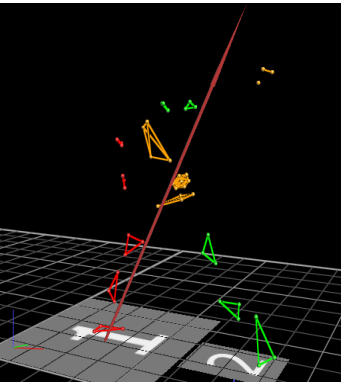
2b) Lumbo-pelvic kinetics



Solid line, mean; dotted lines, SD

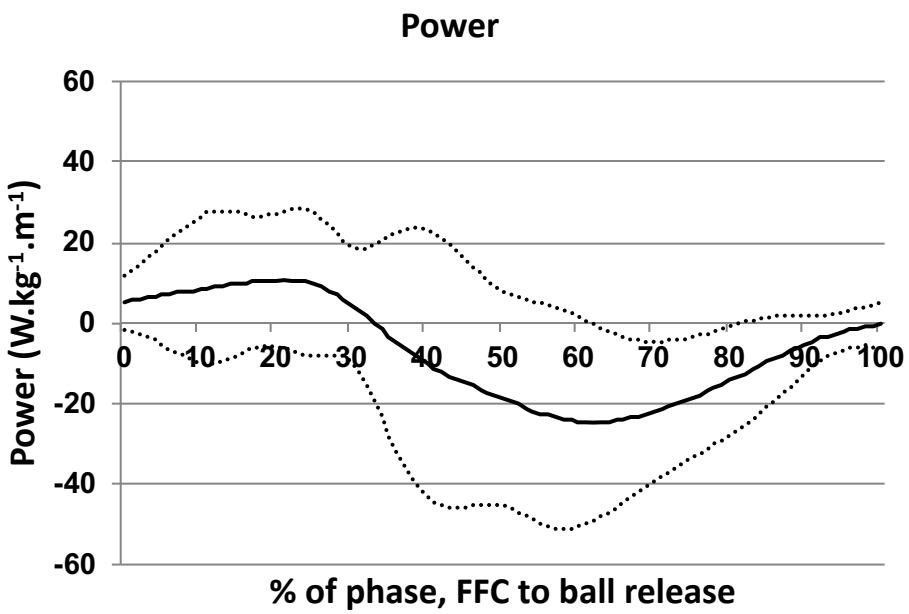
Left lateral flexion moment

≈ 100 x running *Seay et al., 2009*



RESULTS:

2b) Lumbo-pelvic kinetics

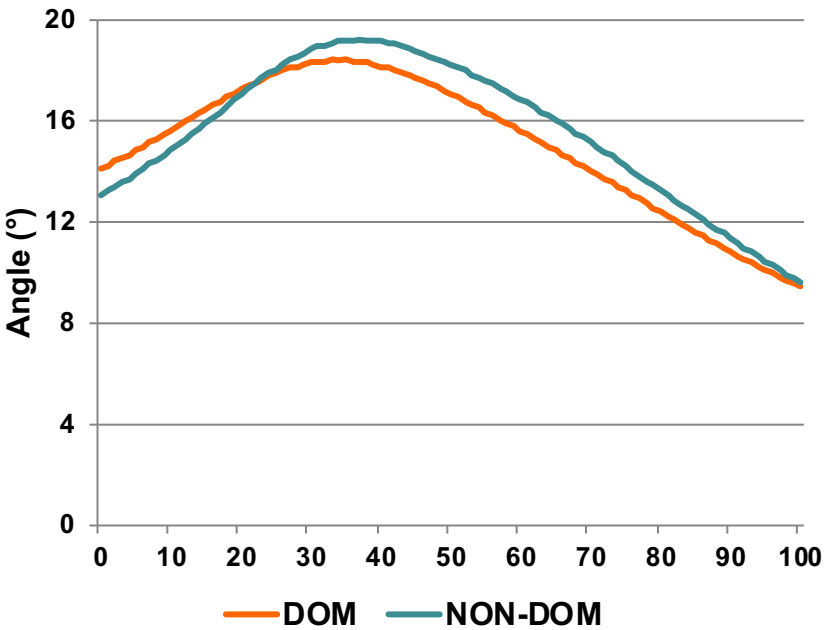


Solid line, mean; dotted lines, SD

Negative power → eccentric action of right lateral flexor muscles (incl. QL)

RESULTS:

