Obesity beyond BMI - Obesities, Clinical Obesity

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Disclosure

The Speaker has no conflict of interest regarding this presentation

Contents

- Body Mass Index (BMI) : a standard measure of Adiposity?
- Issues in Obesity, originated from BMI
- Obesities, beyond BMI
- Clinical Obesity – Obesity addressed in clinical practice

57 years old Man

- Height 1.81 m
- Weight 87 Kg
- BMI 36.5 Kg/m^2
- Waist Circ 100 cm
- Family History of
  - Acute MI, T2DM
  - Stroke
  - Dementia
  - Parkinsonism
  - Colon cancer
- Non-smoker
- Blood pressure 122/78 mmHg
- Glucose 89 mg/dl
- HbA1c 5.6%
- Lipid profile 206/146/69/108 mg/dl
- Mild fatty liver on abdominal us
- Past History of
  - Hepatitits B
  - Pulmonary Tuberculosis
  - Herpes Zoster
  - Exercise induced Asthma
  - Atopic dermatitis
- 10 units of alcohol once a week

Body Mass Index (BMI) : a standard measure of Adiposity?

The definition of Obesity

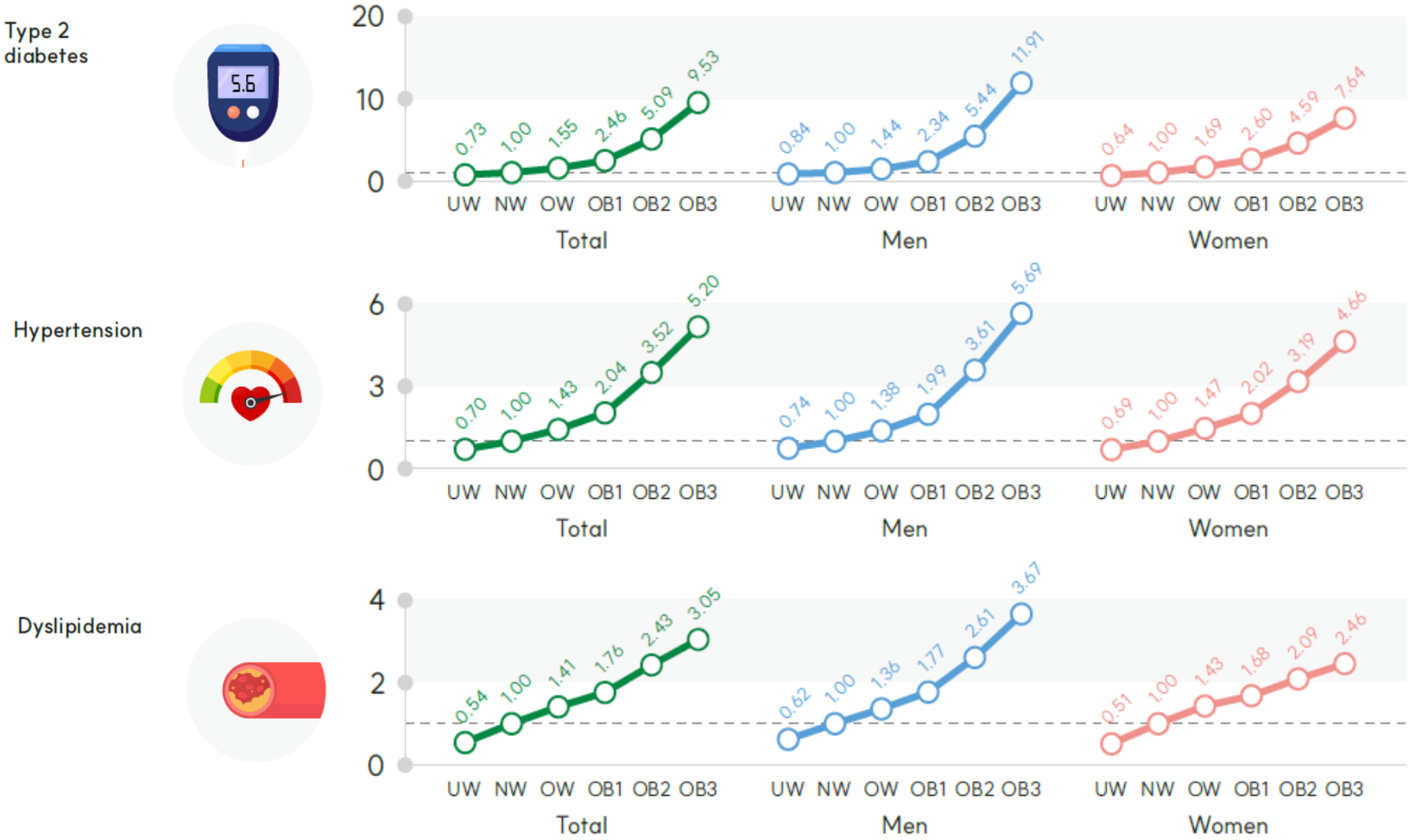
- a " chronic, relapsing, multi-factorial, neurobehavioral disease, wherein an increase in body fat promotes adipose tissue dysfunction and abnormal fat mass physical forces, resulting in adverse metabolic, biomechanical, and psychosocial health consequences."

The Obesity Medicine Association,

The definition of Obesity

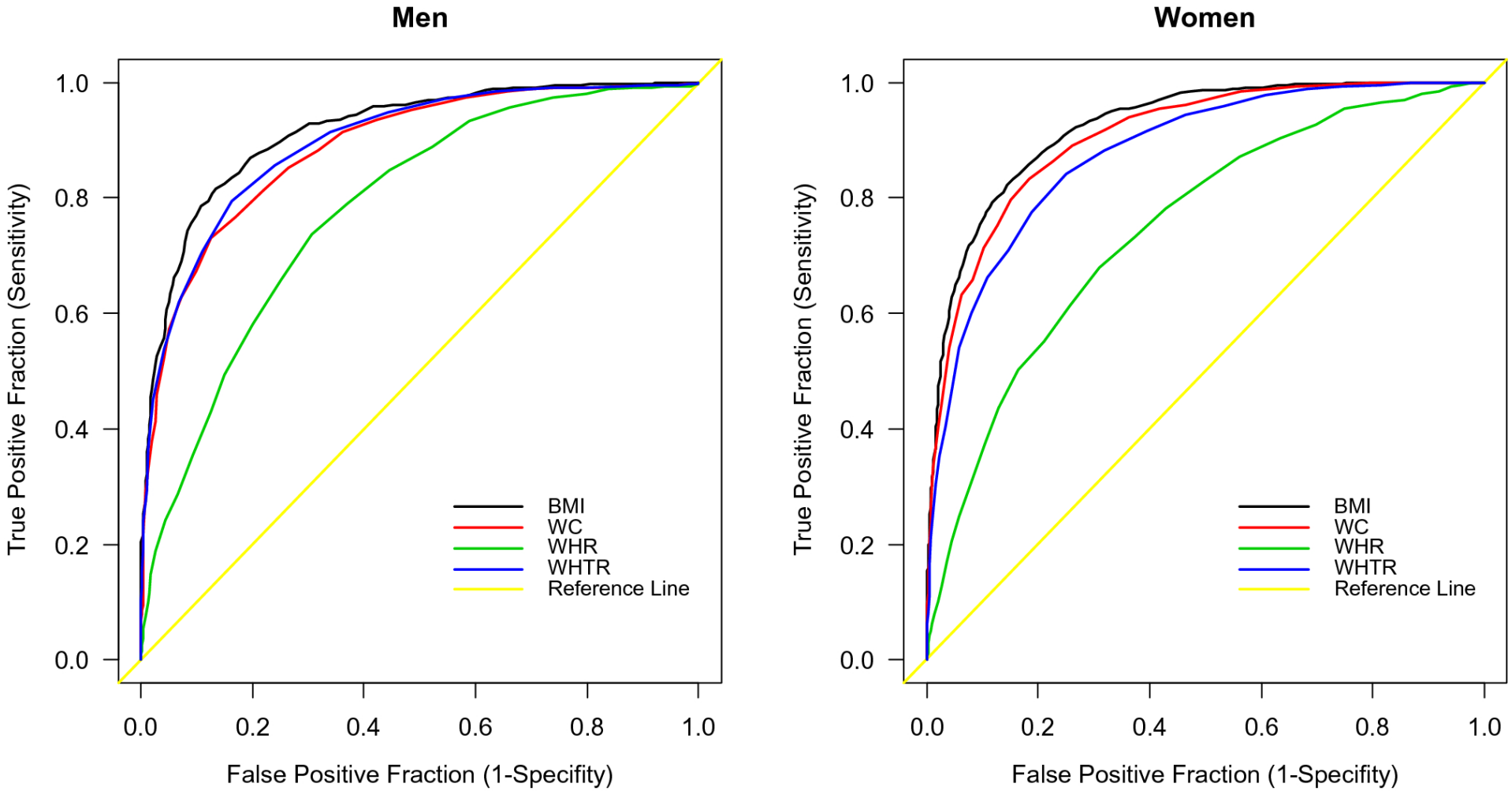
$$\frac{\text{Weight in Kilogram}}{(\text{Height in Meter})^2} \geqq 30 \text{ Or } 25$$

Risk of chronic disease incidence by obesity class based on BMI



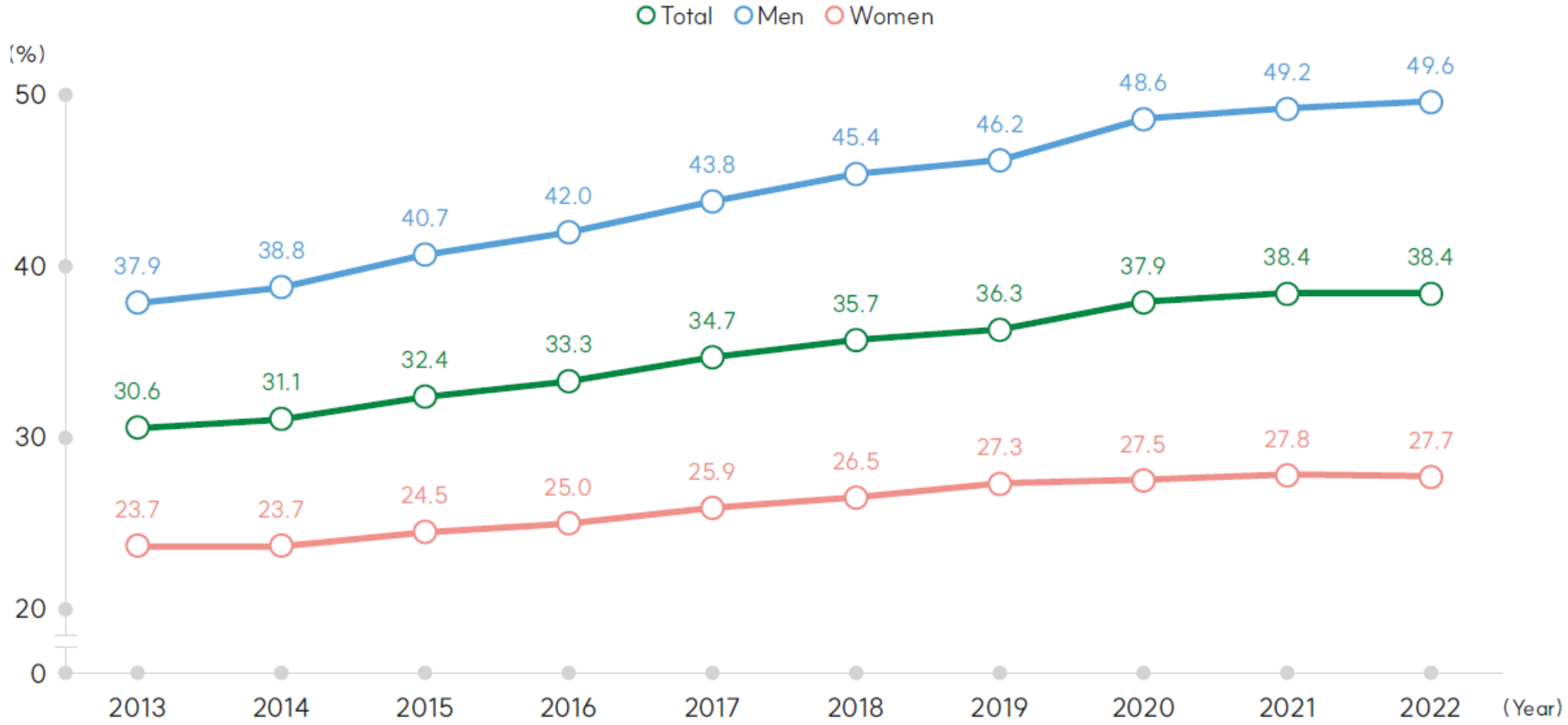
Obesity Factsheet 2024, KSSO

ROC curves for BMI, WC, WHR, and WHTR in screening for cardiovascular risk factors



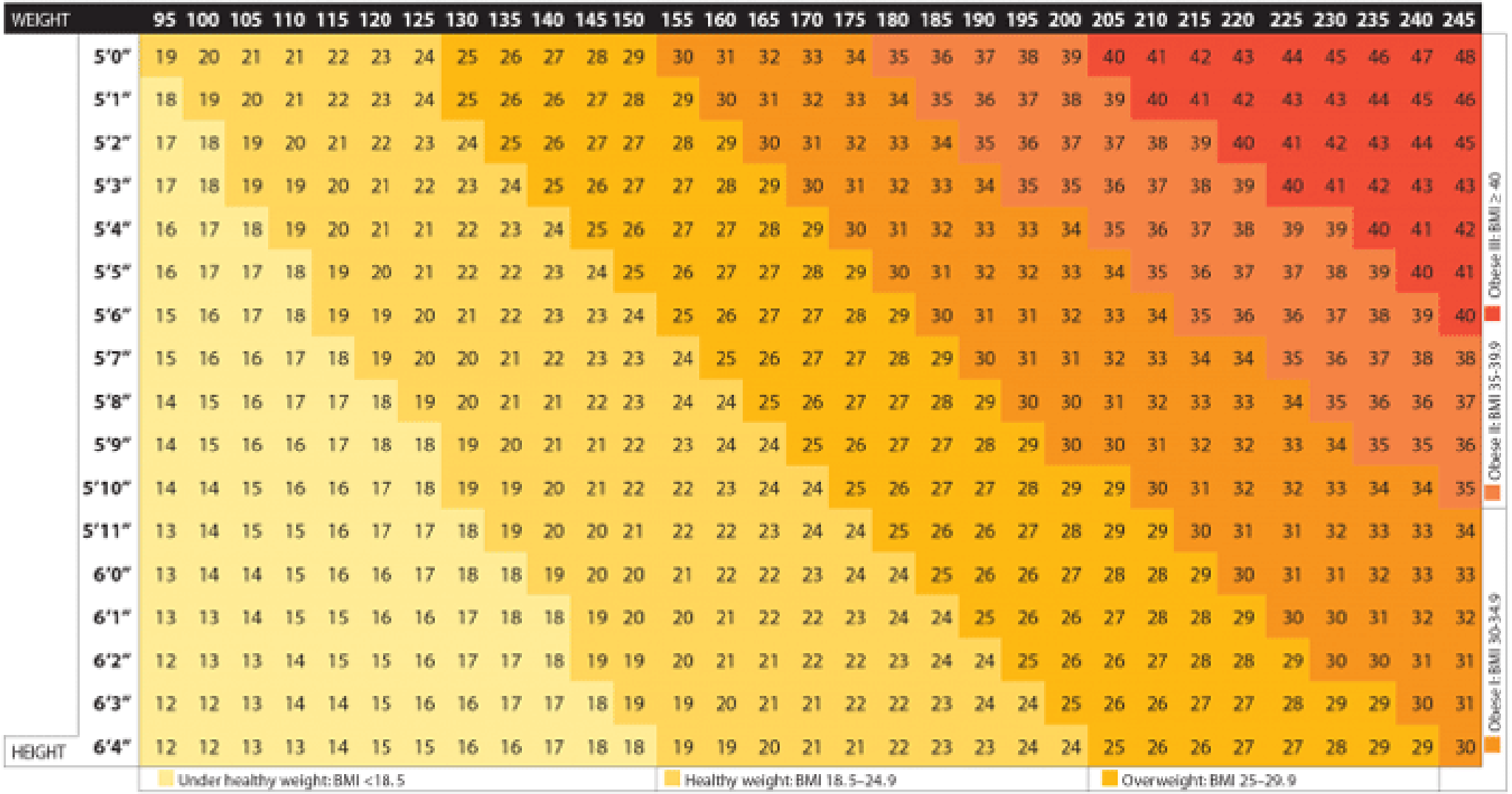
Sci Rep. 2020;10:11253

Prevalence of obesity in Korea during last 10 years



Obesity Factsheet 2024, KSSO

The diagnosis and classification of Obesity



WEIGHT	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200	205	210	215	220	225	230	235	240	245
5'0"	19	20	21	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
5'1"	18	19	20	21	22	23	24	25	26	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	43	44	45	46
5'2"	17	18	19	20	21	22	23	24	25	26	27	27	28	29	30	31	32	33	34	35	36	37	37	38	39	40	41	42	43	44	45
5'3"	17	18	19	19	20	21	22	23	24	25	26	27	27	28	29	30	31	32	33	34	35	35	36	37	38	39	40	41	42	43	43
5'4"	16	17	18	19	20	21	21	22	23	24	25	26	27	27	28	29	30	31	32	33	33	34	35	36	37	38	39	39	40	41	42
5'5"	16	17	17	18	19	20	21	22	22	23	24	25	26	27	27	28	29	30	31	32	32	33	34	35	36	37	37	38	39	40	41
5'6"	15	16	17	18	19	19	20	21	22	23	23	24	25	26	27	27	28	29	30	31	31	32	33	34	35	36	36	37	38	39	40
5'7"	15	16	16	17	18	19	20	20	21	22	23	23	24	25	26	27	27	28	29	30	31	31	32	33	34	34	35	36	37	38	38
5'8"	14	15	16	17	17	18	19	20	21	21	22	23	24	24	25	26	27	27	28	29	30	30	31	32	33	33	34	35	36	36	37
5'9"	14	15	16	16	17	18	18	19	20	21	21	22	23	24	24	25	26	27	27	28	29	30	30	31	32	32	33	34	35	35	36
5'10"	14	14	15	16	16	17	18	19	19	20	21	22	22	23	24	24	25	26	27	27	28	29	29	30	31	32	32	33	34	34	35
5'11"	13	14	15	15	16	17	17	18	19	20	20	21	22	22	23	24	24	25	26	26	27	28	29	29	30	31	31	32	33	33	34
6'0"	13	14	14	15	16	16	17	18	18	19	20	20	21	22	22	23	24	24	25	26	26	27	28	28	29	30	31	31	32	33	33
6'1"	13	13	14	15	15	16	16	17	18	18	19	20	20	21	22	22	23	24	24	25	26	26	27	28	28	29	30	30	31	32	32
6'2"	12	13	13	14	15	15	16	17	17	18	19	19	20	21	21	22	22	23	24	24	25	26	26	27	28	28	29	30	30	31	31
6'3"	12	12	13	14	14	15	16	16	17	17	18	19	19	20	21	21	22	22	23	24	24	25	26	26	27	27	28	29	29	30	31
HEIGHT 6'4"	12	12	13	13	14	15	15	16	16	17	18	18	19	19	20	21	21	22	23	23	24	24	25	26	26	27	27	28	29	29	30

Under healthy weight: BMI <18.5

Healthy weight: BMI 18.5–24.9

Overweight: BMI 25–29.9

Obese I: BMI 30-34.9

Obese II: BMI 35-39.9

Obese III: BMI ≥ 40

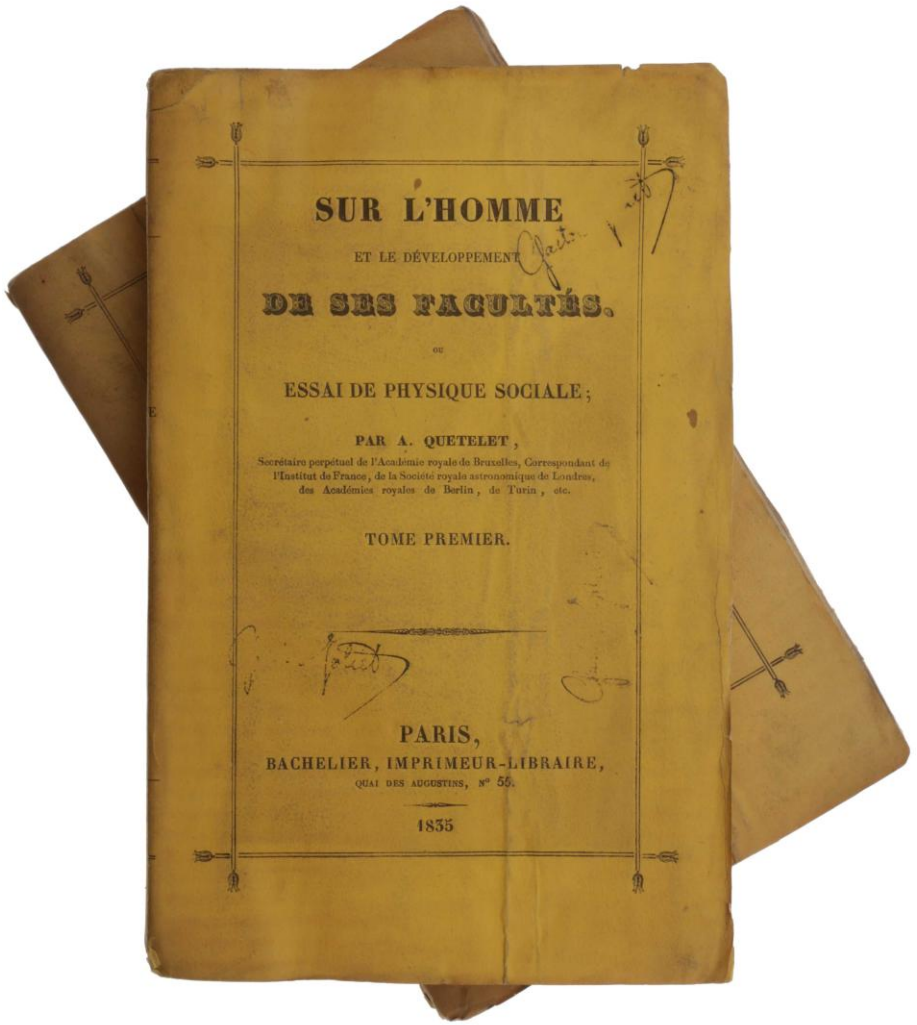
Adolphe Quetelet

(1796 – 1874)

a Belgian
astronomer,
mathematician,
statistician
and sociologist

The founder of
anthropometry

Sur l'homme et le développement de ses facultés, ou Essai de physique sociale


SUR L'HOMME

ET LE DÉVELOPPEMENT

DE SES FACULTÉS.

