

Reliability and Concurrent Validity of Inter-Rectus Distance and Linea Alba Stiffness in Women With and Without Diastasis Recti Abdominis

N. Green¹, E. Nieuwold¹, N. Hills², L. McLean^{1,2}

¹ School of Rehabilitation Sciences, University of Ottawa

² School of Rehabilitation Therapy, Queen's University

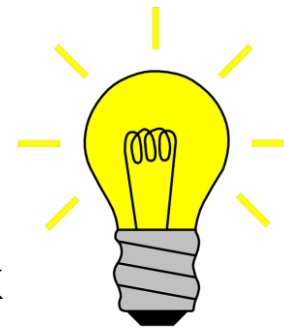
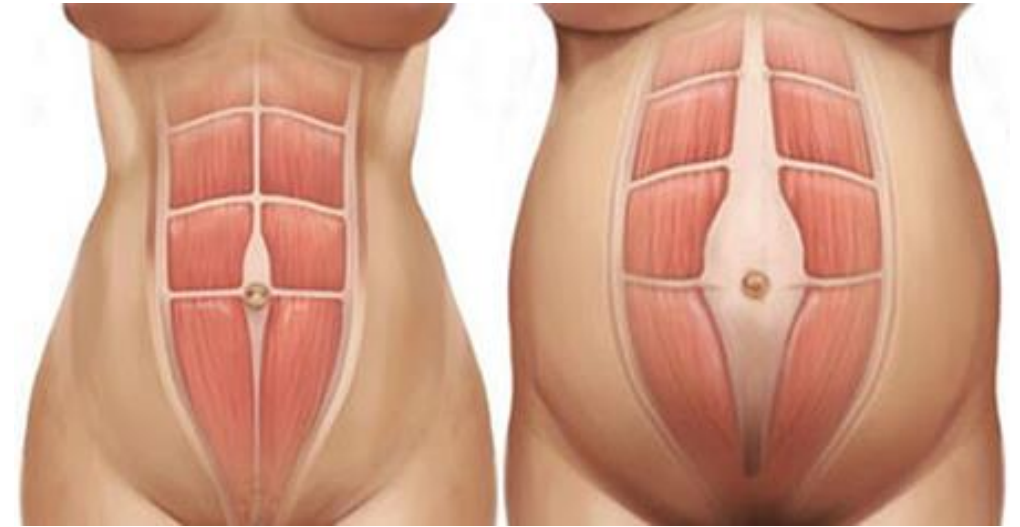


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Background

- Diastasis recti abdominis?
 - Traditionally measured using Inter-rectus distance (IRD)
- Hypothesis put forward by Lee & Hodges (2016)
 - The ability of the linea alba to transmit forces may have a greater impact on trunk function than the magnitude of IRD



Shear Wave Elastography (SWE) is an emerging technology that can be used to quantify tissue mechanical properties

Objectives

1. To examine between and within-rater reliability of linea alba stiffness measured using shear wave elastography (SWE)
2. Investigate the relationship between IRD and linea alba stiffness measured under 3 conditions: (a) Rest, (b) Head lift, and (c) Semi-Curl-up

Methods

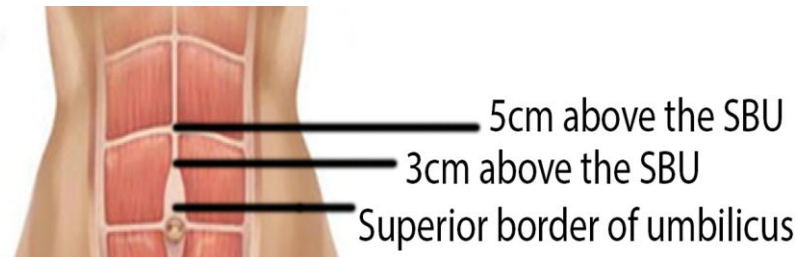
- Recruitment through local recreational facilities and physiotherapy clinics. Written informed consent obtained prior to participation.

