

The Abductometer

**A new way at looking at motor
function in the hand**

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Motor Strength

- **Grip Strength** – Jaymar Dynamometer intrinsic vs. extrinsic test by varying the settings
- **Pinch Strength** - “Pinch” meter tip, key, chuck “settings”

Limitations

- Both tests are non specific in that they always test the function of both median and ulnar nerves together.
- Individual nerve lesions will register some weakness but because of anatomic variation this can vary widely between patients.

Pinch

- A composite function utilizing:
 - First dorsal interosseous
 - Adductor pollicis
 - Flexor, abductor pollicis brevis
 - Opponens pollicis
 - Flexor pollicis longus, flexor sublimis II and profundus II
 - Lumbrical II

Palmar Abduction

- Bringing the straight thumb out of the plane of the palm in a straight line perpendicular to that plane
- Involves the abductor pollicis brevis (APB) almost exclusively, APL and Palmaris –minor role
- Median innervated > 90%
- Profound loss of function in Median Palsy

Palmar adduction

- Bringing the straight thumb into the plane of the palm in a line perpendicular to that plane
- Involves the adductor pollicis and 1st dorsal interosseous, EPL to a minor degree
- Ulnar innervated > 90%
- Profound loss in ulnar palsy
- The “Froment’s” sign

**To date there is no quantitative
means of measuring the
strength of palmar adduction
and abduction**

Utility of Quantitative Measurement

- Measurement of subtle weakness in specific muscle groups innervated by individual nerves and tracking these measurements over time

Primary Uses

- Compressive neuropathies of the median or ulnar nerves such as carpal tunnel syndrome or cubital tunnel syndrome.
- Median or ulnar nerve trauma
- Primary disease of peripheral nerves that affect intrinsic muscles such as Charcot-Marie-Tooth

Primary Uses

- Knowledge of adduction and abduction strength will allow early diagnosis of motor weakness in compressive neuropathy or motor nerve disease.
- After nerve laceration and repair, a numerical value can be placed on the return of motor strength and progress assessed.

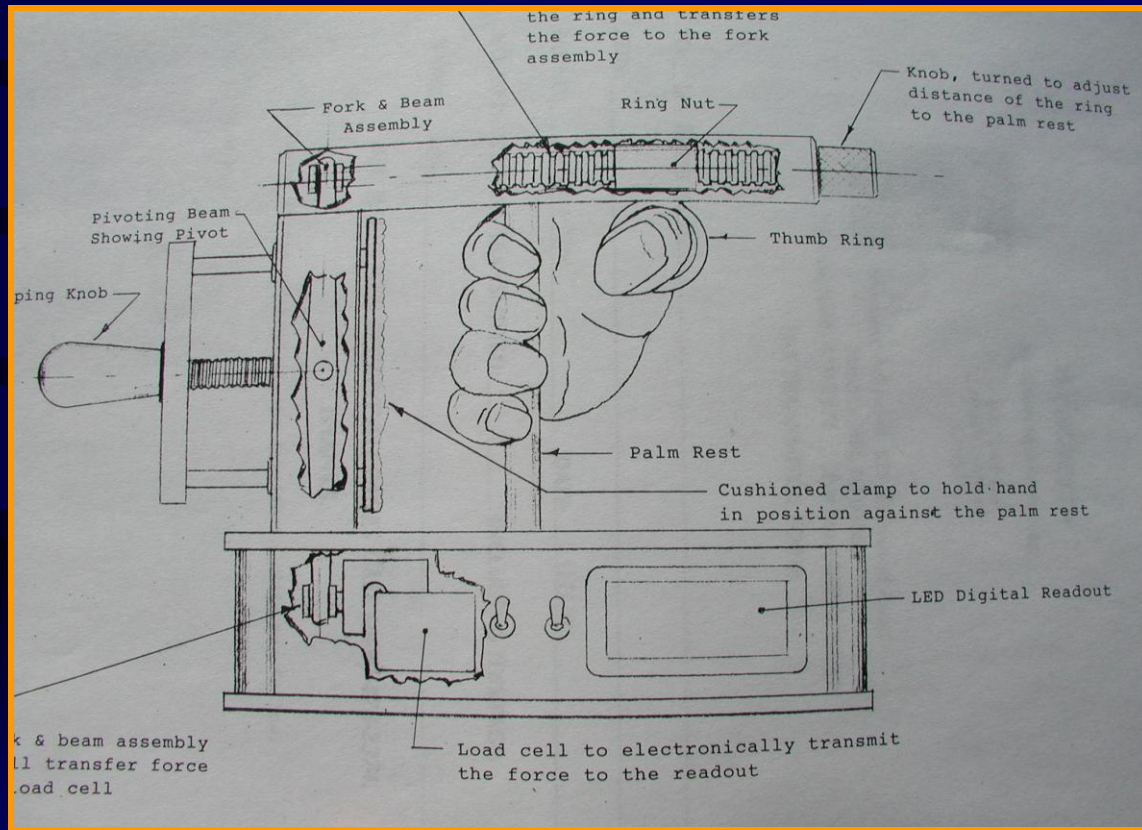
Adjunctive uses

- • osteoarthritis pre and post-op
- • rheumatoid arthritis pre and post-op
- • thumb reconstruction after trauma
- • congenital differences
- • tendon transfer surgery
- • tumor resection and reconstruction.

The Abductometer

- A device designed to quantitatively measure palmar adduction and abduction in the thumb.

Abductometer --schematic

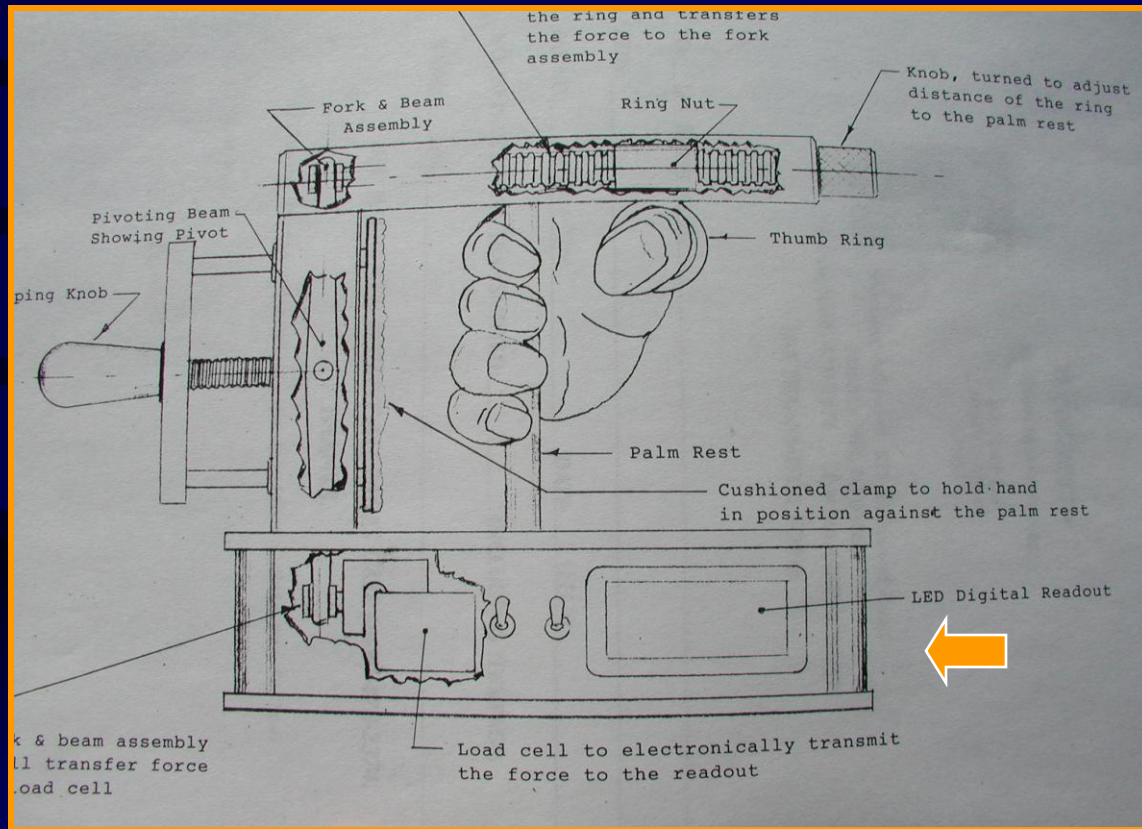


Three components

1. Base

- -readout on each side
- -50 lb load cell
- -separate circuitry to determine direction of the force
- -pound, kilogram converter
- -force vs. peak tracking mode
- -zero calibration node

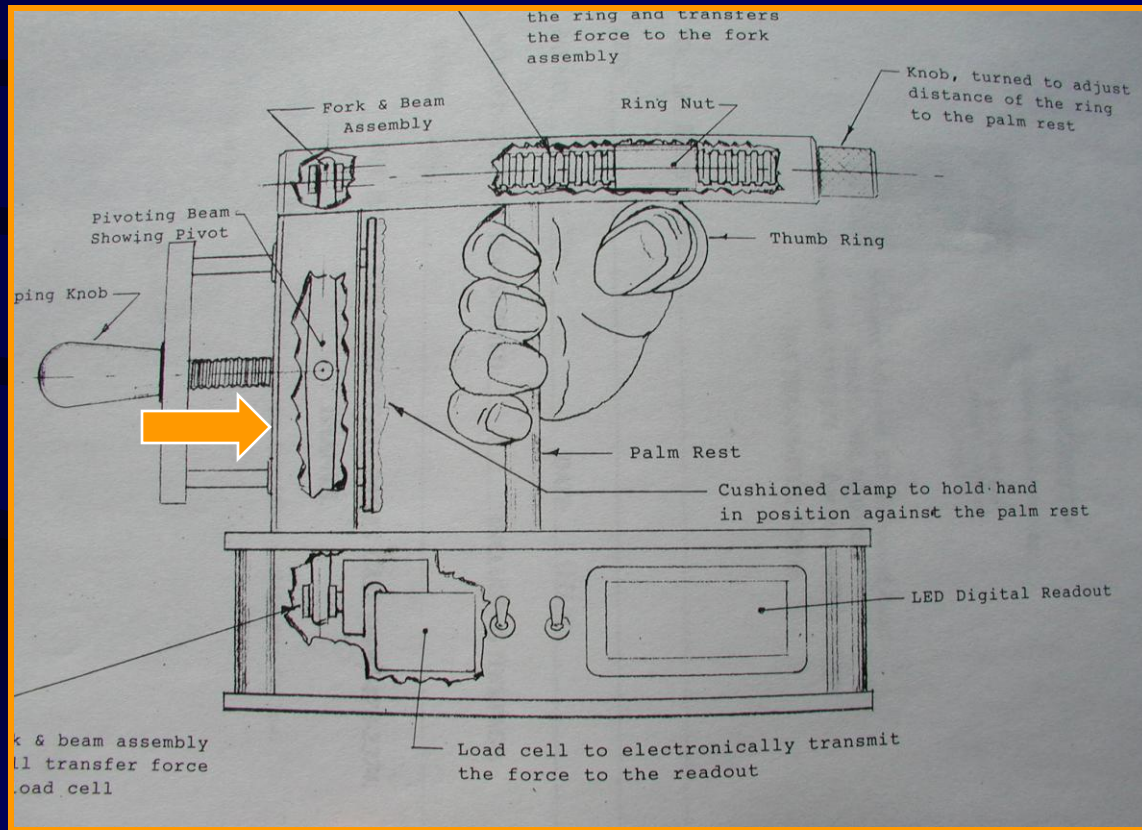
Abductometer --schematic



2. Arm

- - stabilize the hand to isolate thumb function
- - transmits force from the force ring to the load cell