OU

ESSAI DE PHYSIQUE SOCIALE;

PAR A. QUETELET,

Secrétaire perpétuel de l'Académie royale de Bruxelles, Correspondant de l'Institut de France, de la Société royale astronomique de Londres, des Académies royales de Berlin, de Turin, etc.

TOME PREMIER.

PARIS,

BACHELIER, IMPRIMEUR-LIBRAIRE,

QUAI DES AUGUSTINS, N° 55.

1835

1835

A Social Treatise on Man and the Development of his Faculties

described a man's weight in relation to his height in his quest to find values for the "Average man"

Standard body weight chart for Metropolitan Life insurance company in 1920s

Table of the Size and Weight of Man at Different Ages.

Ages.	Size.	Weight.	Ratio of Weight to Size.	Size Observed.		Weight Observed.	
				Max.	Min.	Max.	Min.
	met.	kilog.		met.	met.	kilog.	kilog.
Birth,	0·496	3·20	6·19	0·532	0·438	4·50	2·34
1 year,	0·696	10·00	14·20	0·750	0·682	11·00	9·00
2 ..	0·797	12·00	15·00	0·824	0·730	13·50	10·50
3 ..	0·860	13·21	15·36	0·875	0·840	13·60	12·10
4 ..	0·932	15·07	16·32	0·965	0·840	18·20	12·50
5 ..	0·990	16·70	16·98	1·080	0·915	18·50	14·00
6 ..	1·046	18·04	17·44	1·115	0·960	20·40	15·80
7 ..	1·112	20·16	18·31	1.162	1·109	24·50	17·20
8 ..	1·170	22·26	18·92	1·260	1·120	28·50	19·00
9 ..	1·227	24·09	19·68	1·325	1·150	29·00	22·20
10 ..	1·282	26·12	20·37	1·325*	1·163	32·00	22·70
11 ..	1·327	27·85	21·58	1·405	1·215	33·80	25·00
12 ..	1·359	31·00	22·80	1·450	1·270	36·30	25·00
13 ..	1·403	35·32	25·30	1·490	1·300	39·50	34·60
14 ..	1·487	40·50	27·49	1·630	1·330	45·00	37·00
15 ..	1·559	46·41	29·88	1·658	1·380	61·50	37·00
16 ..	1·610	53·39	33·00	1·730	1·430	61·50	40·00
17 ..	1·670	57·40	34·25	1·790	1·467	65·50	45·00
18 ..	1·700	61·26	35·67	1·790	..	67·00	45·00
19 ..	1·706	63·32	37·00	1·800	..	70·00	48·20
20 ..	1·711	65·00	37·99	1·838	..	72·70	..
25 ..	1·722	68·29	39·66	1·890	..	98·50	..
30 ..	1·722	68·90	40·02	..	..	..	..
40 ..	1·713	68·81	40·03	..	..	..	..
50 ..	1·674	67·45	40·14	..	..	..	..
60 ..	1·639	65·50	40·01	..	..	..	..
70 ..	1·623	63·03	38·83	..	..	..	49·1
80 ..	1·613	61·22	37·96	1·820	1·467	83·00	49·7

Table of the Size and Weight of Woman at Different Ages.

Ages.	Size.	Weight.	Ratio of Weight to Size.	Size Observed.		Weight Observed.	
				Max.	Min.	Max.	Min.
	met.	kilog.		met.	met.	kilog.	kilog.
Birth,	0·483	2·91	6·15	0·555	0·438	4·25	1·12
1 year,	0·690	9·30	13·50	0·704	0·660	10·5	8·3
2 ..	0·780	11·40	14·50	0·798	0·720	12·0	8·3
3 ..	0·850	12·45	14·70	0·895	0·795	15·8	10·5
4 ...	0·910	14·18	15·10	0·950	0·810	15·8	11·5
5 ..	0·974	15·50	15·70	1·085	0·876	17·5	13·3
6 ..	1·032	16·74	16·24	1·085	0·956	20·3	13·3
7 ..	1·096	18·45	16·85	1·177	1·050	23·4	16·0
8 ..	1·139	19·82	17·45	1·330	1·050	23·4	16·0
9 ..	1·200	22·44	18·65	1·380	1·110	25·7	18·3
10 ..	1·248	24·24	19·45	1·380	1·160	28·3	20·3
11 ..	1·275	26·25	20·60	1·385	1·160	39·8	21·6
12 ..	1·327	30·54	23·00	1·476	1·160	42·3	21·6
13 ..	1·386	34·65	24·50	1·580	1·160	42·8	21·6
14 ..	1·447	38·10	25·35	1·580	1·160	51·0	32·0
15 ..	1·475	41·30	28·10	1·638	1·160	55·2	32·0
16 ..	1·500	44·44	29·62	1·638	1·160	57·6	32·0
17 ..	1·544	49·08	31·75	1·688	1·234	61·6	..
18 ..	1·562	53·10	34·05	1·740	..	79·9	..
20 ..	1·570	54·46	34·70	..	..	..	..
25 ..	1·577	55·08	35·26	..	..	..	..
30 ..	1·579	55·14	35·90	..	..	..	..
40 ..	1·555	56·65	36·50	..	..	..	..
50 ..	1·536	58·45	38·15	..	1·444	90·5	39·8
60 ..	1·516	56·73	37·28	..	1·436	..	..
70 ..	1·514	53·72	35·49	..	1·431	93·8	..
80 ..	1·506	51·52	34·21	1·701	1·408	72·5	38·0

Social Sci History 2007; 31(2): 273-296

The rise of Body Mass Index

Ancel Keys (1904–2004).

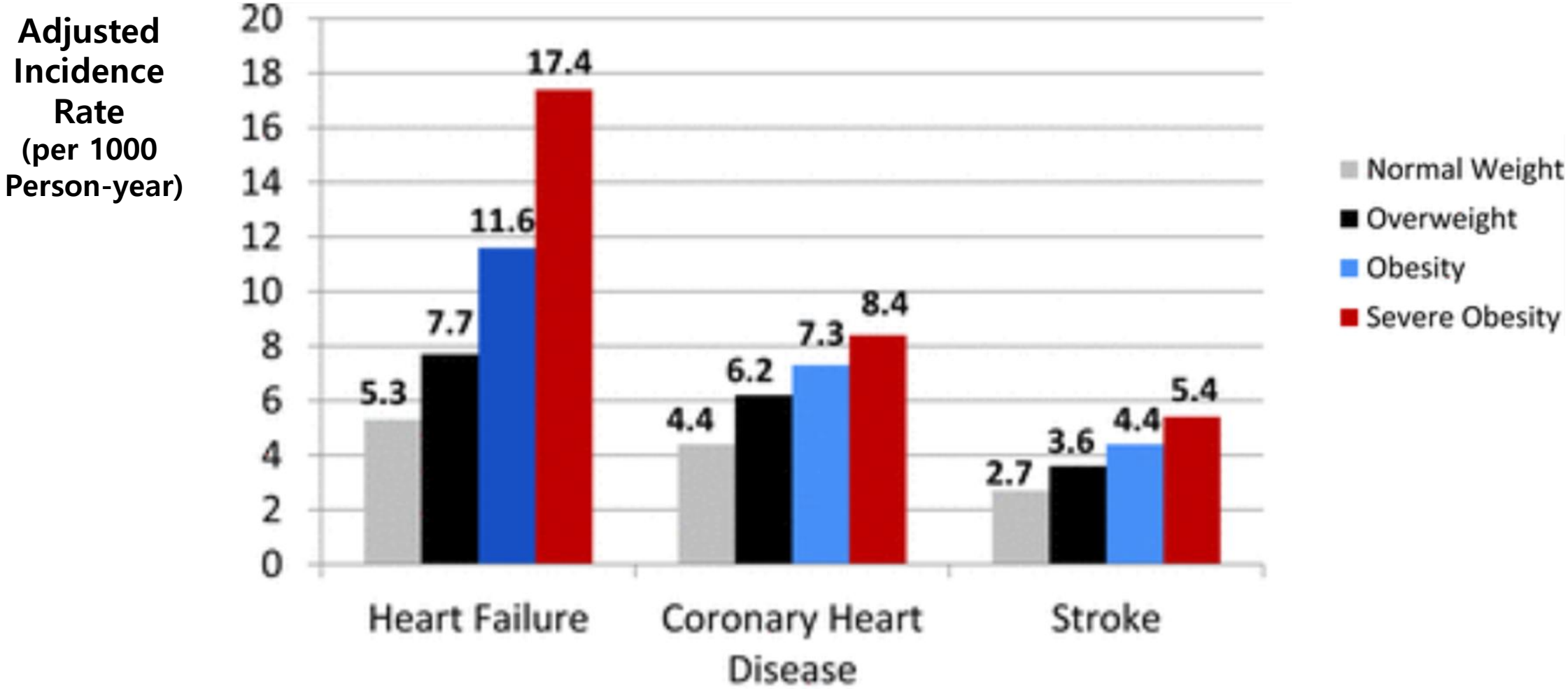
an American physiologist

Adopted Quetelet index as a nutritional indicator

for investigating the relationship between diet and cardiovascular diseases in 1972

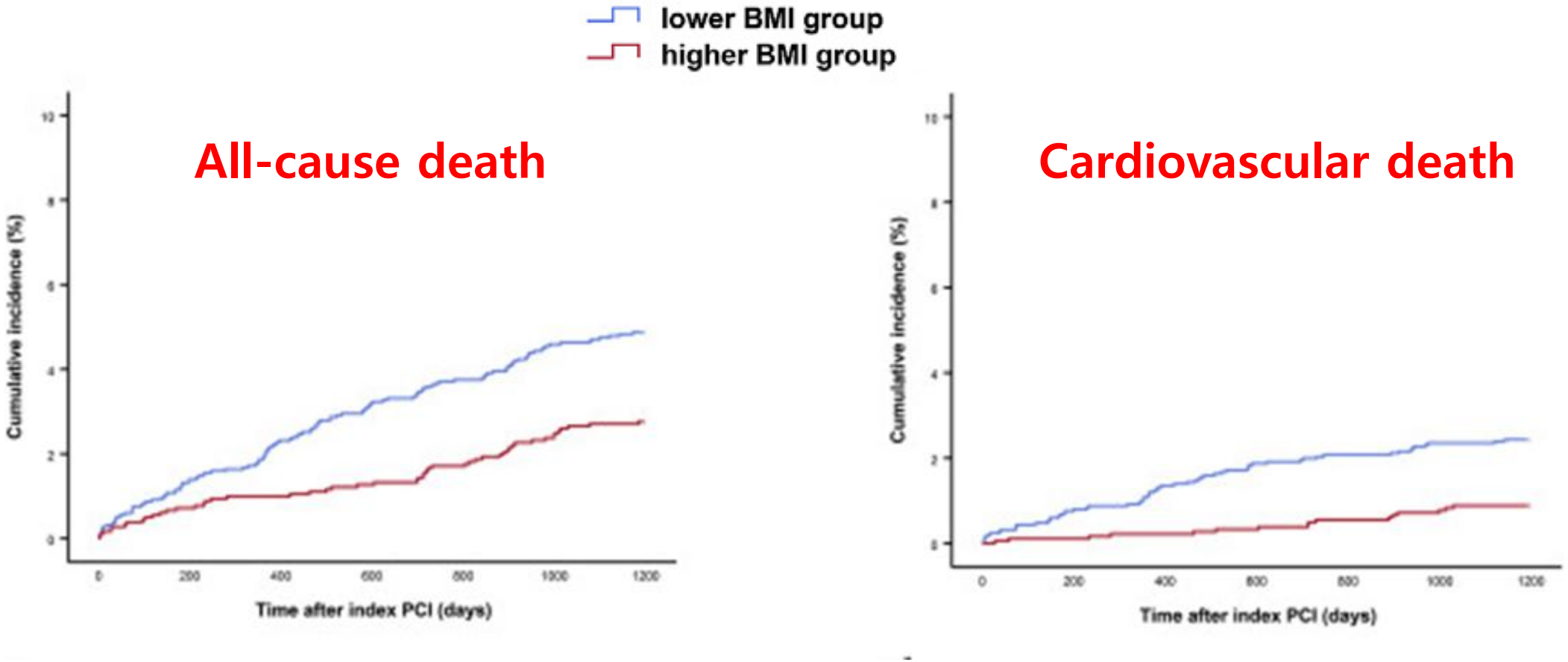
Issues in Obesity, originated from BMI

Obesity Severity based on BMI and Incident Cardiovascular Disease



J Am Heart Assoc. 2016;5(8):e003921.

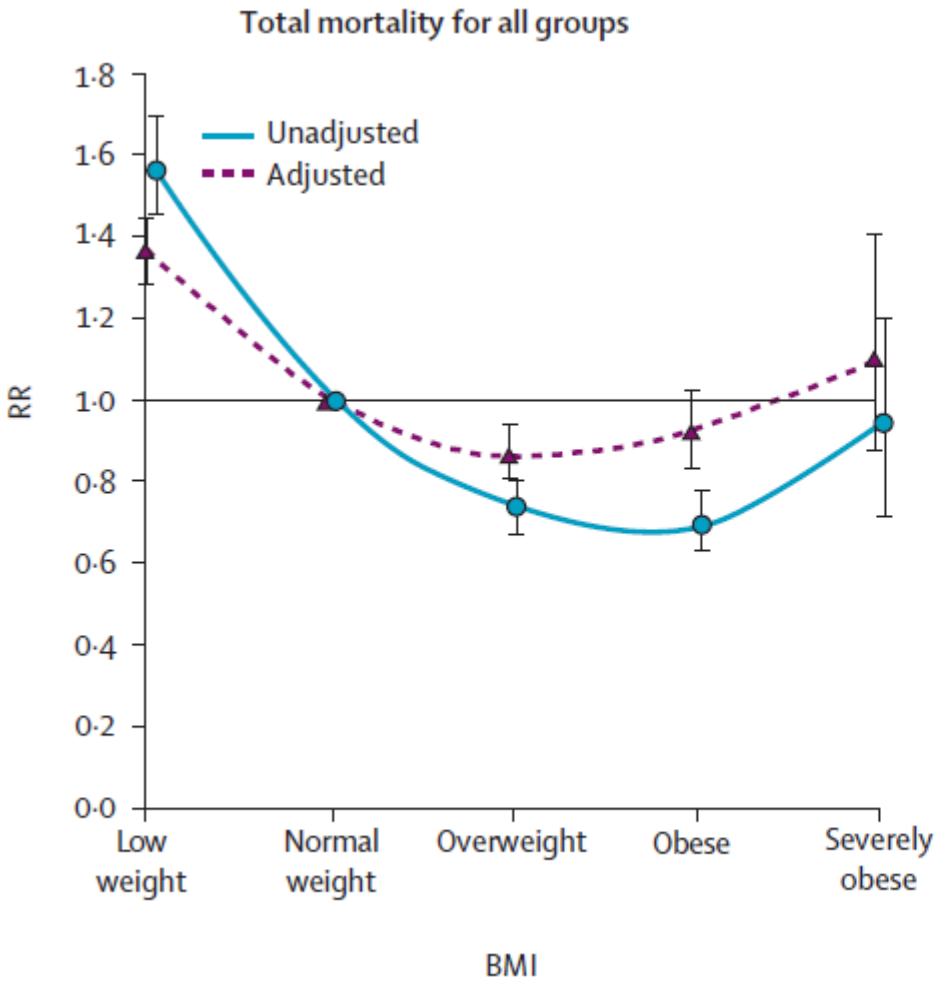
Outcomes comparing lower and higher BMI groups at three-year follow up of MI

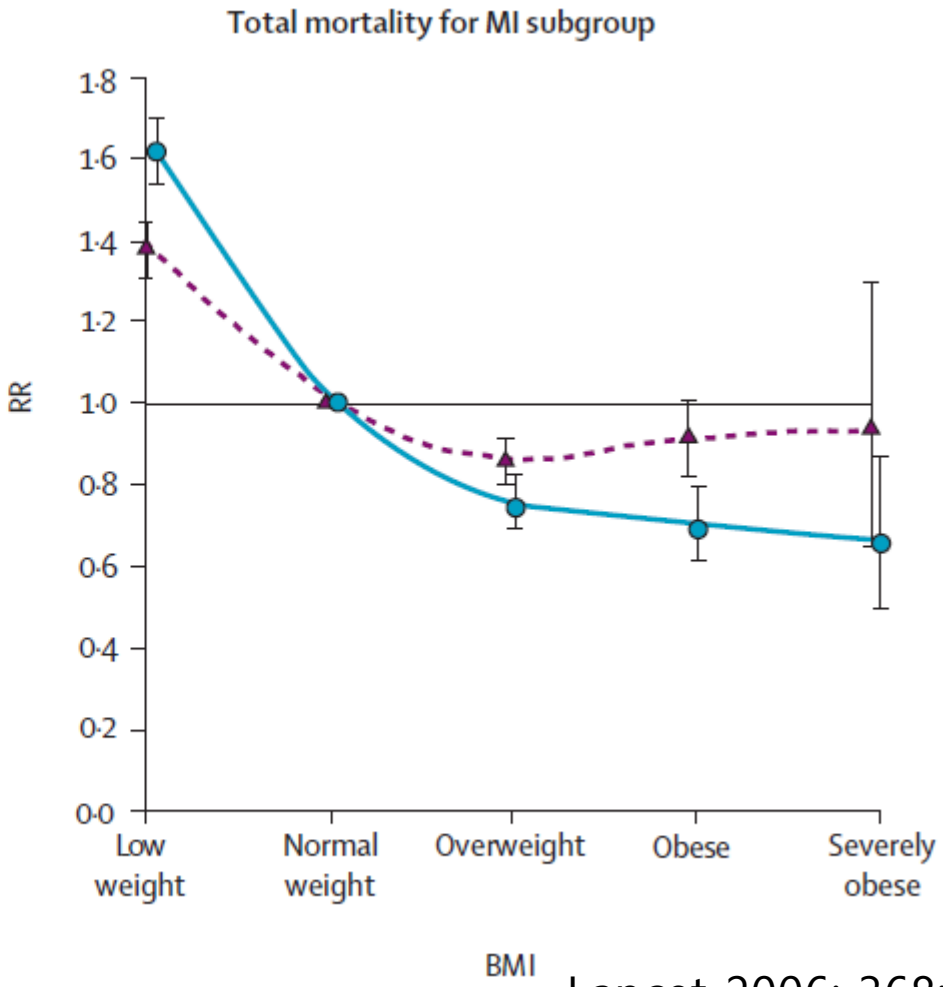


Int J Cardiol 2020; 300: 262 - 267

Relative Risk for Total mortality in patients with Coronary artery disease by BMI groups

