ESTIMATING
BODY COMPOSITION

What is Body Composition?

Refers to the relative amounts of the different compounds in the body

Why Study Body Composition?

- Overweight vs. Over fat vs. Obesity
- Risk for various diseases
- Monitor change from an intervention
- Some job requirements involve body composition standards
- Athletic/sport limit factor

BODY MASS INDEX (BMI)

The ratio of mass to height^2

BMI = body mass (kg) / body height (m)^2

for example

BMI = 80 (kg) / 1.7^2 (m) = 27.68 kg/m^2

BMI < 20.0 is considered underweight

A BMI > 30 is associated with greater prevalence of mortality from heart disease, cancer, and diabetes

BMI	Disease Risk	Classification
<20.00	Moderate to Very High	Underweight
20.00 to 21.99	Low	Acceptable
22.00 to 24.99	Very Low	
25.00 to 26.99	Low	Overweight
27.00 to 29.99	Moderate	
30.00 to 39.99	High	Obese
≥40.00	Very High	

Risk of premature morbidity and mortality (y-axis) vs Body mass index (x-axis)

Body mass index scale: 15, 20, 25, 30, 35, 40, 45

Legend:
- Underweight (green)
- Recommended weight (blue)
- Overweight (purple)
- Obesity (magenta)

© 2005 Wadsworth - Thomson
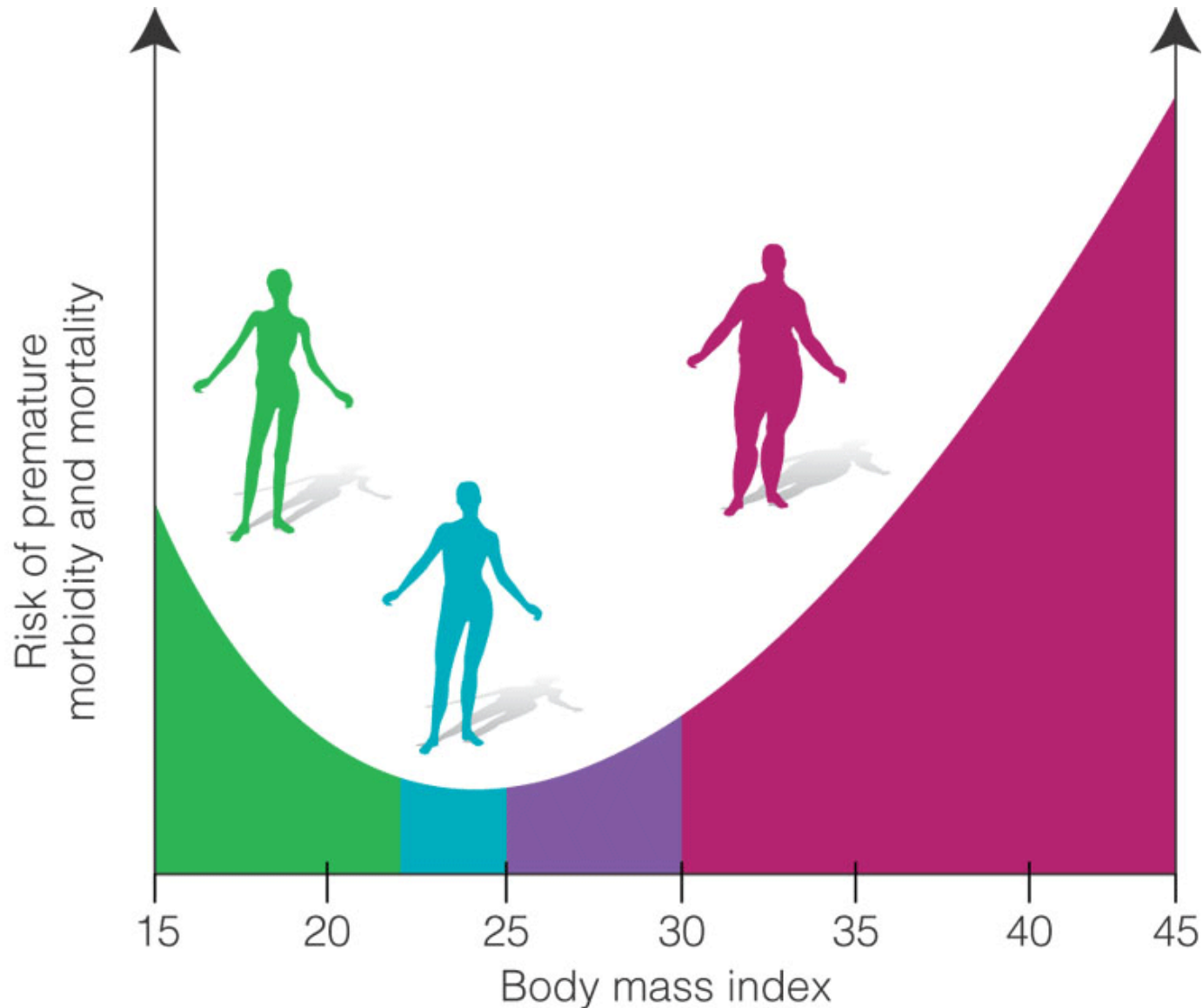
Elementary parameters

- HEIGHT
- BODY MASS

- BODY SURFACE

Body surface S (m^2) - DuBois:

$$S = W^{0,425} \cdot L^{0,725} \cdot 0,007184$$

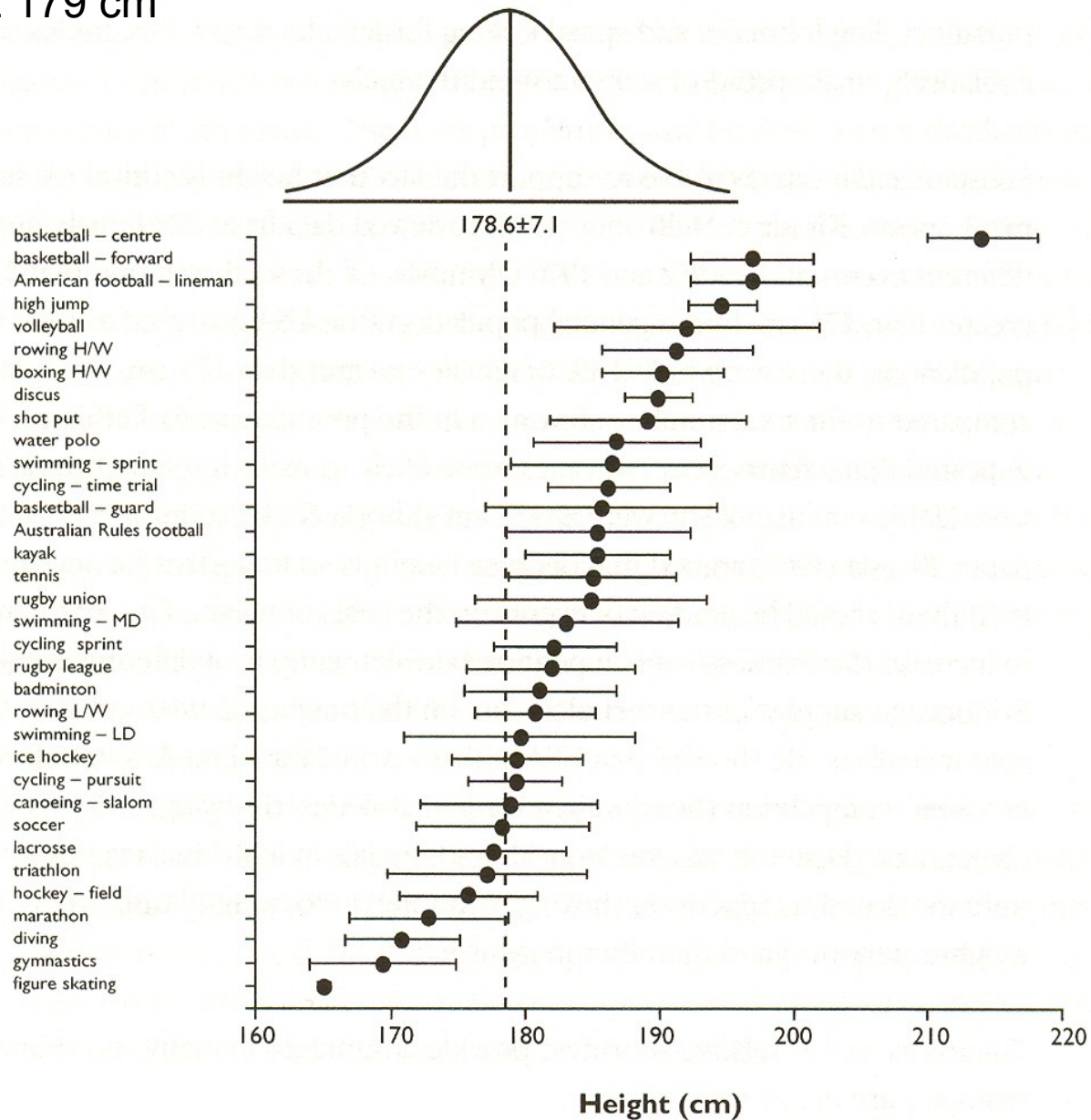W – body mass (kg); L - height (cm)

