


**Universidade de São Paulo**  
 Faculdade de Saúde Pública  
 Departamento de Nutrição – HNT0210 Avaliação Nutricional

# Composição Corporal II

HNT0210 Avaliação Nutricional

Roteiro da aula Composição corporal II HNT0210 Avaliação Nutricional

- Conceitos e modelos da composição corporal;
- A relação entre os métodos de referência e as frações dos modelos da composição corporal;
- Revisão de alguns métodos para estimar a composição corporal;
- O uso de propriedades ou componentes para expressar os valores da composição corporal na avaliação do estado nutricional.

Avaliação nutricional e ciclos de vida Composição corporal II HNT0210 Avaliação Nutricional

Ciclo de vida	Fenômeno fisiológico	Medida antropométrica
CRIANÇA	Crescimento	Altura
ADOLESCENTE ADULTO	Ganho de gordura	Gordura corporal
IDOSO	Desmineralização óssea Sarcopenia	Gordura corporal

Por que devemos estudar magreza ou obesidades nas populações? Composição corporal II HNT0210 Avaliação Nutricional

**Porque são doenças!**  
 (Obesidade: CID-10 capítulo IV E65, E66, E67)  
 (Baixo peso: CID-10 capítulo XVI P05 – P08)  
 [gestação e baixo peso ao nascer]

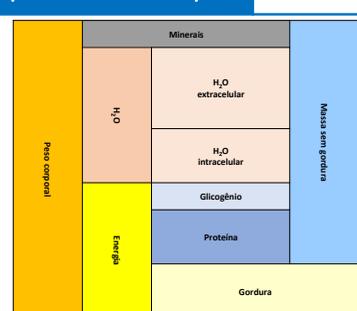
Porque aumentam o risco de outras doenças crônicas na população!

Porque aumentam o risco de mortalidade em vários grupos etários!

**As perguntas da composição corporal**

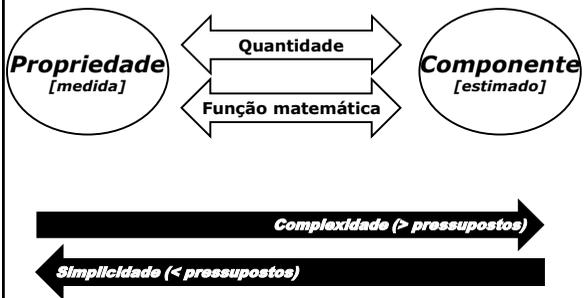
<b>Como descrever a composição corporal?</b>	<b>Qual o ponto de partida?</b>
<b>Como se determina a quantidade de frações do corpo humano?</b>	<b>Como se determinam os tipos de elementos que caracterizam cada fração do corpo humano?</b>

Principais componentes da massa corporal Composição corporal II HNT0210 Avaliação Nutricional



Os principais componentes do peso corporal  
 As proporções médias de água (0,725), proteínas (0,195) e minerais (0,08); glicogênio varia de 0,01 a 0,02. A água intracelular varia de 50 a 55%, a parte restante está no espaço extracelular.

Extraído: WHO. Physical Status... 1995



## Os métodos de referência

Aula I

## Os métodos usuais

### Os métodos usuais

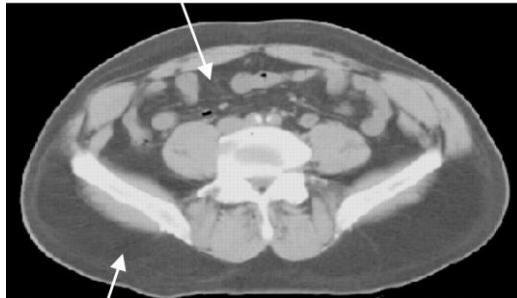
*Mais usados na clínica ou trabalhos de campo:*

- 1) mais práticos, ágeis e baratos;
- 2) requerem o uso de constantes, fórmulas e demandam validação;
- 3) a relação com a gordura corporal

*Boa parte dos métodos de composição corporal está voltada para a descrição da quantidade total e da distribuição da gordura corporal*

Corte transversal de abdômen, no qual as gorduras subcutânea e visceral podem ser distinguidas.

Gordura visceral



Gordura subcutânea

International Journal of  
Epidemiology

Snijder M et al. Int. J. Epidemiol. 2006;35:83-92

**Capacidade de diferentes métodos para estimar a gordura corporal total e a distribuição da gordura corporal**

Método	Capacidade de medir gordura corporal total	Capacidade de medir distribuição da gordura	Aplicação em grandes estudos populacionais
Tomografia computadorizada	Moderada	Muito alta	Baixa
Imagem por ressonância magnética	Alta	Muito alta	Baixa
DXA	Muito alta	Alta	Moderada
Densitometria	Muito alta	Muito baixa	Baixa
Técnicas de diluição	Alta	Muito baixa	Moderada
BIA	Moderada	Muito baixa	Alta
<b>Antropometria</b>			
IMC	Moderada	Muito baixa	Muito alta
CC, CQ, RCQ, SAD	Baixa	Alta	Muito alta
Dobras cutâneas	Moderada	Moderada	Alta

DXA, dual energy X-ray absorptiometry; BIA, bioelectrical impedance analysis; IMC, índice massa corporal; CC, circunferência cintura; CQ, circunferência quadril; RCQ, razão cintura quadril; SAD, âbdomo sagital abdominal.

Snijder M et al. Int. J. Epidemiol. 2006;35:93-92

# BIA Bioimpedance Analysis

## BIA

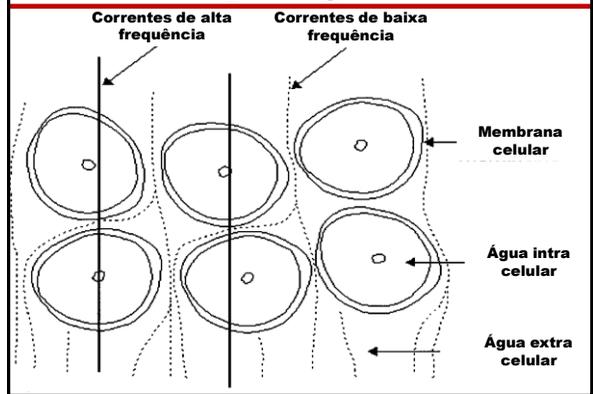
**O que são?**

*Medida da oposição à passagem de corrente elétrica pelo corpo do indivíduo.*

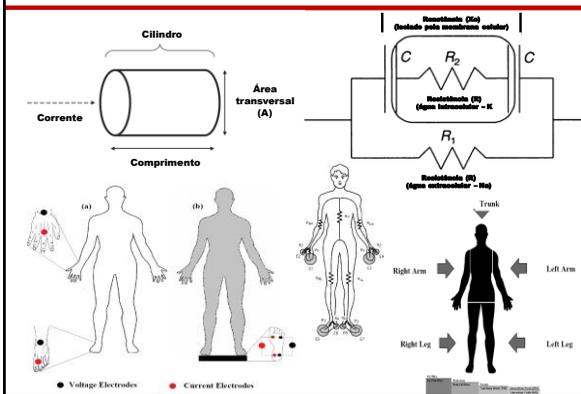
**As premissas do método:**

- ✓ O corpo humano é modelado como um cilindro perfeito com áreas transversais e comprimento uniformes;
- ✓ Assumindo que o corpo é um cilindro perfeito, a impedância ( $Z$ ) à corrente é diretamente relacionada ao tamanho do condutor (altura) e inversamente relacionada à sua área.

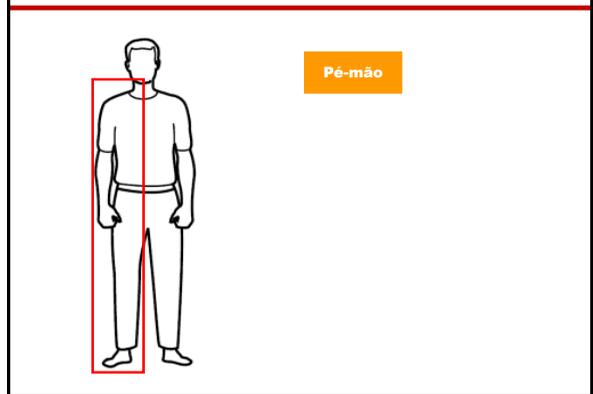
## BIA - passagem da corrente

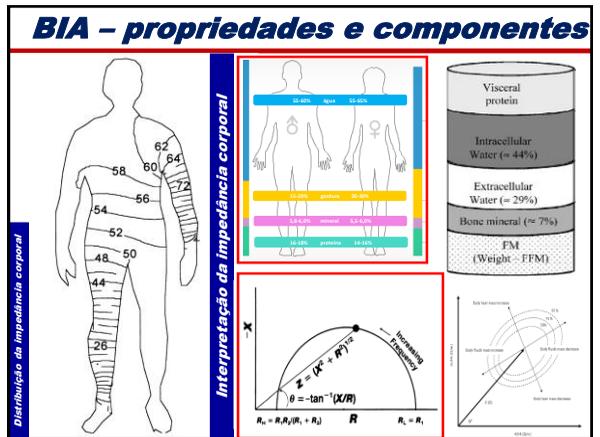
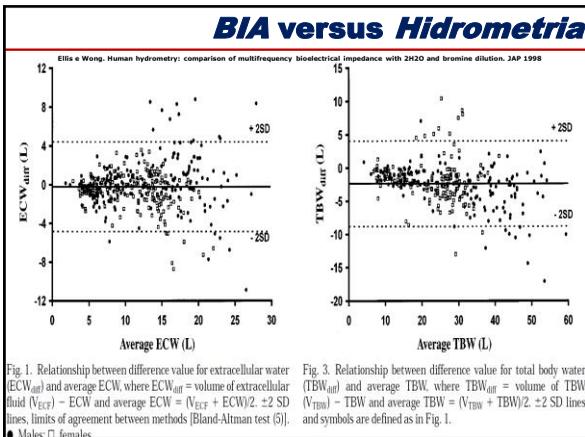
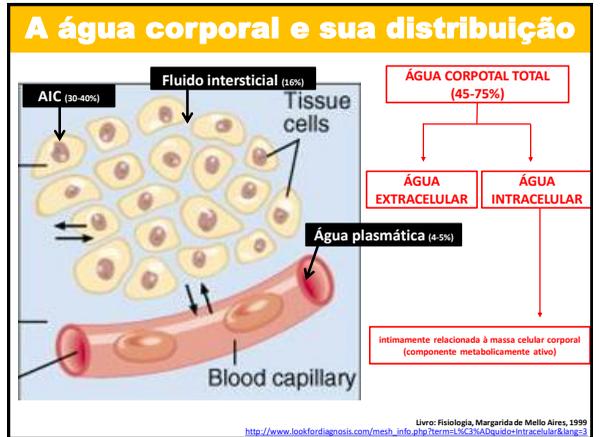
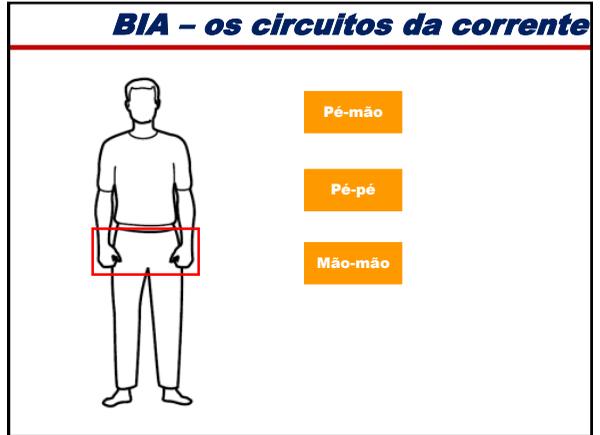
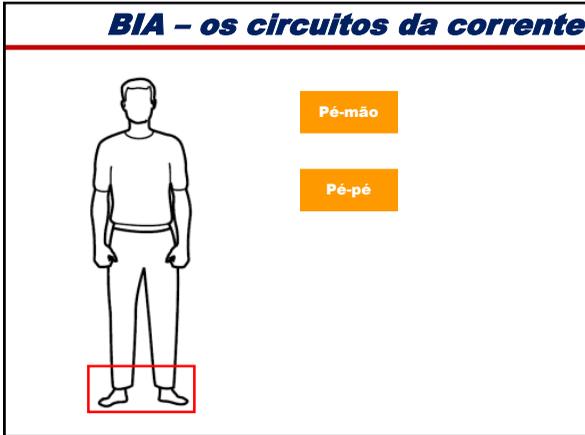


## BIA - os circuitos da corrente



## BIA - os circuitos da corrente





## BIA - a composição corporal

Body composition compartments

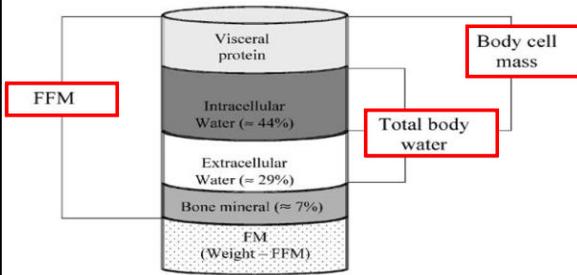


Figure 6 Schematic diagram of fat-free mass (FFM), total body water (TBW), intracellular water (ICW), extracellular water (ECW) and body cell mass (BCM).

