The Human Conductome:

A New Paradigm for Understanding Human Obesity

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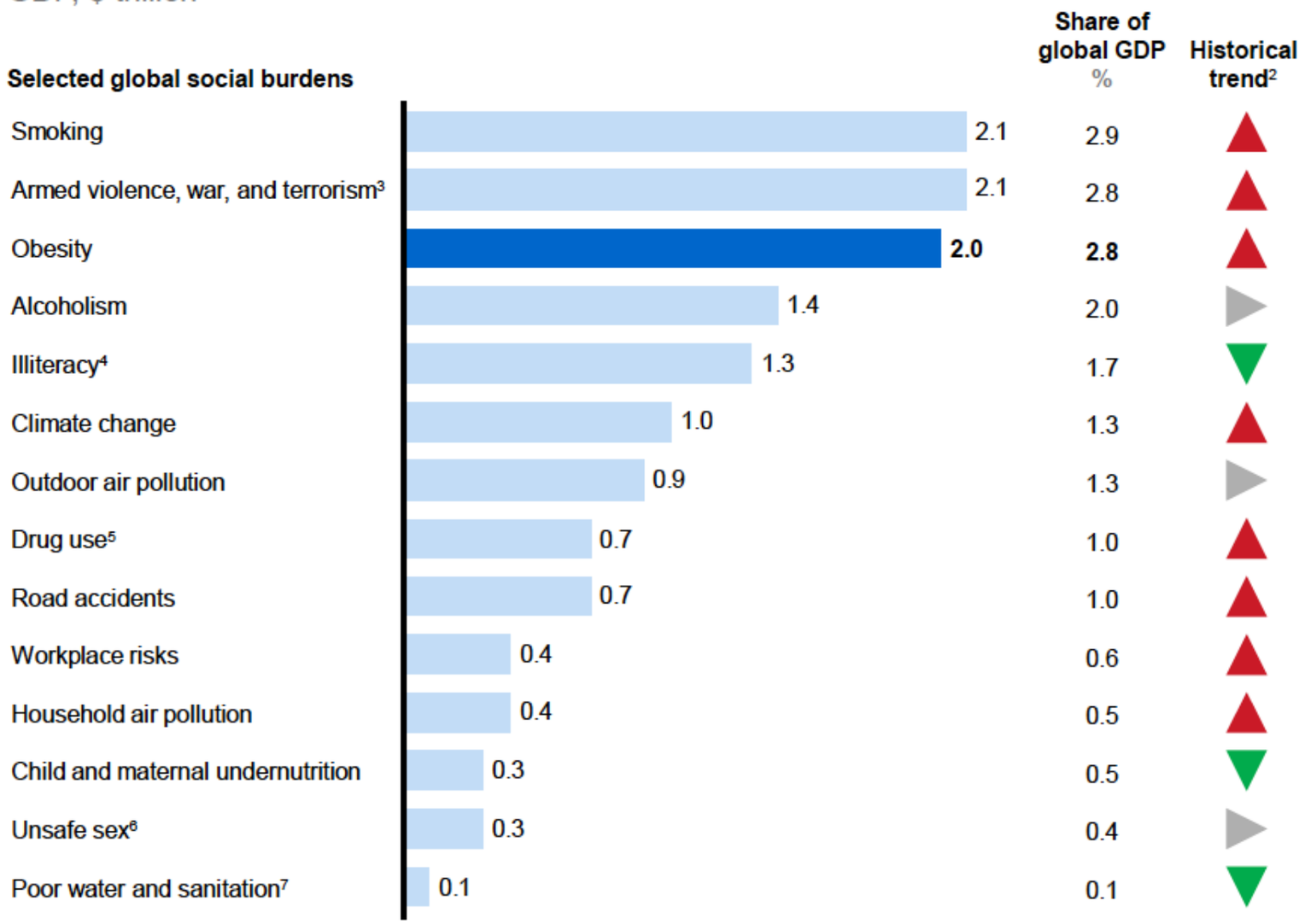
Why is obesity important?

Because its the most expensive threat facing humanity

Obesity is one of the top three global social burdens generated by human beings

Estimated annual global direct economic impact and investment to mitigate selected global burdens, 2012[1]

GDP, $ trillion



1 Based on 2010 disability-adjusted life years (DALY) data from the Global Burden of Disease database and 2012 economic indicators from the World Bank; excluding associated revenue or taxes; including lost productivity due to disability and death, direct cost, e.g., for health care, and direct investment to mitigate; GDP data on purchasing power parity basis.
2 Based on historical development between 1990 and 2010 of total global DALYs lost (Global Burden of Disease).
3 Includes military budget.
4 Includes functional illiteracy.
5 Includes associated crime and imprisonment.
6 Includes sexually transmitted diseases. Excludes unwanted pregnancies.
7 Excludes lost time to access clean water source.