MEN mean CZ 179 cm

Figure 4 Plot of mean (± SD) heights for male athletes in different sports relative to a reference population of non-athletes.
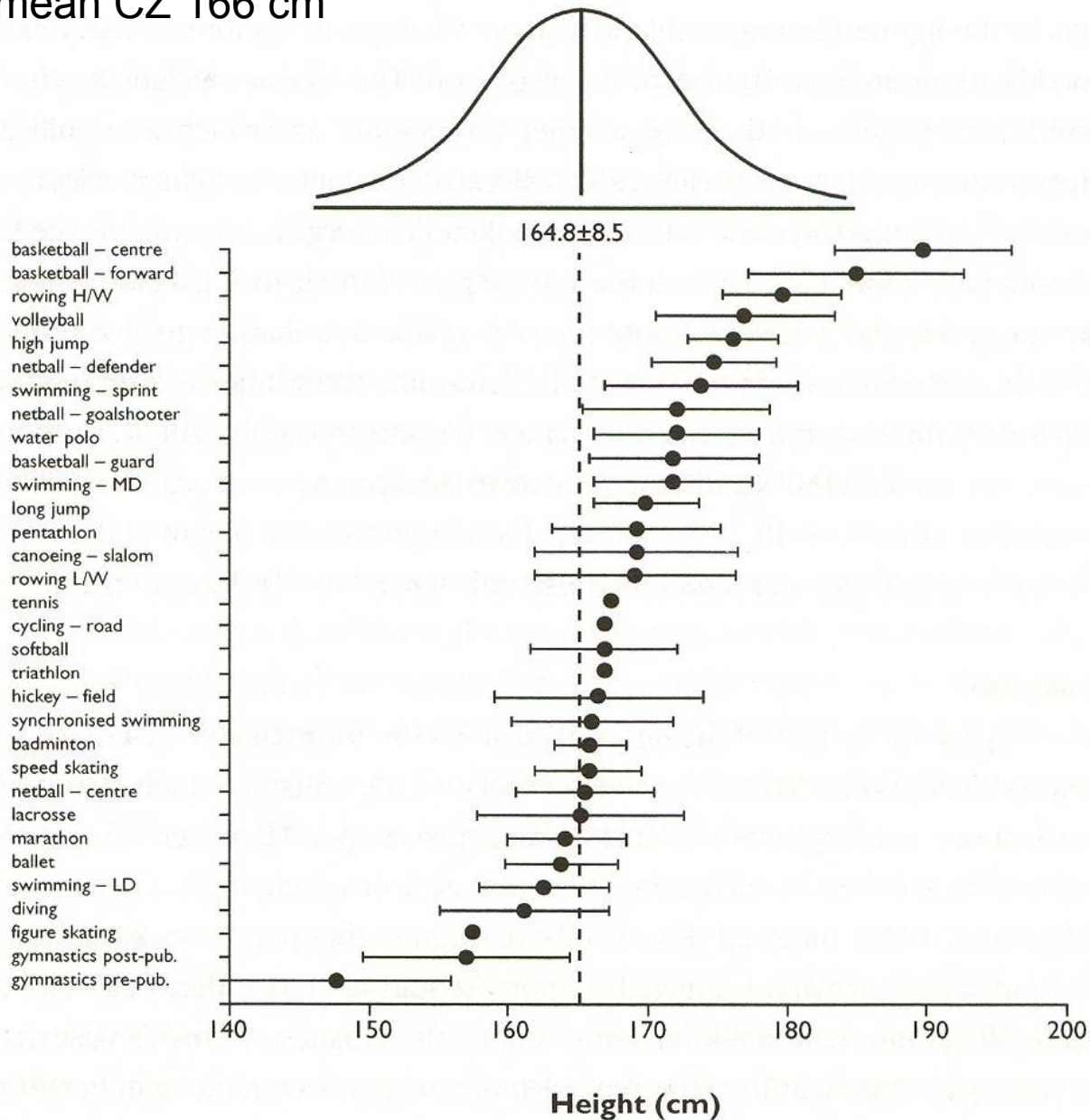
WOMEN mean CZ 166 cm

Figure 5 Plot of mean (± SD) heights for female athletes in different sports relative to a reference population of non-athletes.
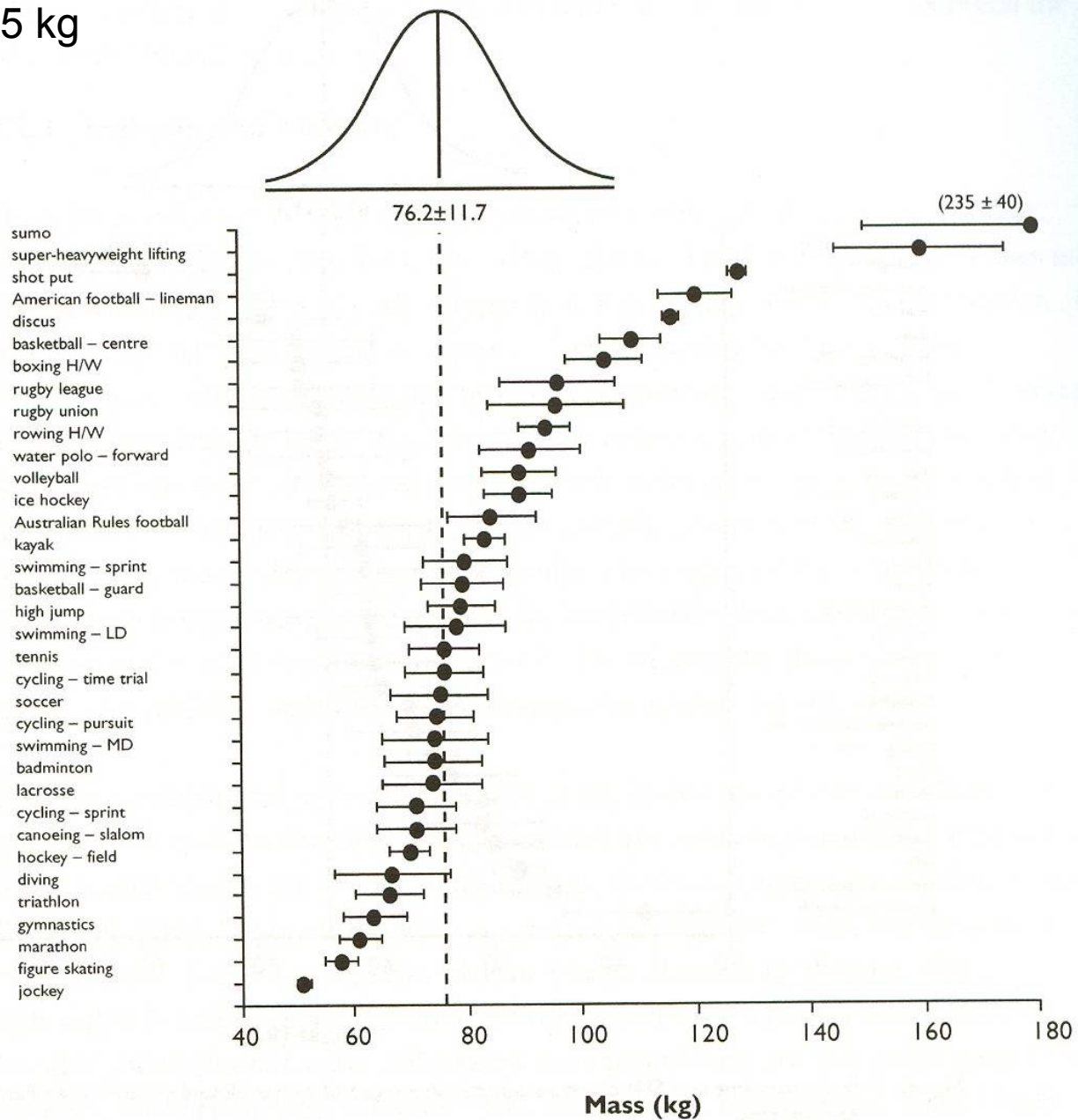
MEN mean CZ 75 kg