Meta-analysis with 40 studies with 250,152 patients

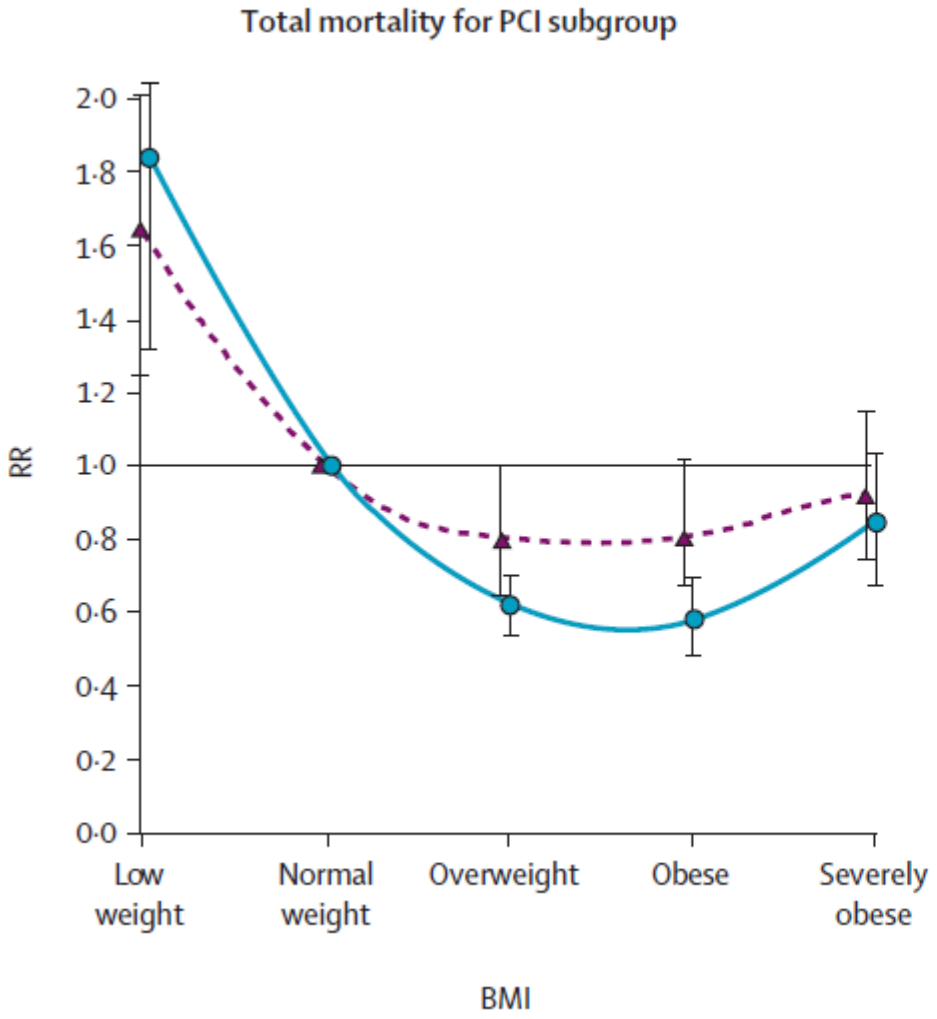


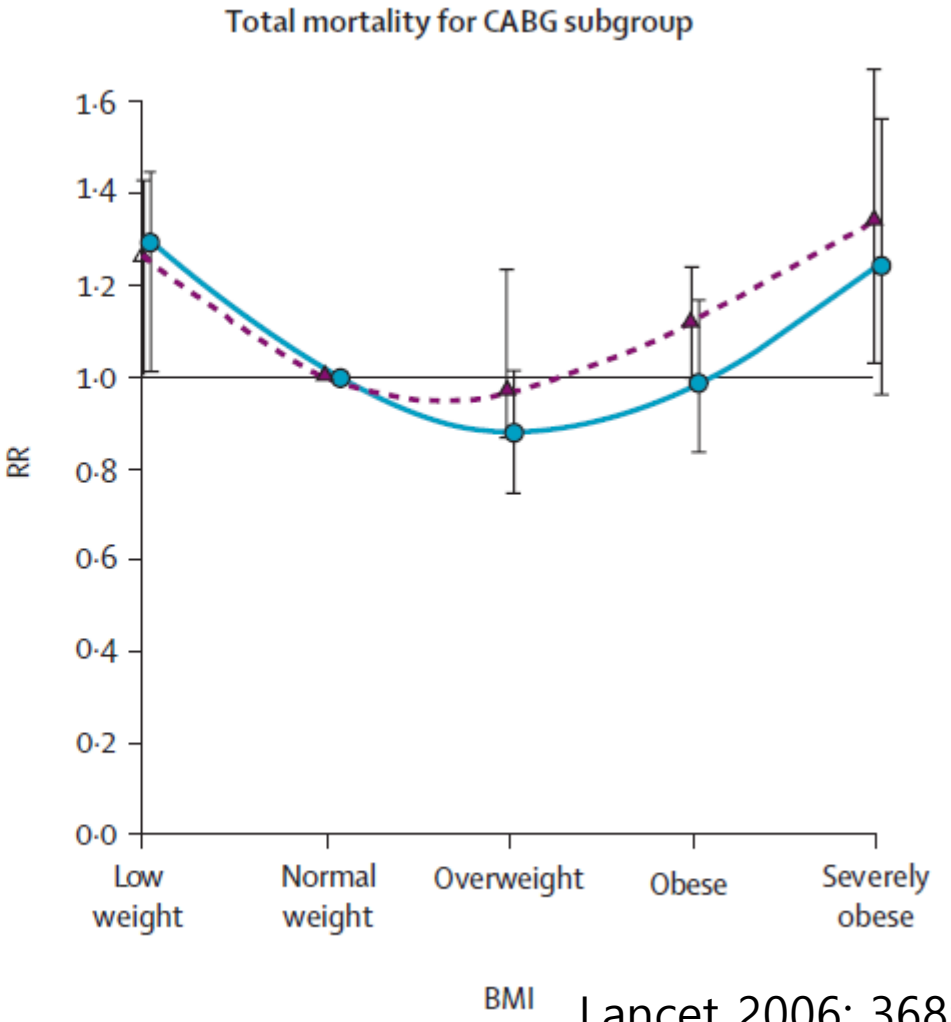


Lancet 2006; 368: 666–78

RR for Total mortality in patients with CAD after PCI or CABG by BMI groups

Meta-analysis with 40 studies with 250,152 patients

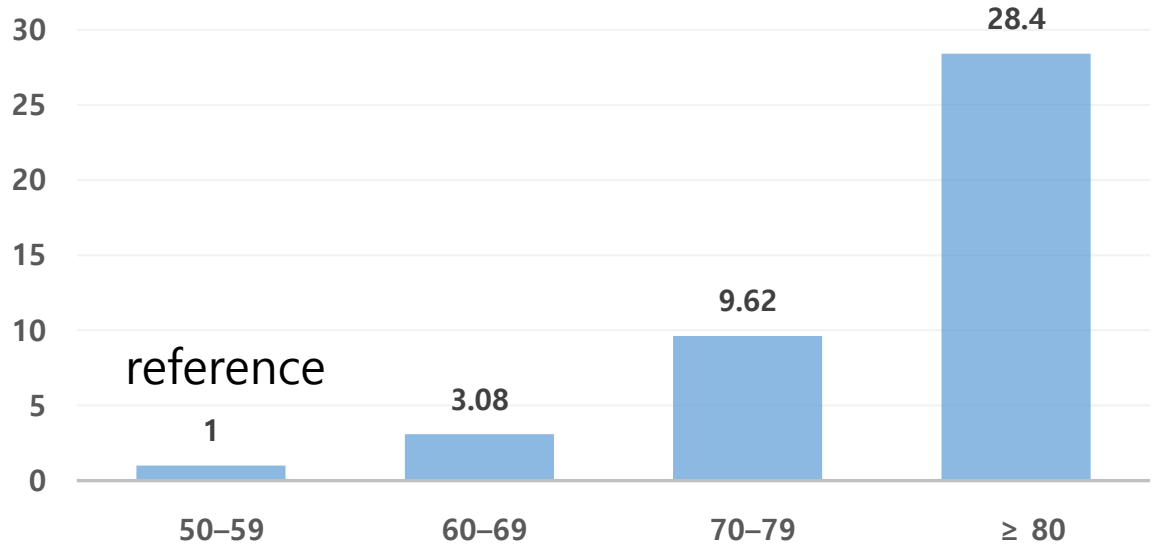




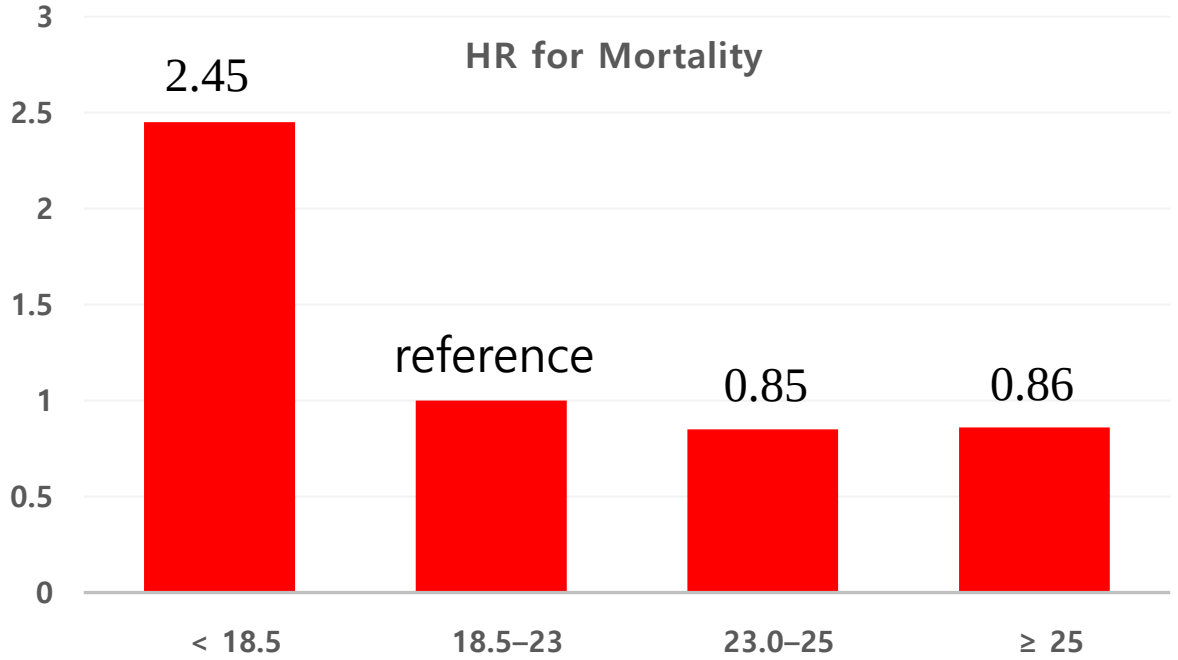
Lancet 2006; 368: 666–78

Adjusted Hazard Ratios for 10 year All-cause Death in Postmenopausal Korean Women

Korean National Health Insurance Service data



Age, years



BMI (kg/m^2)

< 0.001,

Kim BT, unpublished data

Relative Risk of mortality after acute MI according to BMI category

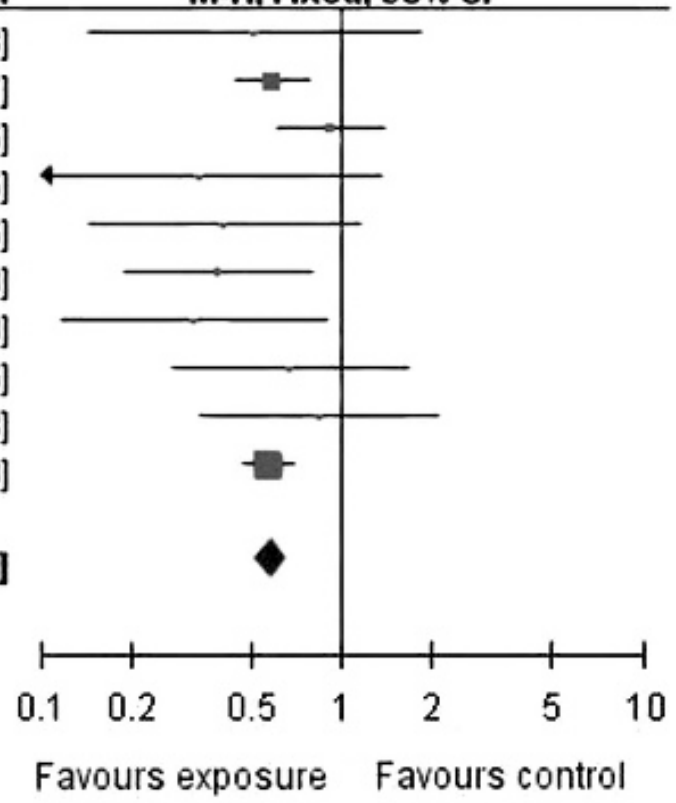
a meta-analysis of prospective studies

obesity(exposure) vs healthy weight(control)

Study or Subgroup	exposure Events	exposure Total	control Events	control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Buettner-2007	3	292	11	551	1.4%	0.51 [0.14, 1.83]
Goldberg-2006	68	931	163	1313	24.4%	0.59 [0.45, 0.77]
Hoit-1987	28	218	92	658	8.3%	0.92 [0.62, 1.36]
Kosuge-2008	2	114	108	2096	2.0%	0.34 [0.09, 1.36]
Lazzeri-2013	4	172	25	440	2.5%	0.41 [0.14, 1.16]
Mehta-2007	10	583	31	703	5.1%	0.39 [0.19, 0.79]
Nikolsky-2006	5	568	15	552	2.7%	0.32 [0.12, 0.89]
Timeteo-2010	6	89	17	171	2.1%	0.68 [0.28, 1.66]
Wells-2006	9	107	8	80	1.7%	0.84 [0.34, 2.08]
Wienbergen-2008	128	2135	358	3398	49.8%	0.57 [0.47, 0.69]
Total (95% CI)		**5209**		**9962**	**100.0%**	**0.58 [0.51, 0.67]**
Total events	263		828			

Heterogeneity: $Chi^2 = 9.53$, $df = 9$ ($P = 0.39$); $I^2 = 6\%$

Test for overall effect: $Z = 7.76$ ($P < 0.00001$)



Int J Obes. 2016; 40:220–8

Risk of short-term mortality after acute MI according to BMI category

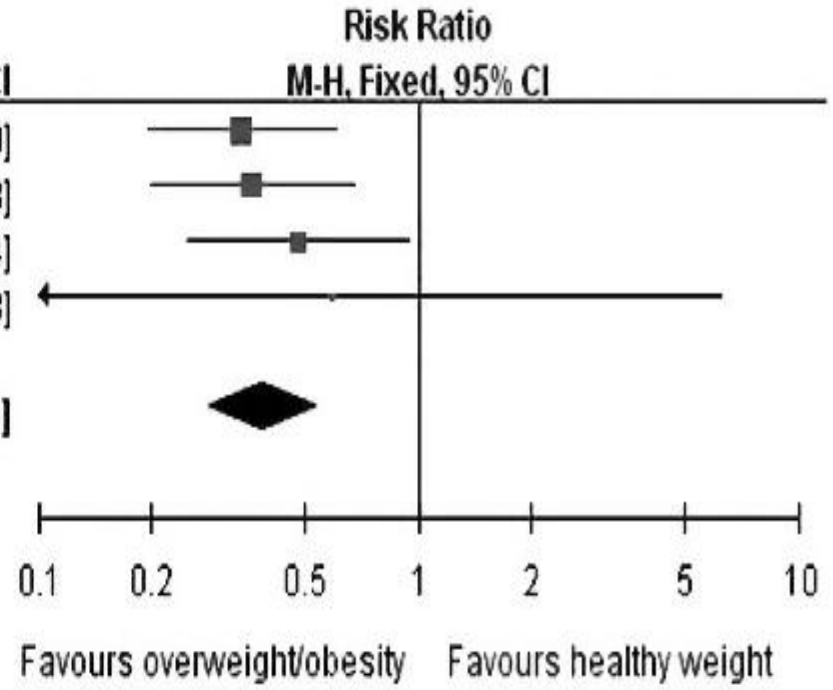
a meta-analysis of prospective studies

short-term mortality

Study or Subgroup	overweight/obesity Events	Total	healthy weight Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Nigam-2006	22	658	23	236	39.1%	0.34 [0.19, 0.60]
Nikolsky-2006	20	1466	20	537	33.8%	0.37 [0.20, 0.68]
Timeteo-2010	15	280	17	154	25.3%	0.49 [0.25, 0.94]
Tomaszuk-2012	2	101	1	30	1.8%	0.59 [0.06, 6.33]
Total (95% CI)		**2505**		**957**	**100.0%**	**0.39 [0.28, 0.55]**
Total events	59		61			

Heterogeneity: Chi² = 0.77, df = 3 (P = 0.86); I² = 0%

Test for overall effect: Z = 5.29 (P < 0.00001)



Int J Obes. 2016; 40:220–8

Risk of medium-term mortality after acute MI according to BMI category

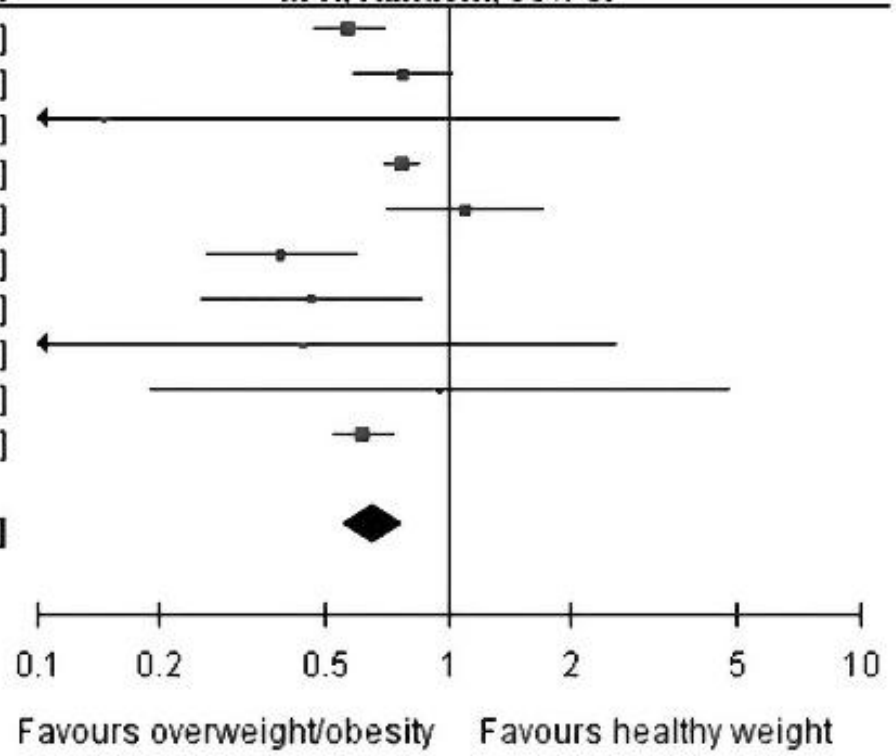
a meta-analysis of prospective studies

medium-term mortality

Study or Subgroup	overweight/obesity Events	Total	healthy weight Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Bucholz-2012	259	4910	133	1449	17.6%	0.57 [0.47, 0.70]
Hoit-1987	101	994	74	566	14.3%	0.78 [0.59, 1.03]
Ikeda-2011	0	46	5	75	0.4%	0.15 [0.01, 2.60]
Kragelund-2005	646	3405	677	2763	21.6%	0.77 [0.70, 0.85]
Lazzeri-2013	58	720	28	384	9.4%	1.10 [0.72, 1.70]
Nikolsky-2006	43	1466	40	537	9.8%	0.39 [0.26, 0.60]
Timeteo-2010	17	280	20	154	5.9%	0.47 [0.25, 0.87]
Tomaszuk-2012	3	101	2	30	0.9%	0.45 [0.08, 2.54]
Wells-2006	5	188	2	72	1.1%	0.96 [0.19, 4.82]
Wienbergen-2008	305	5379	225	2457	19.1%	0.62 [0.52, 0.73]
Total (95% CI)		**17489**		**8487**	**100.0%**	**0.66 [0.55, 0.78]**
Total events	1437		1206			

Heterogeneity: Tau² = 0.03; Chi² = 25.32, df = 9 (P = 0.003); I² = 64%

Test for overall effect: Z = 4.78 (P < 0.00001)



Int J Obes. 2016; 40:220–8

Risk of long-term mortality after acute MI according to BMI category

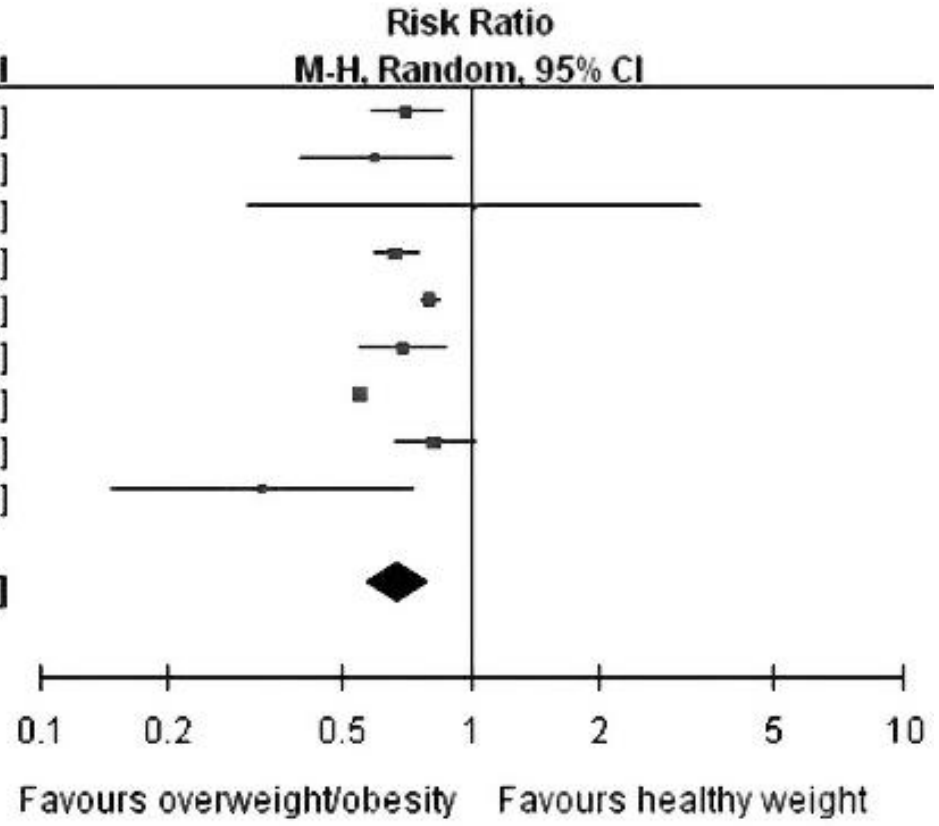
a meta-analysis of prospective studies

long-term mortality

Study or Subgroup	overweight/obesity Events	Total	healthy weight Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Aronson-2010	244	1513	146	644	13.6%	0.71 [0.59, 0.85]
Buettner-2007	50	1116	41	551	8.8%	0.60 [0.40, 0.90]
Ikeda-2011	4	46	6	70	1.9%	1.01 [0.30, 3.40]
Kennedy-2005	500	3482	408	1906	14.8%	0.67 [0.60, 0.76]
Kragelund-2005	1430	3405	1438	2763	15.6%	0.81 [0.77, 0.85]
Nigam-2006	154	658	79	236	12.6%	0.70 [0.56, 0.88]
O'Brien-2014	6261	22043	6353	12422	15.8%	0.56 [0.54, 0.57]
Rana-2004	198	1291	113	607	13.0%	0.82 [0.67, 1.02]
Tomaszuk-2012	10	101	9	30	3.8%	0.33 [0.15, 0.74]
Total (95% CI)		**33655**		**19229**	**100.0%**	**0.68 [0.57, 0.81]**
Total events	8851		8593			