SOURCE: Literature review; World Health Organization Global Burden of Disease database; McKinsey Global Institute analysis

What's being done about it?

Estimates of Funding for Various Research, Condition, and

Disease Categories NIH

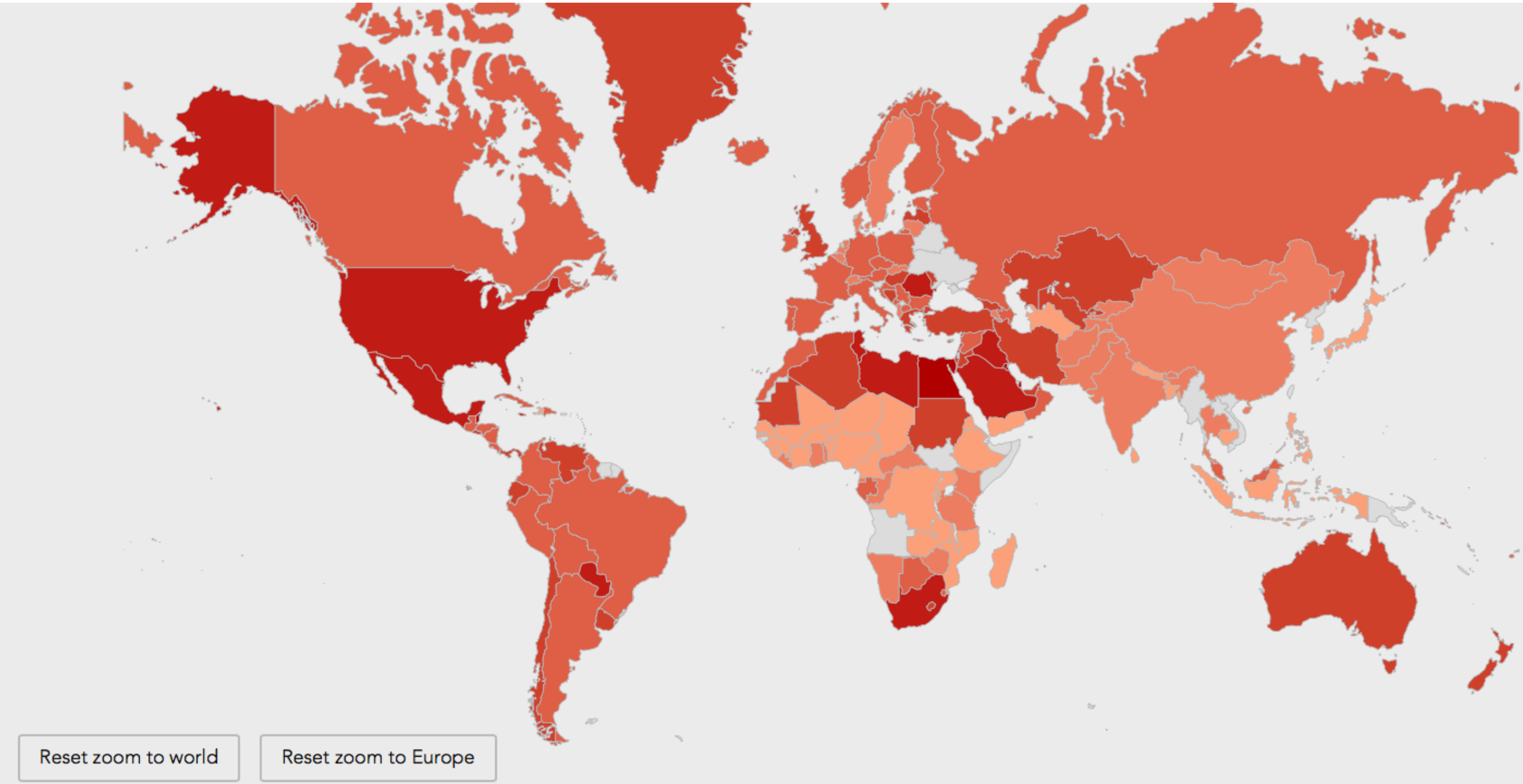
Research/Disease Areas	FY 2016Actual (Dollars in millions)	2015 US Mortality	2015 US Prevalence (Standard deviation)
Cancer	5589.00	652,672	8.7% (0.20%)
Cardiovascular	2108.00	1,464,485	-
Chronic Obstructive Pulmonary Disease	97.00	292,471	6.2% (0.18%)
Diabetes 4/	1084.00	252,806	9.7% (0.22%)
Digestive Diseases	1745.00	-	-
Heart Disease	1289.00	1,202,319	11.7% (0.26%)
Heart Disease - Coronary Heart Disease	419.00	536,339	6.1% (0.17%)
Hypertension	224.00	427,631	27.0% (0.33%)
Inflammatory Bowel Disease	126.00	2,966	-
Obesity	965.00	39,590	30.0% (0.38%)
Stroke	308.00	234,867	-
	13,954	5,106,146	
% of total	17%	73%	
Physical Activity	392.00	-	-
Prevention	7566.00	-	-
Tobacco	299.00	-	-
Nutrition	1615.00	-	-
Basic Behavioral and Social Science	1804.00	-	-
Behavioral and Social Science	4137.00	-	-
	15,813		