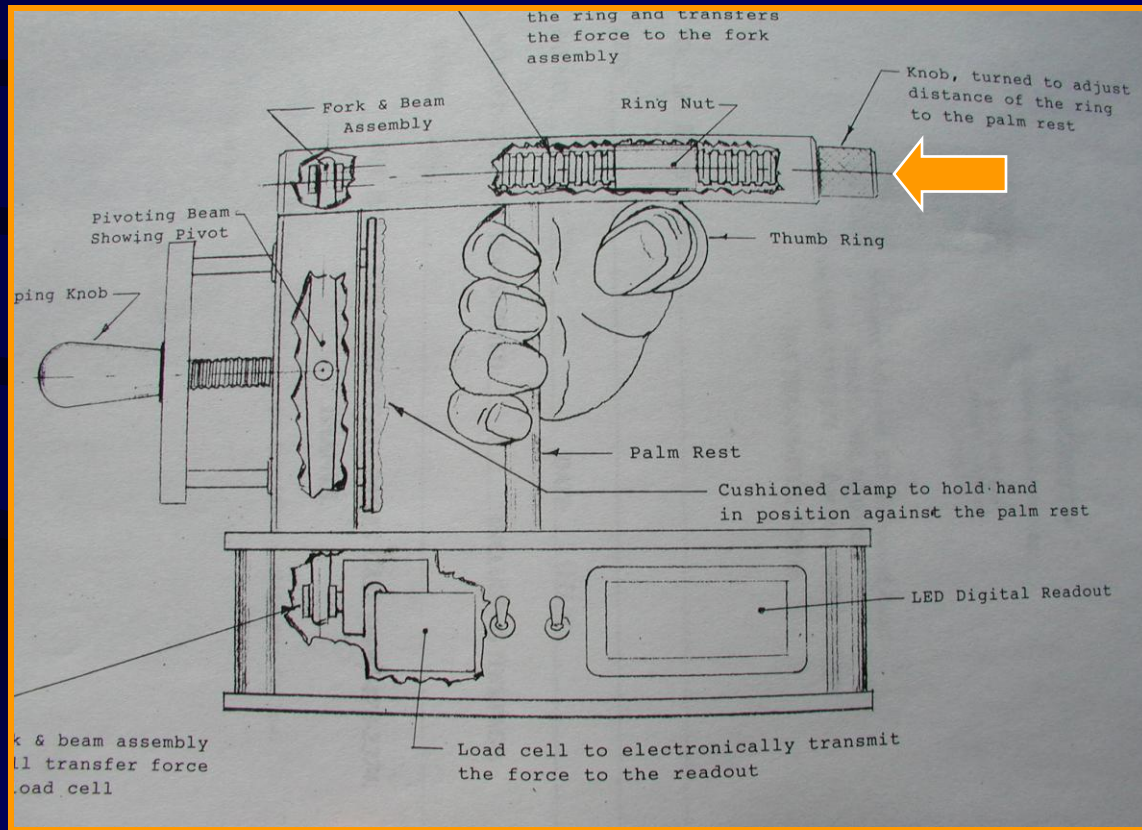
Abductometer --schematic



3. Cross beam

- housing an adjustable thread to vary the angle of abduction and a suspended force ring to house the thumb being tested.
- the position of the ring is fixed to the thread so that a true isometric contraction is performed.

Abductometer --schematic



The Test

- The hand is placed into the armature and secured against a rigid flat bar by an adjustable padded vertical platform that is screwed into place by the threaded knob on the side.
- The thumb is encased by a snug rigid plastic ring placed at the level of the IP joint and then inserted into the ring.

The Test

The static angle of thumb abduction is assessed with a goniometer and the machine is switched from adduction to abduction mode depending on the modality required. The angle between the thumb and the palm is set. Before each run the machine is recalibrated to “zero” it.

The Test

- When thumb pushes the force ring in either direction either toward or away from the palm, the force is transferred to the ring nut which in turn is attached to an acme screw assembly.

The Test

- The acme shaft end is a fork assembly, pushing or pulling on a pivoted beam which in turn has a fork assembly on the opposite end which pushes or pulls on the load cell.

The Test

- When force is applied there is an output voltage change, positive or negative, which is amplified and converted to a digital readout showing force as pounds or kilograms by the LED numbers displayed.

Establishing norms

- 600 healthy volunteers
- Age: 10 – 80 y.o.
- Stratified by age and weight
- mid range grip (position three) measured
- Volunteers with no hx.of hand symptoms

Establishing Norms

- The values for abduction and adduction strength were recorded at the 30, 45, and 60 degree positions. Correlations of results as to age, weight, hand dominance and grip strength were recorded.
- After testing was concluded, the device was reevaluated and found to have maintained calibration

Results

Table 1A: Characteristics of Subjects: Age, Sex, and Hand Dominance

Table 1A: Characteristics of Subjects: Age, Sex, and Hand Dominance

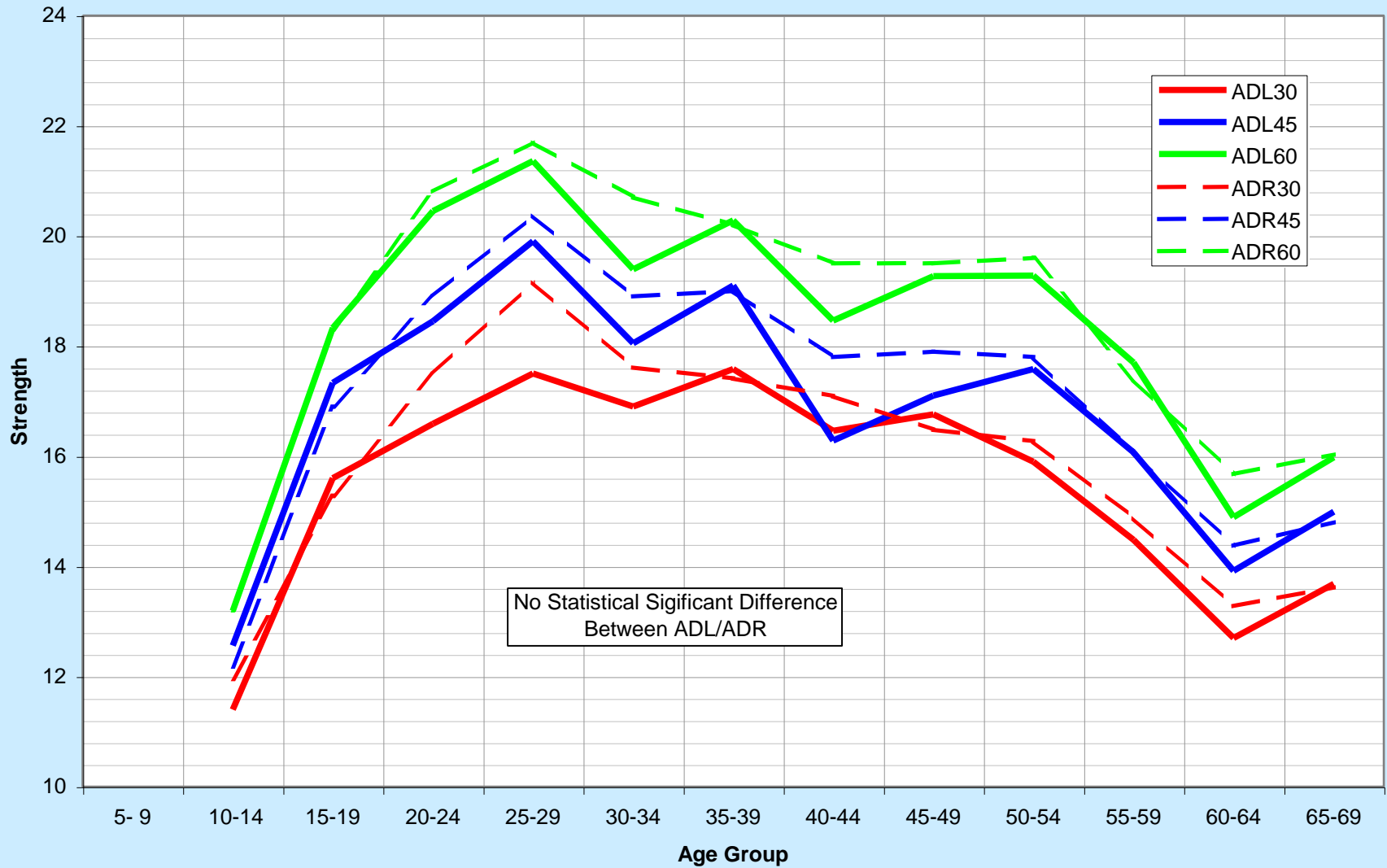
Age Grp.	Age	Dominance							
		Men				Women			
		Count	Age (x)	Right	Left	Count	Age (x)	Right	Left
1	5-9	0				4	8.3	4	0
2	10-14	25	12.4	23	2	25	12.6	25	1
3	15-19	24	16.8	22	2	25	16.5	25	2
4	20-24	26	22.2	26	0	25	21.7	25	1
5	25-29	24	26.8	24	0	26	26.4	26	1
6	30-34	25	31.9	21	4	25	32.4	25	3
7	35-39	27	37.2	25	2	32	37.2	32	1
8	40-44	23	42.1	19	4	24	41.6	24	3
9	45-49	26	46.6	25	1	26	46.8	26	2
10	50-54	27	51.8	26	1	24	51.7	24	4
11	55-59	21	56.8	20	1	23	56.9	23	3
12	60-64	24	61.7	23	1	23	61.4	23	3
13	65-69	22	66.8	21	1	24	65.5	24	3
Total		294	40	275	19	306	38.4	279	27

Table 1B: Characteristics of Subjects: Weight, Sex, and Hand Dominance

Table 1B: Characteristics of Subjects: Weight, Sex, and Hand Dominance

		Men			Women		
Wt. Grp.	Weight	Count	Right	Left	Count	Right	Left
1	50-99	2	2	0	7	7	0
2	100-124	12	12	0	50	47	3
3	125-149	42	38	4	113	104	9
4	150-174	84	77	7	93	81	12
5	175-199	104	99	5	36	33	3
6	200-224	33	32	1	4	4	0
7	225-249	12	12	0	3	3	0
8	250-300	5	3	2	0		
Total		294	275	19	306	279	27

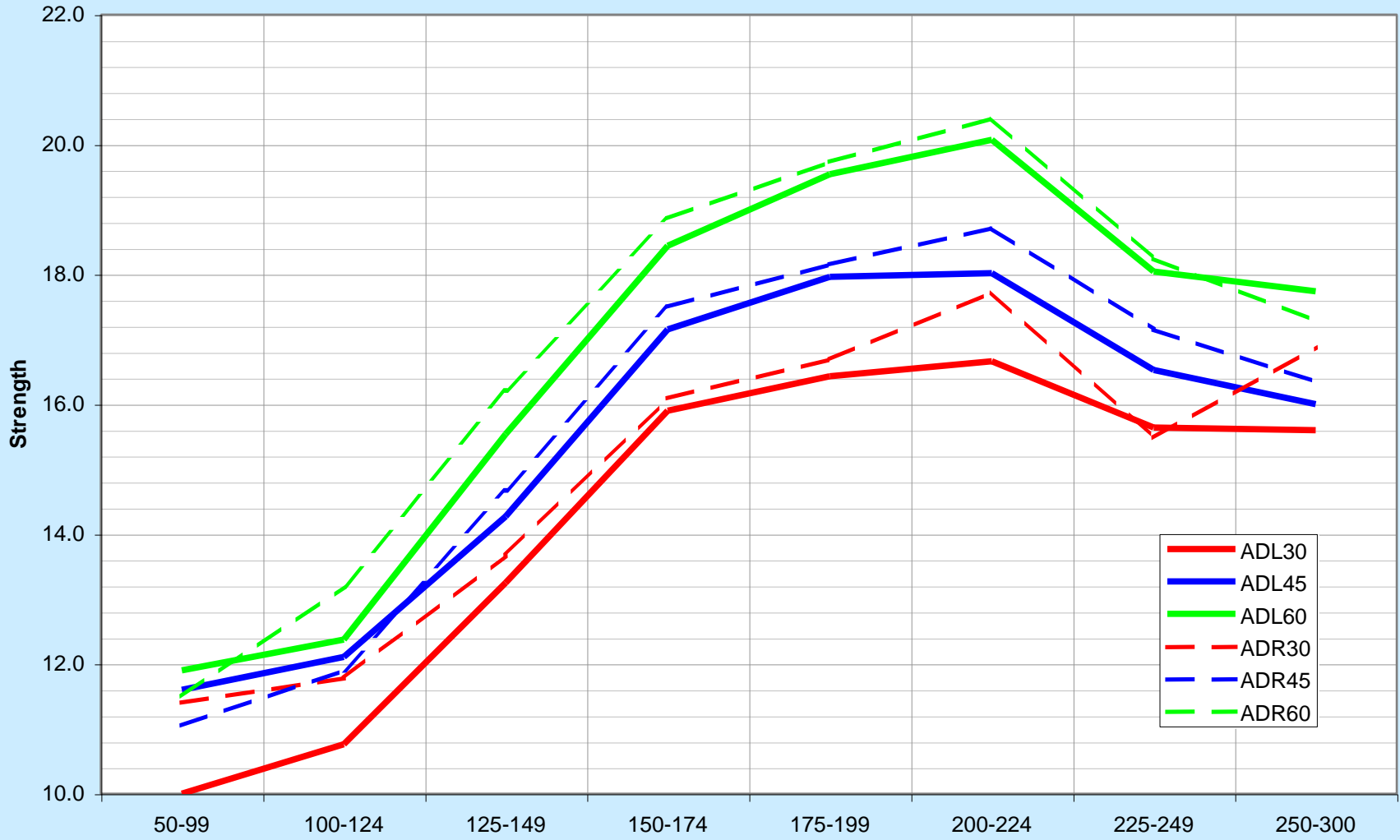
Male ADL/ADR By Age Group



Male ADL/ADR-age

- As the angle of abduction increases adduction strength increases
- The adduction varies with age with three peaks
- There is no significance between right and left
- The shape of the curves are similar