## BIA - medidas

### Medidas baseadas nas propriedades:

$$\text{Resistência (R)} = R_p / 1 + (2\pi f C_p R_p)^2 - \text{expresso em } \Omega$$

$$\text{Reactância (Xc)} = -2\pi f C_p R_p^2 / 1 + (2\pi f C_p R_p)^2 - \text{expresso em } \Omega$$

$$\text{Impedância (Z)} = \sqrt{R^2 + Xc^2} - \text{expresso em } \Omega$$

$$\text{Volume (V)} = A^2 / Z - \text{expresso em cm}^3$$

$$\text{Ângulo de fase (\theta)} = \arctan(Xc/R) * (180/3.1416) - \text{expresso em graus.}$$

## OS MODELOS DA BIA

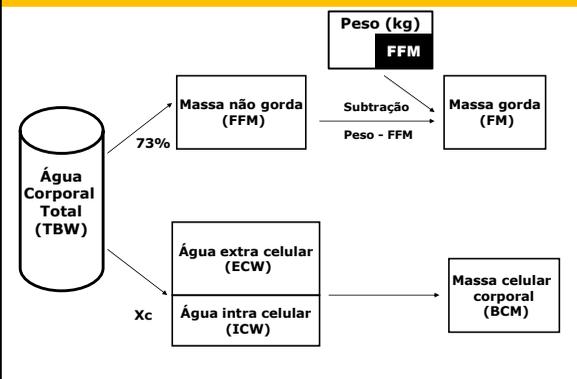
### 1) Componentes

### 2) Propriedades

## OS MODELOS DA BIA

### 1) Componentes

## BIA BASEADA EM COMPONENTES



## Composição corporal segundo componentes da massa corporal

Age Range	Number and Sex	Prediction Equation	SEE
<i>Single-frequency (50 MHz) BIA equations for TBW</i>			
4-7 days	17	$235.8 (Wt \cdot H^2/R) + 567$	0.76 l
<3 yr	65	$0.67 (H^2/R) + 0.48$	0.26 l
5-18 yr	14F, 12M	$0.60 (H^2/R) - 0.50$	1.69 l
35-65 yr	67F, 72M	$0.24 (H^2/R) + 0.172(Wt) + 0.165(Ht) + 0.039 (Ht \cdot Wt) - 17.577$	3.47 l
19-45 yr	20F, 30M	$0.556 (H^2/R) + 0.606(Wt) + 1.72$	1.75 l
19-42 yr	37M	$0.63 (H^2/R) + 2.93$	2.63 l
20-73 yr	28F, 35M	$0.72 (H^2/R) + 2.65 (sex) + 0.142(Wt) - 0.009(age)$	1.61 l
19-51 yr	20F, 38M	$0.484 (H^2/R) + 0.1444(Wt) + 1.3565 + 0.1002(Xc) - 0.057(age)$	1.53 l
<i>Single-frequency (50 MHz) BIA equations for FFM</i>			
10-14 yr	41F, 53M	$0.80 (H^2/R) + 4.43$	2.60 kg
7-15 yr	166	$0.400 (H^2/R) + 0.20(Wt) + 5.58(Ht) + 0.55 (sex) - 0.48$	1.68 kg
7-25 yr	140M	$0.169 (H^2/R) + 0.849(Wt) + 0.475AC - 0.114(LC) - 0.376(MX) - 2.932$	2.31 kg
7-25 yr	110F	$0.182 (H^2/R) + 0.882(Wt) + 0.182(LC) - 0.244(TC) - 0.202(SX) + 4.358$	2.25 kg
17-50 yr	41F, 34M	$0.303 (H^2/R) + 0.214(Ht) + 0.120(Wt)$	3.06 kg
17-52 yr	408F, 1060M	$0.0013(Ht)^2 - 0.044R + 0.366(Wt) - 0.168(age) + 22.968$	2.43 kg (F)
18-50 yr	67F, 84M	$0.759 (H^2/R) + 0.11(Wt) + 0.107(Xc)$	2.96 kg
16-83 yr	661	$0.34 (H^2/R) + 15.34(Ht) + 0.272(Wt) + 4.556(sex) - 0.127(age) - 12.44$	2.65 kg
65-83 yr	37F, 35M	$0.36 (H^2/R) + 0.283(Wt) + 4.56(sex) - 0.20(TC) + 7.0$	2.50 kg
65-94 yr	60F, 35M	$0.25 (H^2/R) + 0.27(Wt) + 4.56(sex) + 0.017(TC) - 1.732$	2.47 kg
<i>Dual-frequency BIA equations for TBW and ECW</i>			
19-64 yr	39M	$TBW = 0.455 (H^2/R_{50}) + 0.14(Wt) + 2.43$	2.64 kg
19-65 yr	20F, 40M	$ECW = 0.284 (H^2/R_{50}) + 0.132(Wt) - 0.115$	1.94 kg
19-52 yr	27F, 35M	$TBW = 0.267 (H^2/R_{50}) + 0.147(Wt) - 0.927(sex) + 14.017$	3.58 kg
		$ECW = 0.600 (H^2/R_{50}) + 0.020(Wt) - 1.306(sex) - 5.178$	1.06 kg
		$TBW = 0.483 (H^2/Z_{50}) + 8.4$	2.77 kg
		$ECW = 0.229 (H^2/Z_{50}) + 4.5$	1.18 kg

BIA: bioelectrical impedance analysis; TBW: total body water; ECW: extracellular water; FFM: fat-free mass; Ht: height; Wt: weight; R: resistance; Z: impedance; Xc: reactance; SEE: standard error of estimate.

O resultado das fórmulas é parecido? Tanto faz usar uma ou outra?

### Predição de componentes a partir da propriedade (BIA)

#### Massa magra (fat free mass)

Table 1 Bioelectrical impedance analysis equation reported in the literature since 1990 for fat-free mass (FFM) classified according to subject category (adult, elderly, overweight) and standard error of the estimate (SEE).

Population	Source	n	Criterion measure	Equation	r <sup>2</sup>	SEE*	BIA instrument
Adults							
Healthy subjects, 18-34 yr	Kyle et al. <sup>14</sup>	343	DXA	$-4.10 + 0.51 \text{ height}^2 / R_{50} + 0.23 \text{ weight}$	0.97	1.8	Xitron
Healthy subjects, 18-29 yr	Lohman <sup>20</sup>	153	Densitometry <sup>20</sup>	$0.11 \text{ height}^2 + 0.29 \text{ weight}$	NR	2.1	Valhalla
Healthy subjects, 30-49 yr	Lohman <sup>20</sup>	122	Densitometry <sup>20</sup>	$-0.29 \text{ weight}$	NR	2.5	Valhalla
Healthy, ethnic diverse	Kotler et al. <sup>18</sup>	126	DXA	$\text{Women} = 11.59 + 0.493 \text{ height}^2 / R_{50} + 0.141 \text{ weight}$	0.71	6.56	R.A.-101
Healthy subjects, >14 yr	Deurenberg et al. <sup>16</sup>	661	Multi-C <sup>17</sup>	$\text{Women} = -0.07 + 0.88 \text{ height}^2 / Z_{50}^2 + (1.0/22.2) + 0.081 \text{ weight}$	0.93	2.6	R.A.-101
Healthy subjects, 18-60 yr	Boutier et al. <sup>22</sup>	202	Densitometry	$-12.44 + 0.34 \text{ height}^2 / R_{50} + 0.1534 \text{ height} + 0.275 \text{ sex (men} = 1, \text{ women} = 2)$	0.92	2.6	IMP B-1
Healthy subjects, 18-29 yr	Stolarczyk et al. <sup>19</sup>	95	Multi-C <sup>17</sup>	$6.37 + 0.64 \text{ weight} + 0.40 \text{ height}^2 / Z_{50}^2$	0.75	2.6	Valhalla
Healthy subjects, 30-70 yr	Lohman <sup>20</sup>	73	Densitometry <sup>20</sup>	$-0.1555 \text{ weight} + 0.1417 \text{ height} - 0.0383 \text{ age}$	NR	2.8	Valhalla
Healthy subjects, 18-29 yr	Lohman <sup>20</sup>	153	Densitometry <sup>20</sup>	$\text{Women} = 6.34 + 0.474 \text{ height}^2 / R_{50} + 0.180 \text{ weight}$	NR	2.8	Valhalla
Healthy subjects, 18-29 yr	Sun et al. <sup>10</sup>	1095	Multi-C	$\text{Men} = 5.22 + 0.485 \text{ height}^2 / R_{50} + 0.338 \text{ weight}$	NR	2.9	Valhalla
Healthy subjects, 18-29 yr	Sun et al. <sup>10</sup>	1095	Multi-C	$\text{Women} = -5.29 + 0.696 \text{ height}^2 / R_{50} + 0.188 \text{ weight}$	0.83	2.9*	Valhalla
Healthy, ethnic diverse	Kotler et al. <sup>18</sup>	206	DXA	$\text{Men} = -0.49 + 0.30 \text{ height}^2 / R_{50} + 0.121 \text{ weight}$	0.92	5.45	R.A.-101

BIA equations are shown in order of increasing standard error of the estimate (SEE). They are limited to studies in healthy subjects that include at least 40 subjects and are validated against a criterion measure.

\*SEE, root mean square error; R, resistance; H<sup>2</sup>/R, height<sup>2</sup>/resistance; K<sub>c</sub>, reactance; V, body volume; Z, impedance; Z<sub>50</sub>, impedance at 5 kHz; Z<sub>100</sub>, impedance at 100 kHz; 1 for men, 0 for women, unless otherwise stated; NR, not reported; height in cm, weight in kg, thigh circumference in cm, resistance in ohm, reactance in ohm; R.A. Systems, Inc, Clinton Twp, NJ; Xitron Technologies, San Diego, CA; Valhalla Scientific, San Diego, CA; BA-2000-M, Data Input, Hofheim, Germany; IMP B-1, 12 tubular electrodes; 1 Population, Cam, France; all subjects are Caucasian, except Jakkio (Caucasian and African-American), Stolarczyk et al. (Hispanic American), and Sun (Caucasian and African-American).

<sup>14</sup>DFB (4.95/body density) - 4.51/100.

<sup>16</sup>DFB (4.95/body density) - 4.51/100.

<sup>18</sup>DFB (4.95/body density) - 4.51/100.

<sup>19</sup>DFB (4.95/body density) - 4.51/100.

<sup>20</sup>DFB (4.95/body density) - 4.51/100.

### Predição de componentes a partir da propriedade (BIA)

#### Água corporal total (total body water)

Table 3 Bioelectrical impedance analysis equation reported in the literature since 1990 for total body water (TBW), classified according to standard error of the estimate (SEE).