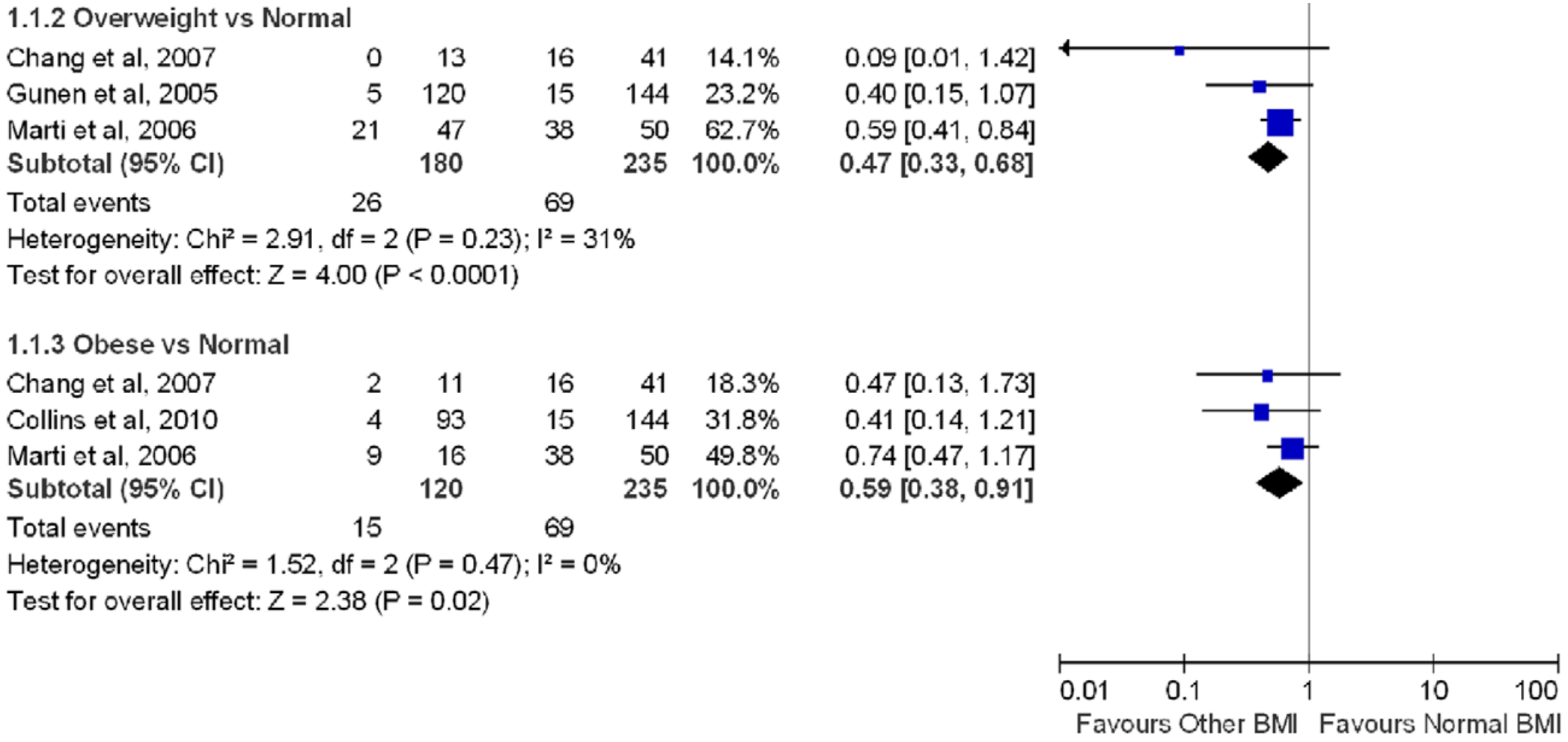
Heterogeneity: $Tau^2 = 0.05$; $Chi^2 = 169.15$, $df = 8$ ($P < 0.00001$); $I^2 = 95\%$

Test for overall effect: $Z = 4.27$ ($P < 0.0001$)



Int J Obes. 2016; 40:220–8

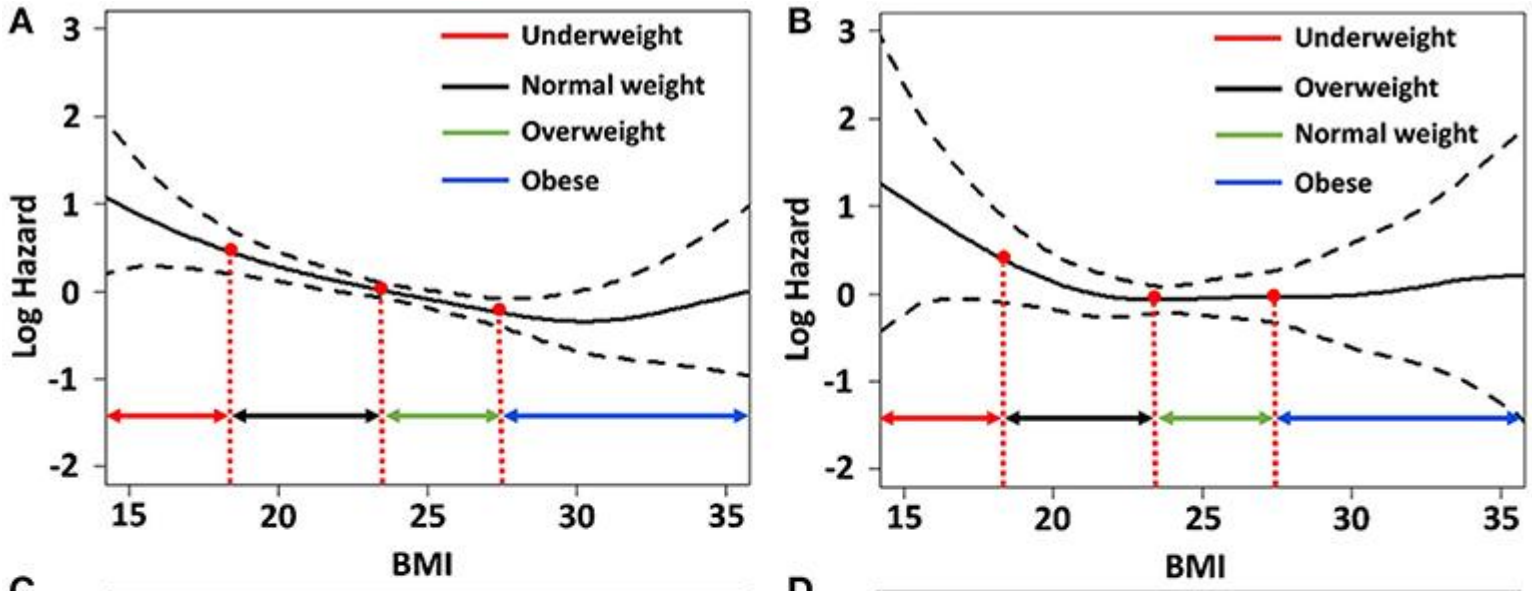
Relative risks of Mortality with Body Mass Index among Patients with Chronic Obstruct Pulmonary Disease



PLoS ONE. (2012) 7:e43892

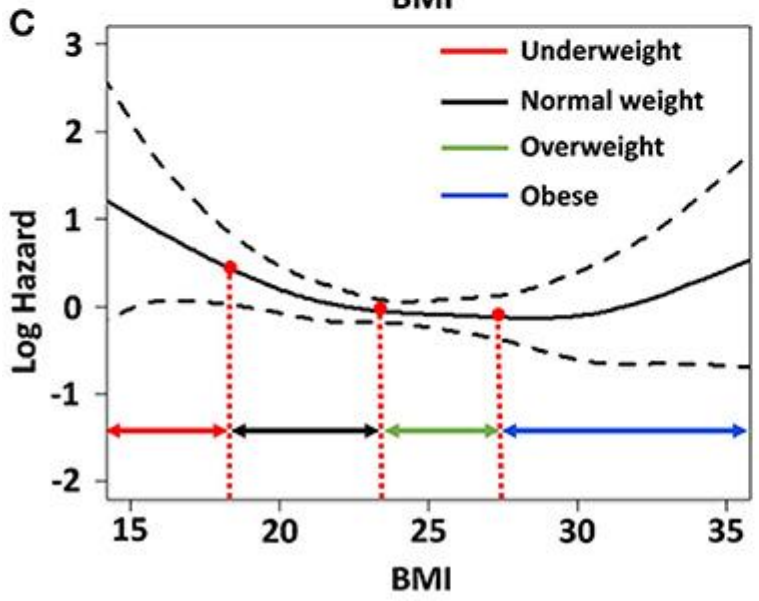
Relative hazards of body mass index (BMI) on CVD outcomes after adjustment

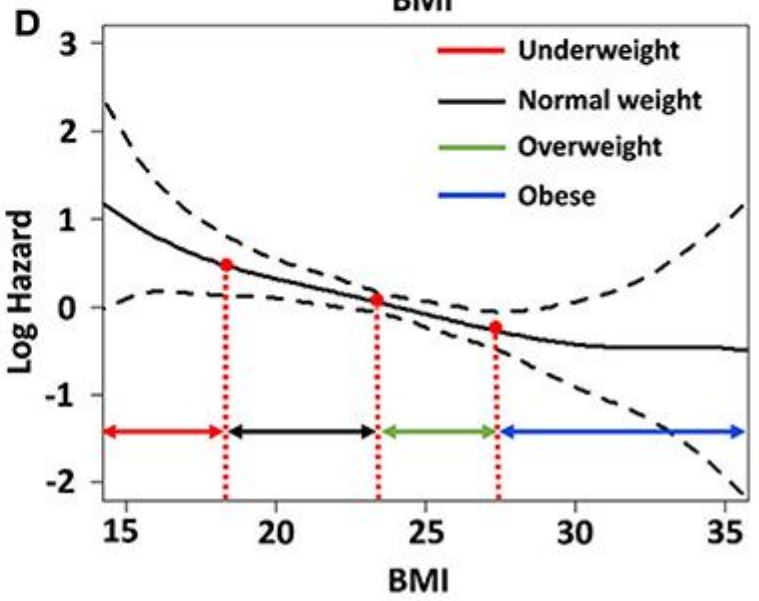
all-cause mortality



fatal stroke

fatal CV events





other-cause mortality

The definition of Obesity

- a " chronic, relapsing, multi-factorial, neurobehavioral disease, wherein an increase in body fat promotes adipose tissue dysfunction and abnormal fat mass physical forces, resulting in adverse metabolic, biomechanical, and psychosocial health consequences."

The Obesity Medicine Association,

3 Questions about BMI

1. First, is BMI a good measure of excess adiposity in an individual patient ?
2. Second, does BMI provide information about body fat distribution, which is a more important predictor to the risk of obesity related consequences than the BMI itself?
3. Finally, does BMI provide any insights into the heterogeneity of obesity or its genetic, metabolic, physiological or psychological origins?

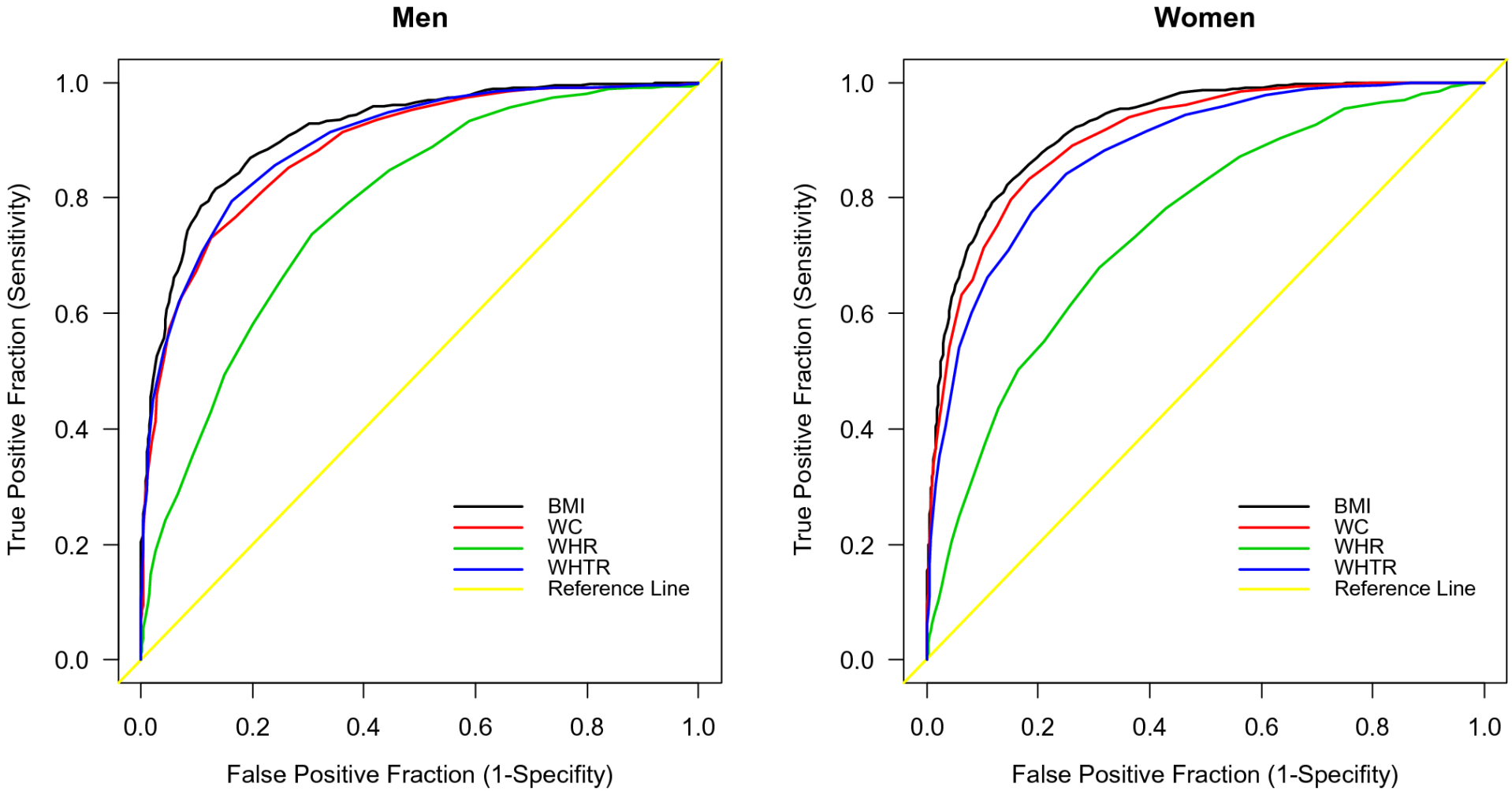
Correlations between body mass index/percent body fat and blood pressure, glucose and lipids.

	Body mass index		Percent body fat	
	Correlation coefficient	Partial correlation coefficient	Correlation coefficient	Partial correlation coefficient
SBP (mmHg)	0.403†	0.071†	0.098†	-0.006
DBP (mmHg)	0.409†	0.054†	0.075†	0.008
FPG (mM)	0.249†	0.02	0.088†	0.038*
TC (mM)	0.169†	-0.019	0.112†	0.078†
TG (mM)	0.350†	-0.021	0.049†	0.051†
HDL-C (mM)	-0.432†	-0.063†	-0.003	-0.050†
LDL-C (mM)	0.189†	0.016	0.097†	0.079†

*P < 0.05 and †P < 0.01 (t-test). Confounding factors such as age, gender, lifestyle, and family history were adjusted in the partial correlation analysis

Braz J Med Biol Res. 2012;45(7):591–600

ROC curves for BMI, WC, WHR, and WHTR in screening for cardiovascular risk factors



Sci Rep. 2020;10:11253

Cut-off values for anthropometric indicators of obesity, based on optimal Body Fat % cut-offs for screening cardiovascular risk factors

	AUC (95% CI)	Optimal cut-off	Sensitivity (%)	Specificity (%)	Youden (%)	DLR (+)	DLR (−)	*P*
Men								
BMI	0.915 (0.902, 0.929)	28.1	81.6	86.6	68.1	6.1	0.2	0.000001
WC	0.887 (0.871, 0.903)	100.0	73.0	87.3	60.4	5.8	0.3	0.000001
WHR	0.781 (0.759, 0.803)	0.96	73.8	69.4	43.2	2.4	0.4	0.000001
WHTR	0.895 (0.880, 0.910)	0.57	79.5	83.6	63.1	4.9	0.2	0.000001
Women								
BMI	0.922 (0.913, 0.931)	27.5	83.3	84.5	67.8	5.4	0.2	0.000001
WC	0.905 (0.895, 0.915)	87.0	83.3	81.6	64.9	4.5	0.2	0.000001
WHR	0.747 (0.730, 0.764)	0.85	67.9	69.0	36.9	2.2	0.5	0.000001
WHTR	0.878 (0.866, 0.889)	0.54	84.1	75.1	59.1	3.4	0.2	0.000001

Sci Rep. 2020;10:11253

BF% in newly estimated non-obesity and obesity categories based on BMI, WC, WHR, WHTR, stratified by gender.

	Men			Women	
	BF < 25.8%	BF ≥ 25.8%		BF < 37.1%	BF ≥ 37.1%
BMI < 28.1	677 (82.0)	149 (18.0)	BMI < 27.5	1522 (87.1)	225 (12.9)
BMI ≥ 28.1	105 (13.7)	659 (86.3)	BMI ≥ 27.5	279 (20.0)	1,119 (80.0)
WC < 100.0	683 (75.8)	218 (24.2)	WC < 87.0	1,470 (86.7)	225 (13.3)
WC ≥ 100.0	99 (14.4)	590 (85.6)	WC ≥ 87.0	331 (22.8)	1,119 (77.2)
WHR < 0.96	543 (71.9)	212 (28.1)	WHR < 0.85	1,287 (73.3)	470 (26.8)
WHR ≥ 0.96	239 (28.6)	596 (71.4)	WHR ≥ 0.85	514 (37.0)	874 (63.0)
WHTR < 0.57	654 (79.8)	166 (20.2)	WHTR < 0.54	1,352 (86.3)	214 (13.7)
WHTR ≥ 0.57	128 (16.6)	642 (83.4)	WHTR ≥ 0.54	449 (28.4)	1,130 (71.6)

Int J Obes 2010 ;34(5):791-9

Odds ratios (and 95% CIs) for metabolic disorders using prediction models with BMI, WC, or both BMI and WC

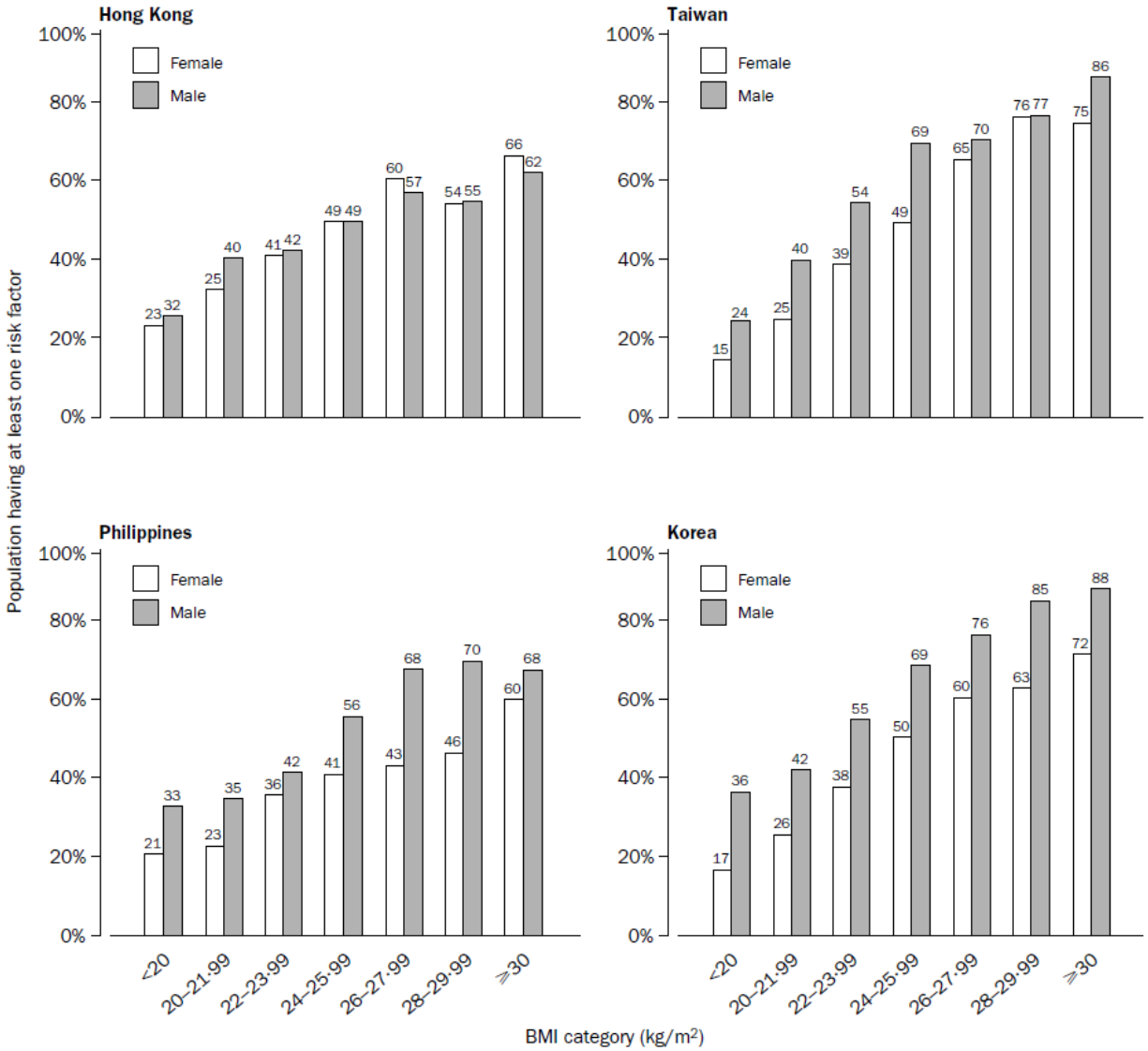
the 3rd National Health and Nutrition Examination Survey.