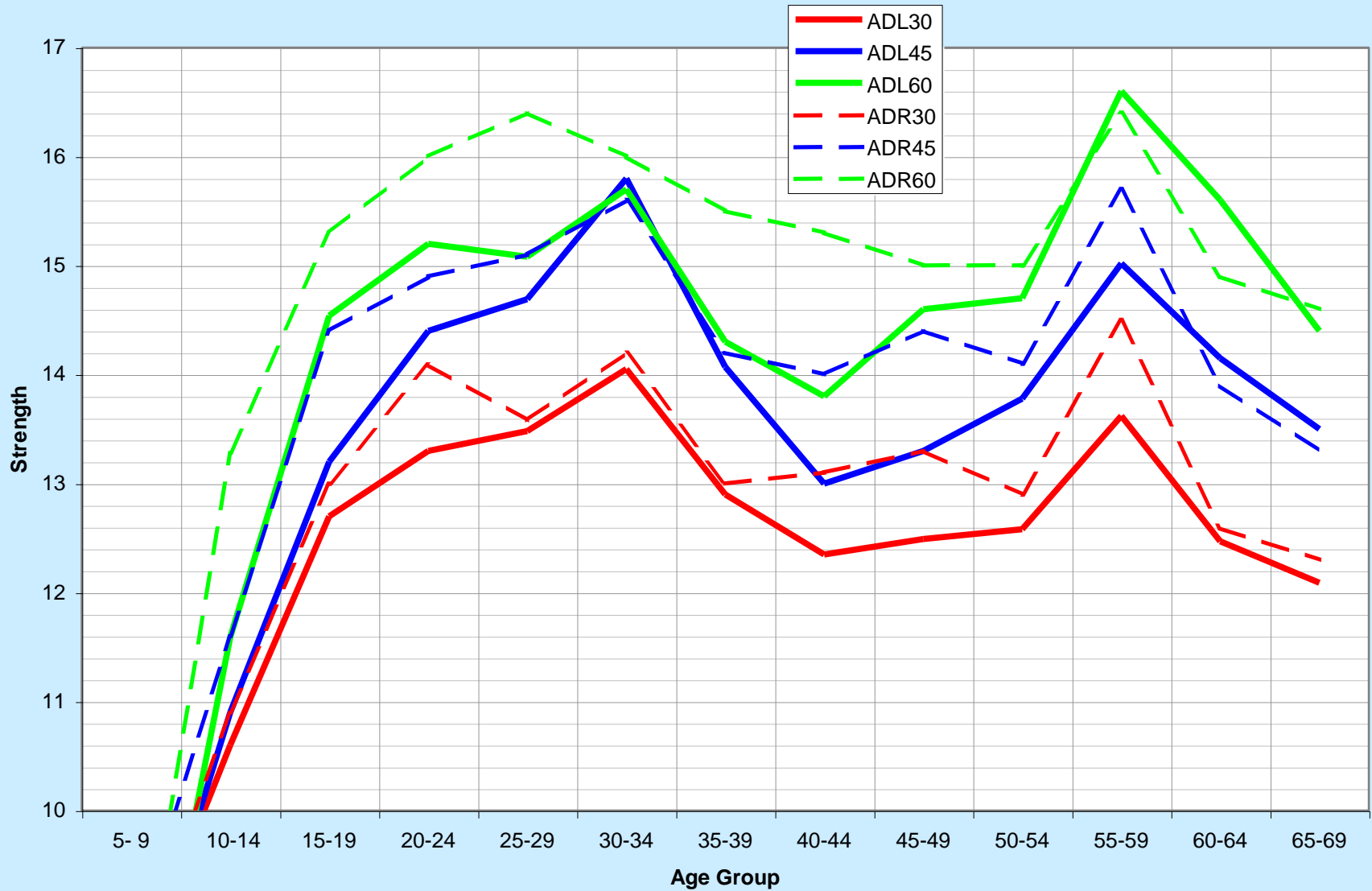
Male ADL/ADR By Weight Group



Male ADL/ADR-weight

- To a point, as weight increases ADR/ADL increases with a drop off after 220 lbs.
- As abduction increases the power of adduction increases
- There is no significant difference between right and left

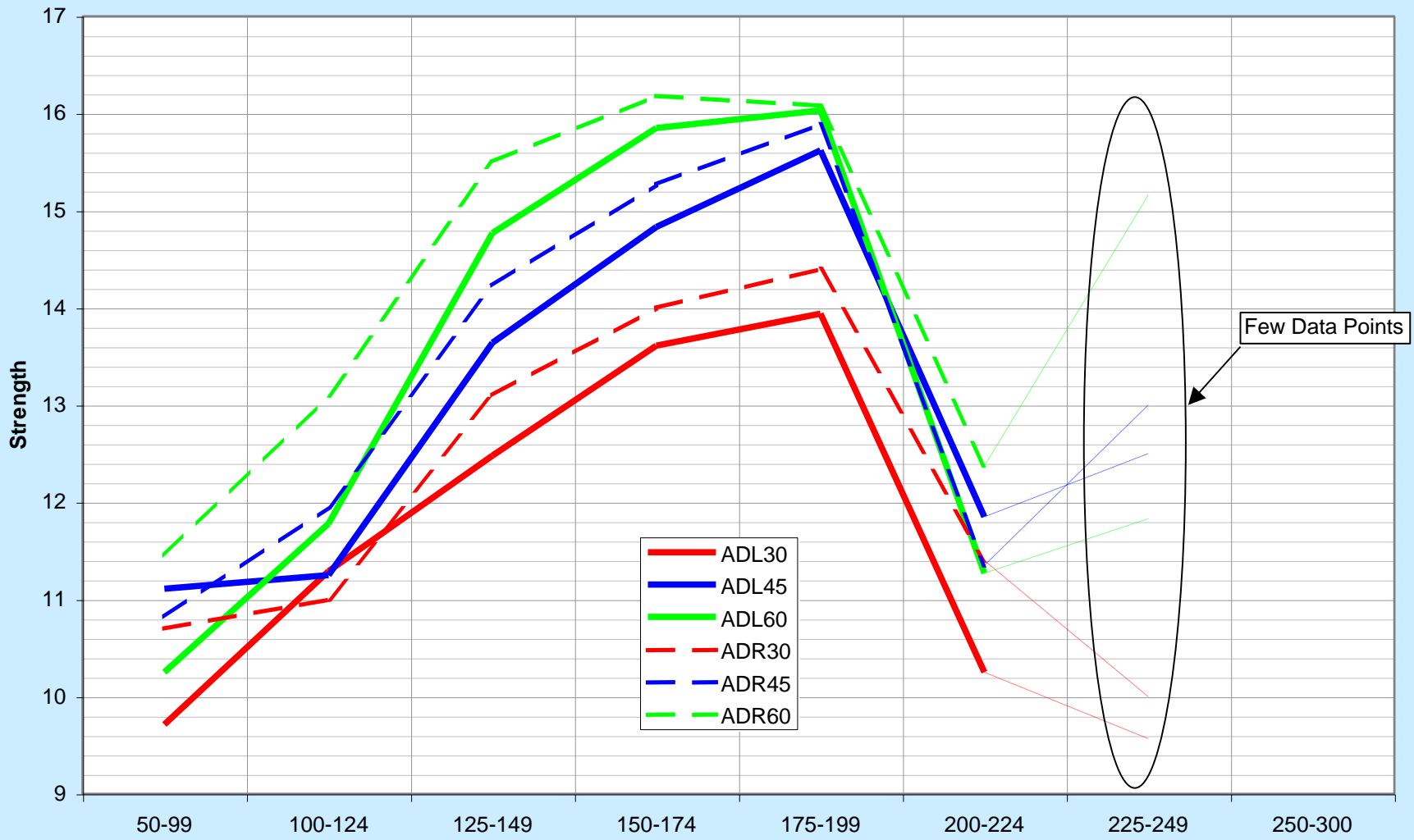
Female ADL/ADR By Age Group



Female ADL/ADR- age

- There is a bimodal peak pattern with apex at 32 and 57 years old.
- There is a wide variation between the values obtained with 30,45, 60 degrees of abduction.
- There is a wider variation between right and left

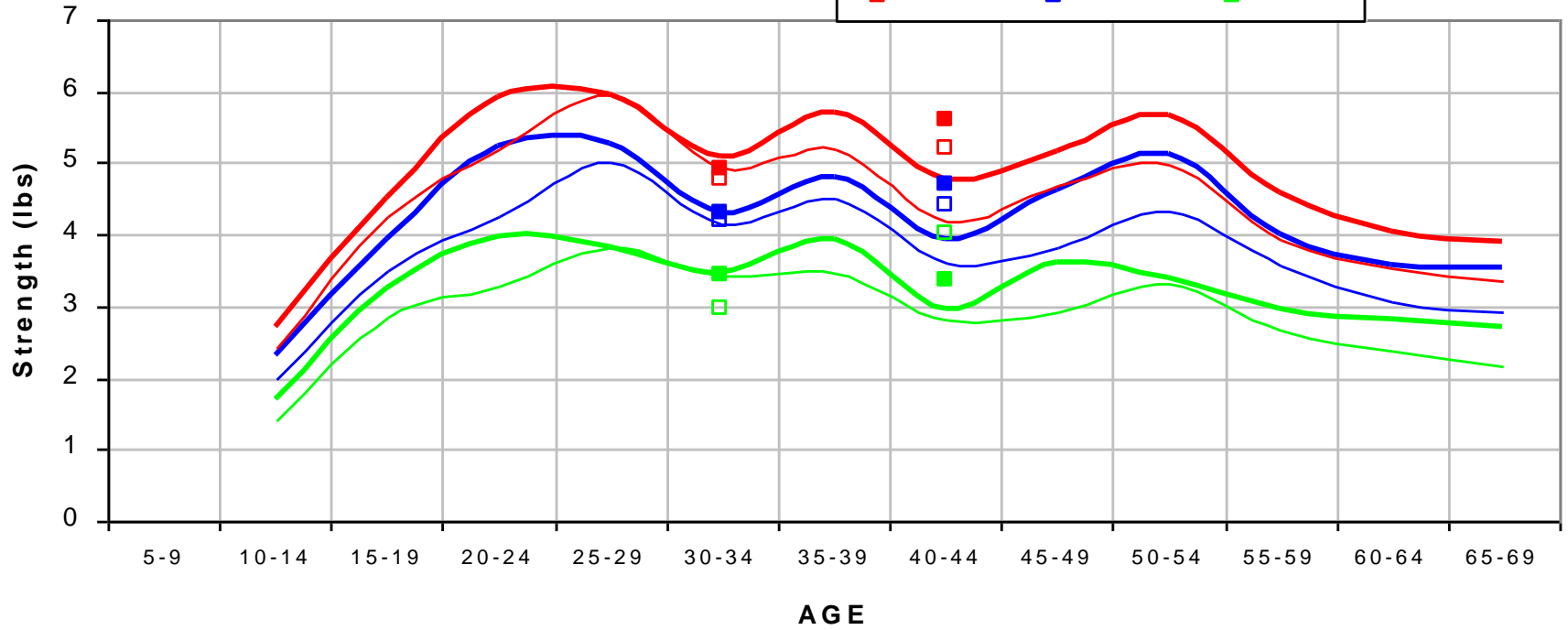
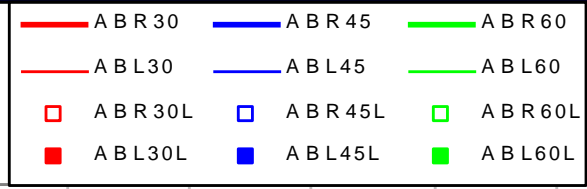
Female ADL/ADR By Weight Group