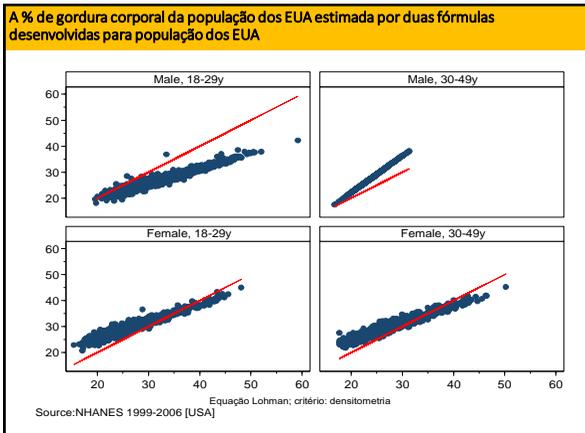
Comments	Source	n	Criterion measure	Equation	r <sup>2</sup>	SEE	BIA instrument
Healthy subjects	Deurenberg et al. <sup>16</sup>	139	<sup>3</sup> H <sub>2</sub> O	$6.69 + 0.3457 \text{ height}^2 / R_{50} + 0.1704 \text{ weight}$	0.95	1.73	Human-IM scanner
Healthy subjects	Deurenberg et al. <sup>16</sup>	139	<sup>3</sup> H <sub>2</sub> O	$-0.11 \text{ age} + 2.83 \text{ sex}$	0.95	1.74	SEAC
Healthy subjects, 18-40 yr	Corbiel et al. <sup>23</sup>	60	<sup>3</sup> H <sub>2</sub> O	$5.8 - 0.059 \text{ height}^2 / R_{50} + 0.180 \text{ weight}$	0.85	3.47	R.A.-103
Healthy subjects, 18-40 yr	Corbiel et al. <sup>23</sup>	139	Multi-C <sup>17</sup>	$17.58 + 0.240 \text{ height}^2 / R_{50} + 0.175 \text{ weight}$	0.85	3.47	R.A.-103
Healthy subjects, 18-40 yr	Corbiel et al. <sup>23</sup>	139	<sup>3</sup> H <sub>2</sub> O	$-0.040 \text{ sex weight} + 0.180 \text{ height}$	0.85	3.47	R.A.-103
Healthy subjects, ethnic diverse	Kotler et al. <sup>18</sup>	206	TBK, TBK	$\text{Men} = (-1.346 + 0.58 \text{ height}^2 / R_{50}^2) / Z_{50}^2 + 1.0/1.35$	0.83	7.80	R.A.-101
Healthy subjects, ethnic diverse	Kotler et al. <sup>18</sup>	126	<sup>3</sup> H <sub>2</sub> O	$\text{Men} = -0.86 + 0.376 \text{ height}^2 / R_{50} + 0.10/18.91$	0.67	8.20	R.A.-101
Healthy subjects, 18-60 yr	Kushner and Schoeller <sup>24</sup>	40	<sup>3</sup> H <sub>2</sub> O	$\text{Men} = 8.39 + 0.39 \text{ height}^2 / R_{50} + 0.143 \text{ weight}$	0.96	11.66	R.A.-101
Healthy subjects, 17-66 yr	Kushner and Schoeller <sup>24</sup>	40	<sup>3</sup> H <sub>2</sub> O	$\text{Women} = 8.315 + 0.382 \text{ height}^2 / R_{50} + 0.105 \text{ weight}$	0.95	F 0.89	R.A.-101
Healthy subjects, 17-66 yr	Sun et al. <sup>10</sup>	714	Multi-C	$17.26 + 0.5504 \text{ height}^2 / R_{50} + 0.0905 \text{ weight}$	0.97	1.75	R.A.-101
Healthy subjects, 17-66 yr	Sun et al. <sup>10</sup>	714	Multi-C	$\text{Men} = 1.203 + 0.449 \text{ height}^2 / R_{50} + 0.176 \text{ weight}$	0.94	1.87	R.A.-101
Elderly subjects	Weihe et al. <sup>25</sup>	58	<sup>3</sup> H <sub>2</sub> O	$\text{Women} = 1.747 + 0.490 \text{ height}^2 / R_{50} + 0.113 \text{ weight}$	0.79	2.4*	Analysator3
Elderly subjects	Weihe et al. <sup>25</sup>	58	<sup>3</sup> H <sub>2</sub> O	$3.024 + 0.558 \text{ height}^2 / R_{50} + 0.149 \text{ weight} + 2.924 \text{ sex}$	0.97	1.3	Analysator3
Healthy subjects, 18-60 yr	Van Loan and Schoeller <sup>26</sup>	60	<sup>3</sup> H <sub>2</sub> O	$2.896 + 0.584 \text{ height}^2 / R_{50} + 0.137 \text{ weight} + 2.485 \text{ sex}$	0.97	1.3	Xitron
Healthy subjects, 18-60 yr	Van Loan and Schoeller <sup>26</sup>	60	<sup>3</sup> H <sub>2</sub> O	$14.017 + 0.2973 \text{ height}^2 / R_{50} + 0.1479 \text{ weight}$	0.86	3.58	Xitron
Elderly, 63-87 yr	Visser et al. <sup>15</sup>	117	<sup>3</sup> H <sub>2</sub> O	$-3.6734 \text{ sex} + 0.102 \text{ height}^2 / R_{50} + 0.1632 \text{ weight}$	0.66	3.1	Xitron
Healthy non-obese and obese subjects	Cox-Retjens and Sauter <sup>27</sup>	90	<sup>3</sup> H <sub>2</sub> O	$\text{Women} = 11.9 + 0.2715 \text{ height}^2 / Z_{50} + 0.1087 \text{ weight}$	0.41	2.7	Xitron
Obese women	De Lorenzo et al. <sup>28</sup>	55	<sup>3</sup> H <sub>2</sub> O	$23.198 + 0.1914 \text{ height}^2 / R_{50} + 0.3315 \text{ height}^2 / Z_{50}^2$	0.94	2.8	Xitron

BIA equations are shown in order of increasing standard error of the estimate (SEE). They are limited to studies in healthy subjects that include at least 40 subjects and are validated against a criterion measure.

TBK, total body potassium; <sup>3</sup>H<sub>2</sub>O, deuterium oxide.

R.A. Systems, Inc, Clinton Twp, NJ; Xitron Technologies, San Diego, CA; Human-IM Scanner, Dietostopien, Milan, Italy; Analysator3, Spermig, France; SEAC, Brisbane, Australia.

\*SEE, root mean square error; R, resistance; H<sup>2</sup>/R, height<sup>2</sup>/resistance; K<sub>c</sub>, reactance; V, body volume; Z, impedance; APT, maximum thickness long full length of sternum, measured with calipers; R<sub>50</sub>, R<sub>100</sub>, R<sub>150</sub>, R<sub>200</sub>, R<sub>250</sub>, R<sub>300</sub>, R<sub>350</sub>, R<sub>400</sub>, R<sub>450</sub>, R<sub>500</sub>, R<sub>550</sub>, R<sub>600</sub>, R<sub>650</sub>, R<sub>700</sub>, R<sub>750</sub>, R<sub>800</sub>, R<sub>850</sub>, R<sub>900</sub>, R<sub>950</sub>, R<sub>1000</sub>, R<sub>1050</sub>, R<sub>1100</sub>, R<sub>1150</sub>, R<sub>1200</sub>, R<sub>1250</sub>, R<sub>1300</sub>, R<sub>1350</sub>, R<sub>1400</sub>, R<sub>1450</sub>, R<sub>1500</sub>, R<sub>1550</sub>, R<sub>1600</sub>, R<sub>1650</sub>, R<sub>1700</sub>, R<sub>1750</sub>, R<sub>1800</sub>, R<sub>1850</sub>, R<sub>1900</sub>, R<sub>1950</sub>, R<sub>2000</sub>, R<sub>2050</sub>, R<sub>2100</sub>, R<sub>2150</sub>, R<sub>2200</sub>, 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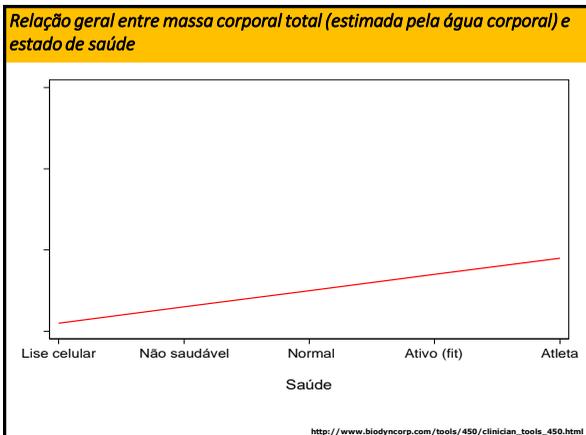
**Uma alternativa:  
componentes básicos comparados a  
distribuições de referência**

**A avaliação da composição corporal baseada em componentes**  
-EUA valores de referência: Água Corporal Total (TBW) -

Idade	Branco				Negro				Hispanico			
	Hm	Hdp	Mm	Mdp	Hm	Hdp	Mm	Mdp	Hm	Hdp	Mm	Mdp
12 - 13	31,3	6,3	28,5	4,2	30,7	7,0	29,3	4,1	30,2	6,2	27,9	4,2
14 - 15	40,6	7,0	29,9	3,7	38,9	6,7	30,9	5,3	37,2	6,9	28,1	3,7
16 - 17	43,1	6,2	30,7	4,0	41,2	6,6	31,0	4,2	39,6	5,5	30,2	4,5
18 - 19	43,2	5,8	31,9	4,2	44,1	7,5	31,4	5,5	41,5	5,9	28,9	3,7
20 - 29	45,5	6,9	31,8	4,5	46,1	8,0	32,8	4,9	41,6	6,1	30,5	4,3
30 - 39	47,2	7,6	33,5	5,1	46,5	7,7	34,4	5,8	43,4	6,5	32,2	4,8
40 - 49	48,0	7,8	33,3	5,2	46,1	7,5	35,8	6,0	44,7	6,6	32,6	4,3
50 - 59	47,9	6,5	33,8	5,1	45,9	8,5	35,2	5,8	45,0	7,1	32,1	4,4
60 - 69	46,2	6,6	32,5	4,8	44,7	7,7	34,0	5,6	42,6	5,9	31,6	4,6
70 - 79	44,0	6,4	31,6	4,9	43,2	7,4	33,4	5,3	39,9	6,3	30,1	4,4

Chumlea et al. Body composition estimates from NHANES III bioelectrical impedance data. IJO 2002

H: Homem  
M: Mulher



# OS MODELOS DA BIA

## 2) Propriedades

**BIA BASEADA EM PROPRIEDADES**  
- funções trigonométricas -

Funções oscilatórias

Funções periódicas, com uso em cardiologia, radioterapia, fisiologia, genética, epidemiologia.

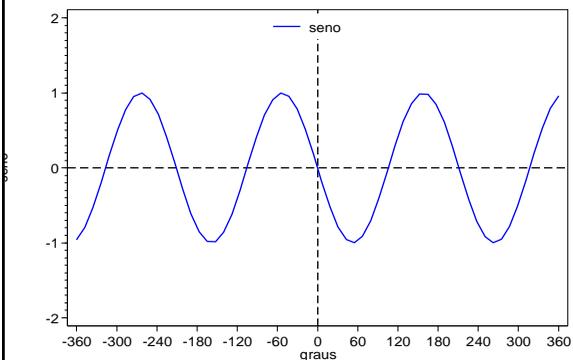
**Seno = perpendicular / radio**

**Coseno = projeção / radio**

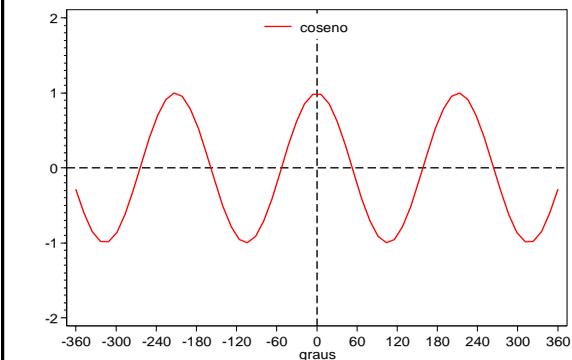
**Seno e coseno** são as oscilações mais elementares e simples que podem surgir da solução de equações diferenciais

**Teorema Pitágoras**  
projeção<sup>2</sup> + perpendicular<sup>2</sup> = radio<sup>2</sup>

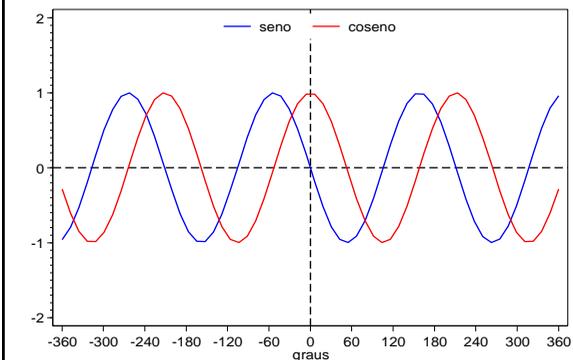
### Funções trigonométricas



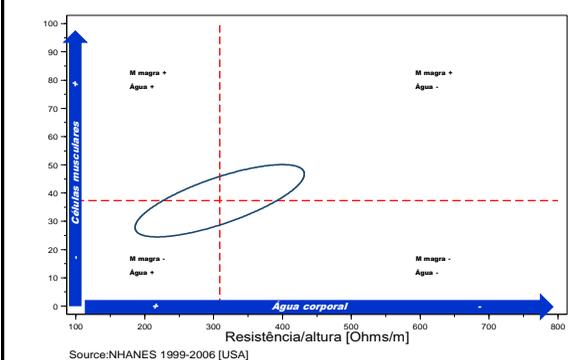
### Funções trigonométricas



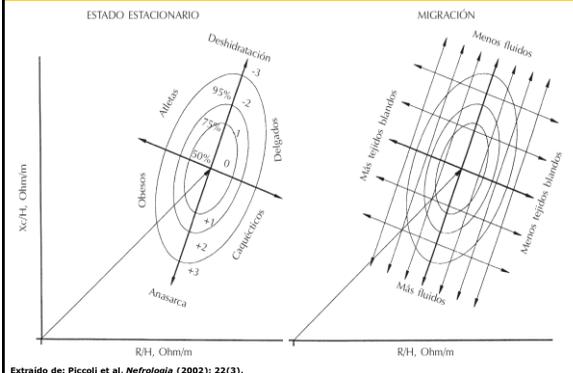
### Funções trigonométricas



### Composição corporal segundo vetores bioelétricos (BIVA)

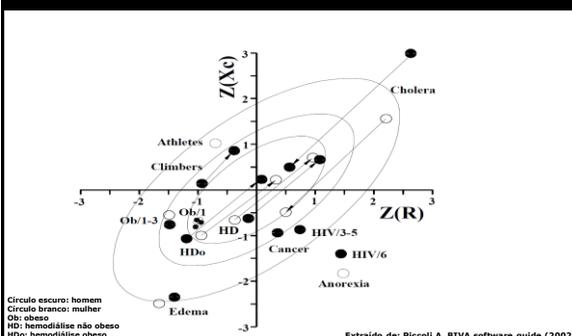


### Composição corporal segundo vetores bioelétricos (BIVA)



### BIVA interpretação dos pontos e deslocamentos do vetor

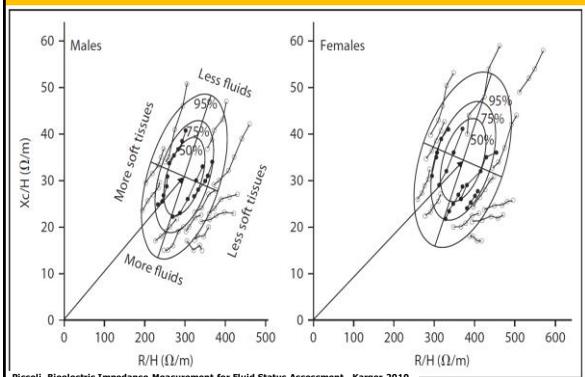
O deslocamento, de avanço ou recuo, do vetor paralelo ao eixo principal da elipse, foi associado com desidratação ou super-hidratação, respectivamente, alcançando extremos fora das elipses. Vetores acima ou abaixo do eixo principal [metade superior esquerda e inferior direita das elipses] foram associados com mais ou menos massa celular nos tecidos musculares, respectivamente, com extremos no eixo secundário.