Participants

- Nulliparae
- Parous women who delivered their most recent baby (vaginally or c-section) at least 1 year prior to participation

Imaging Procedure

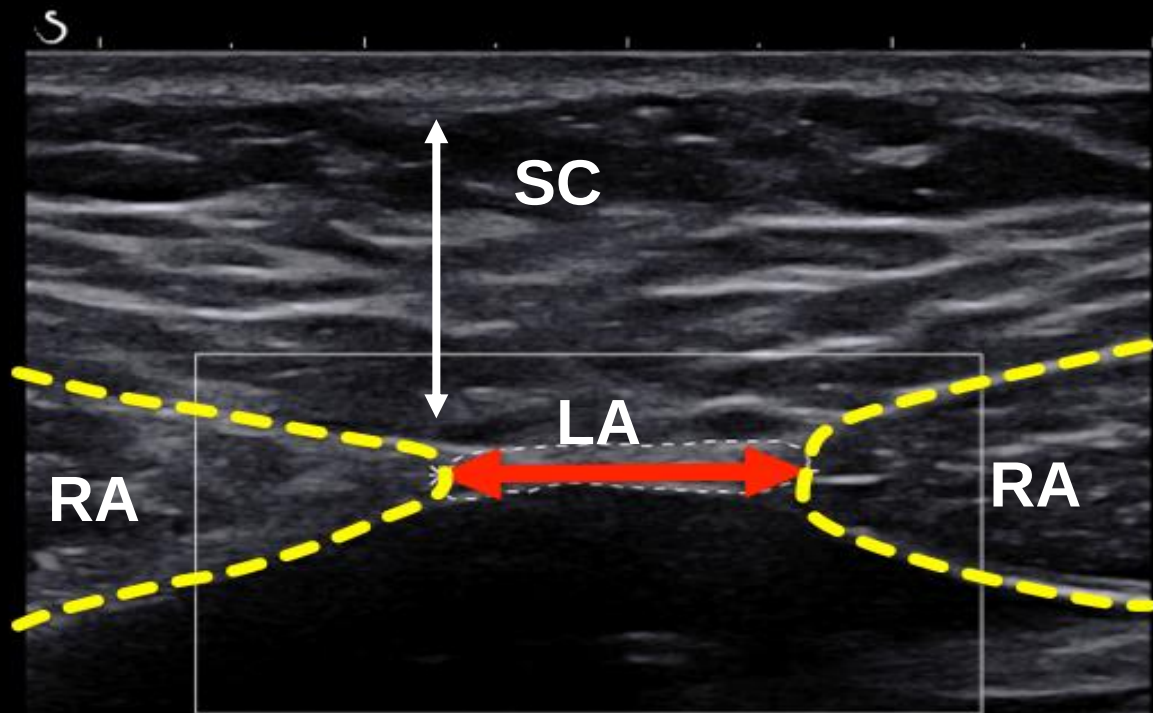
3 B-mode and 3 SWE ultrasound images taken in supine at each of three sites at rest, on head lift, curl-up



Analysis

Measurements of IRD and stiffness taken offline by 2 MSc physiotherapy students blinded to women's DRA status and to each other's results