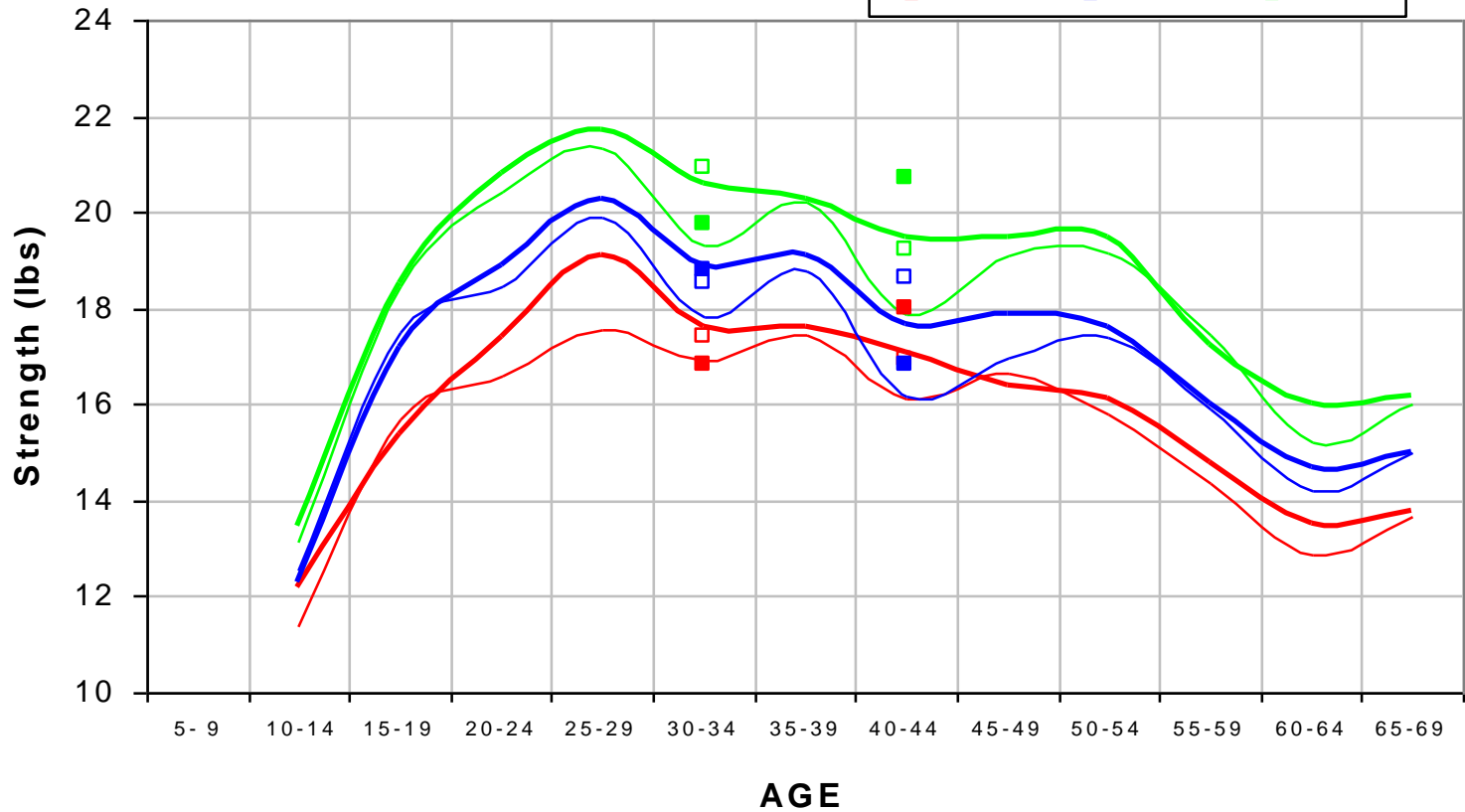
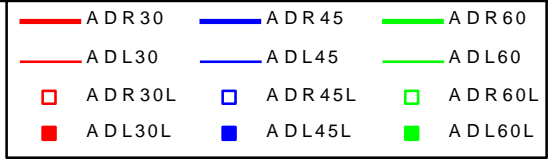
Female ADL/ADR-weight

- As weight increases so do the values of ADL/ADR to a weight of 180 lbs. Then there is a drop off.
- There is a significant difference between right and left.
- The same inverse relationship exist between ADL/ADR and angle of abduction.

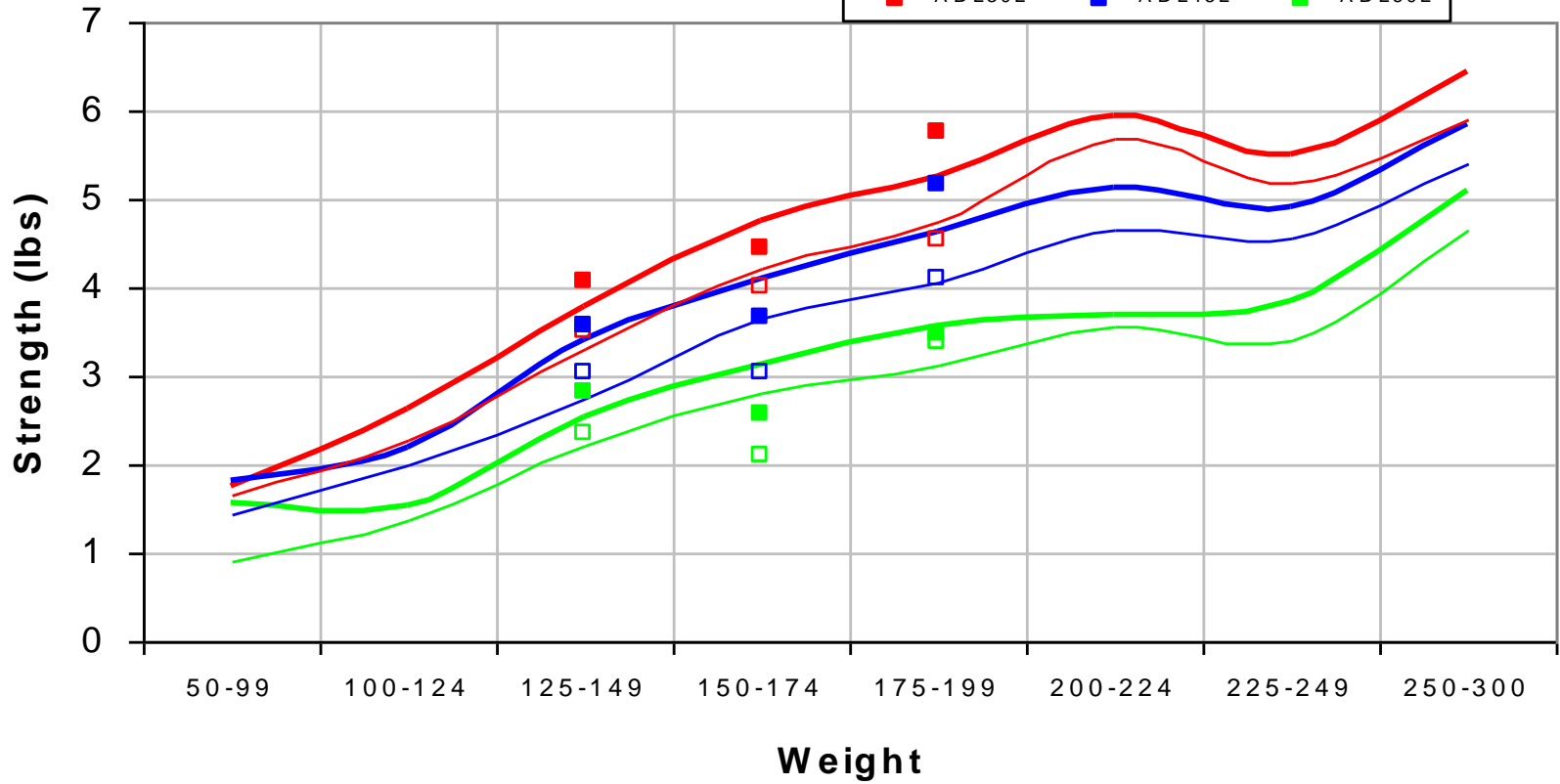
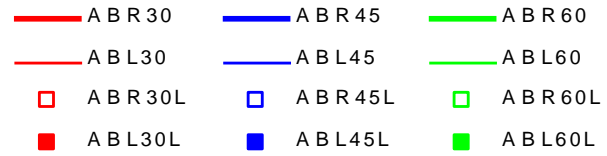
MALE Abduction by Age