Figure 8 Body mass (mean ± SD) of male athletes in a range of sports plotted relative to a reference group of non-athletes.
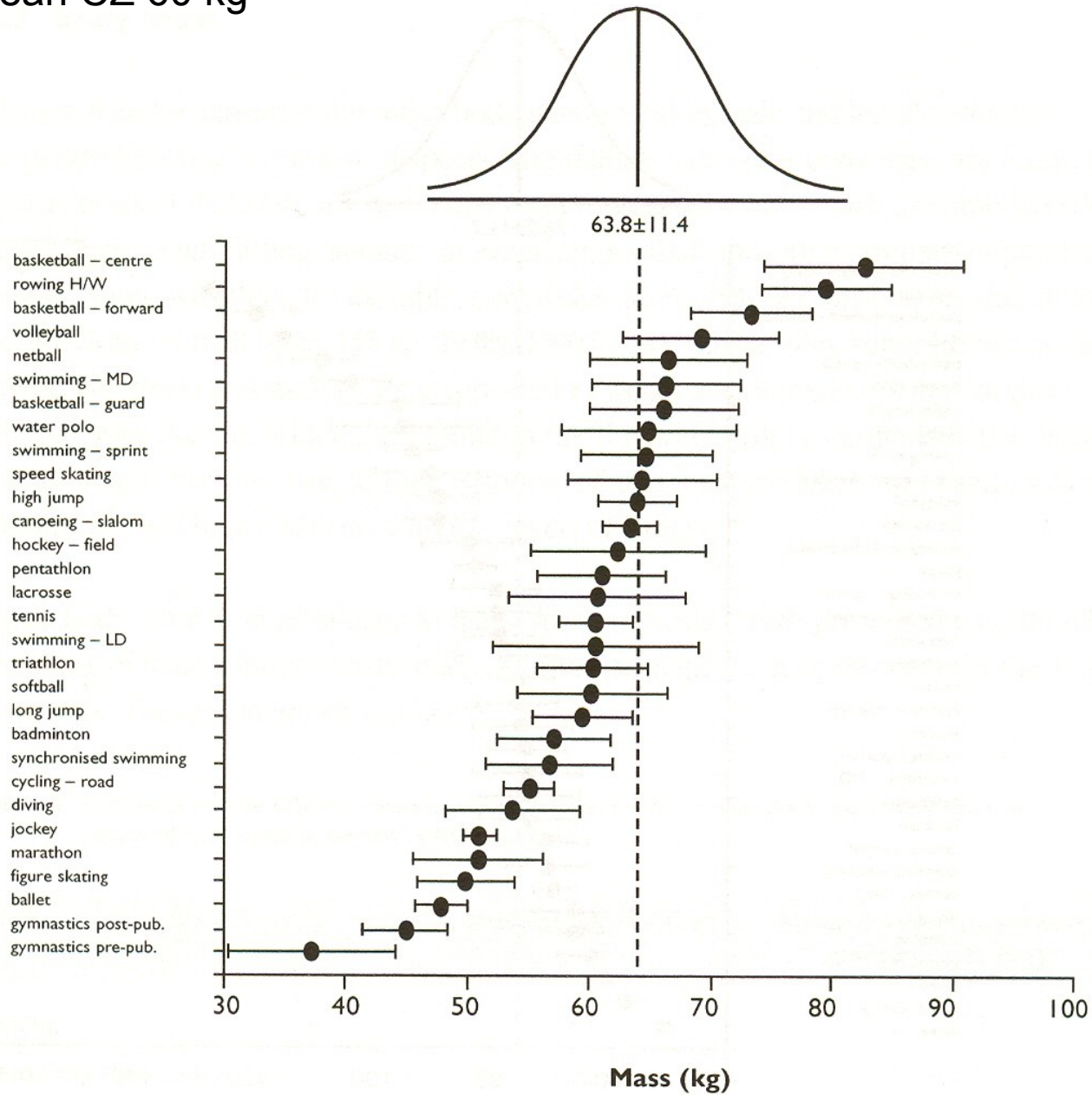
WOMEN mean CZ 60 kg

63.8 ± 11.4

Figure 9 Body mass (mean ± SD) of female athletes in a range of sports plotted relative to a reference group of non-athletes.

Chart A – Determining frame size using wrist size in inches

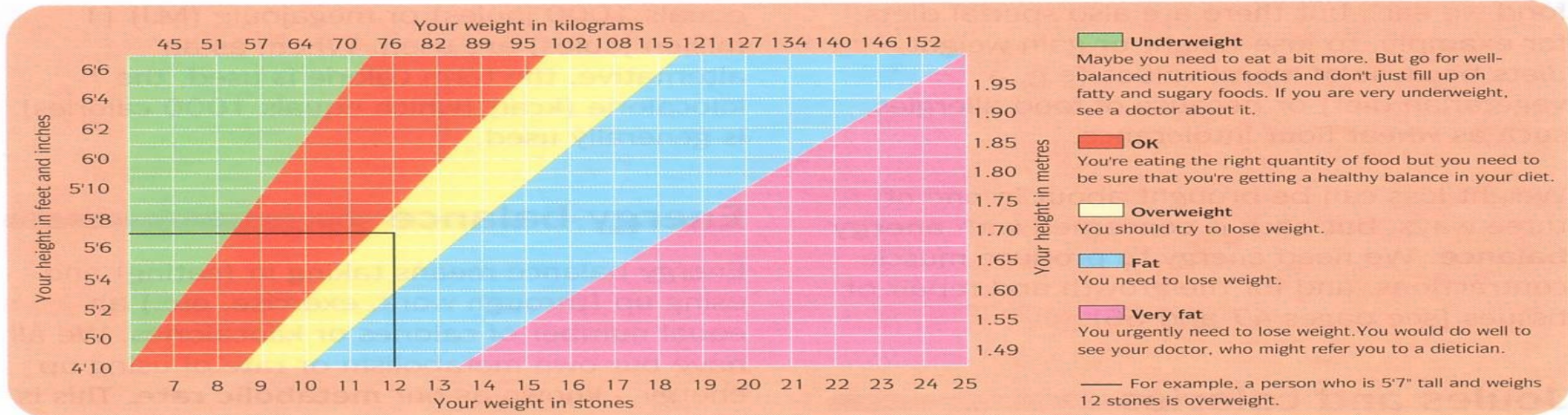| Frame	Men	Women
small	6 inches or less	5.5 or less
medium	6.25 – 7.25	5.75
large	7.5 or more	6 or more

Chart B – Desirable body weight for women (kgs)

Height (metres)	Small frame	Medium frame	Large frame
1·47	46–50	49–55	53–59
1·49	47–51	50–56	54–61
1·52	47–52	51–57	55–62
1·54	48–53	52–58	56–63
1·57	49–55	53–60	58–65
1·60	50–56	54–61	59–67
1·62	51–57	56–62	61–68
1·65	53–59	58–64	62–70
1·67	54–60	59–65	63–72
1·70	55–61	60–67	65–74
1·72	56–62	61–68	66–76
1·75	58–64	63–69	68–77
1·77	59–65	64–71	69–78
1·80	60–67	65–72	70–80
1·82	62–68	67–73	71–81

Chart C – Desirable body weight for men (kgs)

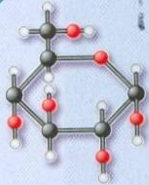| Height (metres)	Small frame	Medium frame	Large frame
1·57	58–60	59–64	62–68
1·60	59–61	60–65	63–69
1·62	59–62	61–66	64–70
1·65	60–63	62–67	65–72
1·67	61–64	63–68	66–74
1·70	62–66	64–70	67–76
1·72	63–67	65–71	69–78
1·75	64–68	67–72	70–80
1·77	65–70	68–74	71–82
1·80	66–71	70–75	73–83
1·82	67–73	71–77	74–85
1·85	70–74	72–79	76–87
1·87	71–76	74–81	78–89
1·90	71–78	76–82	80–92
1·93	73–80	77–85	82–93

Chart D – Height-to-weight chart for men and women

Underweight
Maybe you need to eat a bit more. But go for well-balanced nutritious foods and don't just fill up on fatty and sugary foods. If you are very underweight, see a doctor about it.