Inter-rectus distance

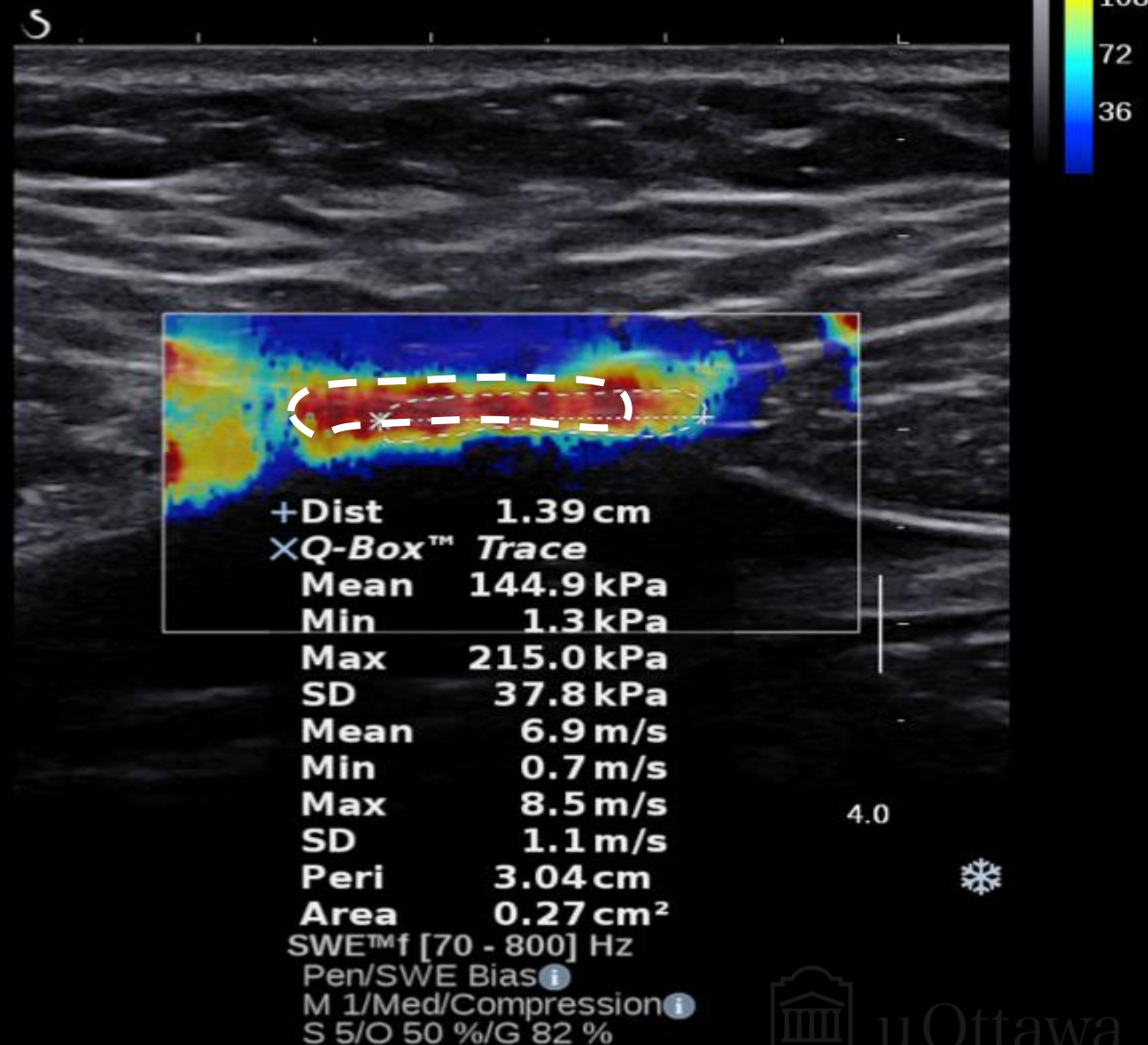


LA = Linea Alba
RA = Rectus Abdominis
SC = Subcutaneous fatty layer

B
Gen/Med
M 9/72 dB/Low
T 1540 m/s/SC/SR 3
G 44 %/Fr. 10 Hz

Z 120 %

Linea alba stiffness



Results

Characteristics	Mean	St Dev
Age (years)	31.8	8.2
IRD (cm)	2.43	1.52
BMI (kg/m ²)	25.04	3.87
Waist:Hip ratio (units)	0.81	0.06
Minutes of moderate to high intensity exercise/week)	143	114
	Number of Children	Number of Participants
Parity (units)	n=0	11
	n=1-3	9

Results

Measures (units)	Site and Condition	Mean	St Dev
Mean Stiffness (kPa)	SBU		
	Rest	30.49	18.42
	HL	33.57	24.59
	CU	36.14	29.95
	3cm SBU		
	Rest	27.00	14.76
	HL	36.28	27.50
	CU	46.87	37.52
	5cm SBU		
	Rest	35.21	17.91
	HL	40.97	30.20
	CU	50.45	37.00

Measures (units)	Site and Condition	Mean	St Dev
Peak Stiffness (kPa)	SBU		
	Rest	51.34	46.43
	HL	55.54	51.43
	CU	64.86	55.91
	3cm SBU		
	Rest	41.94	29.88
	HL	62.21	54.29
	CU	79.64	62.16
	5cm SBU		
	Rest	52.59	30.66
	HL	65.76	58.79
	CU	85.14	61.45