MALE Adduction by Age

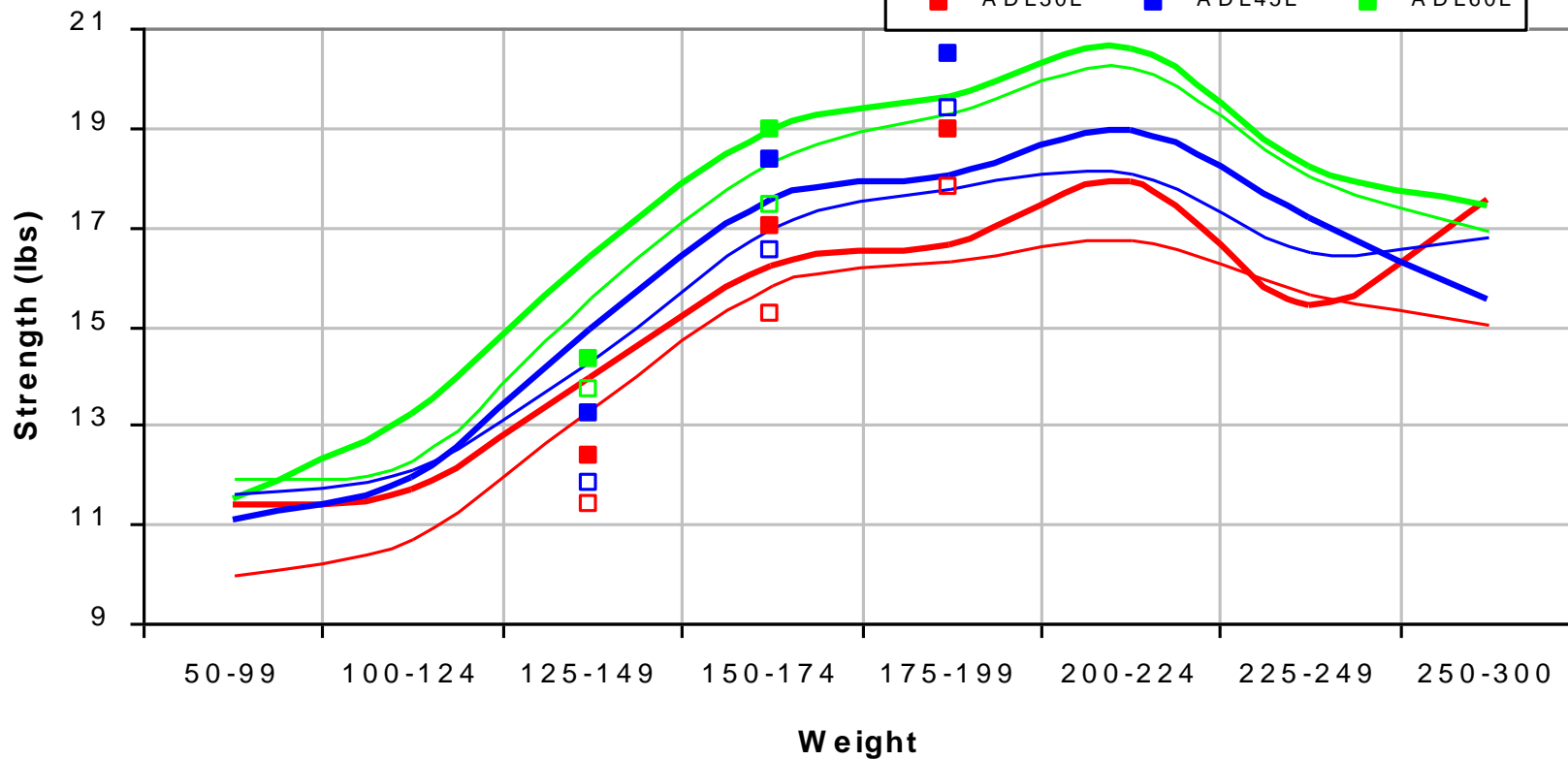


MALE Abduction by Weight

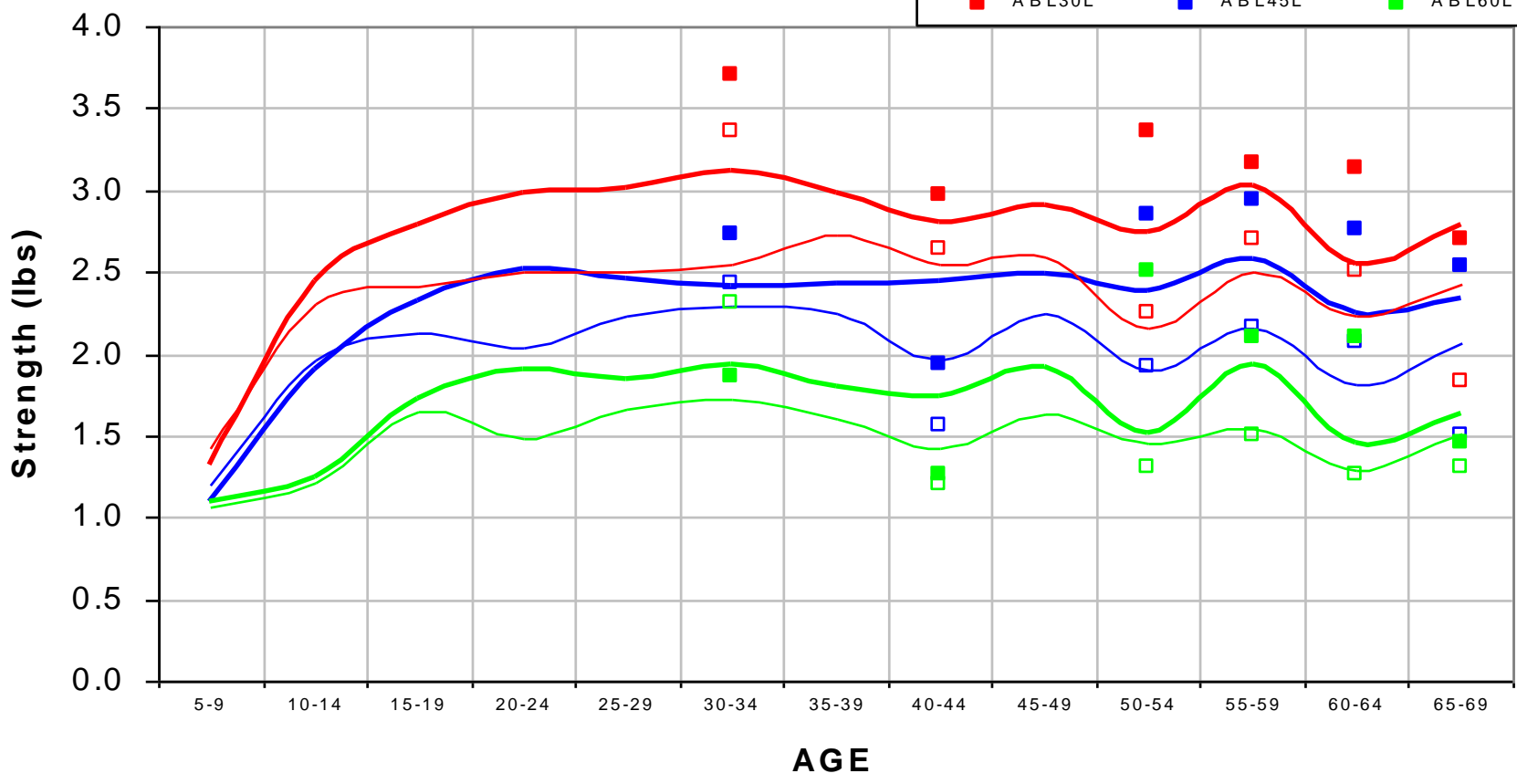
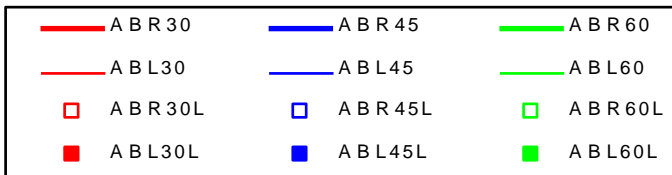


MALE Adduction by Weight

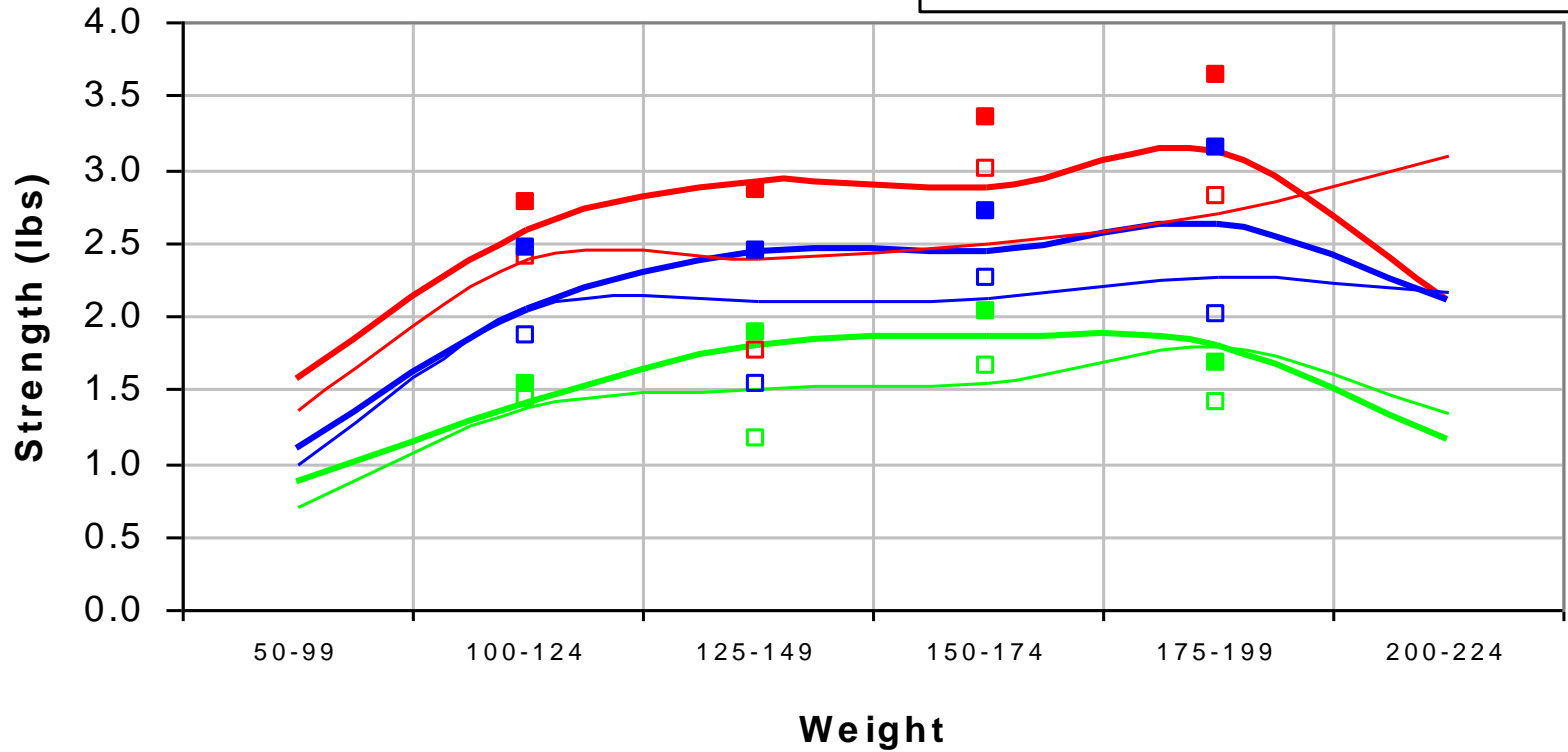
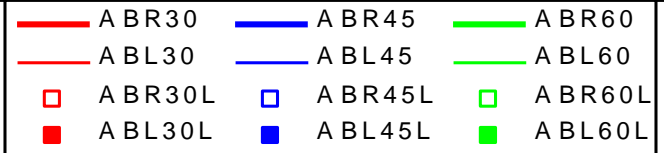
- | | | |
|-----------|-----------|-----------|
| — ADR 30 | — ADR 45 | — ADR 60 |
| — ADL30 | — ADL45 | — ADL60 |
| □ ADR 30L | □ ADR 45L | □ ADR 60L |
| ■ ADL30L | ■ ADL45L | ■ ADL60L |