OK
You're eating the right quantity of food but you need to be sure that you're getting a healthy balance in your diet.

Overweight
You should try to lose weight.

Fat
You need to lose weight.

Very fat
You urgently need to lose weight. You would do well to see your doctor, who might refer you to a dietician.

For example, a person who is 5'7" tall and weighs 12 stones is overweight.

Source: Health Education Authority

Level I Atomic
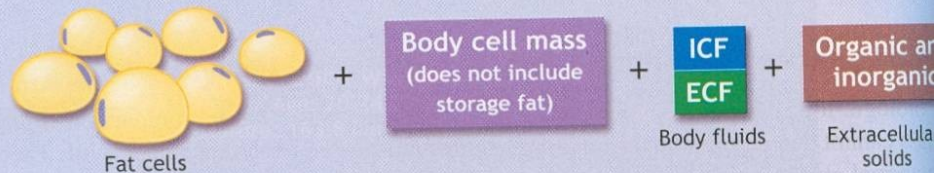
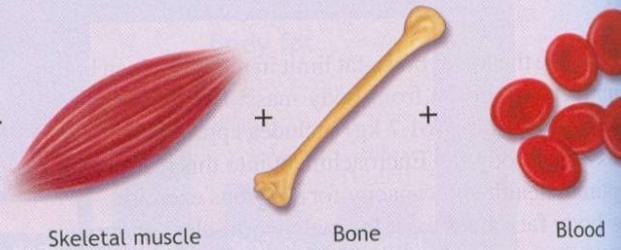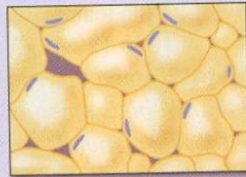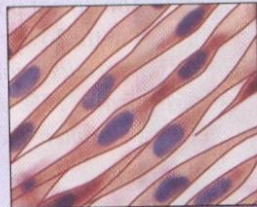| Element	Amount (kg)	% Body Mass
Oxygen	43.0	61.0
Carbon	16.0	23.0
Hydrogen	7.0	10.0
Nitrogen	1.8	2.6
Calcium	1.0	1.4
Remainder	1.2	2.0

Level II Molecular

Protein   Carbohydrate   Lipid   Mineral compounds   Water

Level III Cellular

Fat cells   +   Body cell mass (does not include storage fat)   +   ICF ECF   +   Organic and inorganic

Body fluids   Extracellular solids

Level IV Tissue

+   Adipose tissue   +   Skeletal muscle   +   Bone   +   Blood

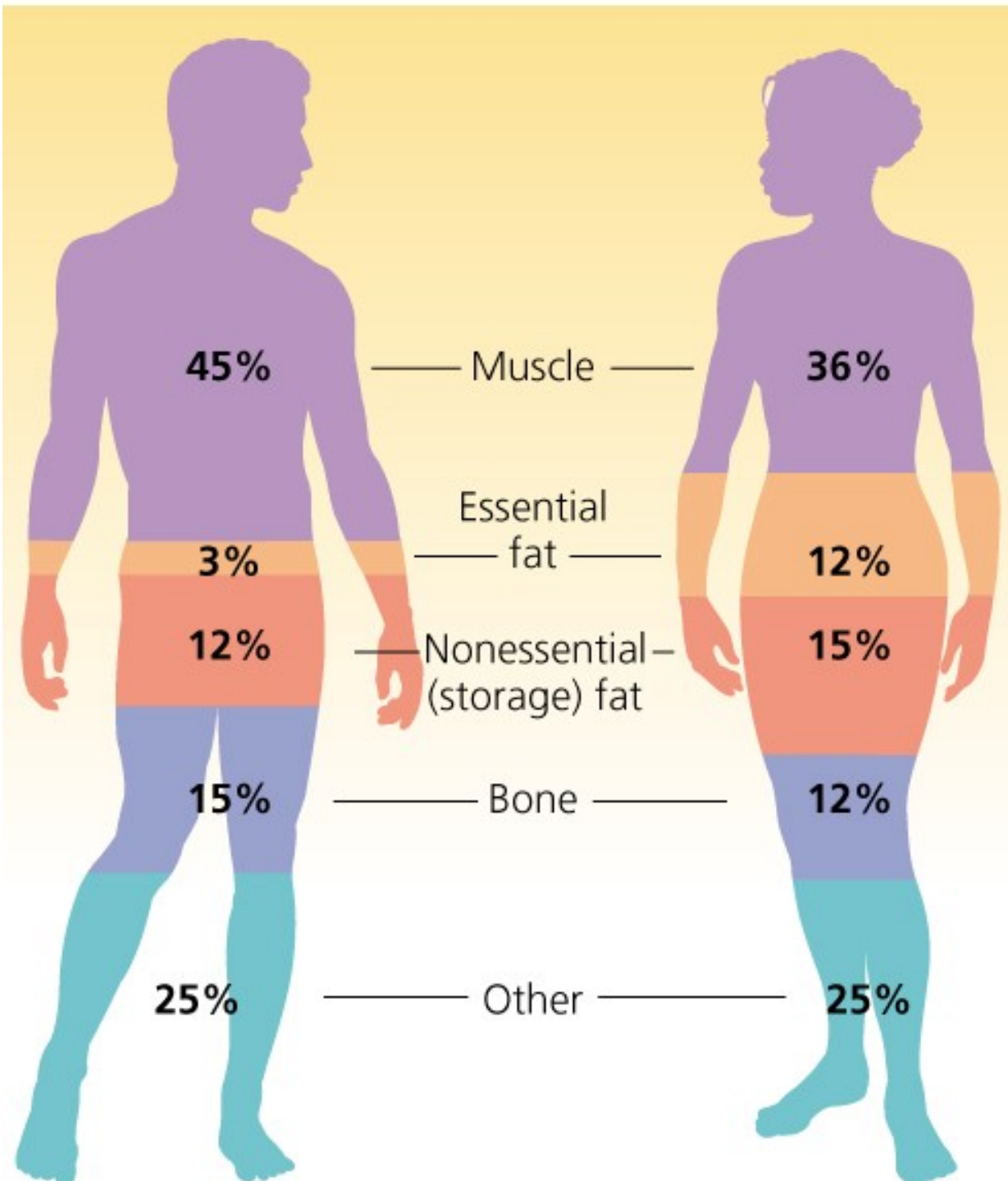**Level V** Whole body

Skinfolds   Girths   Densitometry   Segment volume

Body Composition
Matiegka Method

4 components:

- Skeletal mass (bones)

- Fat body mass (fat)

- Muscle mass (muscles)

- Other

	Male		Female
Muscle	45%		36%
Essential fat	3%		12%
Nonessential (storage) fat	12%		15%
Bone	15%		12%
Other	25%		25%

Width dimensions (diameter)