Results – reliability

Currier's Criteria:

≤ 0.69 = poor

0.70-0.79 = fair

0.80-0.89 = good

≥ 0.90 = excellent

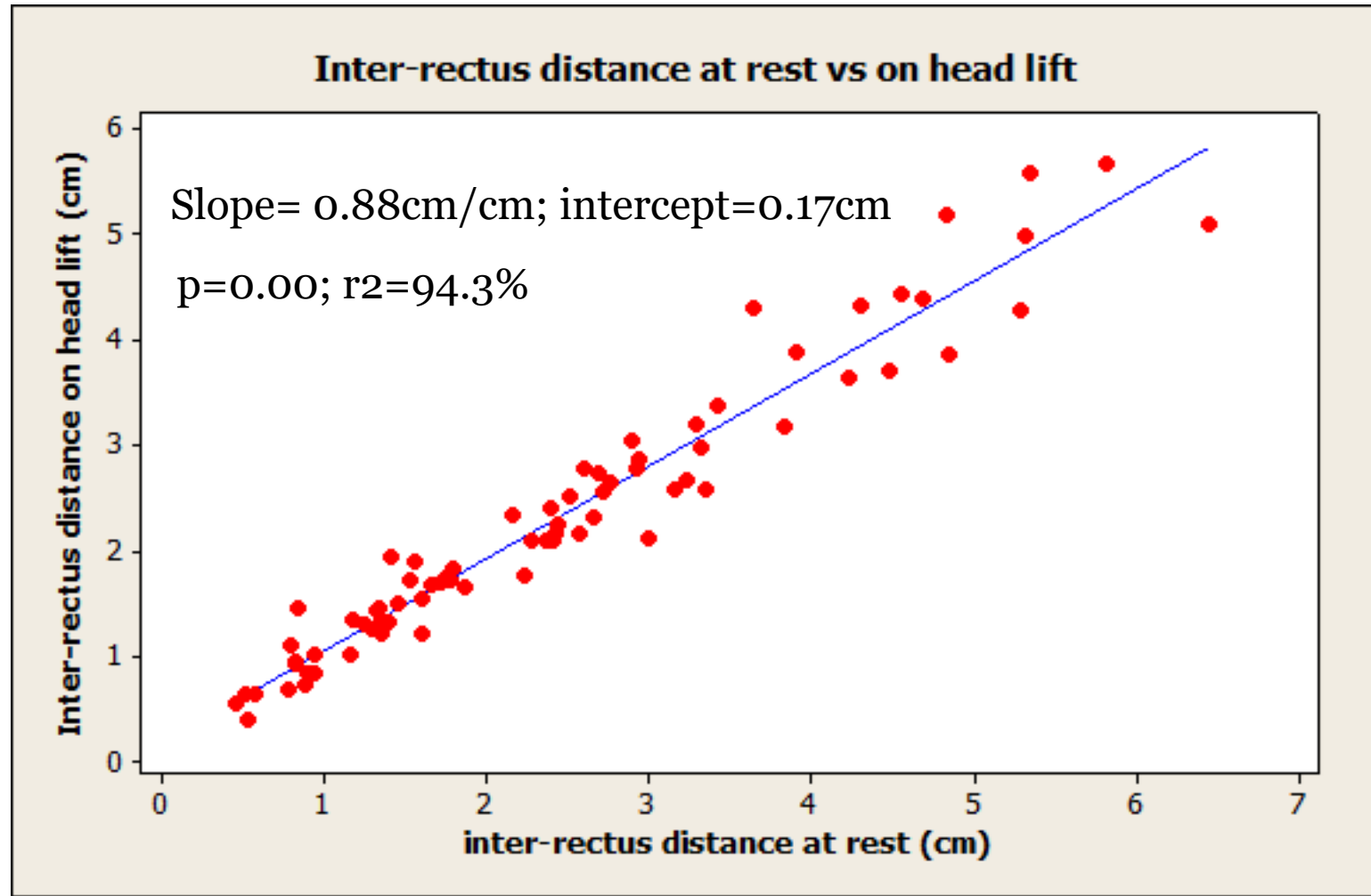
Measure	Task	ICCs (95% CI) (mean values)	SEM	MCID
IRD (cm)	Rest	0.983 (0.975-0.989)	0.542	1.502
	Head lift	0.947 (0.917, 0.967)	0.746	2.069
	Curl up	0.944 (0.910, 0.964)	0.628	1.742
Mean stiffness (kPa)	Rest	0.885 (0.836-0.923)	17.166	47.583
	Head lift	0.868 (0.812-0.911)	28.748	79.685
	Curl up	0.911 (0.871-0.941)	30.22	83.768