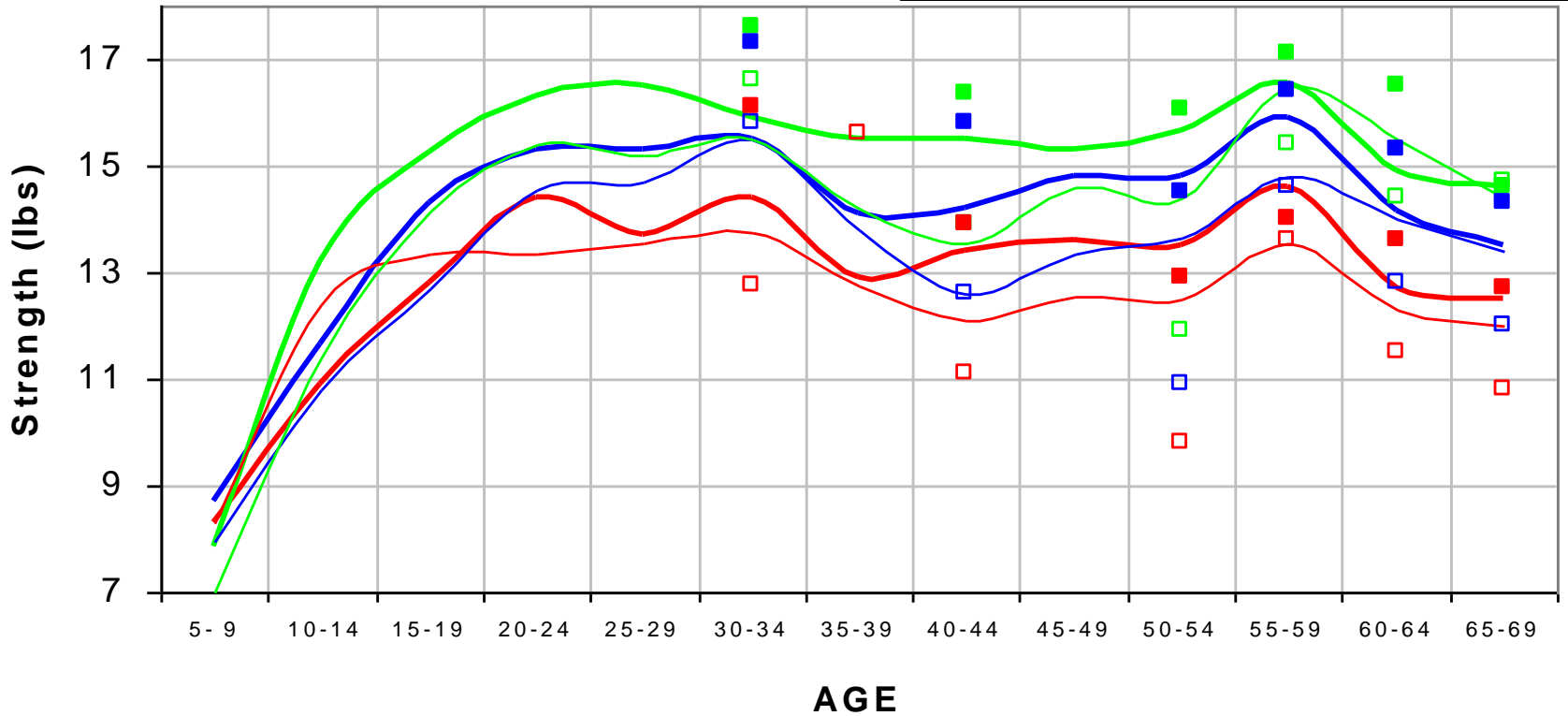
FEMALE Abduction by Age



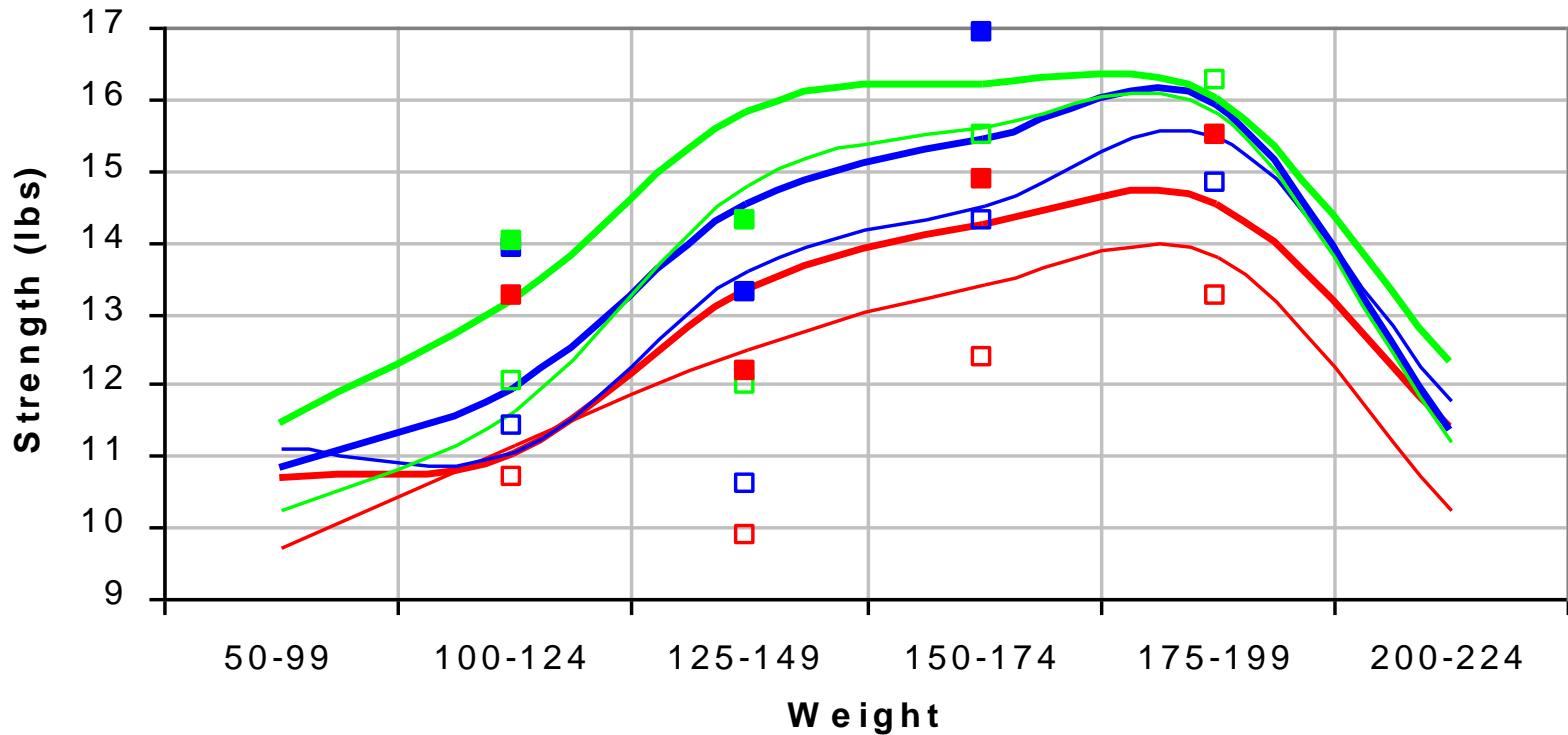
FEMALE Abduction by Weight



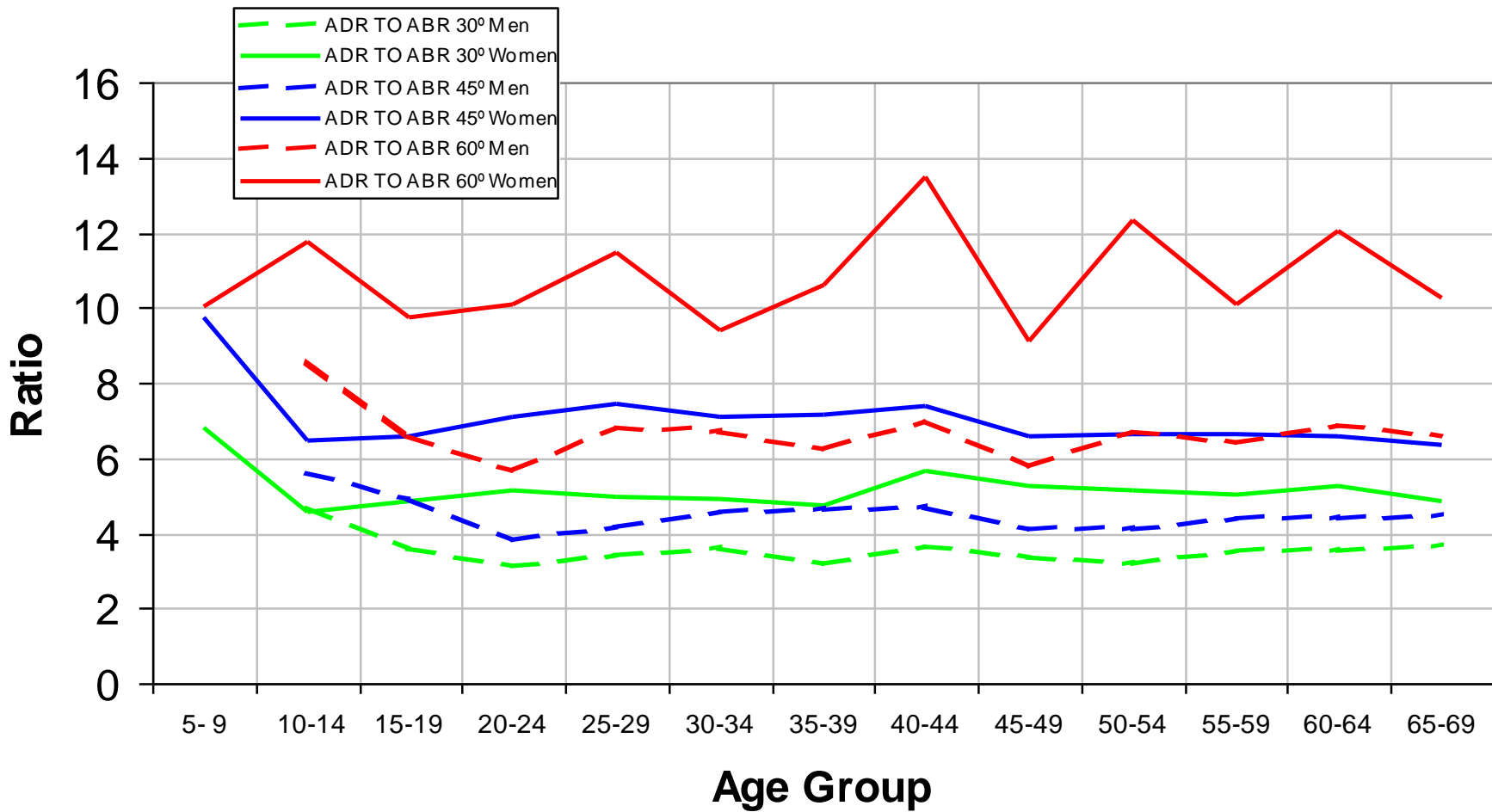
FEMALE Adduction by Age



FEMALE Adduction by Weight



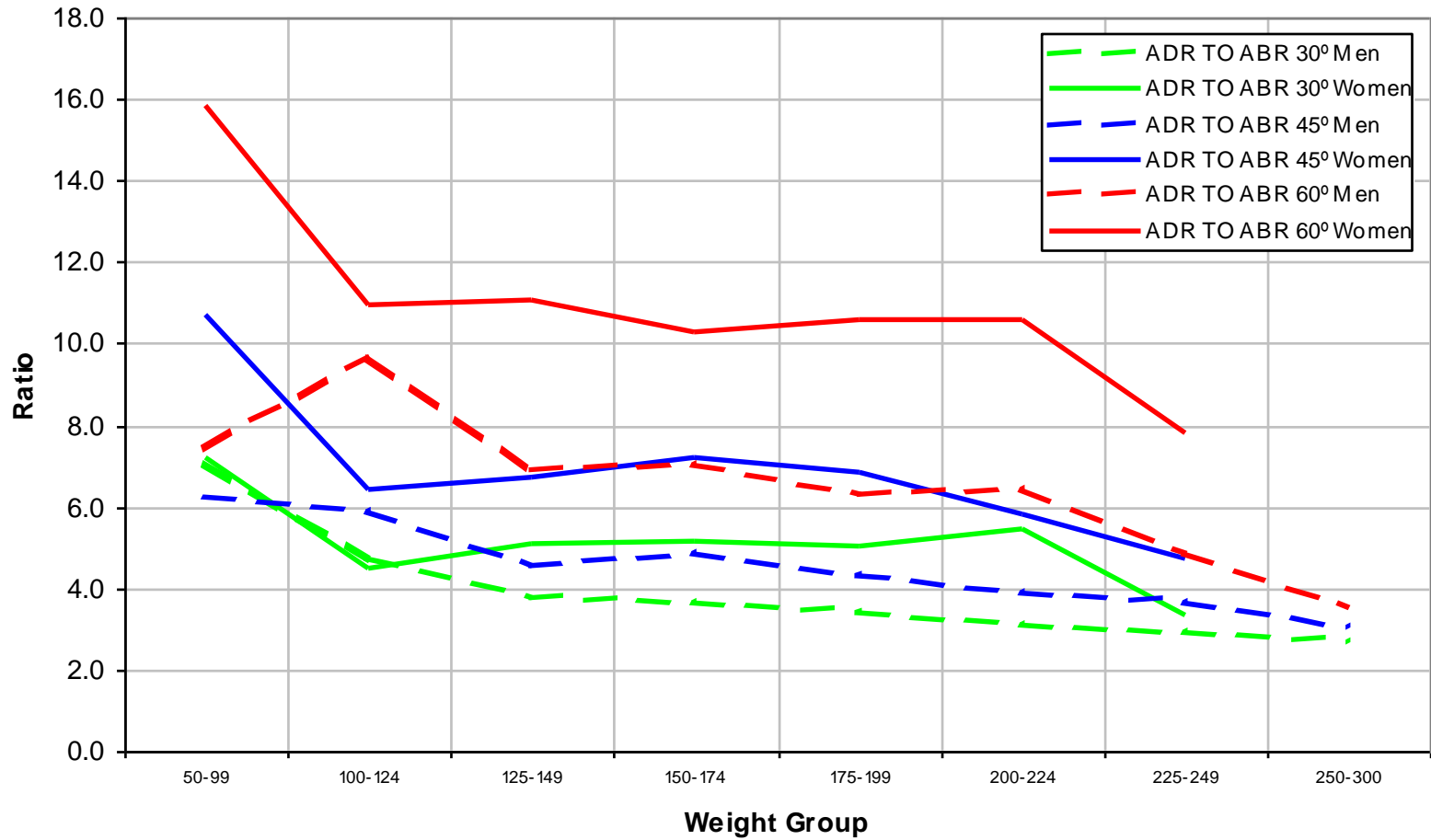
ADR to ABR Ratio Male AND Female By Age



ADR/ABR, Male/Female-age

- Adduction/ abduction ratio stays constant throughout life and hovers between 3.5 –7 except ADR at 60 abduction.
- ADD/ABD ratio increases as the angle of abduction increases.
- The ADD/ABD ratio is much higher in women than men