- biepicondylar humerus

- bistyloideus

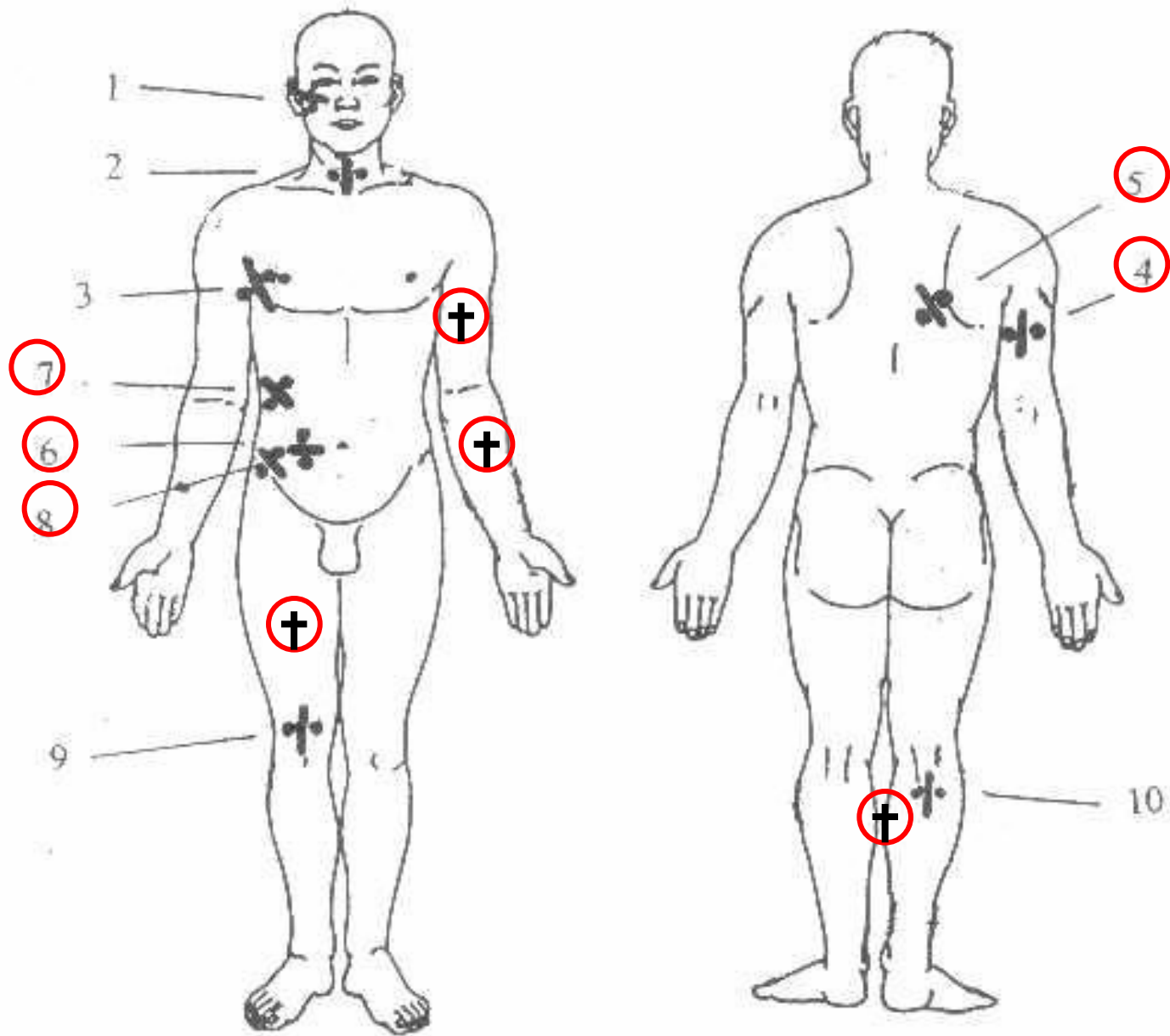- biepicondylar femur

- bimalleolar

GIRTH

- relax arm
- flexed arm
- forearm girth
- thigh girth
- calf girth

SKINFOLD MEASUREMENTS

- triceps
- subscapular
- chest 2
- abdomen
- supraspinal

- biceps
- forearm
- mid-thigh
- medial calf

Standardní místa snímání tloušťky kožních řas pro stanovení relativní hmotnosti depotní tukové tkáně kaliperem.

	MEN	WOMEN
Skeletal mass:	17%	16%
Muscle mass:	46%	41%
Fat body mass:	14%	22%
Other:	23%	21%

BIOELETRIC IMPEDANCE ANALYSIS (BIA)

DEVICE:

- Omron

- Tanita

- Body stat

- In-Body

BIOELETRIC IMPEDANCE ANALYSIS (BIA)

- Body fat scales use the Bioelectrical Impedance Analysis (BIA) technique.

- This method measures body composition by sending a low, safe electrical current through the body.

- The current passes freely through the fluids contained in muscle tissue, but encounters difficulty/resistance when it passes through fat tissue.

- This resistance of the fat tissue to the current is termed 'bioelectrical impedance', and is accurately measured by body fat scales.

- When set against a person's height, gender and weight, the scales can then compute their body fat percentage.

SOMATOTYPING

# The Heat-Carter Somatotype method

SOMATOTYPE

|	
ENDOMORPHY	**describes the relative degree of adiposity of body (fat mass)**
MESOMORPHY	**describes the realtive muscle-skeletal development of the body (apparent robustness - muscle, bone)**
ECTOMORPHY	**describes the relative slenderness of the body (fragilitx of the limbs**

a

b

c
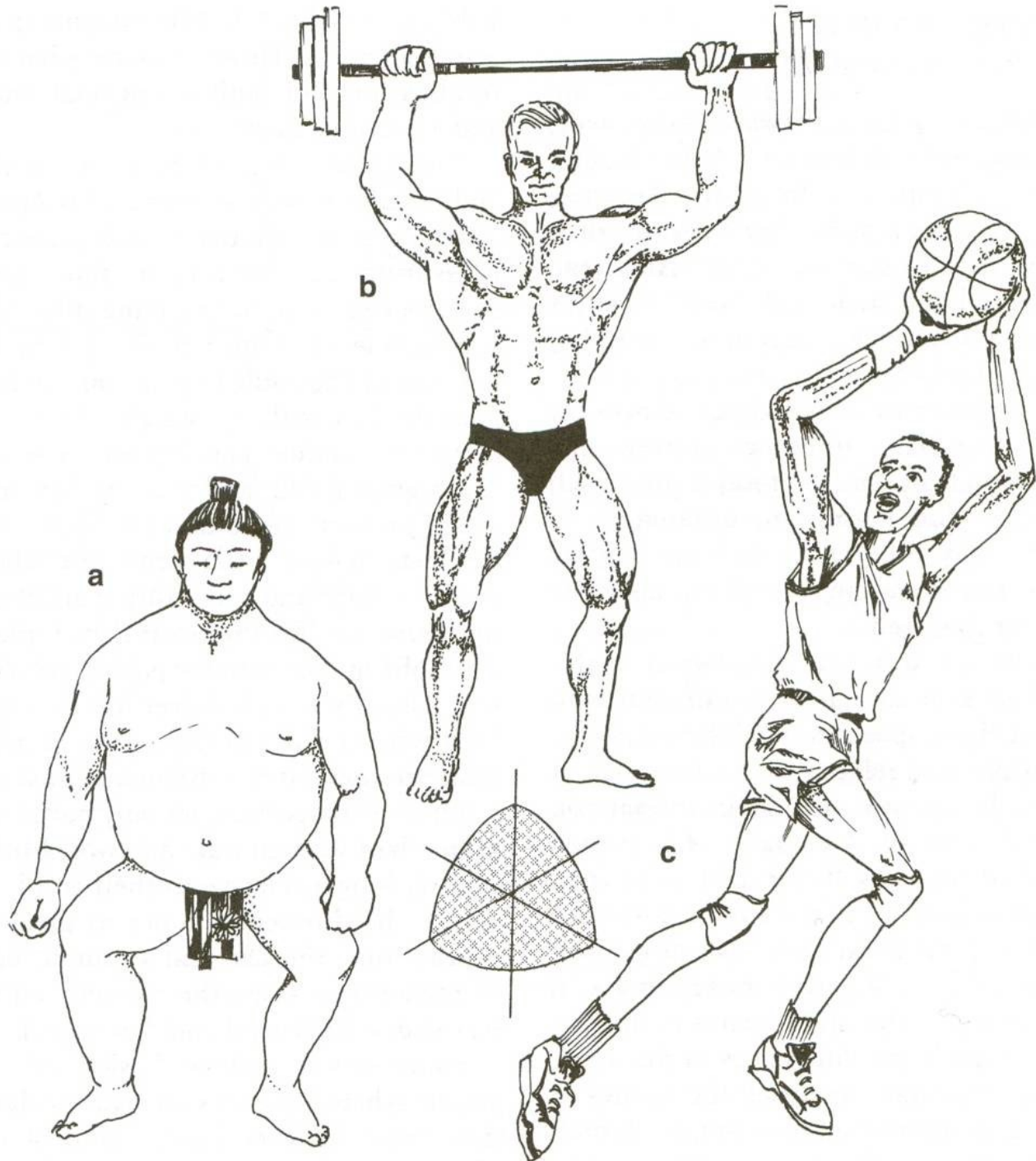
Somatotype categories:

Balance endomorph (balance mesomorph, balance ectomorph)	**1 component predominantes, 2 and 3 are balanced**
Mesomorphic endomoph (ectomorphic endomorph, endomorphic mesomorph, atd.)	**1 component predominantes, 2. is upper than 3.**
endomorph - mesomorph (endomorph - ectomorph, ectomorph - mesomorph)	**1 component is below 3, 2. and 3. are balanced**
Central type	**All components are 3, 4**
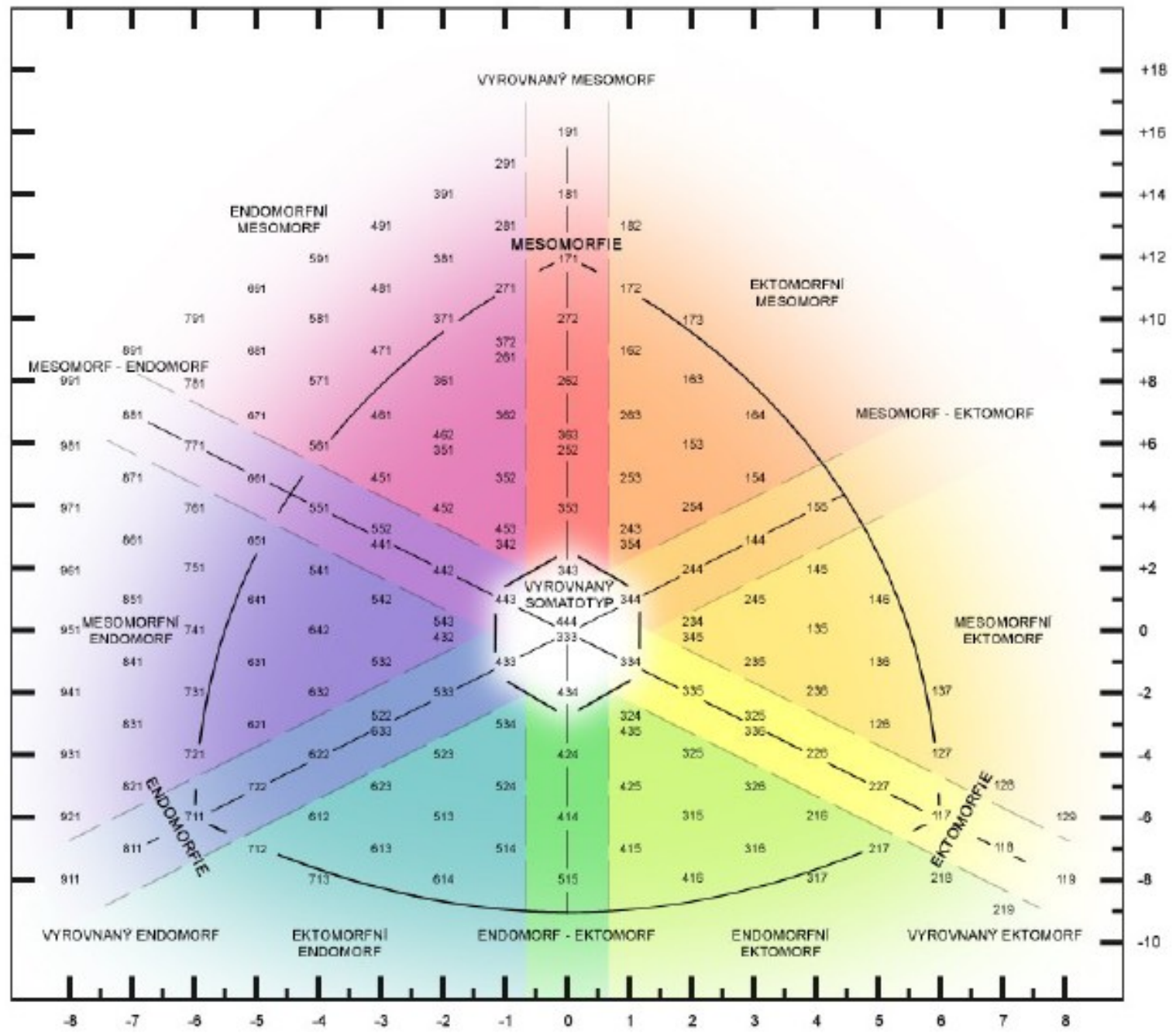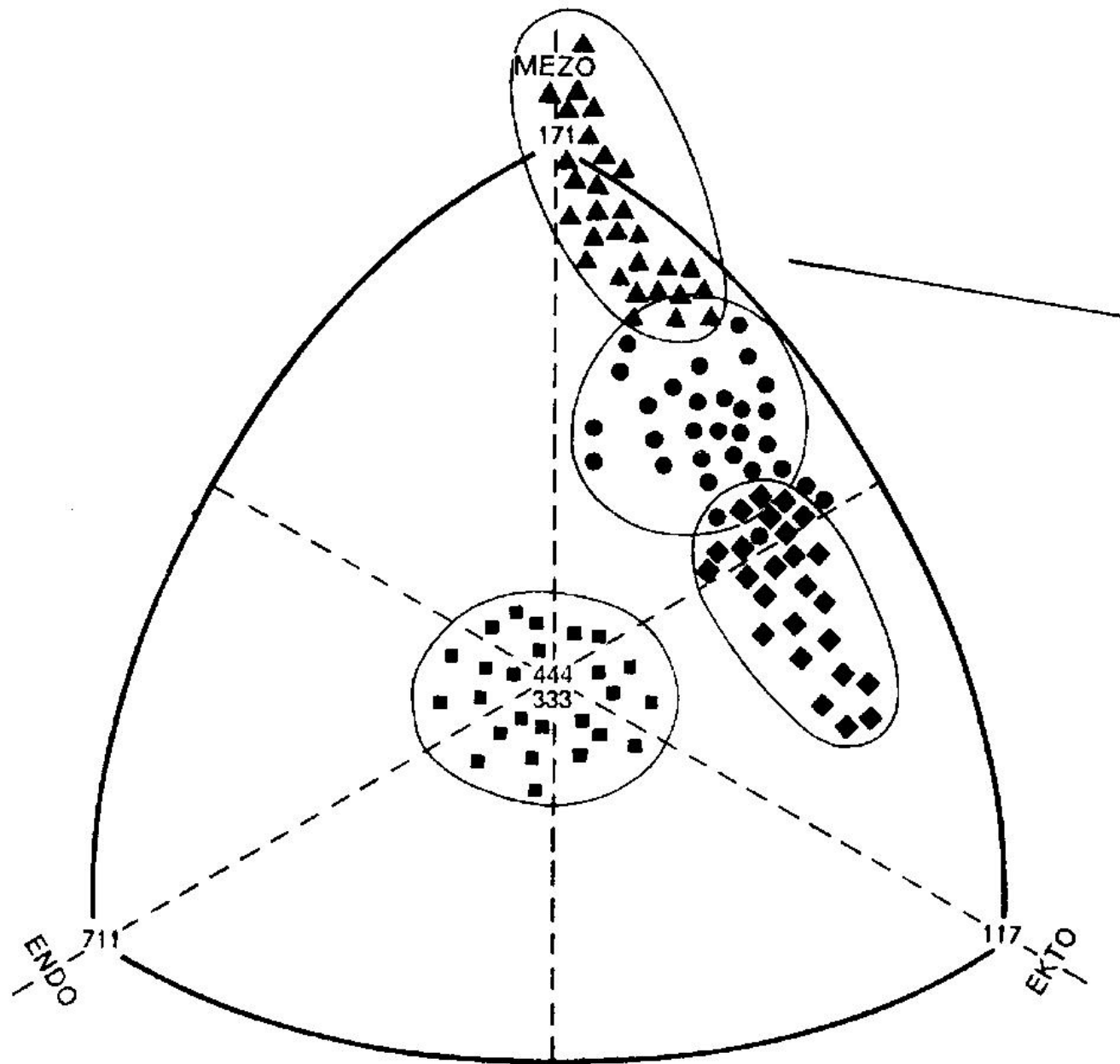
■ průměrná populace	● vrcholoví čs. plavci
▲ vrcholoví čs. gymnasté	◆ vrcholoví čs. hráči košíkové