Within-Rater Between-Trial Reliability using single measures recorded at all measurement sites

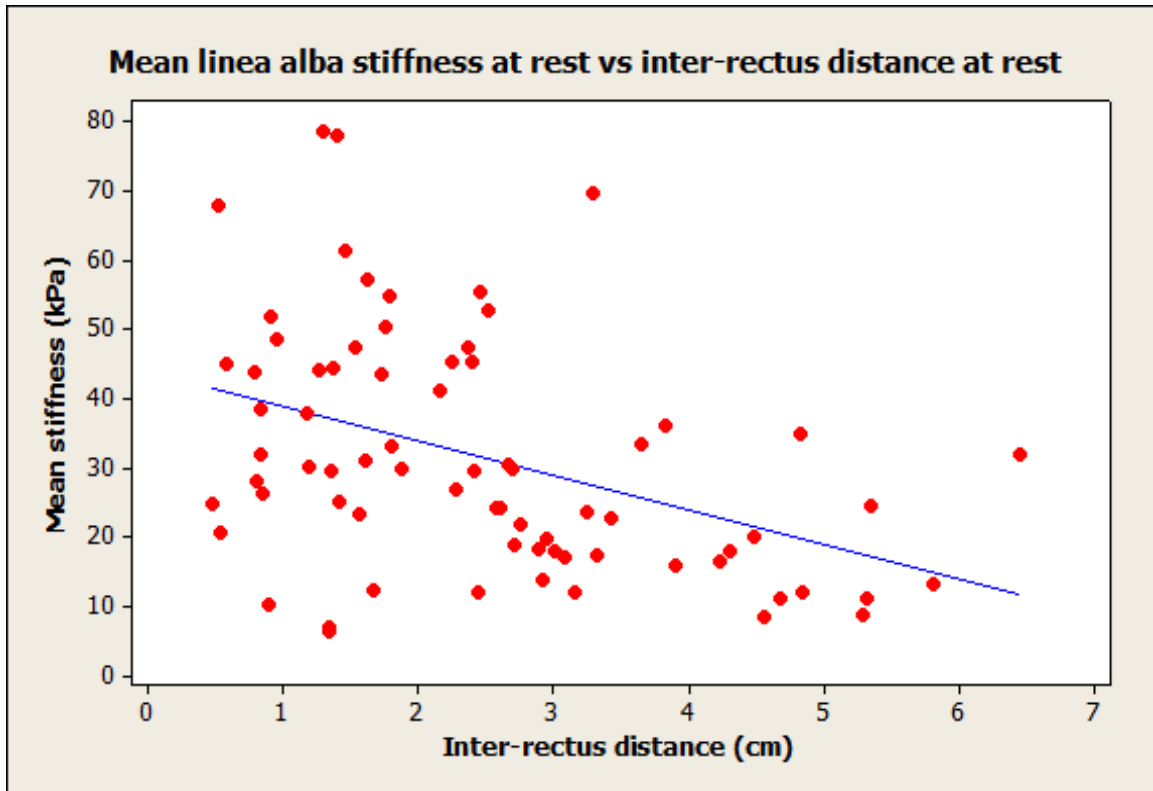
Measure	Task	ICCs (95% CI) (mean values)	SEM	MCID
IRD (cm)	Rest	0.955 (0.929, 0.972)	0.738	2.046
	Head lift	0.947 (0.917, 0.967)	0.746	2.069
	Curl up	0.944 (0.910, 0.964)	0.628	1.742
Mean Stiffness (kPa)	Rest	0.981 (0.970, 0.988)	5.664	15.700
	Head lift	0.991 (0.986, 0.995)	6.118	16.961
	Curl up	0.994 (0.991, 0.996)	6.555	18.169