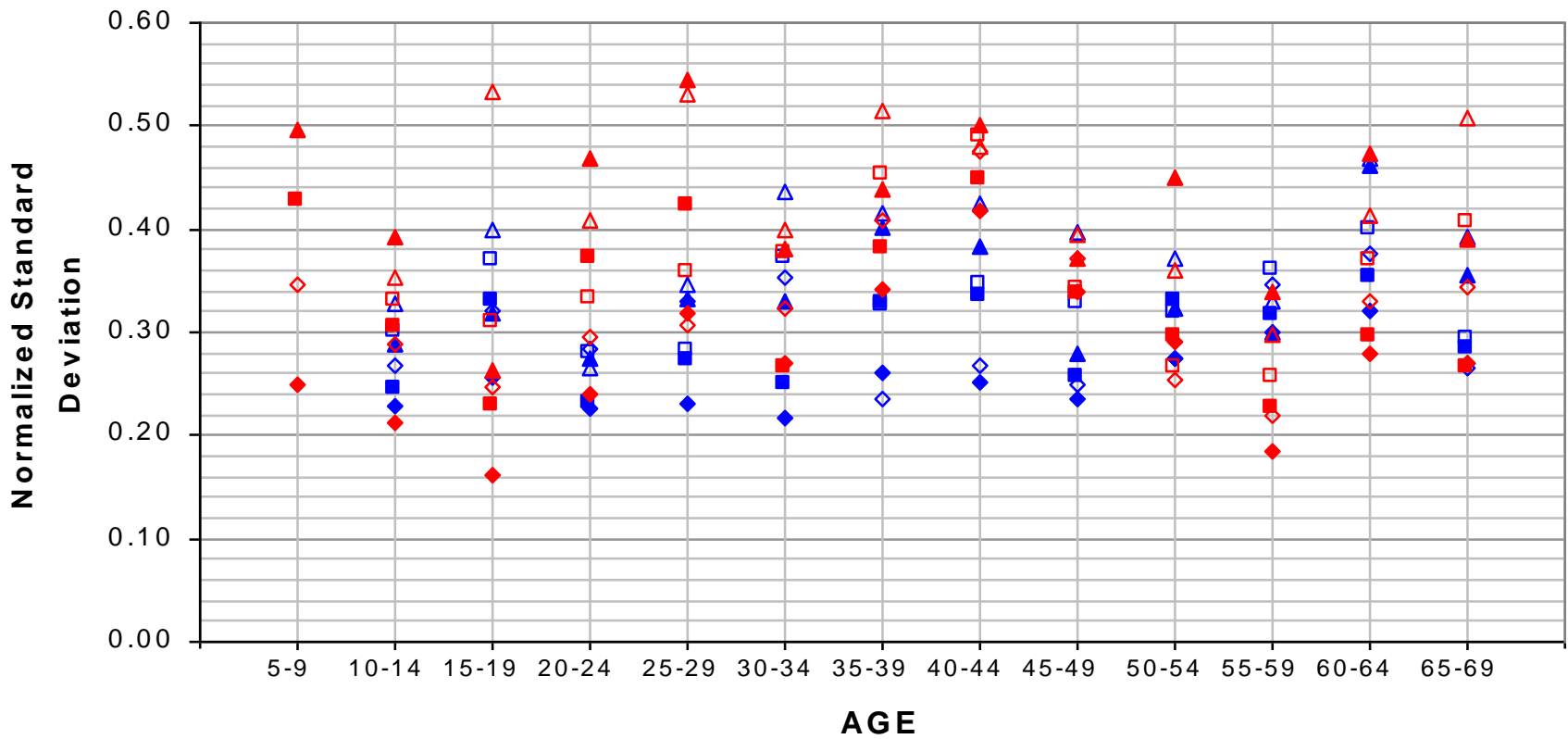
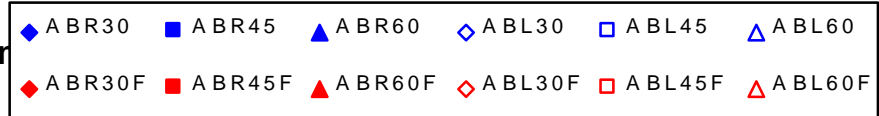
ADR to ABR Ratio Male AND Female By Weight Groups



ADR/ABR, Male/Female-weight

- The ratio of adduction/abduction remains the same regardless of weight and hovers between 3.5-7 except females at 60 degrees abduction.
- The ratio increases as the angle of abduction increases

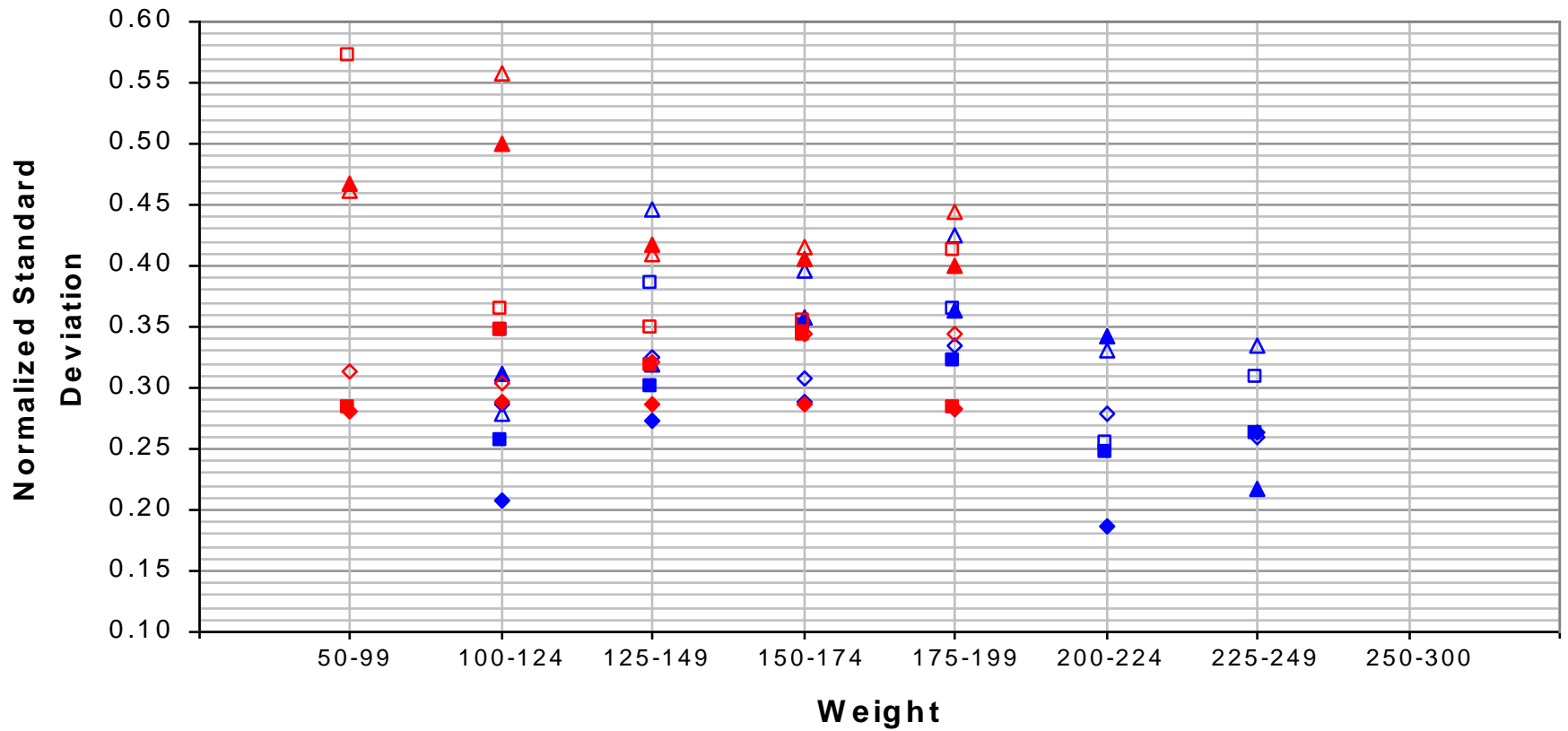
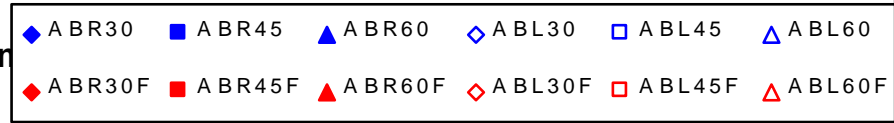
Abduction Standard Deviation-Right Hand Dorn



Abd.- S.D. R HD Male/female, age

- Females have a wider standard deviation than men
- Non dominant hands have a wider SD than dominant hands
- The standard deviation does not vary with age and ranges from 0.2-0.5