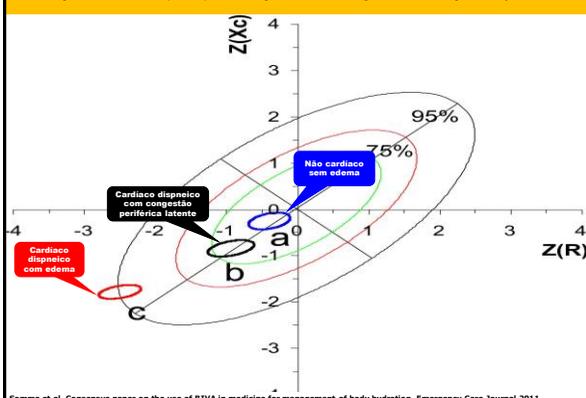
Círculo escuro: homem  
Círculo branco: mulher  
Ob: obeso  
HD: hemodíalise não obeso  
HDv: hemodíalise obeso

Extraído de: Piccoli A. BIVA software guide (2002)

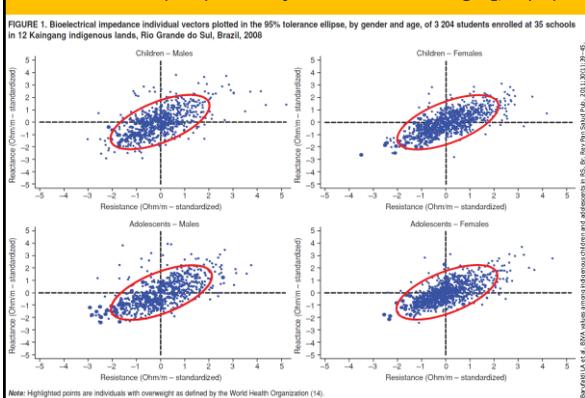
### Mudança nos vetores (BIVA) em pacientes submetidos à hemodiálise



### Mudança nos vetores (BIVA) em função da mudança da hidratação corporal

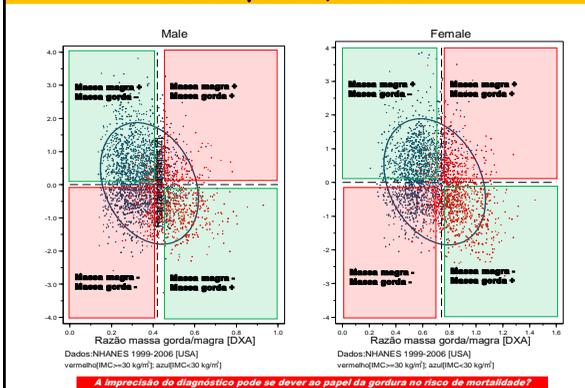


### Valores dos vetores (BIVA) em crianças e adolescentes Kaingang, RS(BR)



**Uso de valores BIA e BIVA**

### Obesidade de homens e mulheres com 20 anos ou mais descrita por DXA, BIA e IMC



### A avaliação da composição corporal baseada em propriedades - EUA valores de referência. Índice impedância (A²/Z²) -

Idade	Branco				Negro				Hispanico			
	Hm	Hdp	Mm	Mdp	Hm	Hdp	Mm	Mdp	Hm	Hdp	Mm	Mdp
12 - 13	46,8	9,9	41,9	6,6	45,2	10,2	43,1	6,3	44,0	9,3	40,5	6,5
14 - 15	60,9	8,8	43,6	6,3	58,8	10,0	44,8	8,3	55,9	9,8	40,0	5,9
16 - 17	65,4	9,4	44,6	6,3	62,3	9,9	44,6	6,3	58,9	8,2	43,1	6,8
18 - 19	64,7	8,1	46,6	6,2	66,2	11,0	44,9	8,2	61,2	8,6	41,0	5,5
20 - 29	67,7	9,9	46,4	7,1	67,5	11,3	47,0	7,5	61,0	9,1	43,1	6,6
30 - 39	69,5	11,3	48,7	7,7	68,3	11,4	48,9	8,6	63,1	9,9	45,3	7,2
40 - 49	70,4	11,5	48,0	7,9	67,3	11,0	50,7	8,6	64,7	9,8	45,8	6,6
50 - 59	70,1	9,9	48,2	7,6	66,8	12,4	49,6	8,7	65,1	10,7	45,1	7,0
60 - 69	67,0	9,9	46,2	7,6	65,1	11,9	47,8	8,4	61,5	9,1	44,4	7,3
70 - 79	64,3	9,9	45,2	8,0	63,2	11,4	47,4	8,4	57,6	9,6	42,1	7,1

Chumlea et al. Body composition estimates from NHANES III bioelectrical impedance data. IJO 2002

H: Homem  
M: Mulher

### A avaliação da composição corporal baseada em propriedades - Alemanha valores de referência: Vetor impedância -

TABLE 3 Body-Weizpahl et al. Patterns of bioelectrical impedance vector distribution by body mass index and age: implications for body-composition analysis. AJCN 2003

Impedance vector components in 9707 girls and 5898 boys by BMI and age classes<sup>a</sup>

Age	n	Height		R		Xc		HF/R		HF/Xc		r
		m	cm	Ω	Ω	Ω	Ω	cm <sup>2</sup> /Ω	cm <sup>2</sup> /Ω			
<b>Age 6-9 y</b>												
<b>Girls</b>												
BMI <10-13	72	1.20 ± 0.11	44.4 ± 4.4	879.4 ± 94.9	78.4 ± 14.9	16.86 ± 4.61	191.5 ± 52.6	0.77				
BMI >15-17	853	1.19 ± 0.06	829.5 ± 74.5	74.8 ± 32.1	17.44 ± 2.80	197.2 ± 34.9	0.71					
BMI >15-17	1168	1.21 ± 0.08	777.6 ± 71.2	72.0 ± 12.0	19.19 ± 3.60	209.5 ± 40.3	0.65					
BMI >17-25	879	1.30 ± 0.14	714.1 ± 79.8	67.8 ± 9.6	24.72 ± 8.02	259.4 ± 75.6	0.91					
<b>Boys</b>												
BMI <10-13	39	1.19 ± 0.06	858.2 ± 97.2	72.0 ± 12.7	16.85 ± 2.51	204.1 ± 39.7	0.74					
BMI >15-17	860	1.20 ± 0.06	787.8 ± 63.0	69.6 ± 9.4	18.99 ± 2.68	214.4 ± 71.3	0.53					
BMI >15-17	1194	1.22 ± 0.07	734.5 ± 66.7	67.1 ± 9.4	20.62 ± 9.35	225.3 ± 44.5	0.27					
BMI >17-25	670	1.28 ± 0.11	676.8 ± 70.3	64.5 ± 8.8	25.04 ± 6.55	263.1 ± 62.1	0.84					
<b>Age 10-13 y</b>												
<b>Girls</b>												
BMI <11-15	190	1.41 ± 0.07	816.0 ± 78.1	74.4 ± 9.9	24.54 ± 3.57	272.7 ± 55.2	0.74					
BMI >15-20	1113	1.44 ± 0.09	733.4 ± 79.1	69.9 ± 9.8	28.86 ± 5.50	304.5 ± 61.8	0.77					
BMI >20-25	748	1.53 ± 0.11	653.0 ± 71.5	63.8 ± 8.5	36.64 ± 7.92	376.1 ± 80.7	0.84					
BMI >25-30	654	1.59 ± 0.09	586.3 ± 62.8	58.7 ± 7.4	43.92 ± 7.82	430.7 ± 80.4	0.80					
BMI >30-35	203	1.63 ± 0.08	538.9 ± 55.1	53.2 ± 7.8	49.75 ± 7.55	490.2 ± 86.6	0.71					
<b>Boys</b>												
BMI <11-15	186	1.42 ± 0.06	786.2 ± 72.0	72.1 ± 8.9	25.93 ± 3.84	285.1 ± 51.0	0.78					
BMI >15-20	1125	1.44 ± 0.07	701.2 ± 68.0	67.3 ± 8.7	29.91 ± 4.86	313.9 ± 58.0	0.77					
BMI >20-25	484	1.51 ± 0.10	626.0 ± 74.2	62.5 ± 7.9	36.60 ± 8.91	372.2 ± 84.9	0.81					
BMI >25-30	379	1.57 ± 0.10	576.3 ± 62.0	57.9 ± 6.9	43.61 ± 8.74	433.9 ± 82.6	0.84					
BMI >30-35	165	1.63 ± 0.11	527.5 ± 60.8	53.0 ± 6.4	51.27 ± 10.63	508.3 ± 95.0	0.81					
<b>Age 14-17 y</b>												
<b>Girls</b>												
BMI <14-19	157	1.68 ± 0.06	697.8 ± 73.4	68.5 ± 10.3	40.78 ± 5.30	420.9 ± 78.3	0.71					
BMI >19-25	1138	1.67 ± 0.06	624.4 ± 65.9	64.7 ± 8.5	45.40 ± 5.79	441.3 ± 69.8	0.72					
BMI >25-30	1375	1.67 ± 0.06	570.0 ± 57.8	61.3 ± 8.1	48.61 ± 6.15	462.1 ± 73.6	0.71					
BMI >30-35	796	1.67 ± 0.07	541.8 ± 53.9	57.1 ± 7.7	52.10 ± 6.55	489.9 ± 79.5	0.73					
BMI >35-40	271	1.67 ± 0.07	564.5 ± 54.2	53.7 ± 7.7	55.90 ± 7.94	529.9 ± 92.2	0.75					
<b>Boys</b>												
BMI <14-19	34	1.74 ± 0.12	627.4 ± 72.8	62.7 ± 8.1	49.31 ± 9.97	494.1 ± 103.1	0.85					
BMI >19-25	167	1.76 ± 0.09	530.6 ± 62.0	59.1 ± 8.5	59.31 ± 10.01	535.7 ± 100.7	0.73					
BMI >25-30	252	1.75 ± 0.10	513.8 ± 64.7	55.6 ± 6.8	60.52 ± 12.06	558.8 ± 96.1	0.75					
BMI >30-35	249	1.76 ± 0.09	479.4 ± 58.3	52.3 ± 6.9	66.02 ± 11.68	605.0 ± 99.2	0.74					
BMI >35-40	94	1.77 ± 0.09	443.6 ± 59.4	48.9 ± 6.4	72.16 ± 11.28	656.0 ± 107.3	0.55					

<sup>a</sup> BMI is in kg/m<sup>2</sup>; R, resistance; Xc, reactance; H, height; r, correlation coefficient between HF/R and HF/Xc; ANOVA showed significant interactions between age and BMI categories for both vector components (HF/R and HF/Xc).

### Avaliação prospectiva de pacientes pós cirurgia bariátrica

### Composição corporal segundo vetores bioelétricos (BIVA)

Avaliação longitudinal: como é a evolução da composição corporal após cirurgia bariátrica?