			BMI and WC	
	BMI alone	WC alone	BMI	WC
Men (n = 7385)				
Hypertension	1.13 (1.11, 1.15)[2]	1.04 (1.01, 1.05)[2]	1.06 (1.00, 1.12)[2]	1.03 (1.01, 1.05)[2]
Hypercholesterolemia	1.07 (1.04, 1.10)[2]	1.03 (1.02, 1.04)[2]	1.02 (0.97, 1.08)	1.02 (1.00, 1.04)[3]
High LDL cholesterol	1.16 (1.12, 1.90)[2]	1.02 (1.01, 1.14)[2]	1.03 (0.94, 1.13)	1.01 (0.99, 1.04)
Low HDL cholesterol	1.20 (1.17, 1.23)[2]	1.06 (1.05, 1.07)[2]	1.03 (0.98, 1.09)	1.05 (1.03, 1.07)[2]
High triacylglycerol	1.20 (1.17, 1.23)[2]	1.07 (1.06, 1.08)[2]	1.05 (0.99, 1.12)	1.05 (1.03, 1.08)[2]
Metabolic syndrome	1.20 (1.15, 1.25)[2]	1.07 (1.06, 1.08)[2]	1.07 (0.99, 1.18)	1.04 (1.02, 1.07)[2]
Women (n = 7539)				
Hypertension	1.13 (1.10, 1.15)[2]	1.05 (1.04, 1.06)[2]	1.02 (0.97, 1.07)	1.05 (1.03, 1.06)[2]
Hypercholesterolemia	1.08 (1.06, 1.10)[2]	1.03 (1.03, 1.04)[2]	1.00 (0.97, 1.04)	1.03 (1.02, 1.05)[2]
High LDL cholesterol	1.08 (1.04, 1.11)[2]	1.04 (1.02, 1.05)[2]	0.97 (0.92, 1.02)	1.05 (1.02, 1.07)[2]
Low HDL cholesterol	1.11 (1.08, 1.13)[2]	1.04 (1.02, 1.05)[2]	1.03 (0.99, 1.08)	1.03 (1.01, 1.05)[2]
High triacylglycerol	1.13 (1.11, 1.15)[2]	1.06 (1.05, 1.07)[2]	0.96 (0.92, 1.00)	1.08 (1.08, 1.09)[2]
Metabolic syndrome	1.15 (1.12, 1.19)[2]	1.06 (1.05, 1.08)[2]	1.01 (0.95, 1.07)	1.06 (1.04, 1.09)[2]

The ORs were adjusted for age, race, physical activity, smoking, alcohol intake, and the poverty-to-income ratio

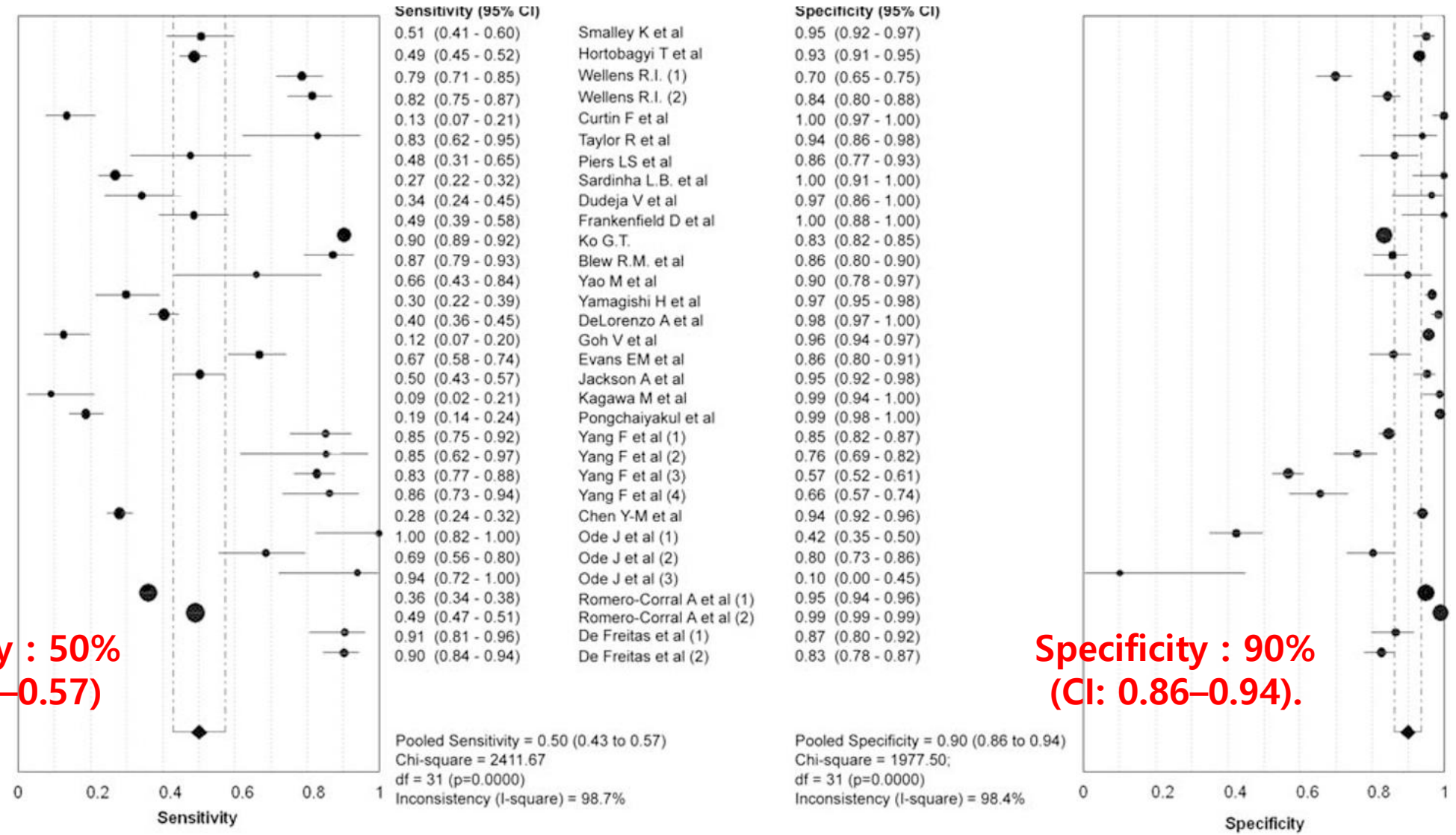
Am J Clin Nutr 2004; 79: 379–384

Proportion of population in various body-mass index (BMI) categories with at least one risk factor for cardiovascular disease in Asians



Lancet 2004;363(9403):157-63

Pooled sensitivity and specificity of BMI to identify obesity in Meta-analysis



Sensitivity : 50%
(CI: 0.43–0.57)

Specificity : 90%
(CI: 0.86–0.94).

Int J Obes 2010 ;34(5):791-9

BMI and Variance in body fat

Multiple regression analysis of body fat percentage versus body mass index, age, sex, and ethnicity for the total study population, New York City, 1986-1992

Regression coefficients					SEE	r^2†
Body mass index	Age	Sex‡	Ethnic group§	Intercept		
Mean ± SE†	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE		
1.34 ± 0.07**				−6.07 ± 2.12*	8.48	0.26
1.23 ± 0.08**	0.15 ± 0.02**			−10.77 ± 2.07**	8.04	0.34
1.46 ± 0.06**	0.12 ± 0.01**	−11.61 ± 0.44**		−10.02 ± 1.46**	5.68	0.67
1.47 ± 0.06**	0.12 ± 0.01**	−11.61 ± 0.44**	−0.22 ± 0.49	−10.13 ± 1.48**	5.68	0.67

* $p < 0.01$; ** $p < 0.0001$.
† r^2, explained variance of the model; SE, standard error; SEE, standard error of the estimate.
‡ 0 = female; 1 = male.
§ 0 = white, 1 = black.

Body mass index alone accounted for only **25%** of the variance in body fat in men and in women

Am. J. Epidemiol. 1996; 143: 228–239

Uses and limitations of the BMI

Measurement	Value Rating
Estimation of body weight	****
Tracking population weight	****
Estimation of body fat	**
Estimating distribution of fat	0
Use in genetic studies	**
Pathophysiology of obesity	0
Phenotyping obesity	0

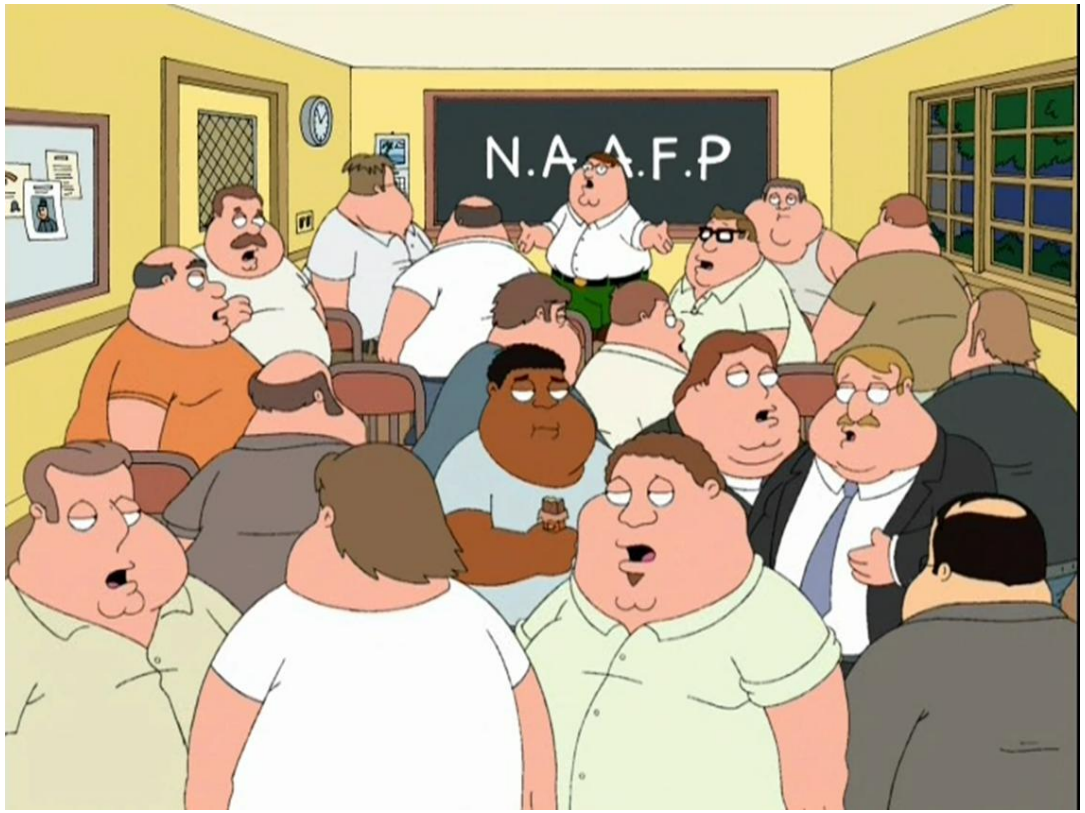
0 = not useful information; ** = some useful information; **** = valuable.

Nutrients 2023 ;15(10):2254

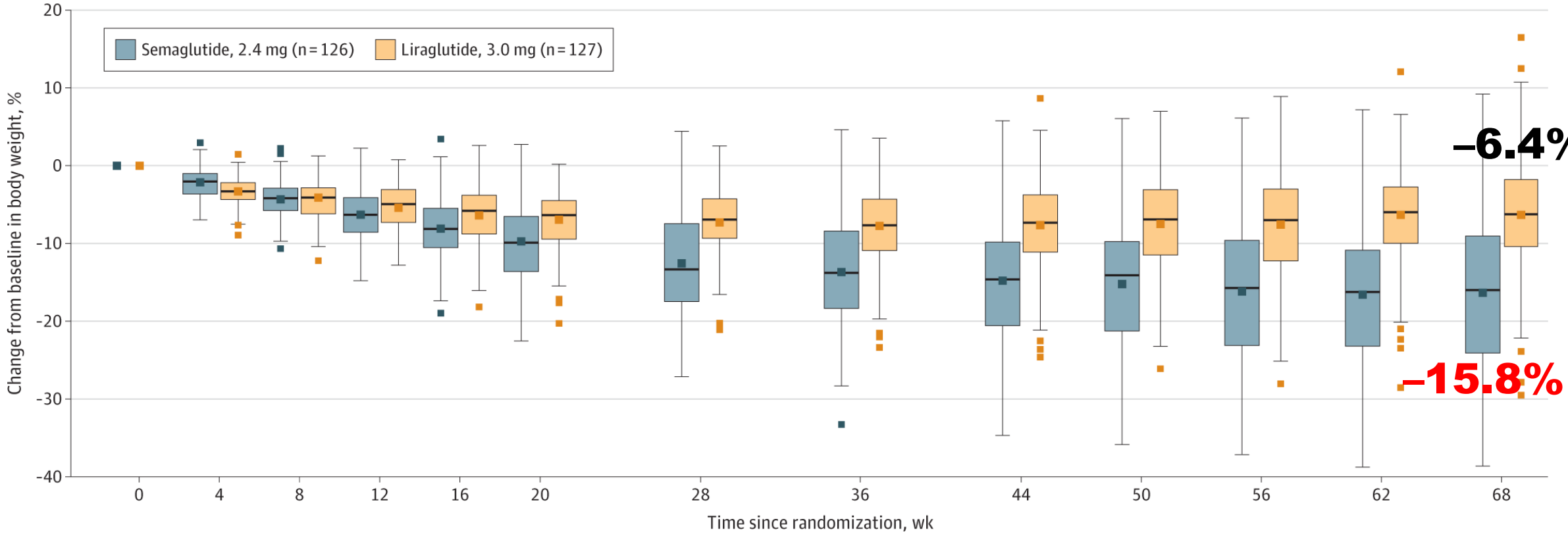
3 issues originated from BMI

1. The BMI has only a fair not a precise correlation with body fat mass.
2. BMI does not provide any indication of how body fat is distributed.
3. the BMI tells us nothing about the genetic, metabolic, physiological or psychological factors involved in the development of obesity.

Obesities, beyond BMI



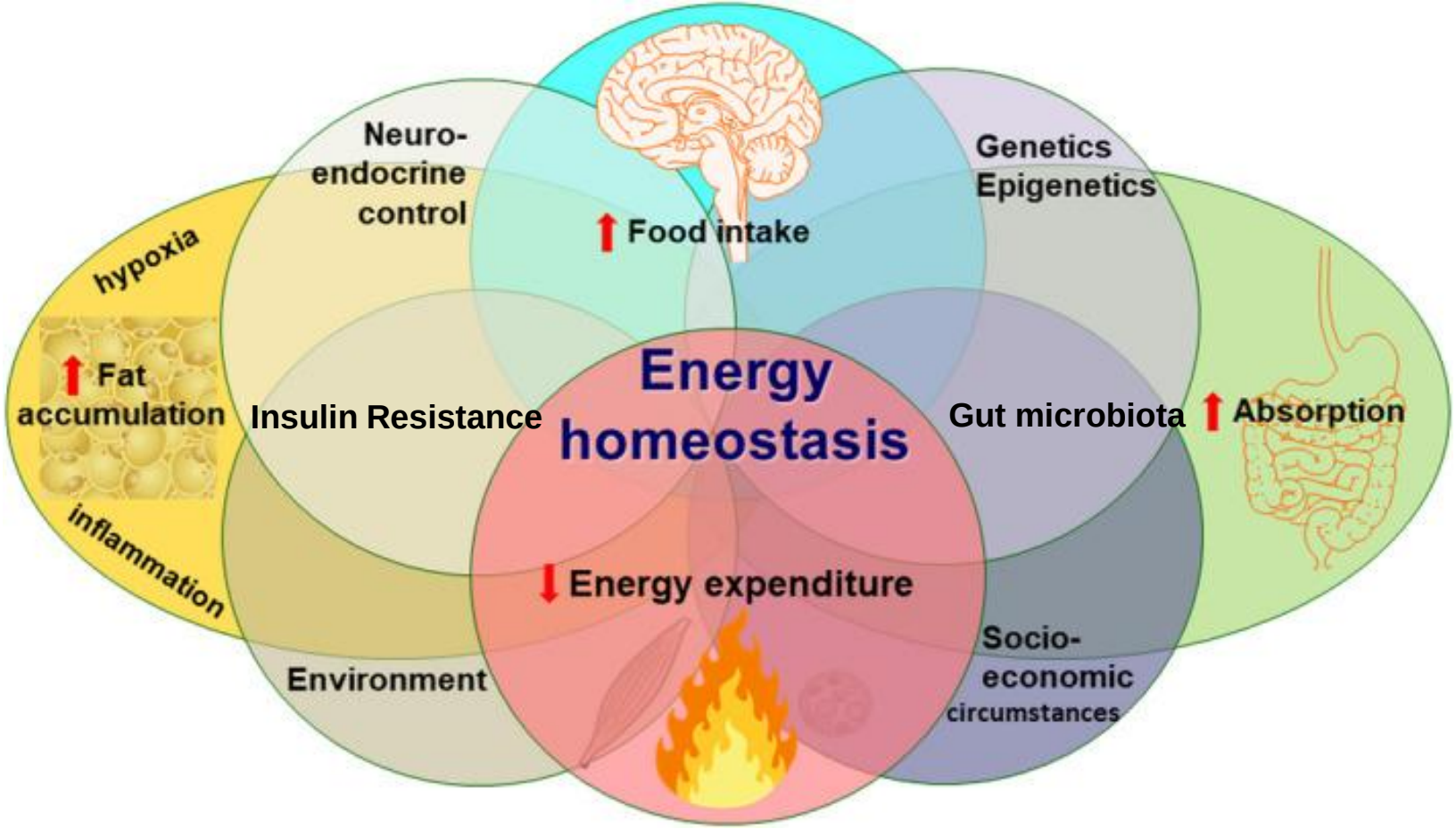
STEP 8 – Body Weight change (% on ITT)



No. of participants													
Semaglutide, 2.4 mg	126	125	122	124	117	102	76	105	114	107	107	92	117
Liraglutide, 3.0 mg	127	124	124	125	118	101	66	102	99	98	110	88	117