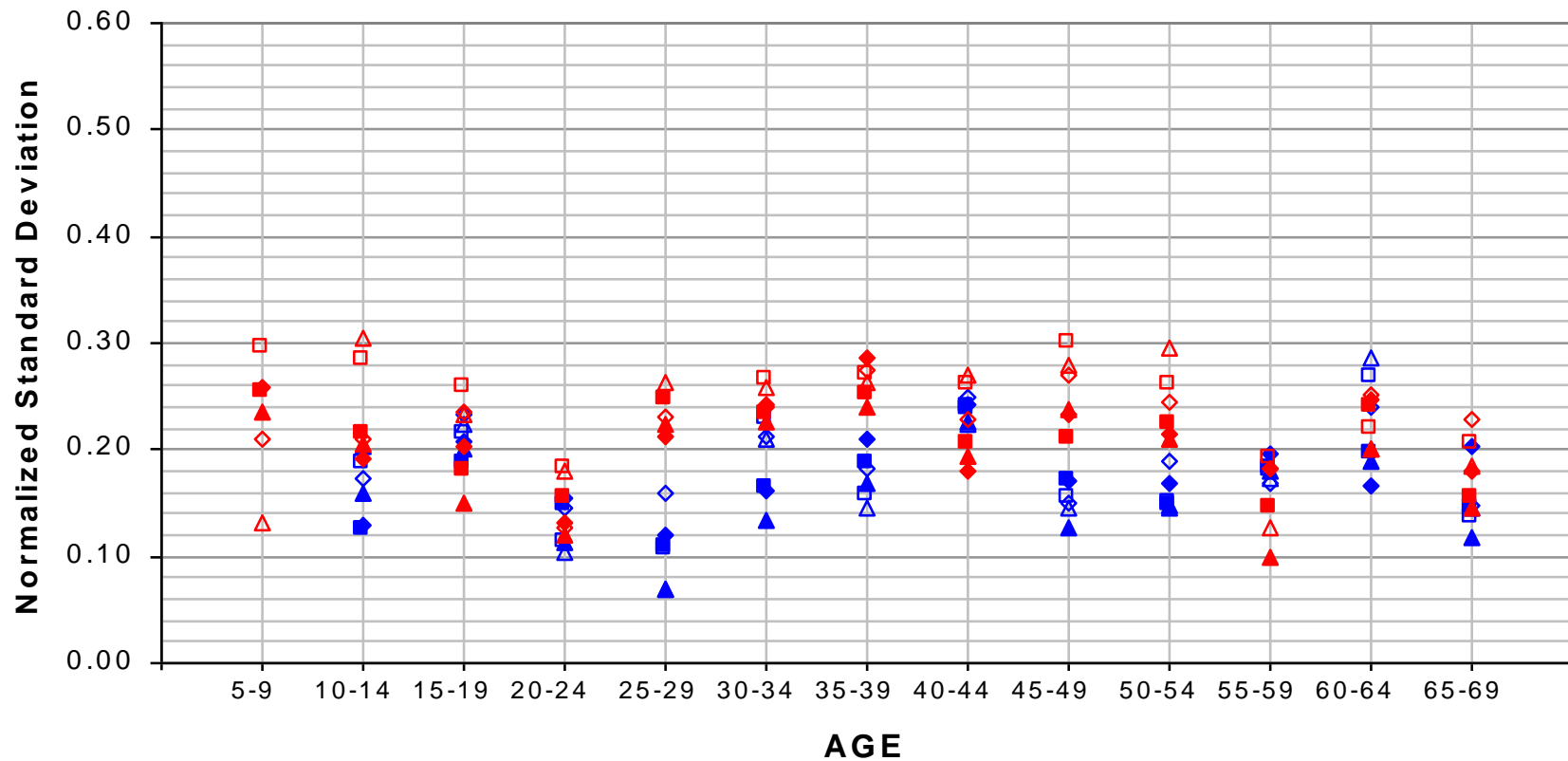
Abduction Standard Deviation-Right Hand Dors



Abd,S.D. RHD Male/ Female, weight

- The standard deviation does not vary with weight
- The SD increases in females , non dominant hands and increased abduction.

Adduction Standard Deviation-Right Hand Don

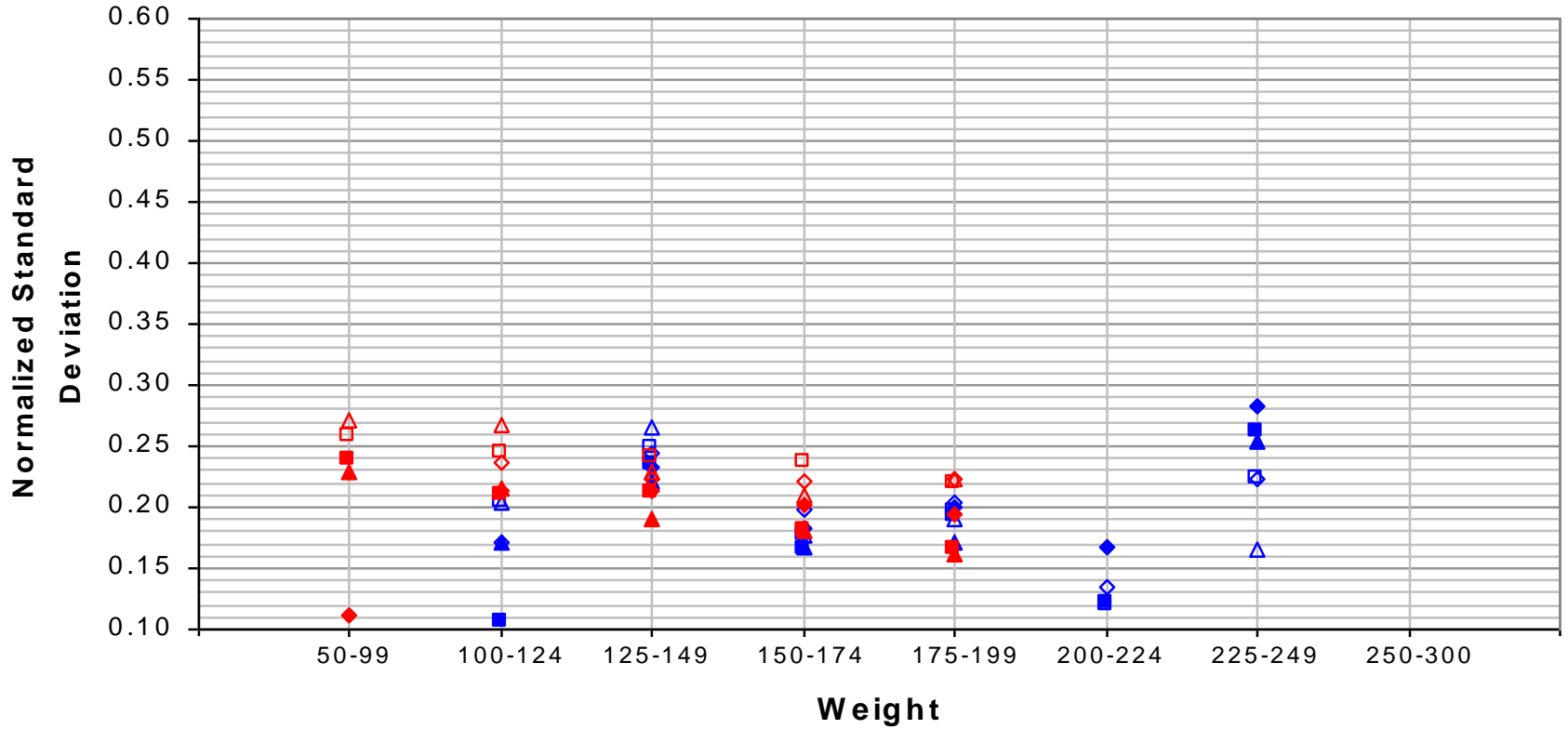


ADD, SD RHD Male/female, age

- The standard deviation does not change with age
- The SD is much smaller than in abduction
- The SD varies little with changes in abduction
- Females have a higher standard deviation than males

Adduction Standard Deviation-Right Hand Domina

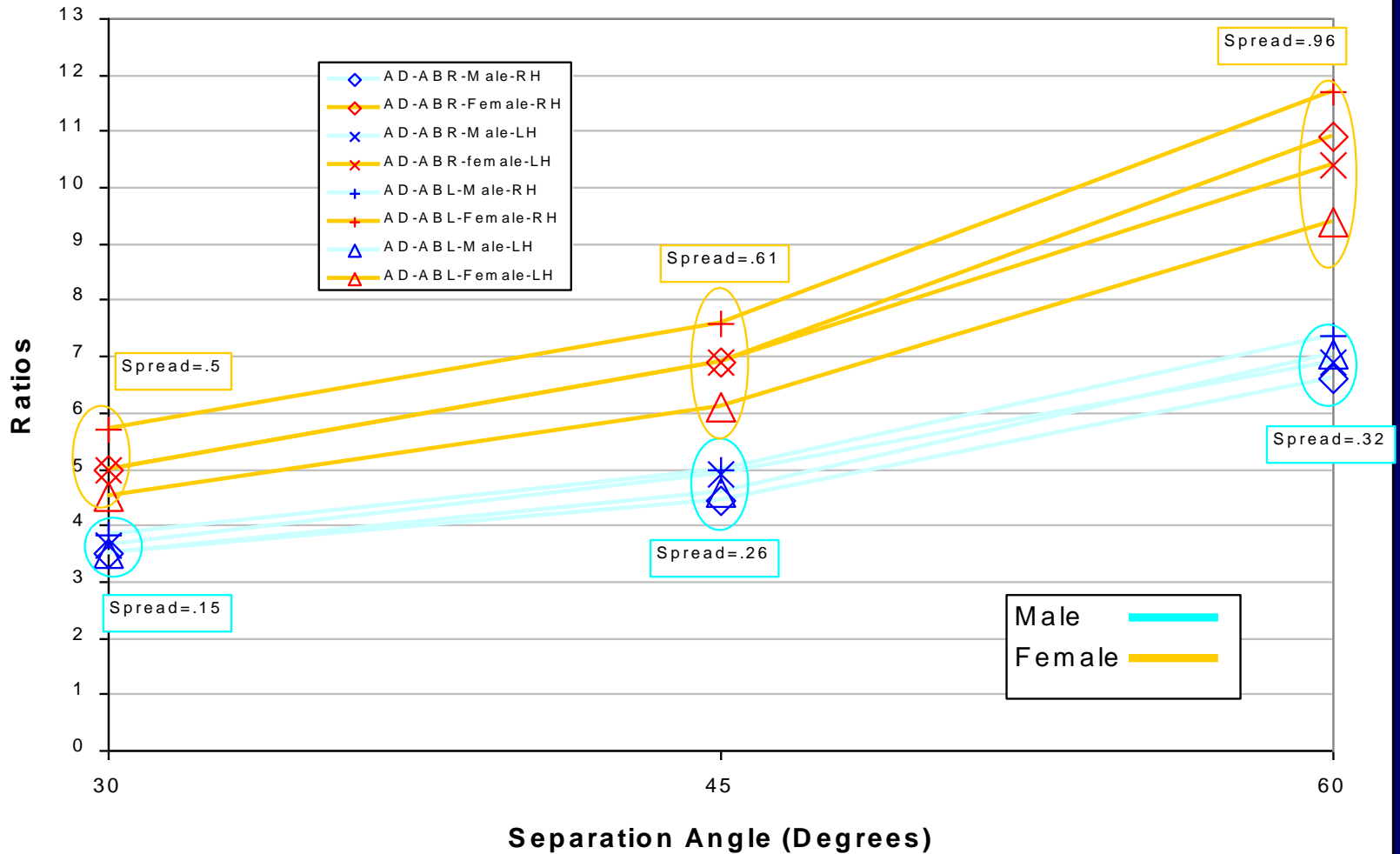
- ◆ ABR30
- ABL45
- ▲ ABR60F
- ◆ ABL30
- ABR45
- △ ABL60
- ◆ ABR30F
- ABL45F
- ▲ ABR60
- ◆ ABL30F
- ABL45F
- ▲ ABL60F



ADD,SD RHD Male/Female,weight

- There is no variation in standard deviation by weight class
- There is virtually no difference in SD by male vs. female, right vs. left and position of abduction.

Ratios Aduction to Abduction by Gender and Dominance



ADD/ABD ratio by gender & dominance

- The ratio increases by increase in abduction
- The ratio is higher in females than males
- The difference in ratios between right and left hand dominance is more pronounced in females and is lowest in ADD/ABD Left in LHD and highest in ADD/ABD Left in RHD
- The spread increases as the angle of abduction increases in males and females

Correlation Coefficients

- There is a low correlation between adduction/ abduction and age and weight
- There is a moderate correlation between ADD/ABD and right and left grip
- There is a moderate to high correlation between right and left ADD/ABD

Discussion

- The utility of the *abductometer* lies in its ability to distinguish between median and ulnarly innervated muscle groups.
- The results illustrate the consistency of the measuring techniques minimizing artifact.
- Evaluation of normals show distinct patterns for males and females, abduction and adduction, right and left, dominant and non dominant hands.
- Full reference tables are available

Further study

- Carpal/ cubital tunnel syndrome preop check for median/ ulnar motor weakness
- Postop follow-up to test for return of motor strength either median or ulnar
- Median or ulnar nerve laceration initial vs. follow-up return of function.
- Median/ ulnar nerve “injection test”
- Return to work criteria as part of a functional capacity evaluation pre and post treatment