Table 1 Anthropometric and body composition data

Groups	Preoperative period	Postoperative period			
		1y	2y	3y	4y
Weight (kg)	135 ± 19.3	87.5 ± 16 <sup>†</sup>	82.9 ± 16.7 <sup>††</sup>	84.8 ± 16.7	86.7 ± 17.6
BMI (kg/m <sup>2</sup> )	51.4 ± 7	33.2 ± 5.3 <sup>†</sup>	31.5 ± 5.7 <sup>††</sup>	32 ± 5.8 <sup>†</sup>	32.6 ± 6.1 <sup>†</sup>
FM (kg)	61.8 ± 6.3	52.9 ± 5	51.7 ± 4.9	52.3 ± 6.5	52 ± 4.9
FM (%)	46.1 ± 2.7	61.9 ± 7.1	63.8 ± 8 <sup>†</sup>	62.7 ± 6.7	61.2 ± 6.8 <sup>††</sup>
FM (kg)	73.1 ± 13.6	47.2 ± 11.6	47.2 ± 12.6 <sup>††</sup>	45.5 ± 11.6	44.7 ± 13.2
FM (%)	53.1 ± 2.7	38.5 ± 7.1	36.2 ± 8 <sup>†</sup>	37.6 ± 6.7 <sup>†</sup>	38.8 ± 6.8 <sup>†</sup>
TBW (l)	44.7 ± 8.8	41.8 ± 6.7 <sup>†</sup>	40.8 ± 6.4 <sup>†</sup>	40.1 ± 6.3 <sup>†</sup>	39.7 ± 5.8 <sup>††</sup>
TBW (%)	33.1 ± 3.8	48.5 ± 6.9 <sup>†</sup>	50.3 ± 8.9 <sup>†</sup>	48.2 ± 7.2 <sup>†</sup>	46.6 ± 6.7 <sup>††</sup>
Phase angle (°)	4.3 ± 1.1	5.2 ± 1.4 <sup>†</sup>	5.1 ± 1.1	4.8 ± 0.8	4.7 ± 0.9 <sup>††</sup>
R (Ohm)	442 ± 90	417.4 ± 52.4	417.9 ± 56.6	404.4 ± 65.4	404.1 ± 57.8
RH (Ohm/m)	277.7 ± 58	270.4 ± 35.8	276.6 ± 37.5	278 ± 43 <sup>†</sup>	286.6 ± 36.8 <sup>††</sup>
Xc (Ohm)	46.2 ± 12.8	39.2 ± 10.8 <sup>†</sup>	39 ± 11.7 <sup>†</sup>	38.5 ± 6.4 <sup>†</sup>	37.3 ± 11.7
Xc/RH (Ohm/m)	30.4 ± 8	24.1 ± 6.4 <sup>†</sup>	24.1 ± 7.4 <sup>†</sup>	23.7 ± 4.9 <sup>†</sup>	23.1 ± 7.5 <sup>†</sup>
R/RH (Ohm/m)	0.77	0.22	0.52	0.09	0.44

BMI, body mass index; FM, fat free mass; FM, fat mass; TBW, total body water; R, resistance; Xc, reactance; H, height

<sup>†</sup> P < 0.05 compared with preoperative period.

<sup>††</sup> P < 0.05 compared with postoperative period of 1 y.

<sup>†††</sup> P < 0.05 compared with postoperative period of 2 y.

### Composição corporal segundo vetores bioelétricos (BIVA)

Avaliação longitudinal: como é a evolução da composição corporal após cirurgia bariátrica?

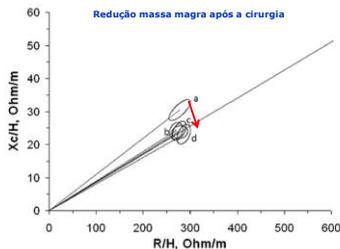
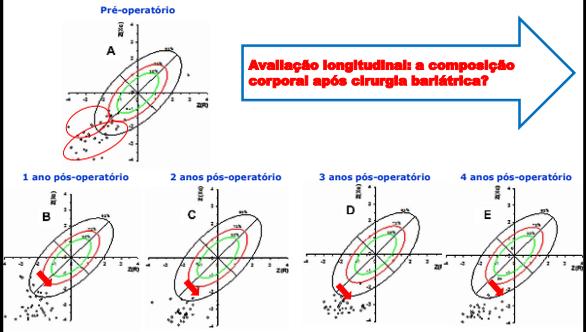
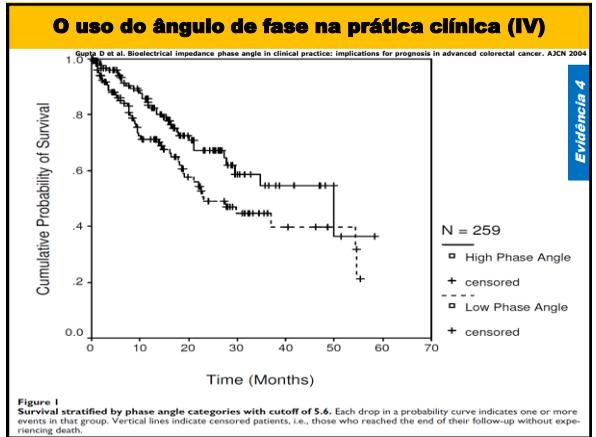
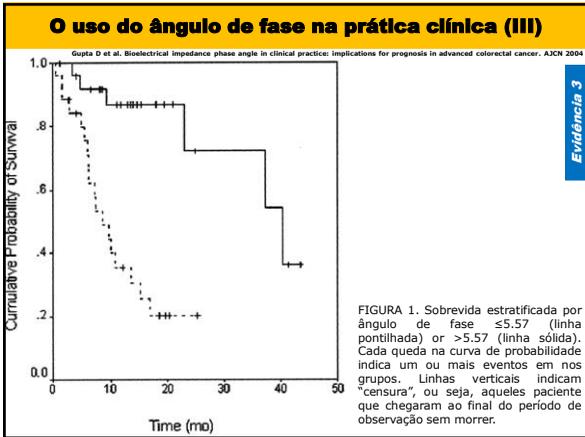
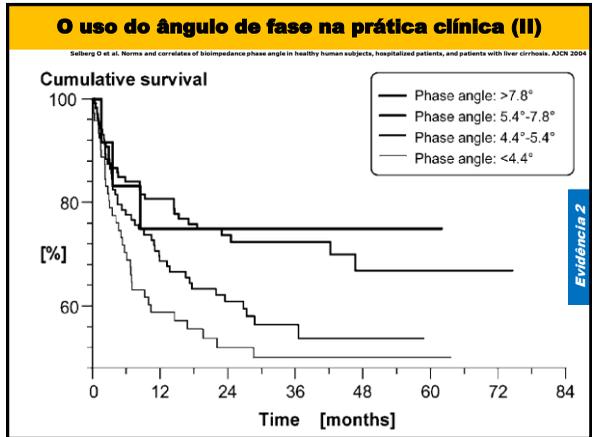
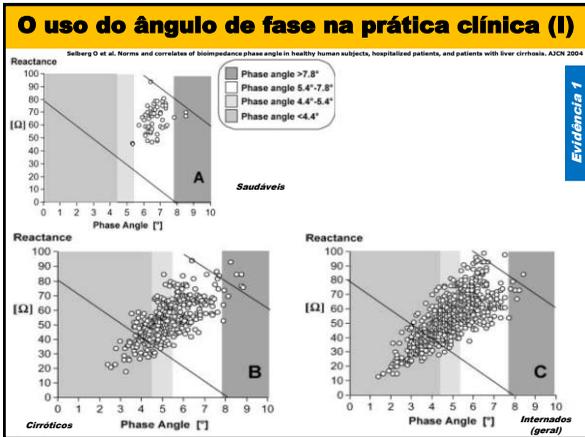
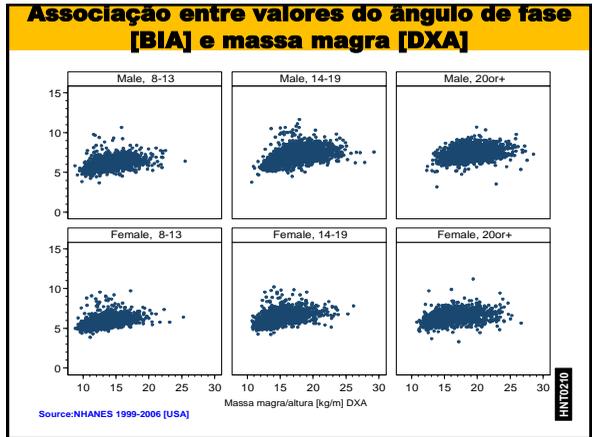
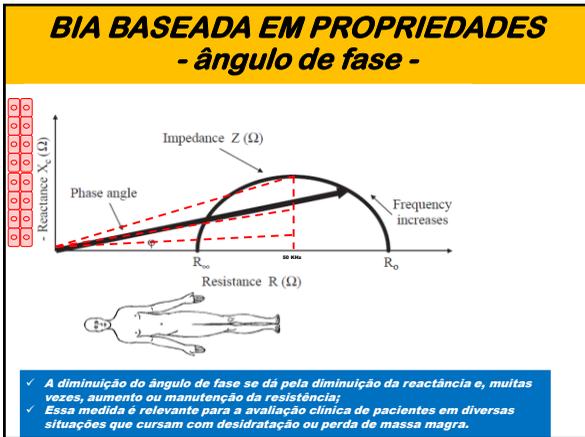


Fig. 2. Mean impedance vector with the 95% confidence ellipse for the patients before and after bariatric surgery: (a) preoperative; (b) 1-y postoperative period; (c) 2-y postoperative period; (d) 3-y postoperative period; (e) 4-y postoperative period. Xc, reactance; R, resistance; H, height.

### Composição corporal segundo vetores bioelétricos (BIVA)

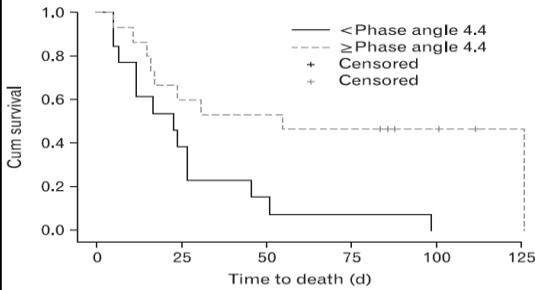


### Ângulo de fase



## O uso do ângulo de fase na prática clínica (V)

Lee SY et al. The Association between Phase Angle of Bioelectrical Impedance Analysis and Survival Time in Advanced Cancer Patients. Korean J Fam Med. 2014;35:251-256



Evidência 5

**Figure 1.** Kaplan-Meier survival analysis by phase angle group (log-rank, 6.208; P-value = 0.013). Phase angle score below 4.4 showed significant shorter survival than phase angle score over 4.4.

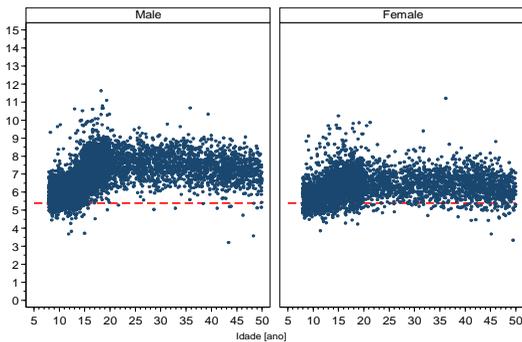
## O uso do ângulo de fase na prática clínica (VI)

Studies on prognostic impact of phase angle [6, 13, 14, 15, 16, and 17]

Study population	N	Cut-off value	BIA device	Clinical outcome of patients below cut-off value
HIV/AIDS				
HIV <sup>6</sup>	75	5.6	101,RJL,Systems	Decreased survival parameter estimate in LR test
HIV	469	5.3	2000-1,Data input	Increased progression of disease
Tumor Disease <sup>6</sup>	63	4.5	101,RJL System	Decreased Survival
Lung Cancer				
Colorectal Cancer <sup>6</sup>	52	5.57	101Q,RJL System	Decreased survival
Pancreatic Cancer <sup>6</sup>	58	5.08	101Q,RJL System	Decreased Survival
Breast Cancer <sup>6</sup>	259	5.6	101Q,RJL System	Decreased Survival
Lung Cancer <sup>5</sup>	165	5.3	101Q,RJL Systems	Decreased Survival

Evidência 6

## O distribuição dos valores do ângulo de fase na população dos EUA.



Source:NHANES 1999-2006 [USA]

**Não usar o mesmo raciocínio clínico em dados populacionais!**

## Exemplo de resultado completo de BIA

```

**** BIOMEDANCE ANALYSIS ****
Date: 11/17/14      Time: 03:13 pm
PATIENT:
Sex: Male           Height: 71.5 in
Age: 29             Weight: 178.0 lbs

MEASUREMENT RESULTS
Phase Angle: 7.4
Body Capacitance: 795 pF
Resistance: 525.7 ohm
Reactance: 69.2 ohm

Mass Distribution
-----
Body Cell Mass: 67.5      37.9%
Extracellular Mass: 68.7  38.6%
Lean Body Mass: 136.2    76.5%
Fat Mass: 41.8          23.5%
Total Weight: 178.0     100.0%

ECM/BCM: 1.02
Body Mass Index: 24.5
Basal Metabolic Rate: 1925 cal/d

Water Compartments
-----
Intracellular Water: 26.0    59.0%
Extracellular Water: 38.1    81.0%
Total Body Water: 44.1      100.0%

TBW/Lean Body Mass: 71.4
TBW/Total Weight: 24.6
    
```