JAMA. 2022;327(2):138-150

Complex pathophysiology of Excessive Adiposity

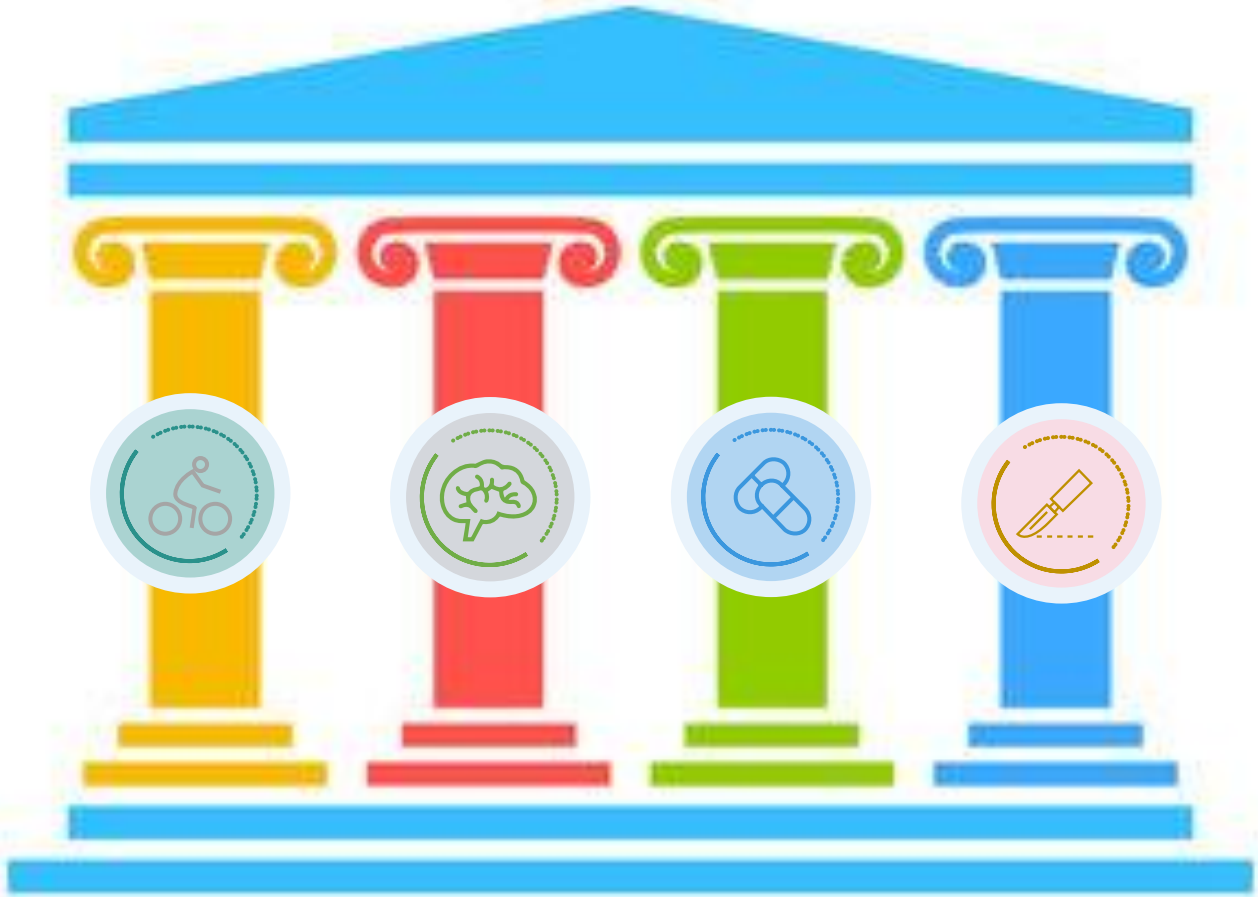


Eur J Clin Invest. 2022 ;52(7):e13811

4 pillars of Obesity Management

Lifestyle change
Diet & Exercise

Behavioral
Interventions
: ~5% weight loss



Pharmacotherapy
: ~5–15% weight loss

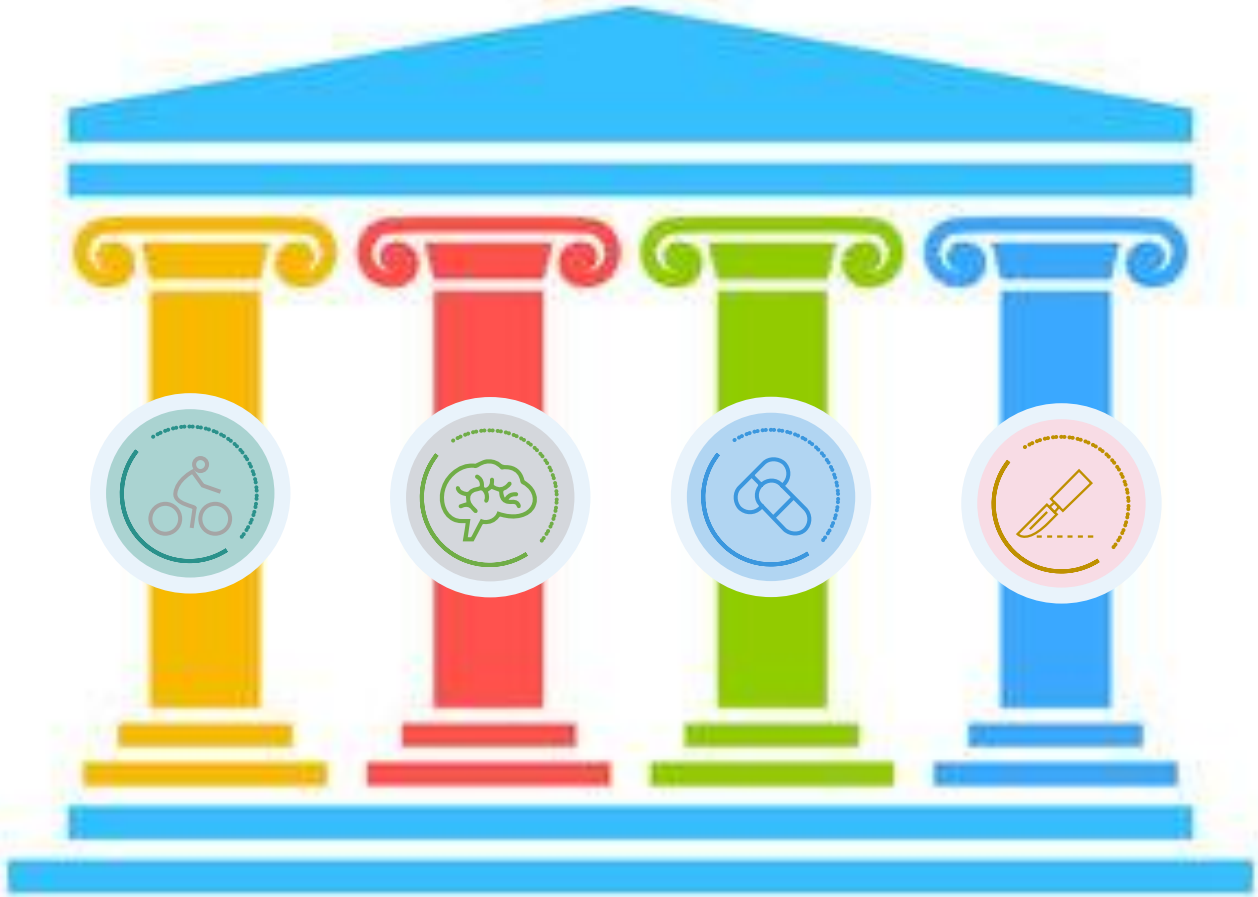
Surgical
Interventions
: ~12–30% weight loss

Variety in phenotypes of Weight Gain

4 pillars of Obesity Management

Lifestyle change
Diet & Exercise

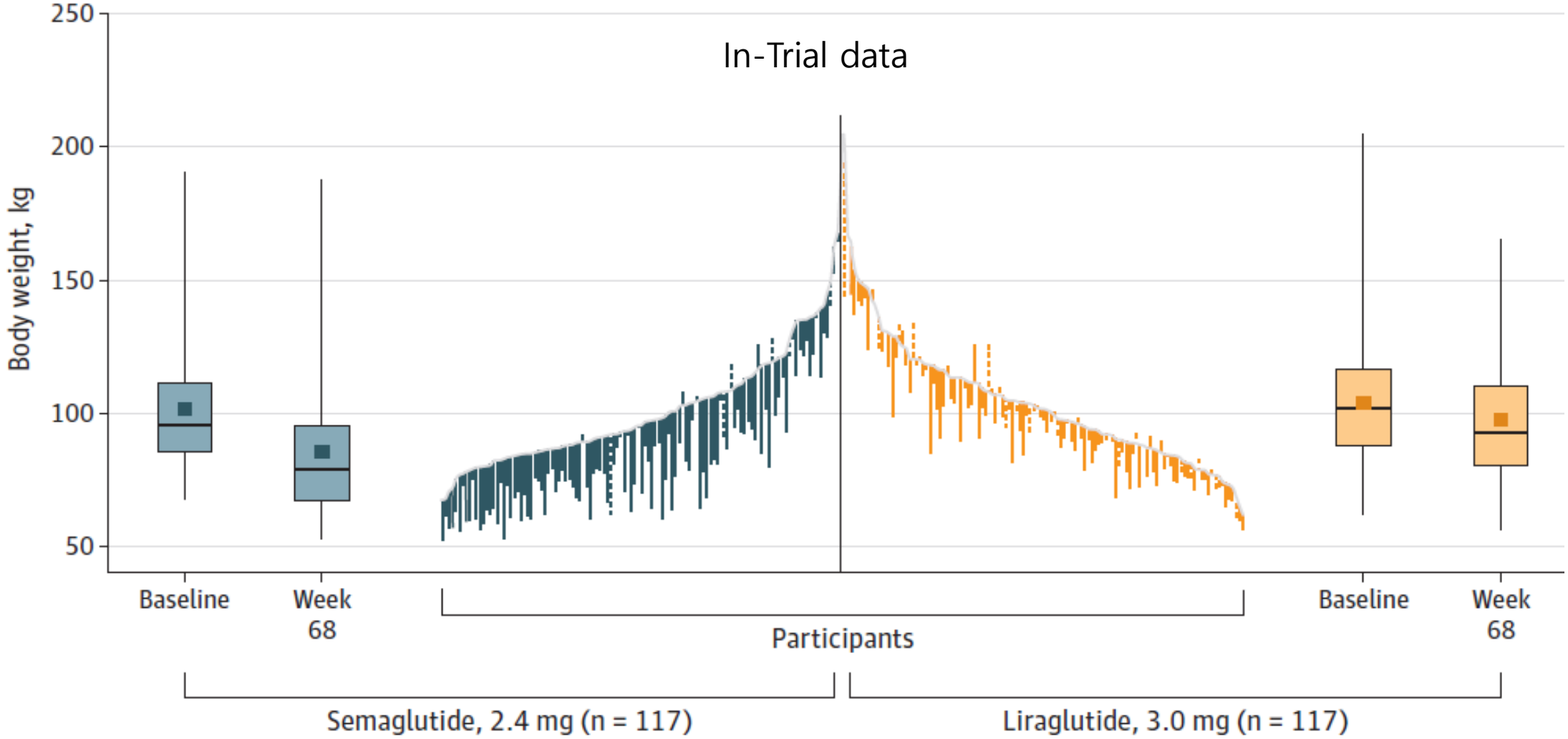
Behavioral
Interventions
: ~5% weight loss



Pharmacotherapy
: ~5–15% weight loss

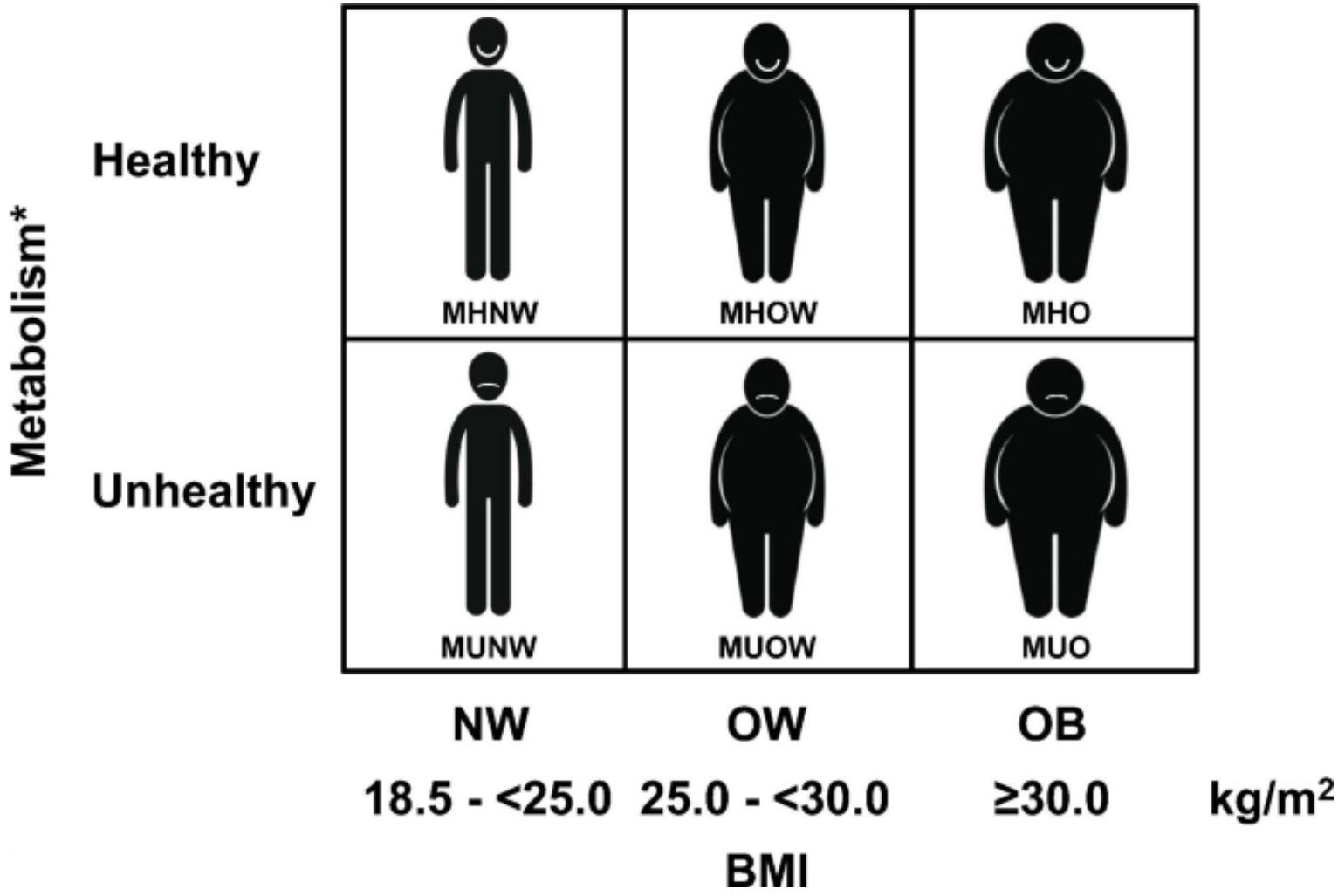
Surgical
Interventions
: ~12–30% weight loss

Change in Absolute Body Weight From Baseline to Week 68 for Individual Participants : STEP 8 trial

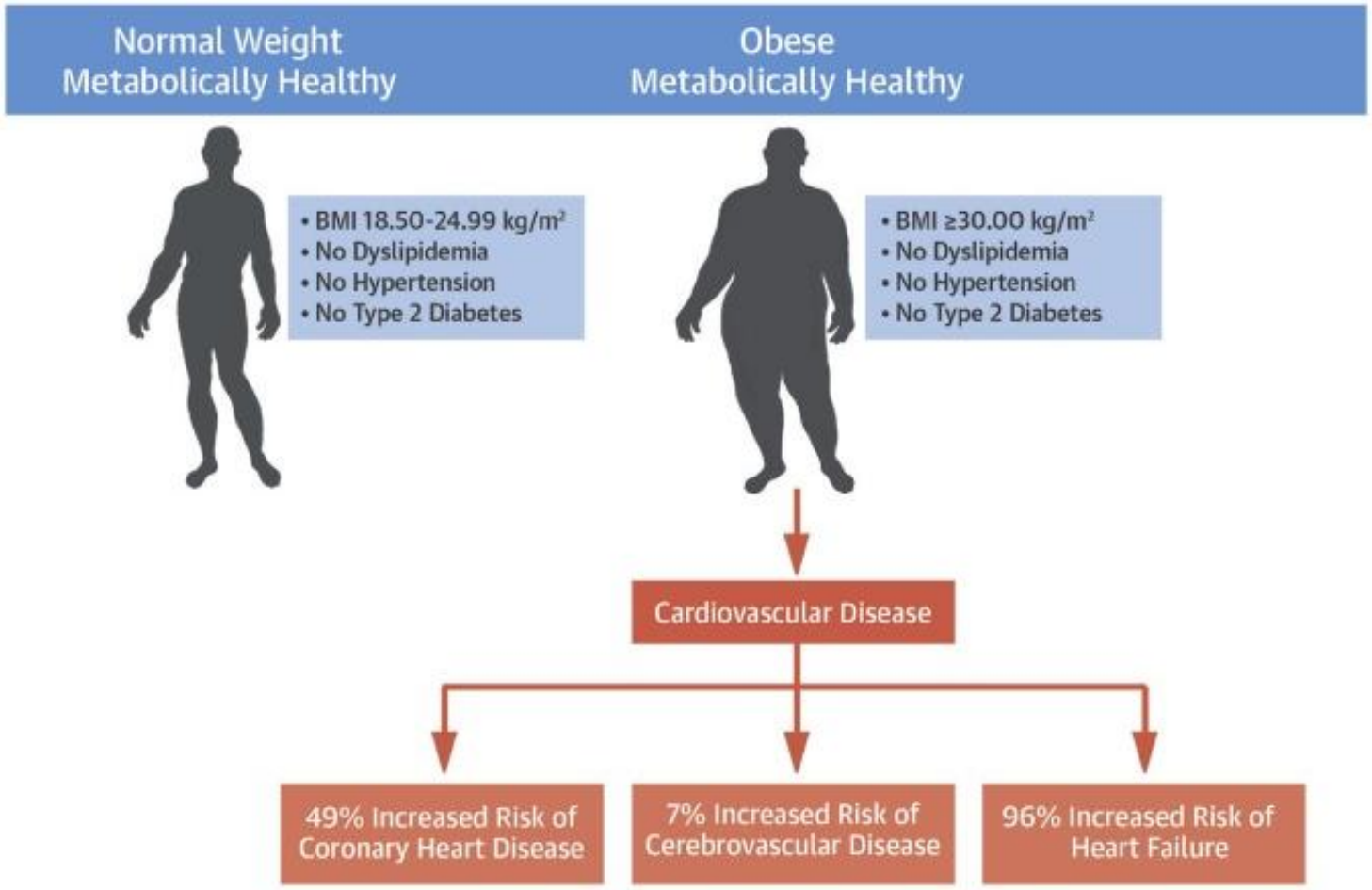


JAMA. 2022;327(2):138-150

Metabolic phenotype of Obesity



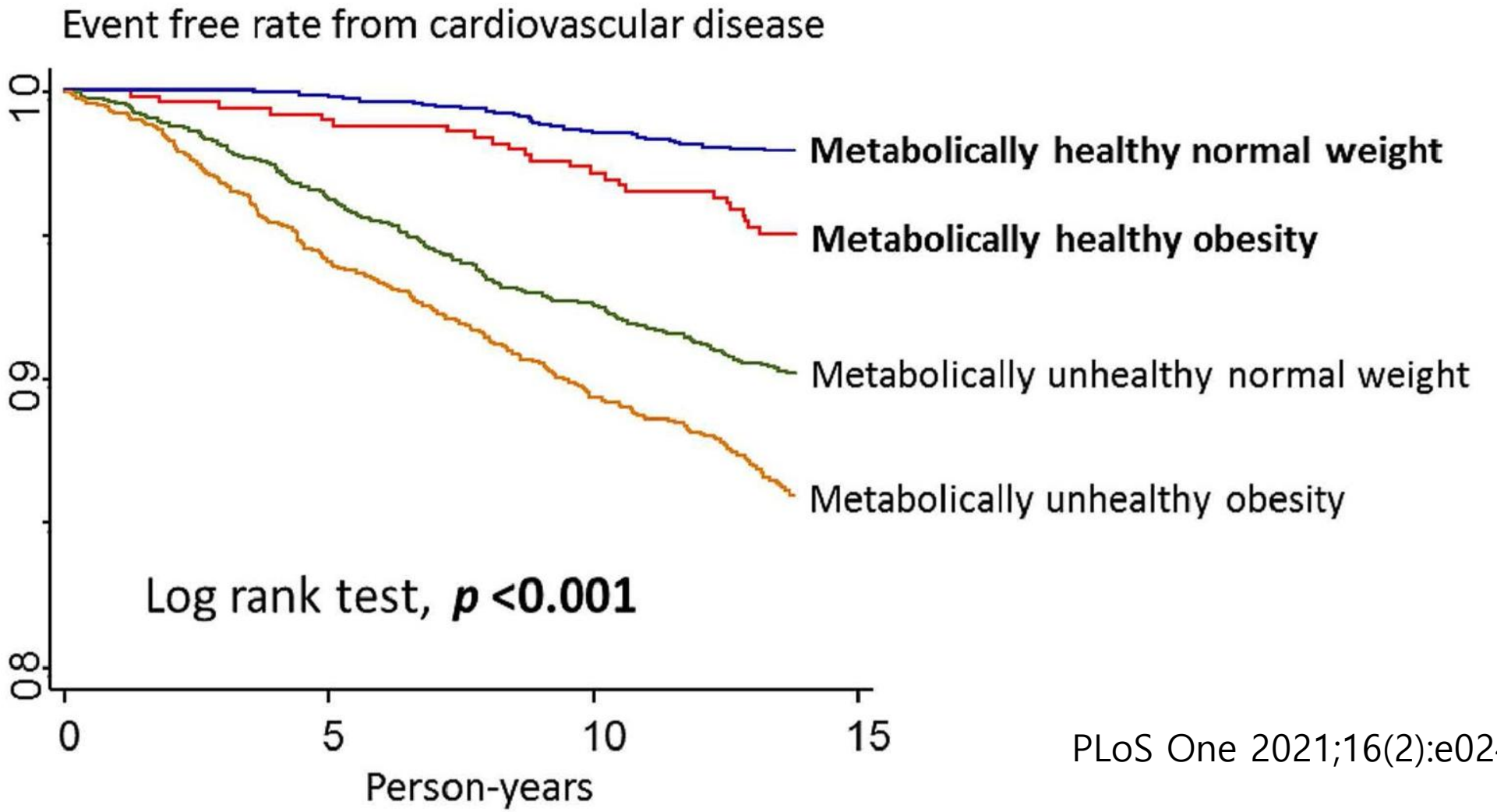
Metabolically Healthy Obese and Incident Cardiovascular Disease Events



J Am Coll Cardiol. 2017 ;70(12):1429-1437.