3) Biomechanics comparison between bowlers with DOM / NON-DOM side QL asymmetry

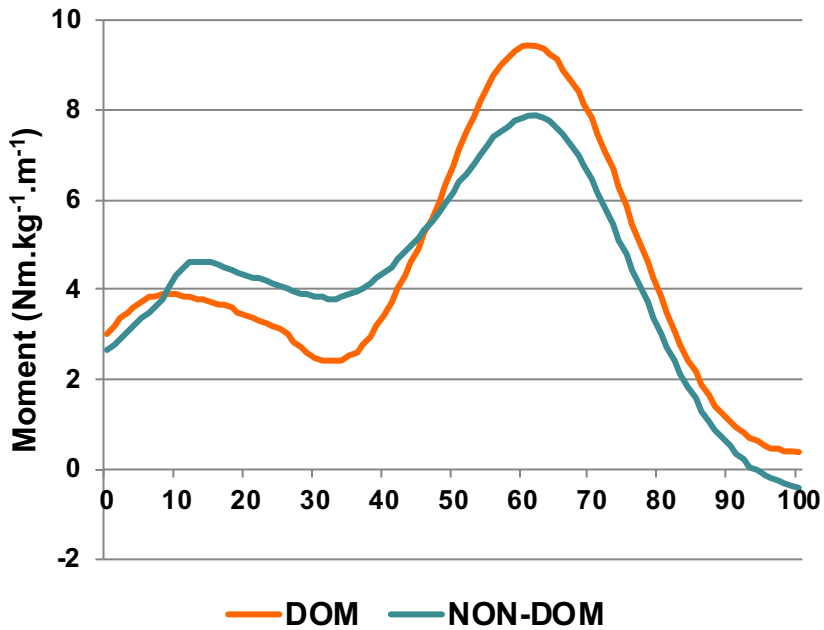


Group	n	Peak angle, mean (SD)
DOM	12	20.3° (4.5)
NON-DOM	11	20.6° (3.9)

No significant difference

RESULTS:

3) Biomechanics comparison between bowlers with DOM / NON-DOM side QL asymmetry

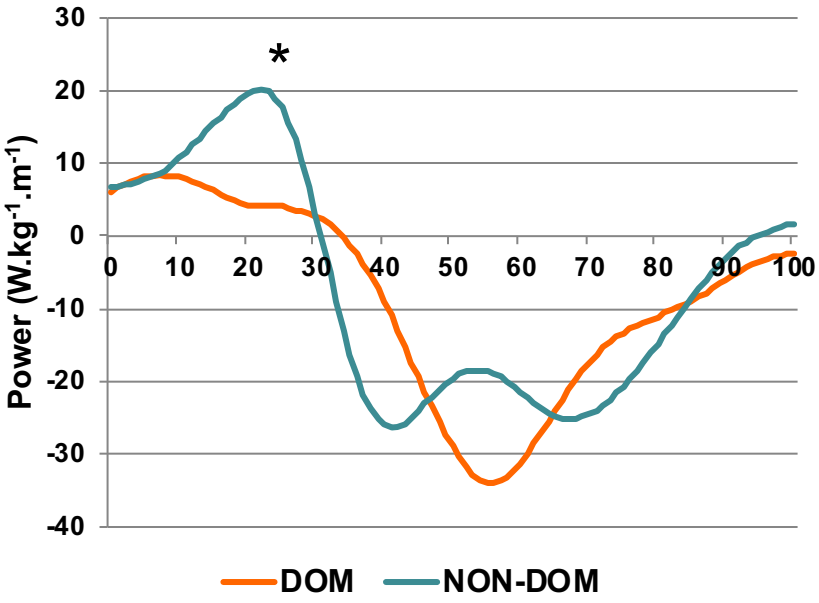


Group	n	Peak moment, $Nm.kg^{-1}.m^{-1}$, mean (SD)
DOM	12	13.4 (5.1)
NON-DOM	11	12.4 (2.7)

No significant difference

RESULTS:

3) Biomechanics comparison between bowlers with DOM / NON-DOM side QL asymmetry



Group	n	Peak positive power, $W.kg^{-1}.m^{-1}$, mean (SD)	Peak negative power, $W.kg^{-1}.m^{-1}$, mean (SD)
DOM	12	16.2 (9.2)	-57.1 (51.4)
NON-DOM	11	33.4 (31.1)*	-46.1 (31.5)

** Significantly different from DOM, $p<0.05$*

CONCLUSION AND FUTURE DIRECTIONS

Large lumbar moments at extreme ROM

Negative power → eccentric, dominant side

Positive power → concentric, non-dominant side

Currently underway: prospective study to investigate lumbar loading and muscle asymmetry patterns associated with spondylolysis incidence

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THANK YOU

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