MEZO

171

444
333

711 ENDO

117 EKTO

| Name | A. Medhurst | | Age | 20yr 5 mo | Sex (M) | F | No A |

Occupation Designer   Ethnic Group Black   Date 1 Jan 1996

Project Track Sprinter   Measured by TSO

Skinfolds mm		Sum 3 Skinfolds (mm)

Triceps = 6.4

Subscapular = 7.1

Supraspinale = 4.6

Sum 3 Skinfolds = 18.1

Calf = 5.2

Upper Limit 10.9 14.9 18.9 22.9 26.9 31.2 35.8 40.7 46.2 52.2 58.7 65.7 73.2 81.2 89.7 98.9 108.9 119.7 131.2 143.7 157.2 171.9 187.9 204.0

Mid-point 9.0 13.0 (17.0) 21.0 25.0 29.0 33.5 38.0 43.5 49.0 55.5 62.0 69.5 77.0 85.5 94.0 104.0 114.0 125.5 137.0 150.5 164.0 180.0 196.0

Lower Limit 7.0 11.0 15.0 19.0 23.0 27.0 31.3 35.9 40.8 46.3 52.3 58.8 65.8 73.3 81.3 89.8 99.0 109.0 119.8 131.3 143.8 157.3 172.0 188.0

$\times \left(_{ht} = \dfrac{170.18}{178.3} \right) = 17.3$ (height corrected skinfolds)

Endomorphy 1 (1½) 2 2½ 3 3½ 4 4½ 5 5½ 6 6½ 7 7½ 8 8½ 9 9½ 10 10½ 11 11½ 12

Height (cm) = 178.3

139.3 143.5 147.3 151.1 154.9 158.8 162.6 166.4 170.2 174.0 (177.8) 181.6 185.4 189.2 193.0 196.9 200.3 204.5 208.3 212.1 215.9 219.7 223.5 227.3

Humerus width (cm) = 7.20

5.19 5.34 5.49 5.64 5.78 5.93 6.07 6.22 6.37 6.51 6.65 6.80 6.95 7.09 (7.24) 7.38 7.53 7.67 7.82 7.97 8.11 8.25 8.40 8.55

Femur with (cm) = 9.75

7.41 7.62 7.83 8.04 8.24 8.45 8.66 8.87 9.08 9.28 9.49 (9.70) 9.91 10.12 10.33 10.53 10.74 10.95 11.16 11.36 11.57 11.78 11.99 12.21

Biceps girth (cm) = 33.9

-- triceps skinfolds (cm) = 0.6

33.3

23.7 24.4 25.0 25.7 26.3 27.0 27.7 28.3 29.0 29.7 30.3 31.0 31.6 32.2 (33.0) 33.6 34.3 35.0 35.6 36.3 37.0 37.6 38.3 39.0

Calf girth (cm) = 37.6

-- calf skinfold (cm) = 0.5

37.1

27.7 28.5 29.3 30.1 30.8 31.6 32.4 33.2 33.9 34.7 35.5 36.3 (37.1) 37.8 38.6 39.4 40.2 41.0 41.7 42.5 43.3 44.1 44.9 45.6

Mesomorphy ½ 1 1½ 2 2½ 3 3½ 4 4½ 5 (5½) 6 6½ 7 7½ 8 8½ 9

Weight (kg) = 69.2

Ht/∛Wt = 43.4

Upper Limit 39.65 40.74 41.43 42.13 42.82 (43.48) 44.18 44.84 45.53 46.23 46.92 47.58 48.25 48.94 49.63 50.33 50.99 51.68

Mid-point and 40.20 41.09 41.79 42.48 43.14 43.84 44.50 45.19 45.89 46.32 47.24 47.94 48.60 49.29 49.99 50.68 51.34

Lower Limit below 39.66 40.75 41.44 42.14 42.83 43.49 44.19 44.85 45.54 46.24 46.93 47.59 48.26 48.95 49.64 50.34 51.00

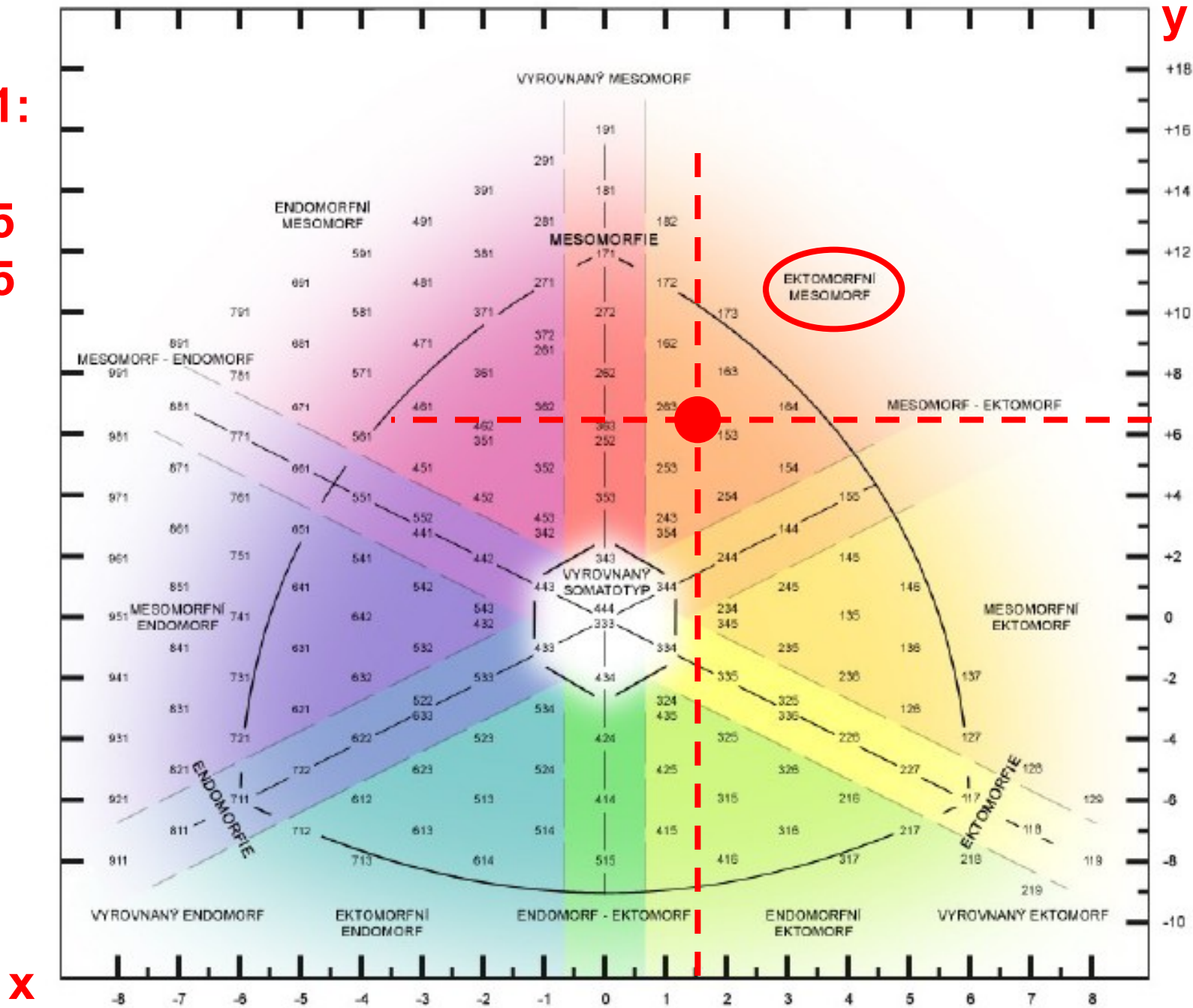**Ectomorphy** ½ 1 1½ 2 2½ (3) 3½ 4 4½ 5 5½ 6 6½ 7 7½ 8 8½ 9