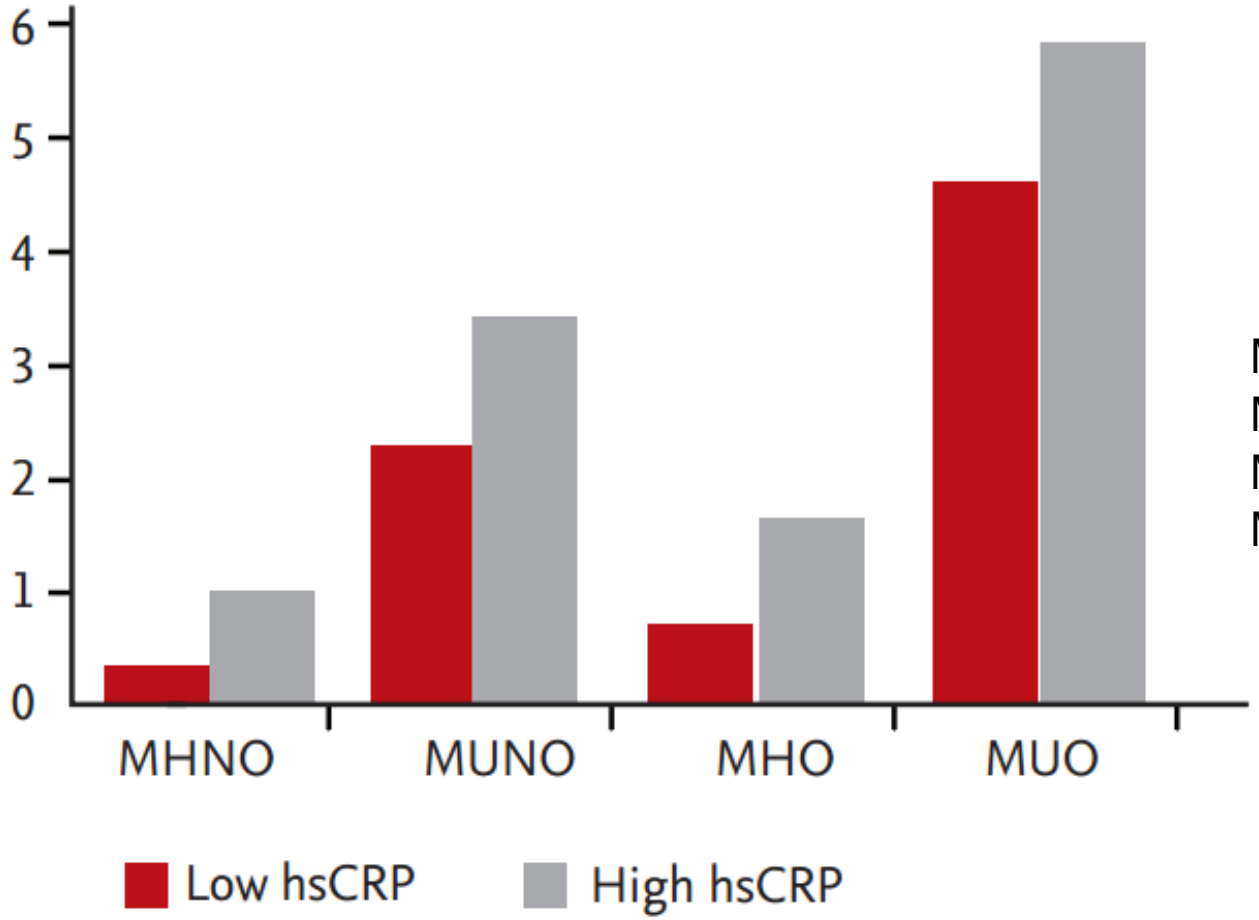
Association between metabolically healthy obesity/overweight and cardiovascular disease risk

A representative cohort study in Taiwan



PLoS One 2021;16(2):e0246378

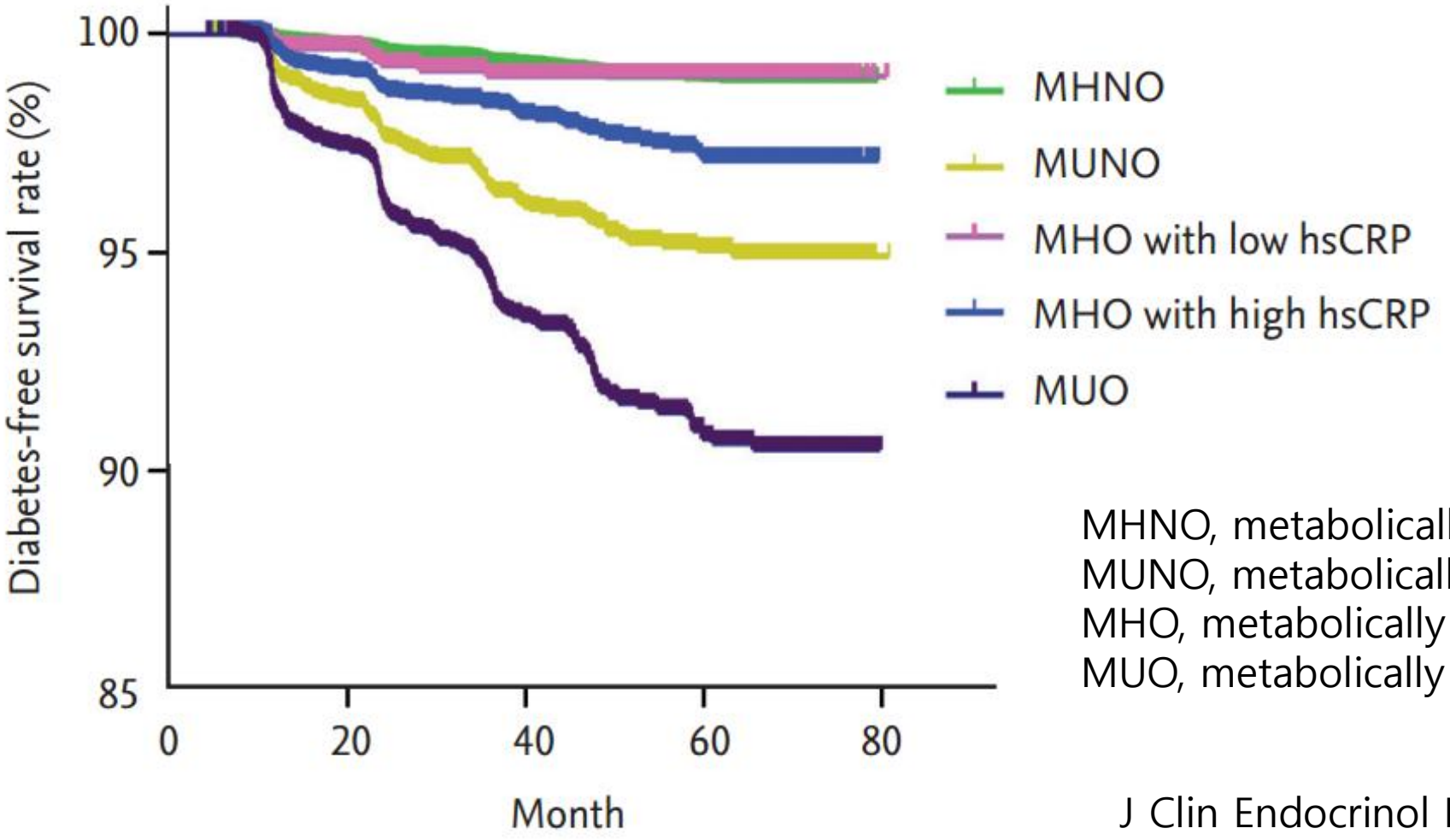
Interaction of low grade inflammation and obesity in the development of type 2 DM



MHNO, metabolically healthy non-obesity
MUNO, metabolically unhealthy non-obesity
MHO, metabolically healthy obesity
MUO, metabolically unhealthy obesity

J Clin Endocrinol Metab 2015;100:934–941.

Interaction of low grade inflammation and obesity in the development of type 2 DM



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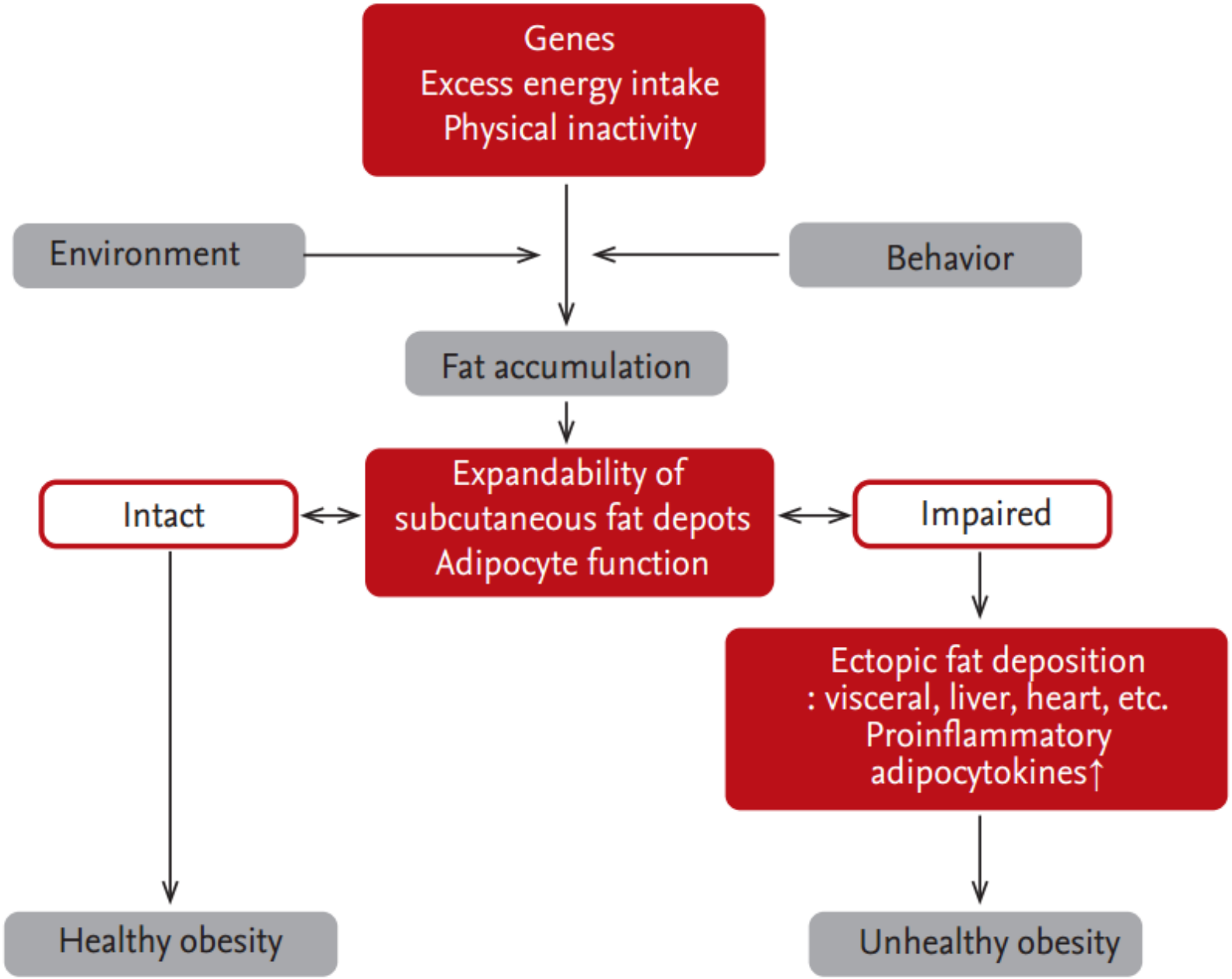
J Clin Endocrinol Metab 2015;100:934–941.



Korean J Intern Med. 2017 ;32(4):611-621

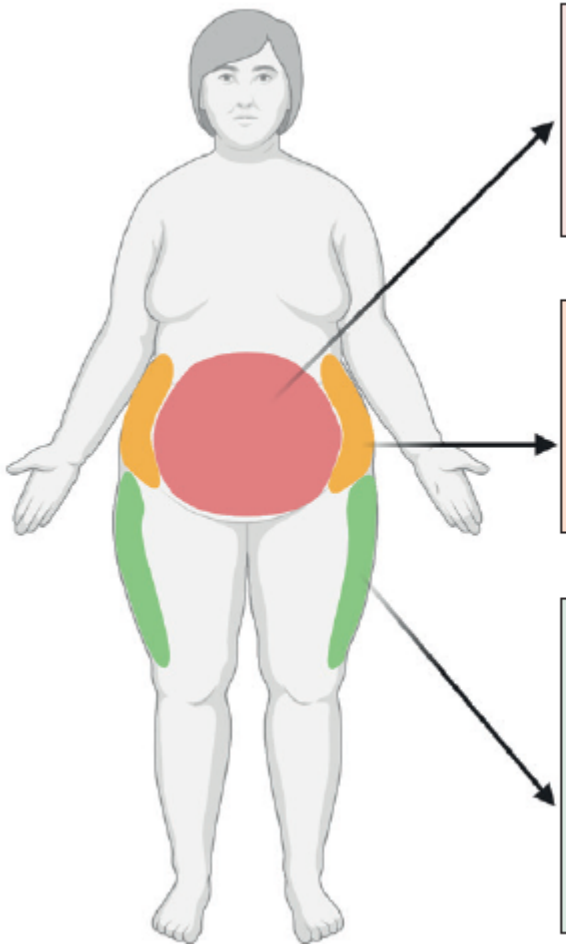
Genetic phenotype of Obesity

Association of selected GLP-1R polymorphisms with response to liraglutide

Polymorphism	Genotype	Poor responders $N=37$ N (%)	Strong responders $N=20$ N (%)	OR (95 % CI)	P
rs10305420	CC	12 (48.0)	13 (52.0)		
	CT+TT	24 (77.4)	7 (22.6)	0.27 (0.09–0.85)	0.025
rs6923761	GG	21 (77.8)	6 (22.2)		
	GA+AA	16 (53.3)	14 (46.7)	3.06 (0.96–9.74)	0.058

Eur J Clin Pharmacol. 2015;71(7):817-24.

Associations of specific adipose tissue depots with metabolic consequences and distinct genetic loci



VAT
- VAT volume substantially higher in males
- VAT adj associated with increased risk of type 2 diabetes and coronary artery disease

VATadj loci
AMBRA1, CEBPA, CEBPA-DT*, CPEB4, EBF2, GPR158, HLA-B, HLA-DQB1, HLA-DRB5, JAZF1, LINC00310, LINC01101, LINC01948, LINC02953, MTOR, PEPD, PIK3C2B, PNKD, WT1-AS

ASAT
- ASAT volume substantially higher in females
- ASAT adj associated with neutral risk of type 2 diabetes and coronary artery disease

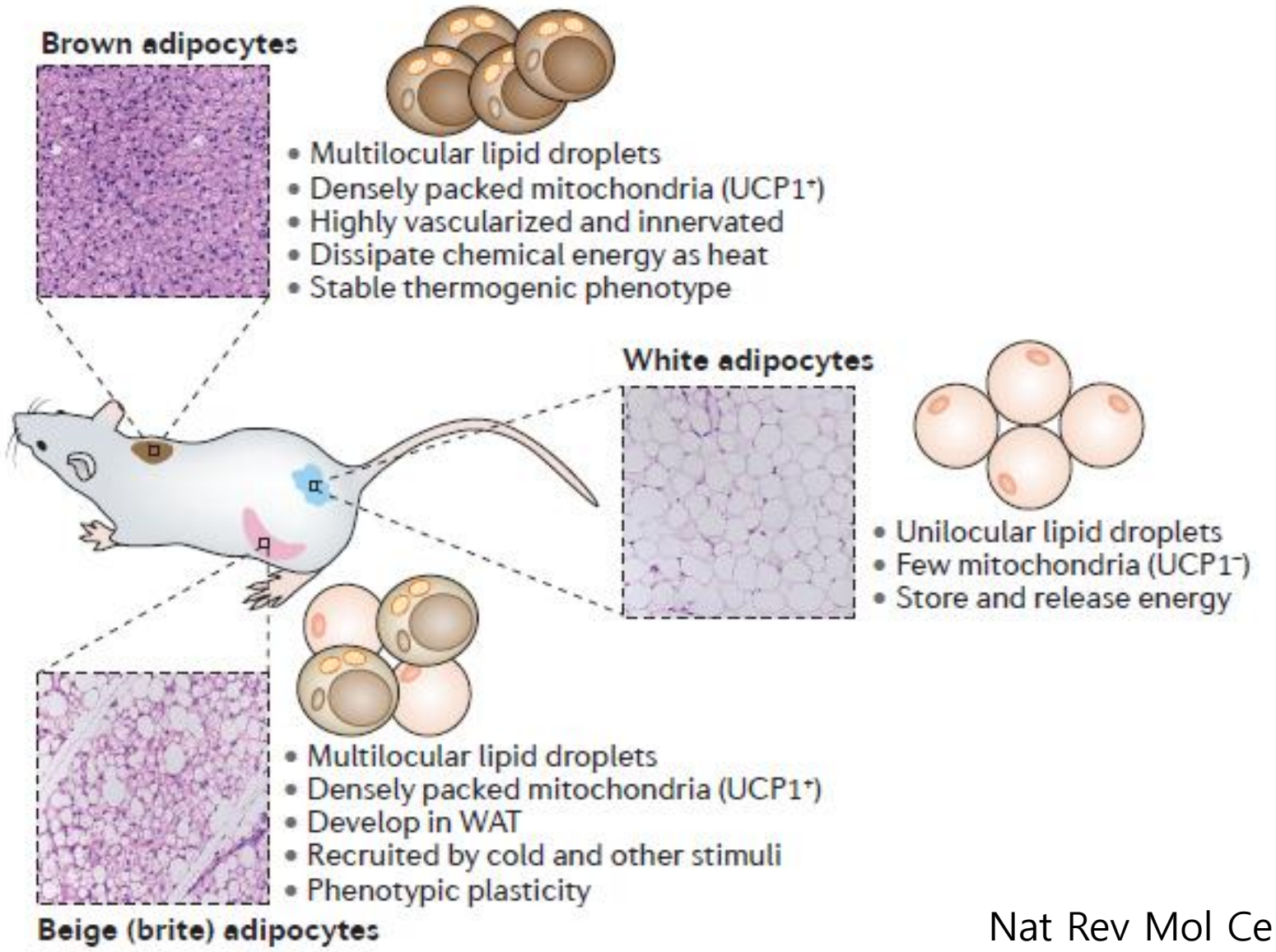
ASATadj loci
ADAMTSL3, ARL17A, ARL17B, CACNA1S, CENPW, DMRT2, FST, KLF14, LINC01230, MIR6085, OPTC, PDE4C, SOCS3, TBX15, UBE2Q2P1

GFAT
- GFAT volume substantially higher in females
- GFAT adj associated with decreased risk of type 2 diabetes and coronary artery disease

GFATadj loci
ABCA1, CCDC92, COBLL1†, COLEC11, DLG1, EYA1, FAM13A, FGF2, FGFR2, GTF2H3, H6PD, HOXC13, ITPR2, KAT5, KNTC1, LINC01214, LINC02227, LINC02537, LOC101928306, LOC646736, LY86, MAFB, MAFF, MTMR11, NYAP2, OSMR-DT, PDCL2, PDGFC, PEMT, PEPD, PLCB3, PPARG, PRKAG3, PRR5L, SETD2, SHBG, SLC44A1, SMIM20, SSPN

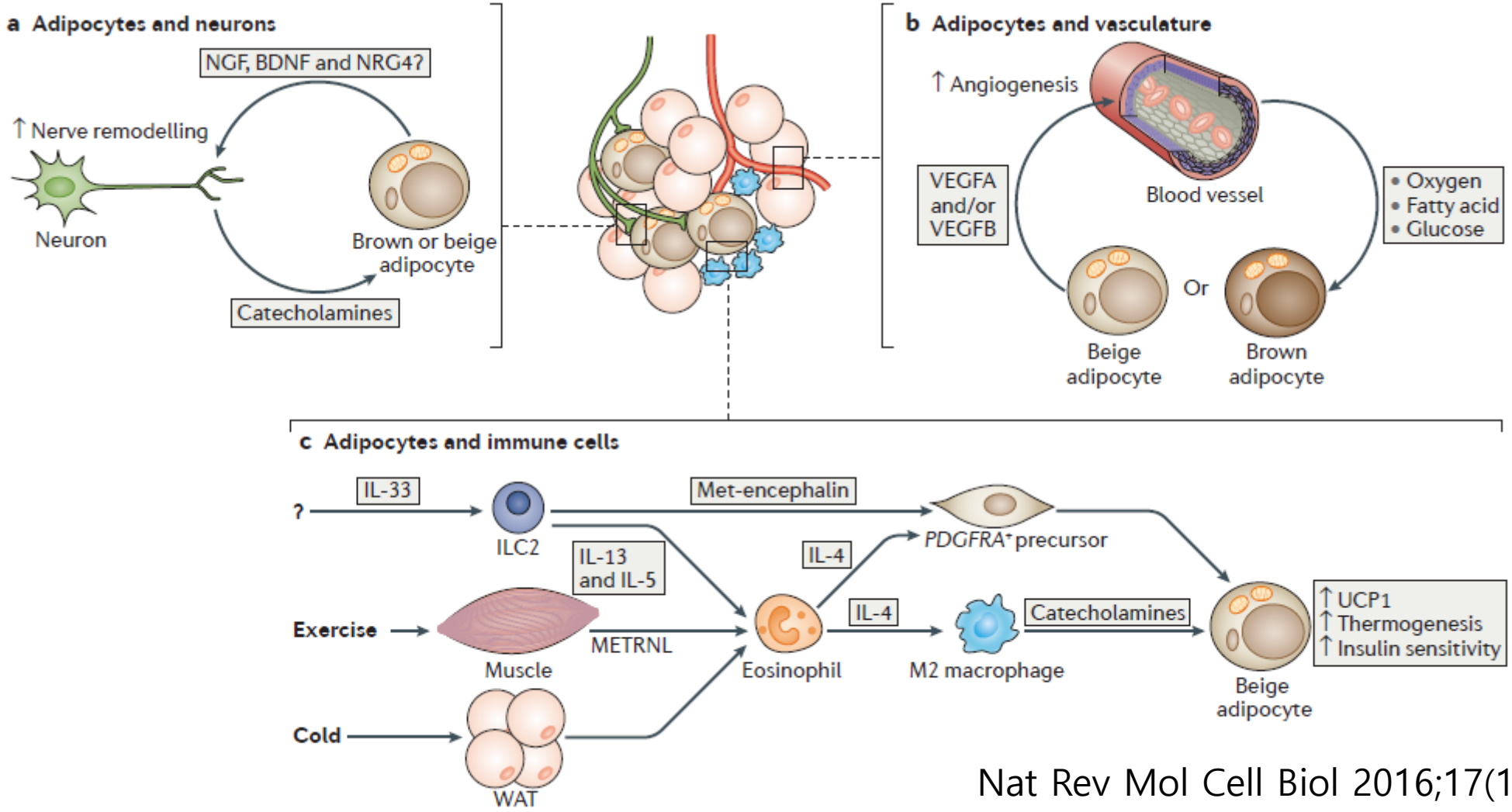
Lancet Diabetes Endocrinol 2023;11(11):861-878

3 types of Adipocyte : brown, white and beige.