As medidas

Ângulo de fase  
Resistência  
Reactância

As predições

Massa celular  
Massa magra  
Massa gorda  
Água total, extra e intra  
Taxa metabólica basal

## As condições para realizar o exame de BIA

Para fazer o exame de BIA o indivíduo deve:

- 1) Não ter feito atividade física moderada ou intensa nas 4 a 6 horas anteriores;
- 2) Não ingerir café ou álcool 12h antes do exame;
- 3) Não ingerir líquidos com eletrólitos;
- 4) Retirar jóias;
- 5) Não usar maquiagem;
- 6) Não ter realizado grande refeição nas 2h anteriores;

**Verificar as especificações dadas pelo fabricante para a realização do teste**

# ANTROPOMETRIA

## Dobras cutâneas

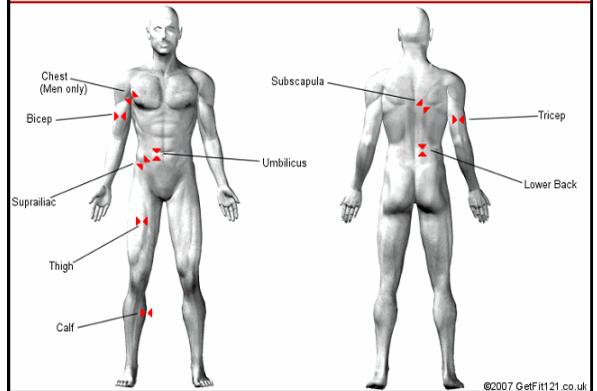
### O que é?

Medida indireta da espessura do tecido adiposo subcutâneo.

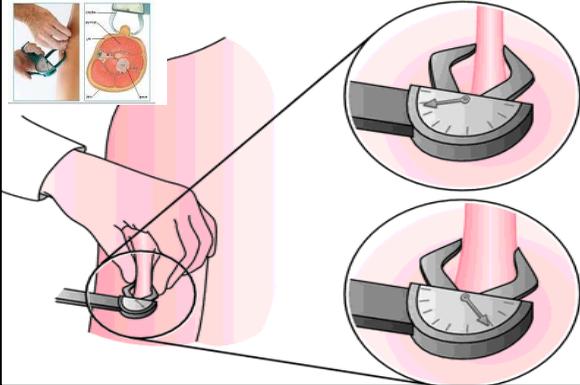
### As premissas do método:

- ✓ A dobra é uma boa medida da gordura subcutânea;
- ✓ A distribuição subcutânea e interna da gordura corporal é semelhante entre indivíduos do mesmo sexo;
- ✓ Como há uma associação entre gordura subcutânea e gordura total, a soma dos valores das dobras pode estimar a gordura corporal total;
- ✓ Há relação entre somatório de dobras cutâneas e densidade corporal;
- ✓ Idade é um preditor independente da densidade corporal em homens e mulheres.

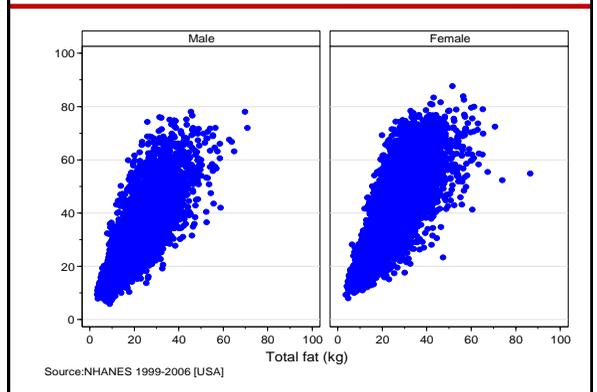
## Dobras cutâneas e gordura corporal



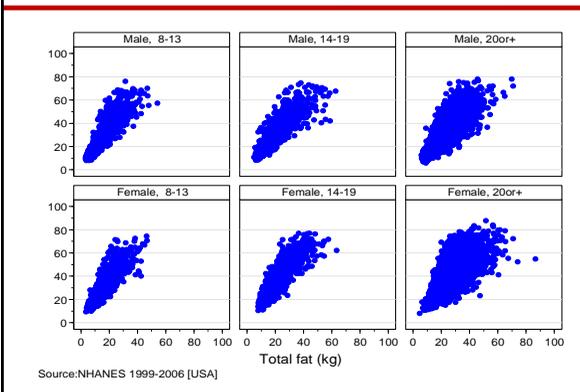
## Dobras cutâneas e gordura corporal



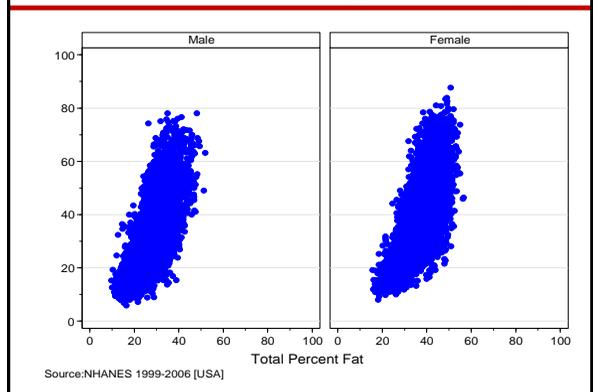
## Dobras cutâneas e gordura corporal



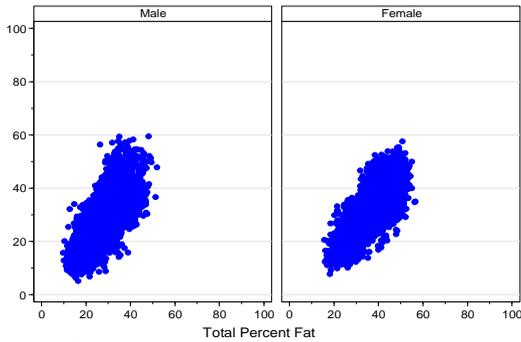
## Dobras cutâneas e gordura corporal



## Dobras cutâneas e gordura corporal



## Dobras cutâneas e gordura corporal



## As equações de predição da gordura corporal total a partir das dobras cutâneas apresentam resultados similares?

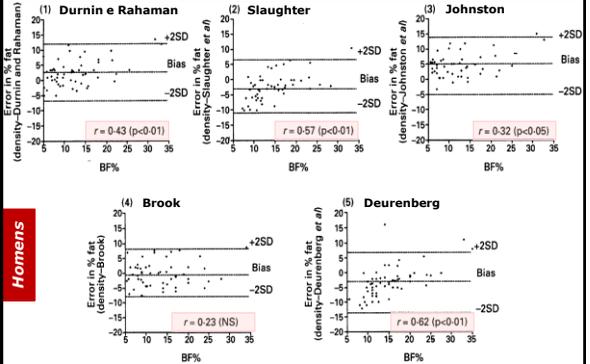


Figure 1 Biases (reference method minus prediction) in BF% estimates in relation to body fatness in 57 boys; (1)–(5) refer to equations in subjects and method.

## As equações de predição da gordura corporal total a partir das dobras cutâneas apresentam resultados similares?

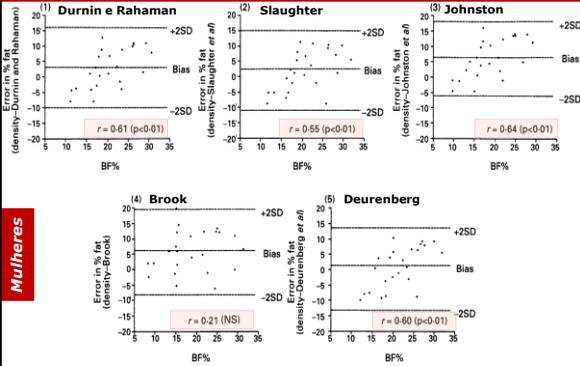


Figure 2 Biases (reference method minus prediction) in BF% estimates in relation to body fatness in 24 girls; (1)–(5) refer to equations in subjects and method.

## Estimativa da densidade corporal a partir das dobras cutâneas

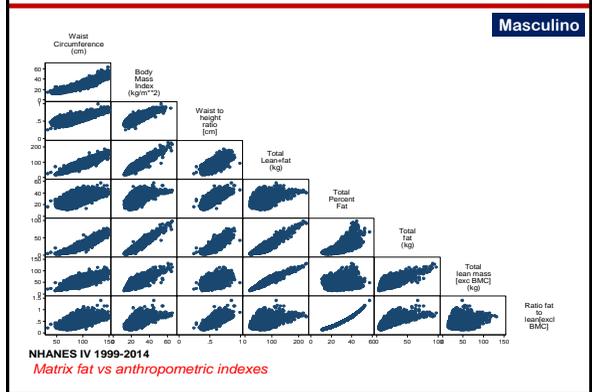
Table II.2. Regression equations for the estimation of body density (D) from the logarithm of skinfold thickness

Age Groups	D = a - (b x log of Triceps)	
	Males	Females
17–19	D = 1.1252 - (0.0625 x log Ts)	D = 1.1159 - (0.0648 x log Ts)
20–29	D = 1.1131 - (0.0530 x log Ts)	D = 1.1319 - (0.0776 x log Ts)
30–39	D = 1.0834 - (0.0361 x log Ts)	D = 1.1176 - (0.0686 x log Ts)
40–49	D = 1.1041 - (0.0609 x log Ts)	D = 1.1121 - (0.0691 x log Ts)
50–72	D = 1.1041 - (0.0662 x log Ts)	D = 1.1160 - (0.0762 x log Ts)
D = a - (b x log of Subscapular)		
17–19	D = 1.1312 - (0.0670 x log Subs)	D = 1.1081 - (0.0621 x log Subs)
20–29	D = 1.1360 - (0.0700 x log Subs)	D = 1.1184 - (0.0716 x log Subs)
30–39	D = 1.0978 - (0.0416 x log Subs)	D = 1.0979 - (0.0567 x log Subs)
40–49	D = 1.1246 - (0.0686 x log Subs)	D = 1.0860 - (0.0505 x log Subs)
50–72	D = 1.1334 - (0.0760 x log Subs)	D = 1.0899 - (0.0590 x log Subs)
D = a - (b x log of Triceps + Subscapular)		
17–19	D = 1.1561 - (0.0711 x log Ts + Subs)	D = 1.1468 - (0.0740 x log Ts + Subs)
20–29	D = 1.1525 - (0.0687 x log Ts + Subs)	D = 1.1582 - (0.0813 x log Ts + Subs)
30–39	D = 1.1165 - (0.0484 x log Ts + Subs)	D = 1.1356 - (0.0686 x log Ts + Subs)
40–49	D = 1.1519 - (0.0771 x log Ts + Subs)	D = 1.1230 - (0.0635 x log Ts + Subs)
50–72	D = 1.1527 - (0.0793 x log Ts + Subs)	D = 1.1347 - (0.0742 x log Ts + Subs)

Source: Adapted from Durnin, J., and Wommersley, J. 1974. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. Br. J. Nutr.