What’s being done about it?

What’s being done about it?

In spite of this…

Its everywhere

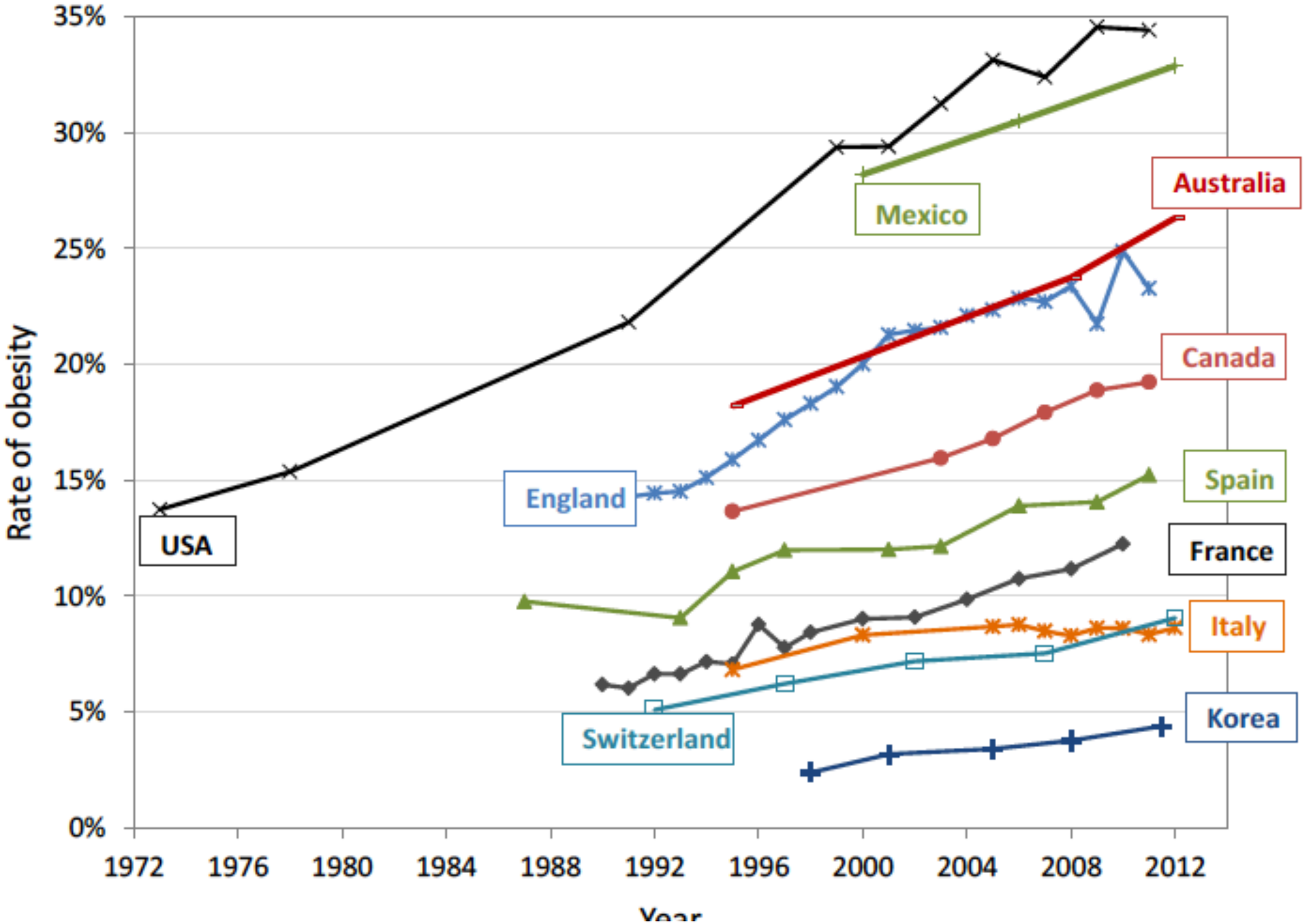


Percentage of adults with obesity *click countries for survey details and definitions*