Nat Rev Mol Cell Biol 2016;17(11):691-702

Crosstalk between brown and/or beige adipocytes and other adipose-resident cells



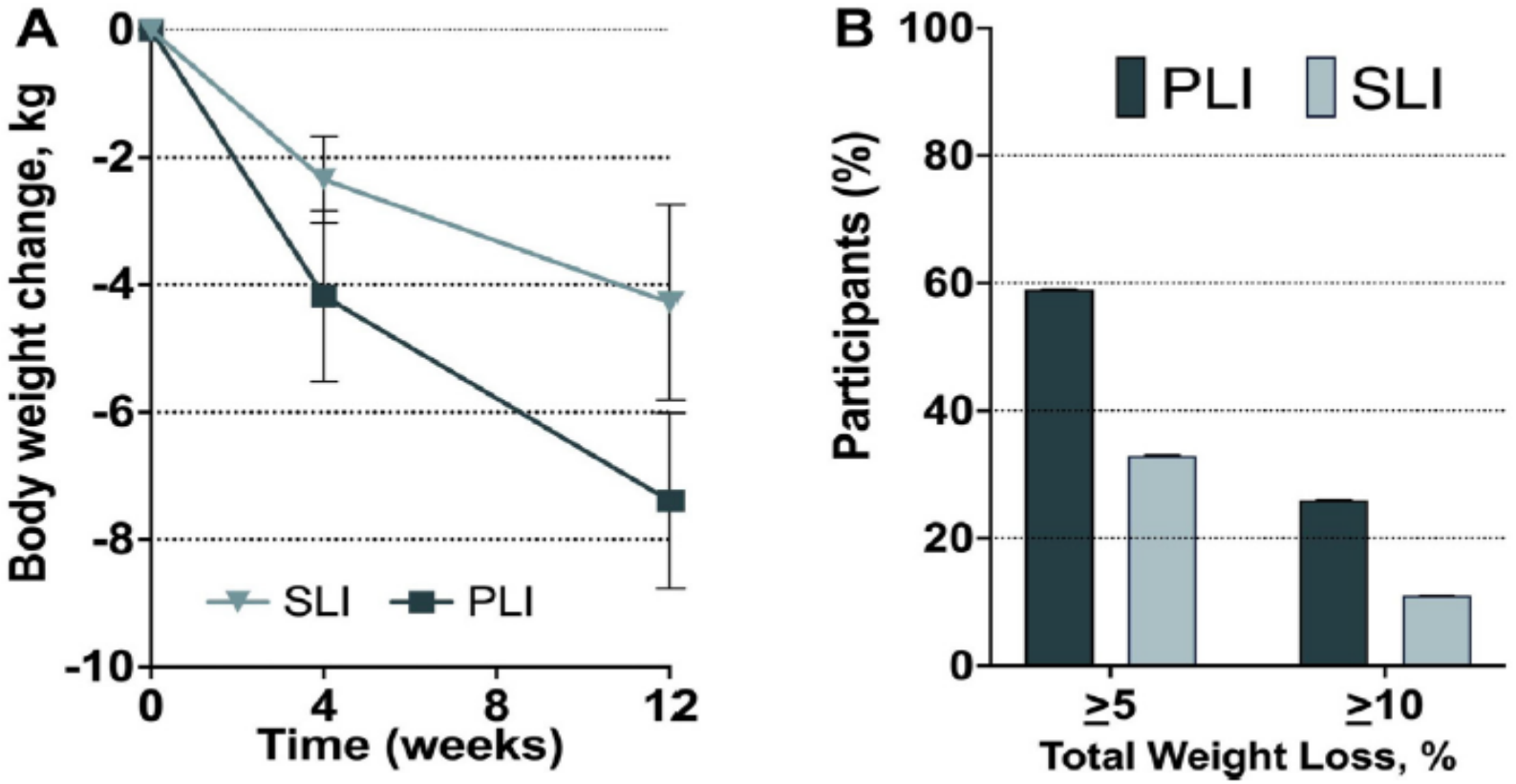
Nat Rev Mol Cell Biol 2016;17(11):691-702

Functional Phenotypes of Obesity

	Hungry brain	Emotional hunger	Hungry gut	Slow burn
				
Main obesity phenotype	Abnormal satiation*	Abnormal hedonic eating†	Abnormal satiety‡	Low predicted energy expenditure
Features (compared with a non-phenotype group)	• Consume 62% more calories before reaching fullness	• 2·3 times higher anxiety levels	• 31% faster gastric emptying rate	• 12% lower predicted resting energy expenditure • Reduced muscle mass • Less active
Proposed targeted LIFESTYLE therapy	• Time-restricted eating	• Low-calorie diet with intensive behavioural group therapy	• Low-calorie diet with pre-meal protein supplements	• Low-calorie diet with post-workout protein supplementation and high-intensity interval training
Proposed targeted PHARMACOTHERAPY	• Phentermine plus topiramate extended release	• Oral naltrexone plus bupropion sustained release	• Liraglutide	• Phentermine

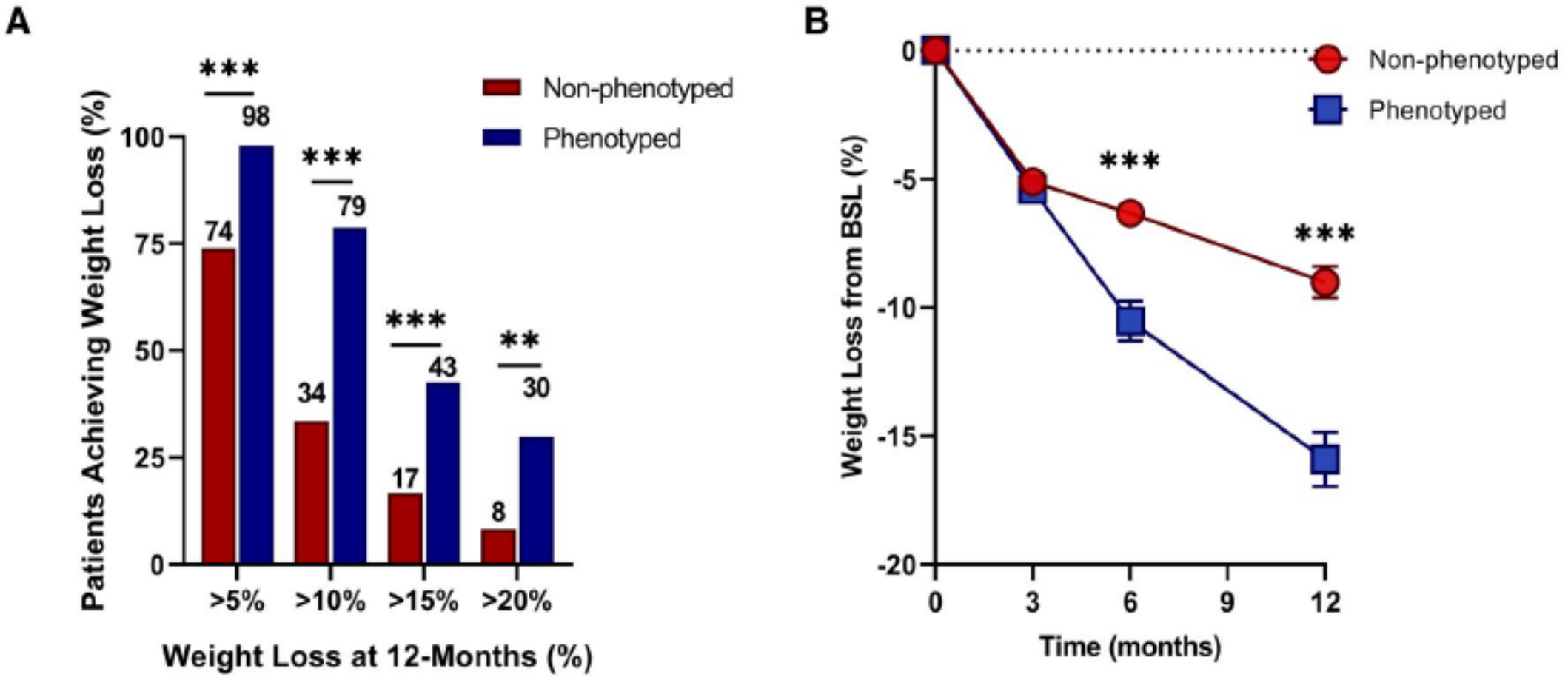
Lancet Diabetes Endocrinol 2023;11(11):861-878

Total Body Weight loss (kg) in standard lifestyle intervention (SLI) and the phenotype-tailored lifestyle intervention (PLI).



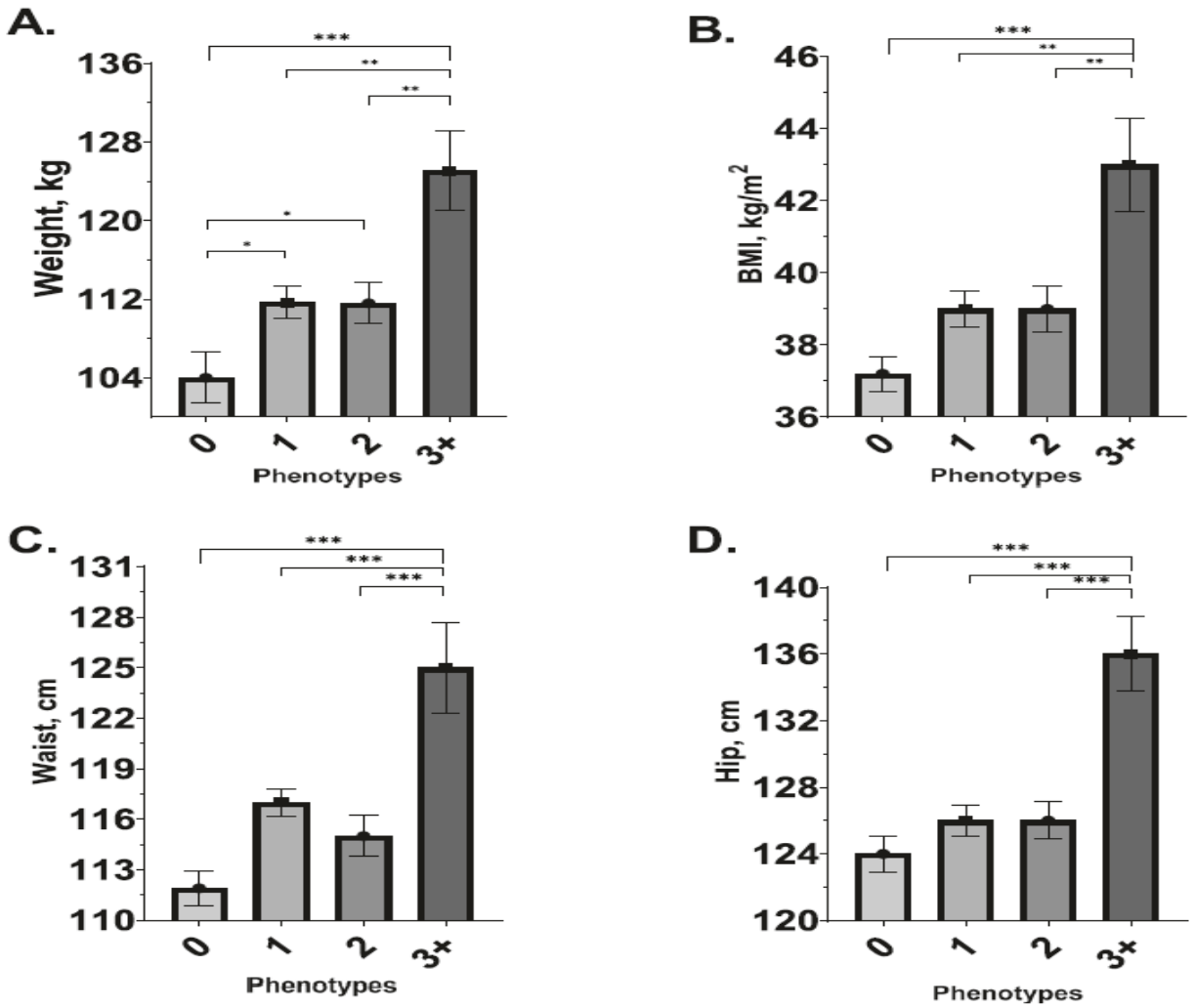
EClinicalMedicine. 2023;58:101923

Phenotype Guided pharmacotherapy for obesity management improves weight loss outcomes



Obesity (Silver Spring). 2021;29(4):662-671.

Cumulative effect of obesity phenotypes on body weight and body mass index



Int J Obes (Lond) 2024;48(6):884-890

Clinical Obesity,
Obesity addressed in clinical practice

Obesity Controversy

A Disease? vs A Risk Factor?

Obesity Controversy

A Disease? vs A Risk Factor?

Medical Treatment

Encouraging unhealthy behaviours

Financial Burden

Social responsibility

Social Stigma – disability

Life style intervention

Promoting healthy life

Financial freedom

Individual responsibility

Self-efficacy

The recognition of obesity as a disease

- associated with

1. distinct pathophysiological alterations of tissues and organs
2. discrete clinical signs and symptoms
3. increased risk of secondary complication ,
4. restrictions of daily activities.

NOT just with the number of BMI

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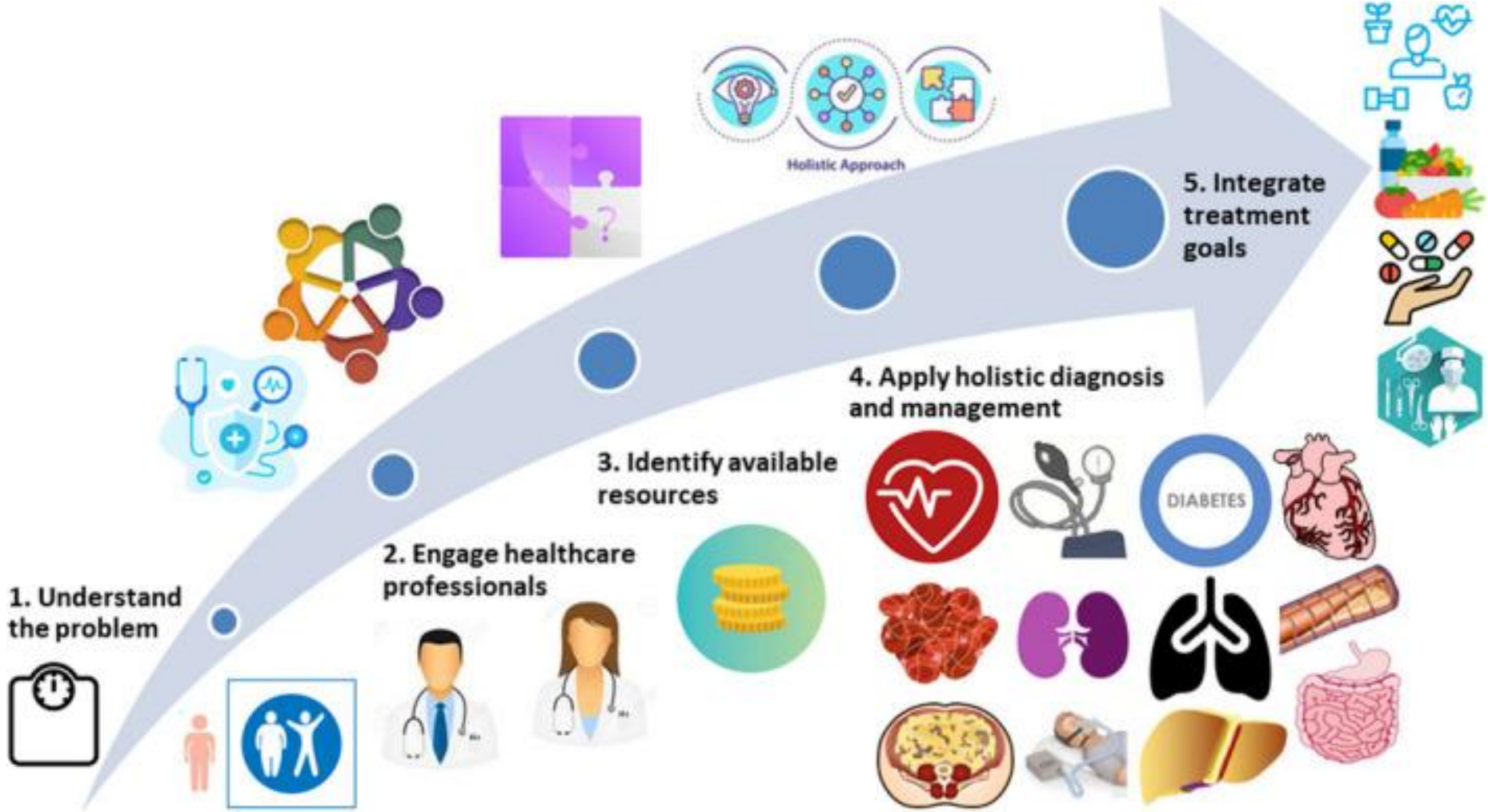
Setting up Clinical Obesity Paradime



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CREATING A NEW HOLISTIC DIAGNOSTIC FRAMEWORK

Lancet Diabetes & Endocrinology Commission on the Definition and Diagnosis of Clinical Obesity

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Obesity was first recognised as a disease by WHO in 1948, then between 2013 and 2022 by several medical societies and countries.[1–8] However, the notion that obesity is a disease and not merely a risk factor for other illnesses remains highly controversial, both within and beyond medical circles. This debate constitutes far more than arcane semantics, and seriously affects the provision of therapeutic strategies to improve health among people living with obesity.

On one side of the controversy, there is concern that defining obesity as a disease could have negative ramifications on individuals who have obesity and on society overall, by minimising the role of individual responsibility, thereby encouraging unhealthy behaviours and undermining efforts to tackle the increasing rates of obesity globally. Such arguments might, in part, reflect current intrinsic weight bias and stigma in our societies. Some experts also point to the fact that although a BMI in the traditional obesity range (ie, ≥27·5 kg/m^2 for people of Asian origin or >30·0 kg/m^2 for everyone else[1]) is well known to be associated with increased risk of illness and death, a risk factor per se is not a disease. Indeed, and overdiagnosis of obesity. In our opinion, the risk of overdiagnosis is a legitimate concern, especially for policy makers, because a blanket definition of obesity as a disease would classify approximately 30–40% of people in many nations as having this illness.[9] This definition could render over a third of these populations suddenly eligible for claims of disability or expensive treatments. Such claims would effectively make obesity a financially and socially intractable issue. In summary, there is apprehension within and outside the medical profession that categorising obesity as a disease could unnecessarily medicalise the problem, undermining adherence to healthy lifestyles and potentially resulting in unwarranted use of drugs, medical technologies, and surgical procedures, with staggering economic and societal costs.

On the other side of the controversy, those who support the recognition of obesity as a disease cite evidence that the condition, like any other chronic disease state, is associated with distinct pathophysiological alterations of tissues and organs, discrete clinical signs and symptoms, increased risk

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The 4 conditions of New diagnostic Framework for Clinical Obesity

1. New diagnostic tools should has a precise correlation with body fat and provide information about fat distribution
2. New diagnostic tools should offer better prediction for obesity related consequences including mortality than BMI.
3. New diagnostic tools should inform the genetic, metabolic, physiological or psychological contributions involved in the development of obesity.
4. New diagnostic tools should be easy to apply assessment in clinical practice and medical research.

57 years old Man

- Height 1.81 m
- Weight 87 Kg
- BMI 36.5 Kg/m^2
- Waist Circ 100 cm
- Family History of
  - Acute MI, T2DM
  - Stroke
  - Dementia
  - Parkinsonism
  - Colon cancer
- Non-smoker
- Blood pressure 122/78 mmHg
- Glucose 89 mg/dl
- HbA1c 5.6%
- Lipid profile 206/146/69/108 mg/dl
- Mild fatty liver on abdominal us
- Past History of
  - Hepatitits B
  - Pulmonary Tuberculosis
  - Herpes Zoster
  - Exercise induced Asthma
  - Atopic dermatitis
- 10 units of alcohol once a week

Summary

- The current diagnosis of obesity based on BMI has serious limitations for individuals in identifying excess adiposity and predicting obesity related consequences of them.
- Current clinical practice and health research is tied to BMI. There have been some shifts in looking at non-weight-related health indicators. However, we need more robust studies evaluating other health indicators beyond weight and BMI.
- The availability of these tools will help eliminate the need for BMI and promote individualized health assessment in future.