	ENDOMORPHY	MESOMORPHY	ECTOMORPHY	
Anthropometric Somatotype	1½	5½	3	BY: TSO
Anthropometric plus Photoscopic Somatotype				RATER:

X = EKTOMORFIE - ENDOMORFIE
Y = 2 x MESOMORFIE - (ENDOMORFIE + EKTOMORFIE)

Příklad 1:

Endo 1,5
Mezo 5,5
Ekto 3

1	Basketball (3.7–4.0–2.9)	6	Squash (3.4–4.0–2.8)
2	Hockey (3.7–4.5–2.2)	7	Volleyball (3.0–3.5–3.5)
3	Netball (3.0–3.8–3.3)	8	Badminton (4.1–4.4–2.5)
4	Soccer (4.2–4.6–2.2)	9	Lacrosse (4.1–4.5–2.4)
5	Softball (3.8–4.3–2.7)	10	Cricket (4.9–4.4–2.0)

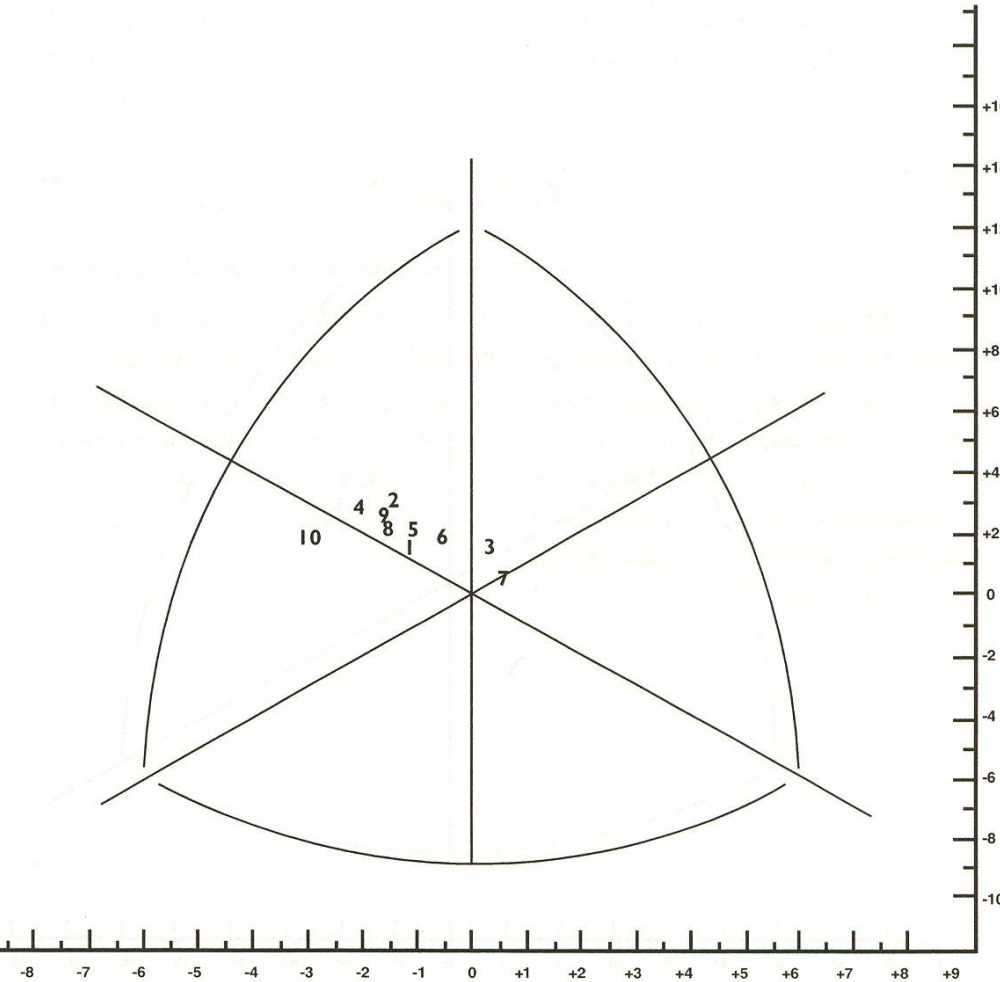|	Australian Rules (2.1–5.7–2.5)	6	Powerlifting (2.7–7.9–0.6)
	Basketball (2.1–4.5–3.5)	7	Heavyweight rowing (2.0–5.2–3.0)
	Gymnastics (1.9–6.1–2.5)	8	Rugby Union (2.7–6.0–2.0)
	Hockey (2.4–5.4–2.6)	9	Distance running (1.8–4.4–3.7)
	Hurdles (1.8–4.1–3.9)	10	Squash (2.5–5.2–2.8)

Figure 7 Somatochart showing the somatoplots for Australian female athletes. The mean values are shown after each sport. (Data from Withers, et al., 1987).
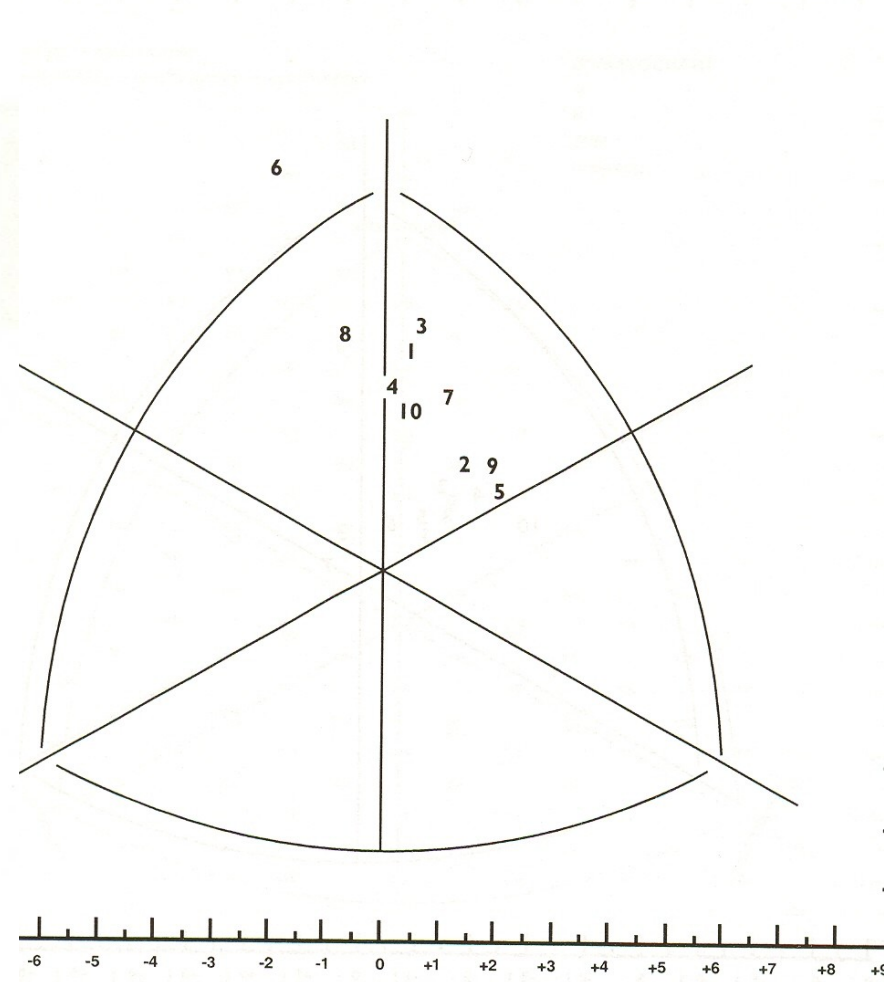
Figure 8 Somatochart showing the somatoplots for Australian male athletes. The mean values are shown after each sport. (Data mainly from Withers, et al., 1986).