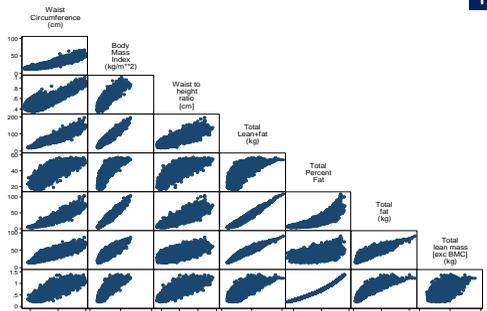
## As associações entre as variáveis da gordura corporal

## Matriz de correlação



## Matriz de correlação

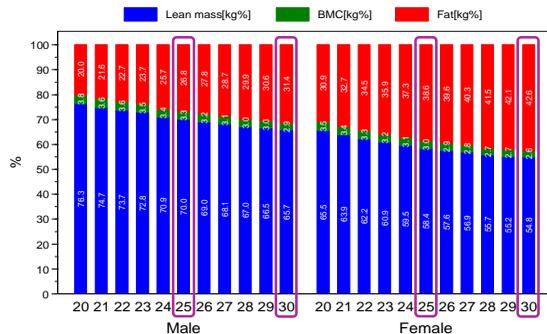
Feminino



NHANES IV 1999-2014

Matrix fat vs anthropometric indexes

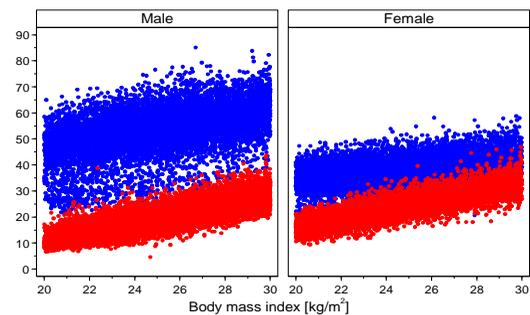
## As massas segundo categorias do IMC



Source: NHANES IV 1999-2014

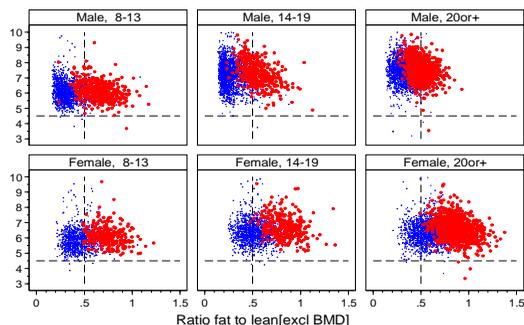
## As massas do IMC

Lean mass[kg] Fat mass[kg]



NHANES IV 1999-2014

## BIA, DXA e obesos

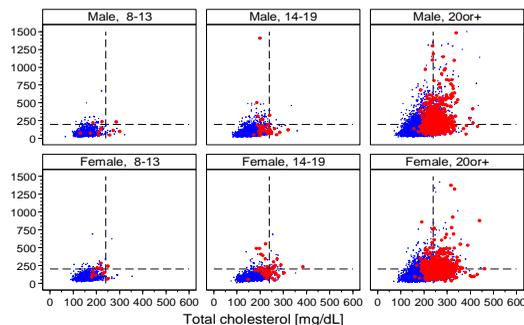


NHANES IV 1999-2014

in red: BMI ≥ 30 [kg/m<sup>2</sup>]

## As associações entre gordura corporal e marcadores bioquímicos

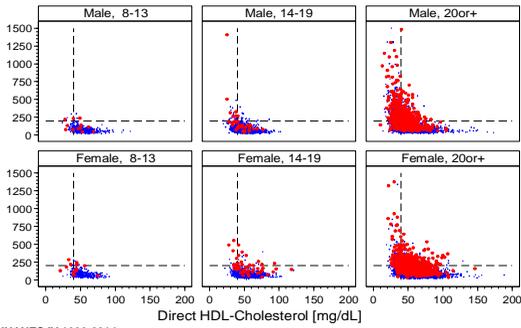
## Triglicerídeo, Colesterol e Apo-B



NHANES IV 1999-2014

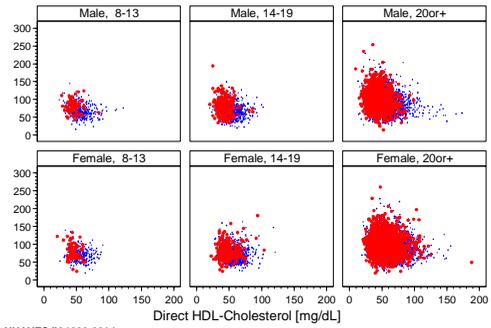
in red: ApoB ≥ 110/120 [mg/dL]

## Triglicéridio, HDL-Colesterol e Apo-B



NHANES IV 1999-2014  
in red: ApoB>=110/120[mg/dL]

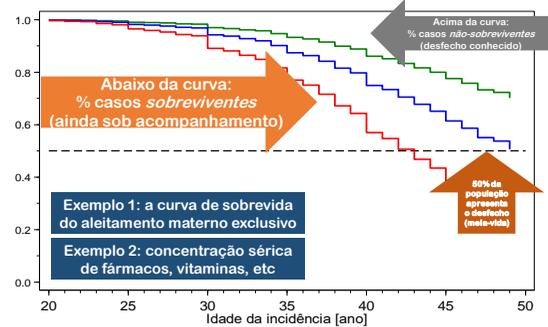
## Apo-B, Colesterol e obesos



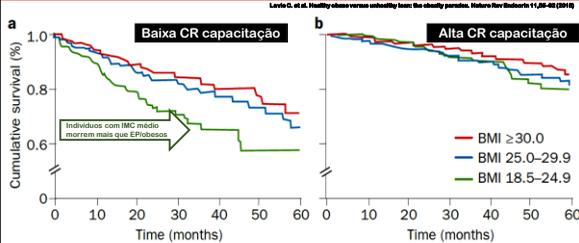
NHANES IV 1999-2014  
in red: BMI>=30[kg/m²]



## A curva de sobrevivida

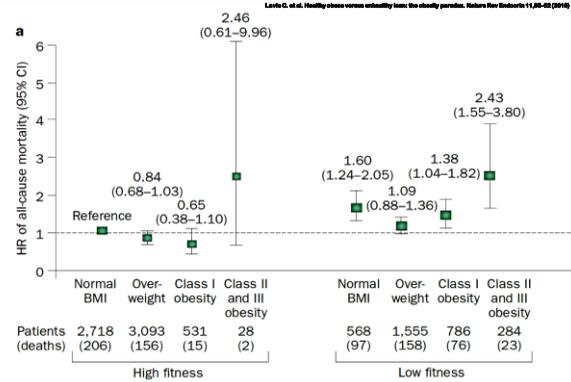


## O paradoxo da obesidade



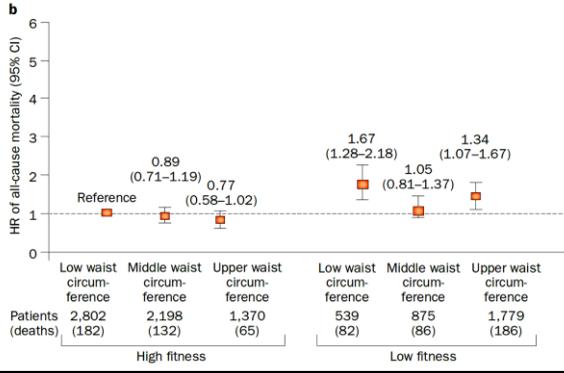
**Figure 5** | Kaplan–Meier survival analyses according to BMI in a study of 2,066 patients with systolic heart failure. **a** | Low cardiorespiratory fitness group ( $VO_2$  max <14 ml/kg per min, log rank 11.7,  $P=0.003$ ). **b** | High cardiorespiratory fitness group ( $VO_2$  max  $\geq$ 14 ml/kg per min, log rank 1.72,  $P=0.42$ ). Permission obtained from Elsevier © Lavie, C. J. et al. *Mayo Clin. Proc.* **88**, 251–258 (2013)<sup>49</sup> and from Elsevier © Lavie, C. J. et al. *Am. Heart J.* **166**, 1–3 (2013).<sup>51</sup>

## IMC e risco de mortalidade



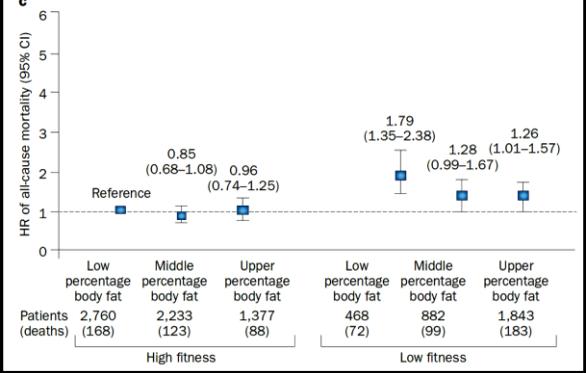
## Cintura e risco de mortalidade

Leite C. et al. *Cardiometabolic syndrome and risk of cardiovascular mortality: Meta-analysis* *Diabetes Care* 11; 26:107-115 (2003)



## Gordura e risco de mortalidade

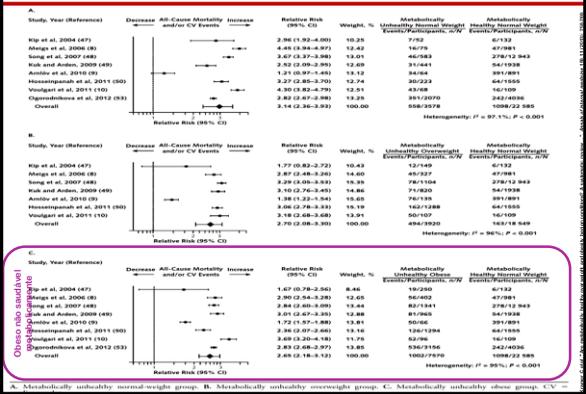
Leite C. et al. *Healthy obese versus unhealthy lean in the elderly gender: Meta-analysis* *Diabetes Care* 11; 25:102-110 (2002)



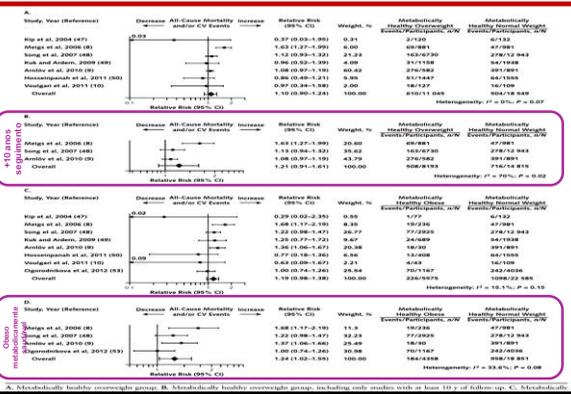
## MH: definição de metabolicamente saudável

istics, or all of these. As shown in Table 1, the classification of participants in these studies as **metabolically unhealthy** was based on the presence of metabolic syndrome components by criteria from the Adult Treatment Panel III (waist circumference >88 cm; fasting triglyceride level >1.69 mmol/L [ $>150$  mg/dL]; high-density-lipoprotein [HDL] cholesterol level  $\leq 1.29$  mmol/L [ $<50$  mg/dL]; systolic blood pressure  $\geq 130$  mm Hg, diastolic blood pressure  $\geq 85$  mm Hg, or use of antihypertensive medication; fasting glucose level  $\geq 6.1$  mmol/L [ $\geq 110$  mg/dL]) (19) or International Diabetes Federation (waist circumference  $\geq 94$  cm in men or  $\geq 80$  cm in women; fasting triglyceride level  $>1.69$  mmol/L [ $\geq 150$  mg/dL]; HDL cholesterol level  $<1.04$  mmol/L [ $<40$  mg/dL] in men or  $<1.29$  mmol/L [ $<50$  mg/dL] in women; systolic blood pressure  $\geq 130$  mm Hg, diastolic blood pressure  $\geq 85$  mm Hg, antihypertensive medication, or history of hypertension; fasting glucose level  $\geq 5.6$  mmol/L [ $\geq 100$  mg/dL] or glucose-lowering medication) (20). In addition, 2 studies (5, 21) assessed insulin resistance and inflammatory markers as part of the definition of metabolic status. Fatal and nonfatal CV events were defined as death due to CV disease or one of the following: myocardial infarction, the acute coronary syndrome, hospitalization for unstable angina or coronary catheterization that resulted in angioplasty or coronary artery bypass surgery, congestive heart failure, stroke, transient ischemic attack, and claudication.

## MUNW e mortalidade



## MHO e mortalidade



## MHO e mortalidade

Table 2. Absolute Incidence of Events per Year of Follow-up, by Body Mass Index Category and Metabolic Status

Study, Year (Reference)	Normal Weight, %		Overweight, %		Obese, %	
	Metabolically Healthy	Metabolically Unhealthy	Metabolically Healthy	Metabolically Unhealthy	Metabolically Healthy	Metabolically Unhealthy
Kip et al, 2004 (47)	1.51	4.48	0.55	2.68	0.43	2.53
Meigs et al, 2006 (8)	0.43	1.94	0.71	1.25	0.73	1.27
Song et al, 2007 (48)	0.21	0.79	0.24	0.70	0.26	0.61
Kuk and Arden, 2009 (49)	0.32	0.80	0.30	0.99	0.40	0.96
Amiriv et al, 2010 (9)	1.46	1.77	0.58	2.02	2.00	2.52
Hosainipah et al, 2011 (50)	0.50	1.66	0.43	1.55	0.39	1.20
Youngein et al, 2011 (10)	2.45	10.54	2.36	7.78	1.55	9.02
Ogordimova et al, 2011 (53)	0.39	1.13	Not available	Not available	0.39	1.13

## MHO e mortalidade: conclusão

In conclusion, our meta-analysis supports the concept of heterogeneity of metabolic status among individuals within the same BMI range. Metabolically healthy obese individuals are at increased risk for death and CV events over the long term compared with metabolically healthy normal-weight persons, suggesting that increased BMI is not a benign condition even in the absence of metabolic abnormalities. In addition, all metabolically unhealthy individuals (normal weight, overweight, obese) had increased risk for events compared with metabolically healthy normal-weight individuals. Thus, in evaluating CV and mortality risk, it is important to consider both BMI and metabolic status to reliably estimate long-term outcome.