Between-Rater Reliability using the average of the three measures taken at all measurement sites

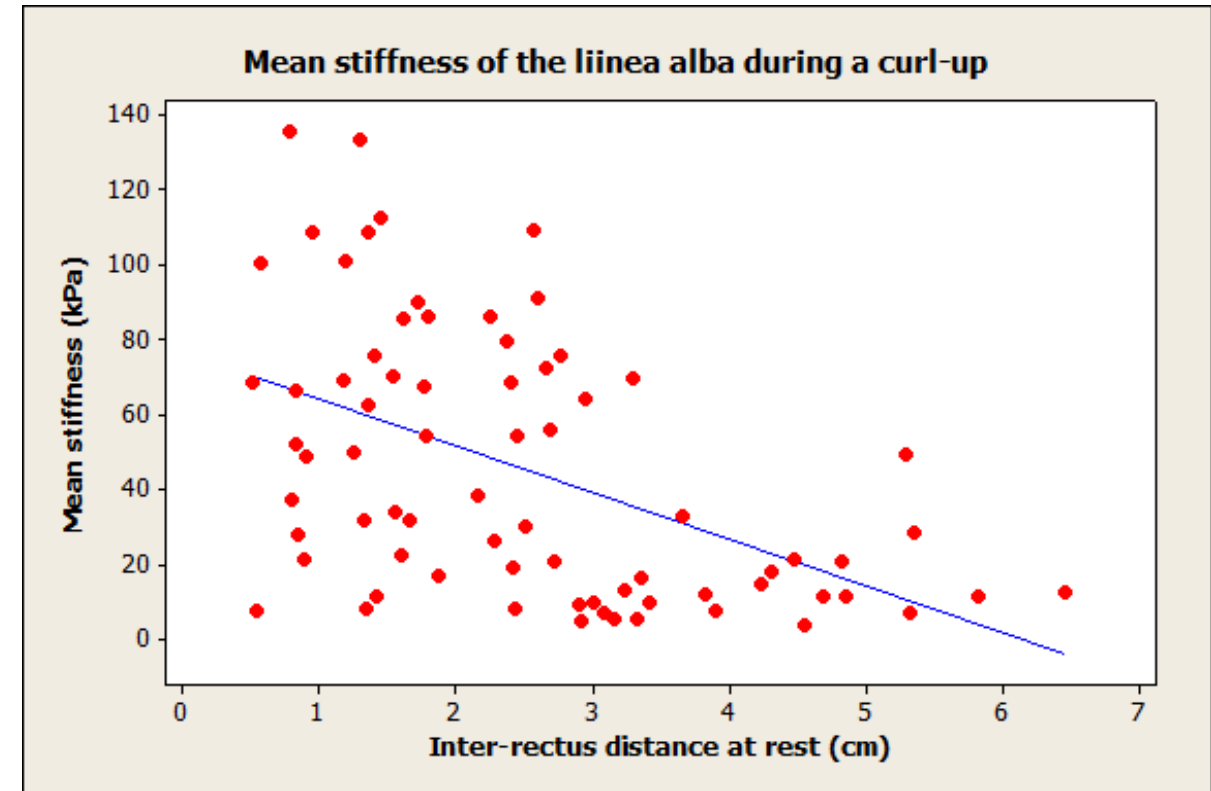
Results



Results



$r = -0.41$; slope = -4.97 kPa/cm ; intercept = 43.7 kPa ;
 $p < 0.001$

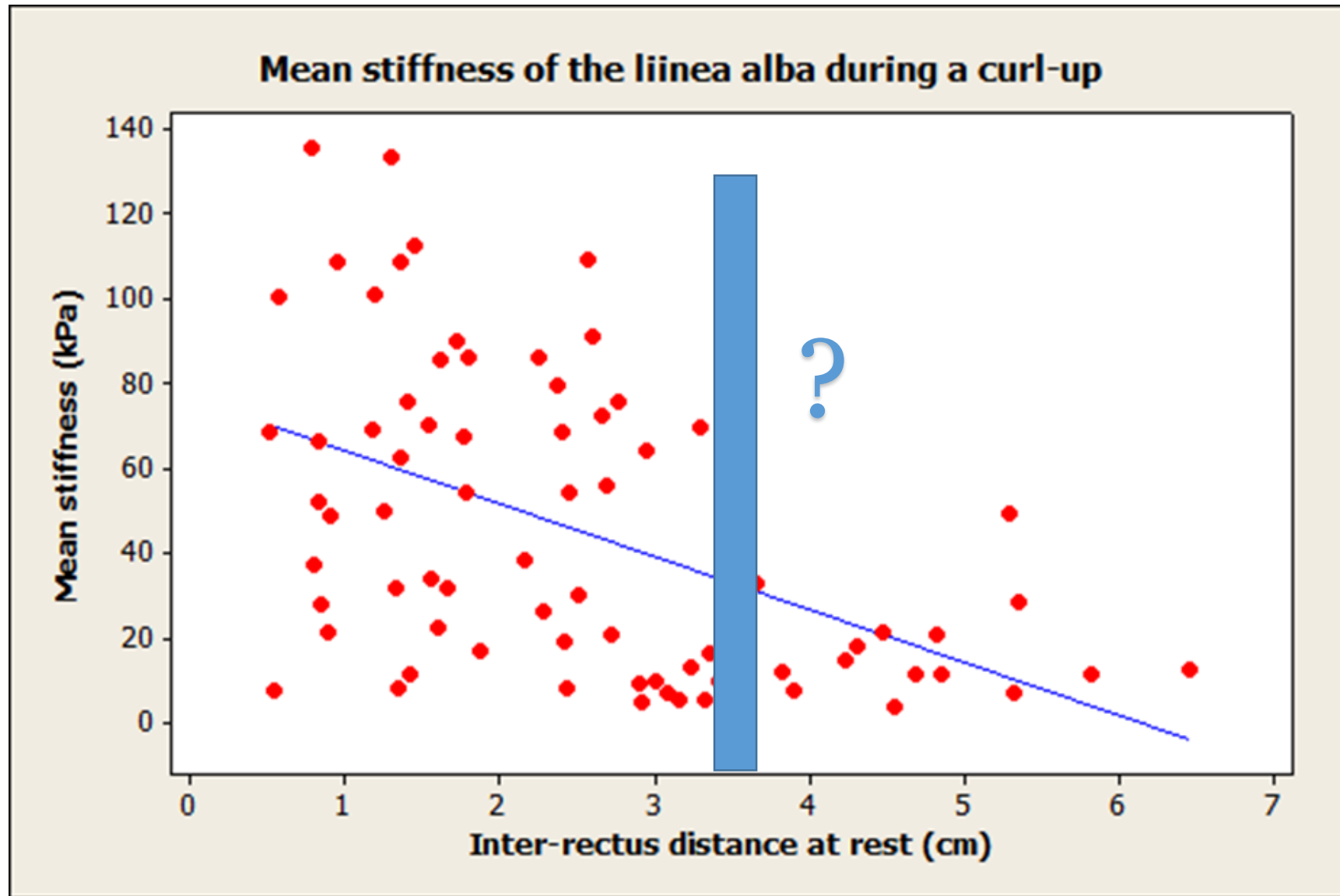


$r = -0.498$; slope = -12.50 kPa/cm ; intercept = 76.800 ;
 $p < 0.001$

Discussion

Objectives:

- I. Both IRD and LA stiffness had acceptable reliability, which was highest at the sites above the umbilicus
- II. Significant linear relationships exist between IRD and LA stiffness
 - As IRD  , LA stiffness 



Discussion

- The relationship between LA stiffness and IRD were consistent with our expectations, but much of the model variance was unexplained. The models explain only approximately 14% of the variance in the data
- Next steps
 - investigating these relationships using non-linear models and in a larger sample of women
 - comparing parous women to nulliparous women
 - comparing women with and without DRA
- Goal - to more fully understand the impact of both parity and DRA on the mechanical properties of the linea alba and on trunk function

Conclusion

- Linea alba stiffness measured using shear wave elastography demonstrates adequate reliability to be used in research and in clinical practice
- Large IRDs appear to be associated with lower linea alba stiffness in women, and this warrants further investigation in order for us to more fully understand the impact of pregnancy on trunk mobility and function in women

Thank you!