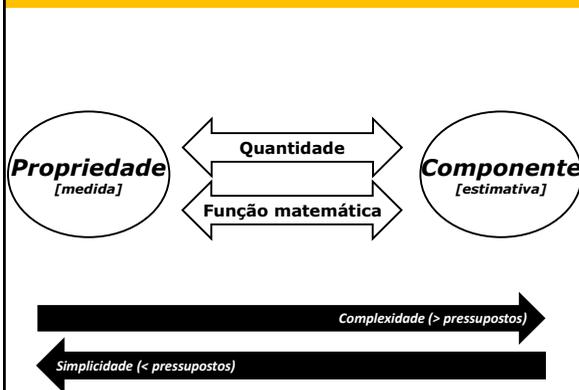
## Uma breve síntese dos métodos de estudo da composição corporal

### Características dos métodos para avaliação da composição corporal

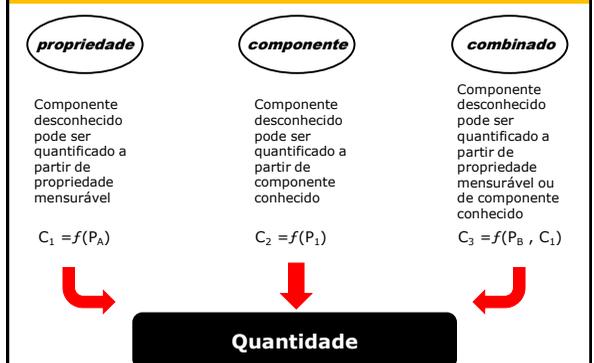
Método	Modelo de composição corporal	Compartimento mensurado	Estudos de composição corporal	
			Componente	Propriedade
DXA	Três compartimentos	Massa óssea Massa não-óssea	Massa gorda e %Gordura	Massa óssea Massa magra
Pleüstimografia	Dois compartimentos	Massa corporal	Densidade e %Gordura	Volume corporal (deslocamento ar)
Pesagem hidrostática	Dois compartimentos	Massa corporal	Densidade e %Gordura	Volume corporal (deslocamento ar)
Hidrometria	Dois compartimentos	Água corporal	Massa não gorda e massa gorda	Água corporal (Total, intra, extra)
BIA	Dois compartimentos	Água corporal	TBW (FFM-FM) ECW-ICW(BCM)	R/Kg/Z (Ângulo de fase)
Antropometria (Dobras cutâneas)	Dois compartimentos	Gordura (tecido adiposo subcutâneo)	Equações de predição (DC)	Idobras (pop referência)

## O estudo da composição corporal

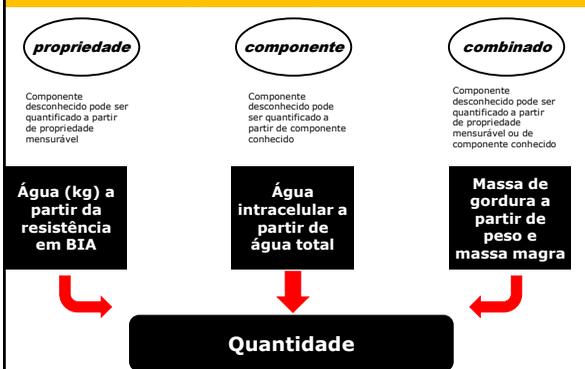
### Os estudos da composição corporal



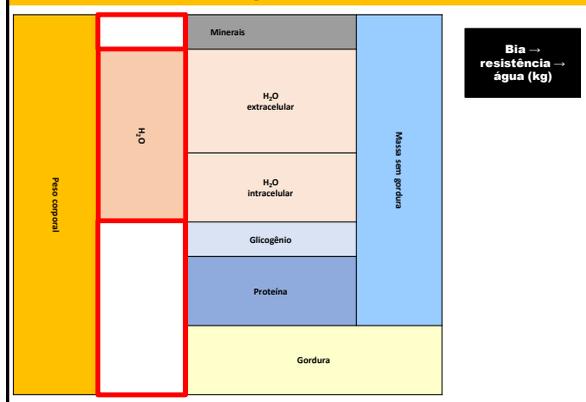
### OS ESTUDOS DA COMPOSIÇÃO CORPORAL (I)



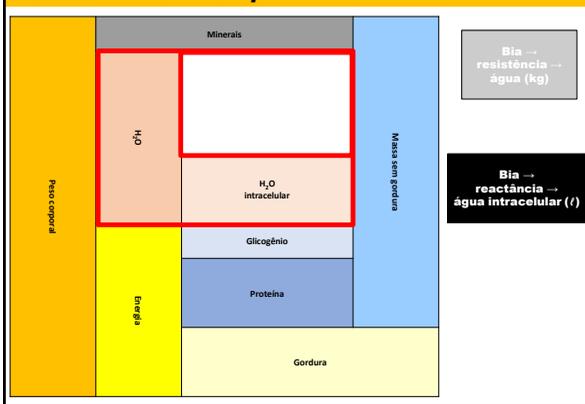
## OS ESTUDOS DA COMPOSIÇÃO CORPORAL (I) - exemplos



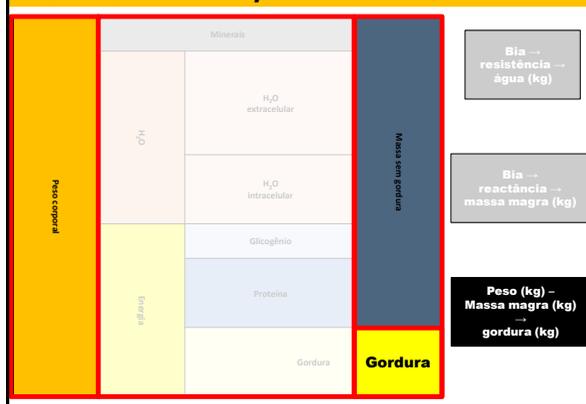
## Detalhes dos exemplos



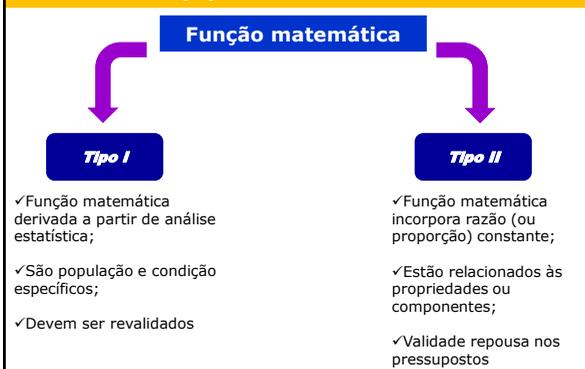
## Detalhes dos exemplos



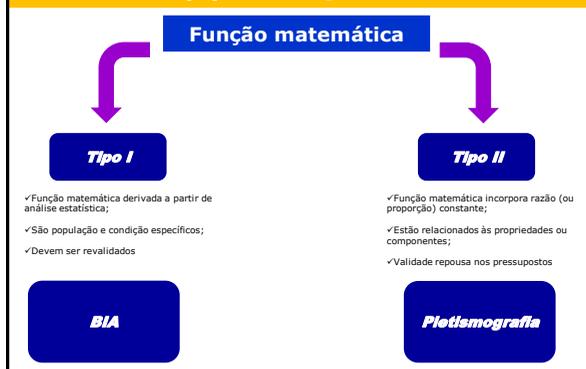
## Detalhes dos exemplos



## OS ESTUDOS DA COMPOSIÇÃO CORPORAL (II)



## OS ESTUDOS DA COMPOSIÇÃO CORPORAL (II) - exemplos



## OS ESTUDOS DA COMPOSIÇÃO CORPORAL (III)

Quais as questões que emergem dessa maneira de organizar os estudos da composição corporal?

- 1) Que tipo de **quantidade** estou usando?
- 2) Que tipo de **função** estou usando?
- 3) Preciso **validar essa estimativa** para minha população?
- 4) Minha estimativa pode servir de **medida de referência**?
- 5) Qual o espectro de **validade** ou **extrapolação** de meus resultados?

## Idade e medidas corporais

TABELA 49.7. EFEITOS DA IDADE SOBRE A COMPOSIÇÃO CORPORAL E MEDIDAS ANTROPOMÉTRICAS

MEDIDA ANTROPOMÉTRICA	EFEITO DA IDADE
Peso	Valor populacional médio aumenta até 5ª década, então se estabiliza ou declina.
Altura	Valor populacional médio diminui 0,5 a 1,5 cm/década após a maturidade, a taxa de declínio é dependente do sexo e etnia.
Gordura	Gordura aumenta como % do peso corporal, até 50 anos então se estabiliza ou declina até 70 anos; certa redistribuição ocorre dos membros para o tronco e do tecido subcutâneo para o regiões visceral, interna e intersticial.
FFM (massa sem gordura)	FFM diminui após 40 anos devido redução do músculo esquelético e da massa óssea; taxas de perda são elevadas em homens e se aceleram após 70 anos; taxas de perda óssea são maiores em mulheres e se aceleram durante a menopausa; a massa de órgãos viscerais diminui levemente com a idade; a hidratação da FFM se torna variável.
Dobras cutâneas	A compressibilidade das dobras cutâneas muda com a idade pela perda de elasticidade da pele e pelo aumento do tempo de recuperação elástica da pele; dobras musculares em idosos são flácidas e adicionalmente difíceis de medir pela perda de tecido muscular subcutâneo.
Circunferências	Flacidez da pele (formação de dobras) pode tornar mais difícil a mensuração das circunferências em idosos; é mais difícil localizar os pontos de referência da mensuração em obesos.

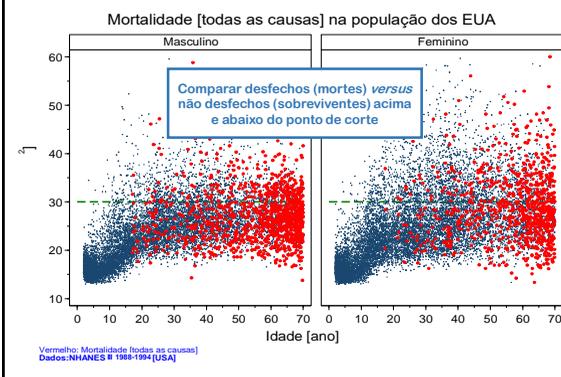
Extraído de: Shils M. Modern Nutrition in Health and Disease

## O IMC e o risco de mortalidade

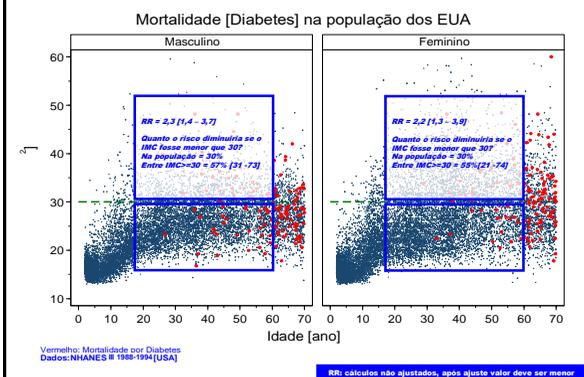
Após a comparação com os dados da composição corporal vamos rever por que o IMC é relevante em avaliação nutricional e saúde?

## Análise baseada em dados do ciclo III da NAHNES 1988-1994 [EUA]

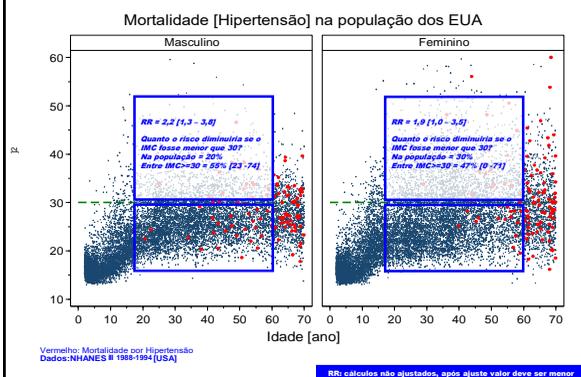
## Relação entre IMC e mortalidade



## Relação entre IMC e mortalidade



## Relação entre IMC e mortalidade



## Os principais pontos da aula (I)

- a) A composição corporal por métodos ou medidas mais apropriadas para uso clínico e seus fundamentos:

BIA;

Dobras cutâneas.

- b) As associações entre gordura corporal estimada em métodos de referência e métodos clínicos

## Os principais pontos da aula (II)

- c) *Bia baseada em componentes e em propriedades:*

Fundamentos;

Usos e interpretação.

- d) *A associação da gordura corporal com a massa corporal:*

As associações entre massa gorda e IMC;

Os valores críticos do IMC e a mortalidade.

## Os principais pontos da aula (III)

- f) *Tipologia dos estudos sobre composição corporal:*

Propriedades, componentes e usos de equações ou constantes.