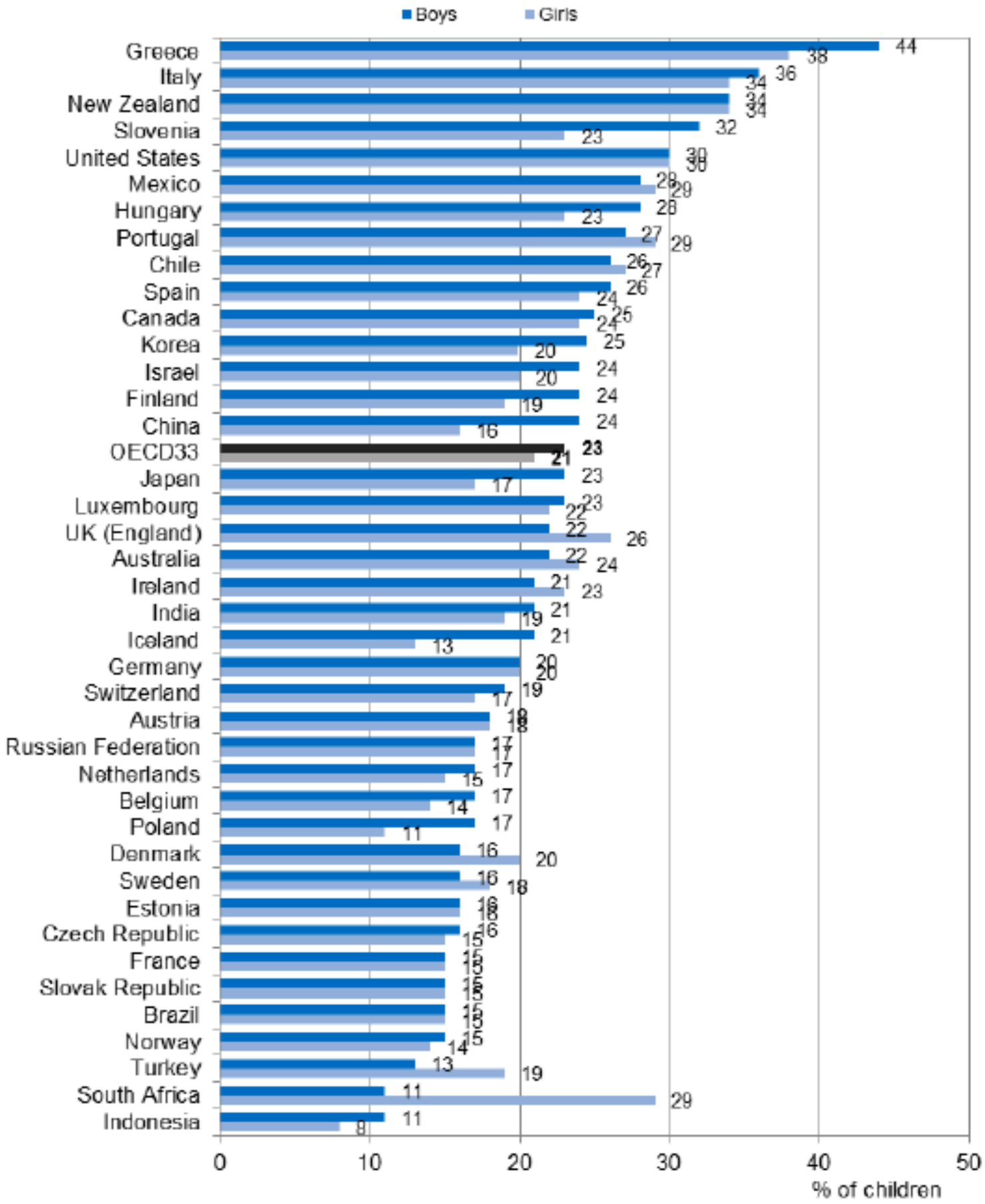
0 8.3 16.7 25 33.3 41.7

Its getting worse

Figure 2. Obesity rates

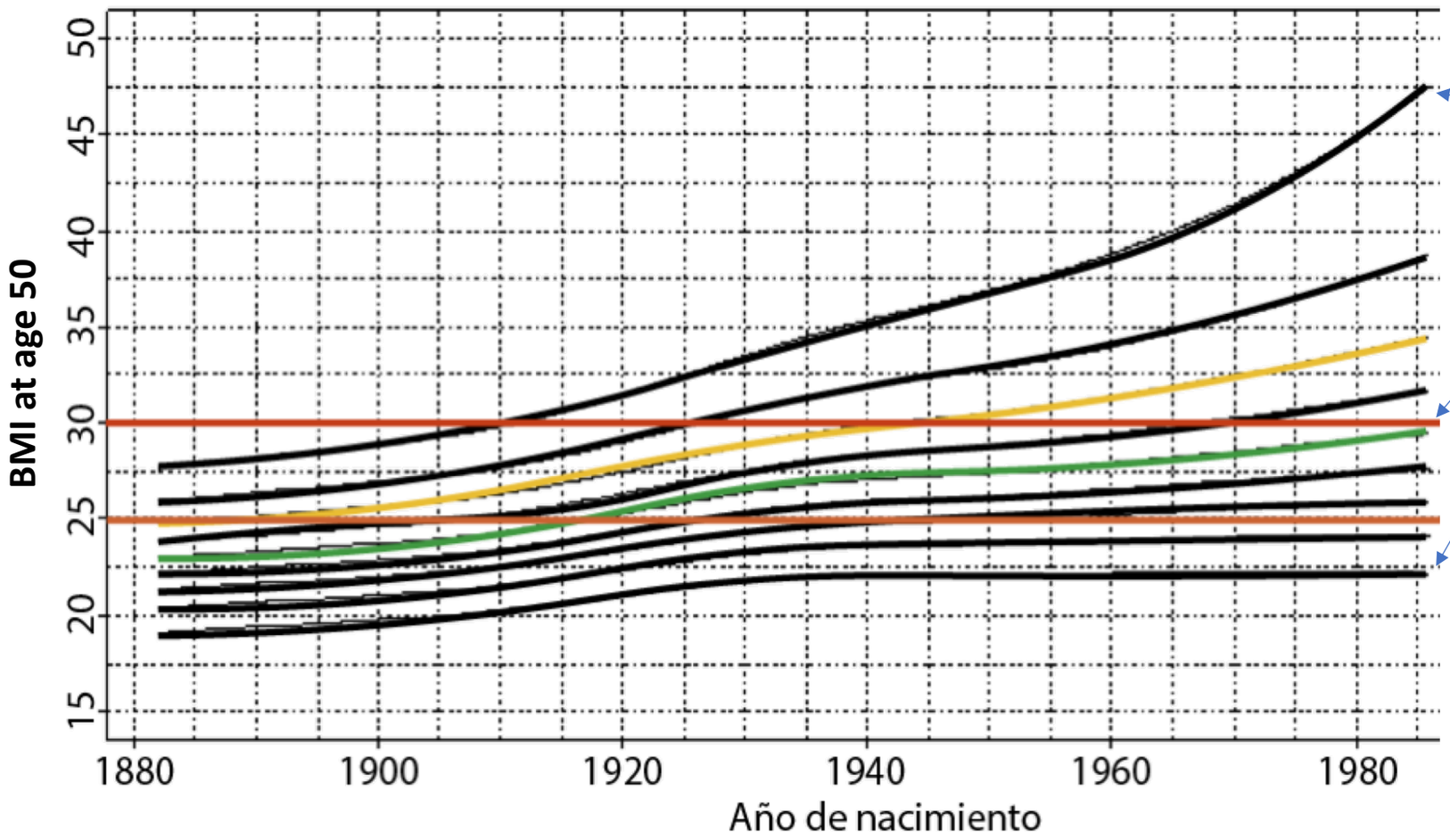


Its affecting our children


Boys
Girls
Greece 44 38
Italy 36 34
New Zealand 34 34
Slovenia 32 23
United States 30 30
Mexico 29 29
Hungary 28 23
Portugal 27 29
Chile 26 27
Spain 26 24
Canada 25 24
Korea 25 20
Israel 24 20
Finland 24 19
China 24 16
OECD33 23 21
Japan 23 17
Luxembourg 23 22
UK (England) 22 26
Australia 22 24
Ireland 21 23
India 21 19
Iceland 21 13
Germany 20 20
Switzerland 19 17
Austria 18 18
Russian Federation 17 17
Netherlands 17 15
Belgium 17 14
Poland 17 11
Denmark 16 20
Sweden 16 18
Estonia 16 16
Czech Republic 16 15
France 15 15
Slovak Republic 15 15
Brazil 15 15
Norway 15 14
Turkey 13 19
South Africa 11 29
Indonesia 11 8
0
10
20
30
40
50
% of children

But is it new?

Deciles trends in white US males by birth cohort

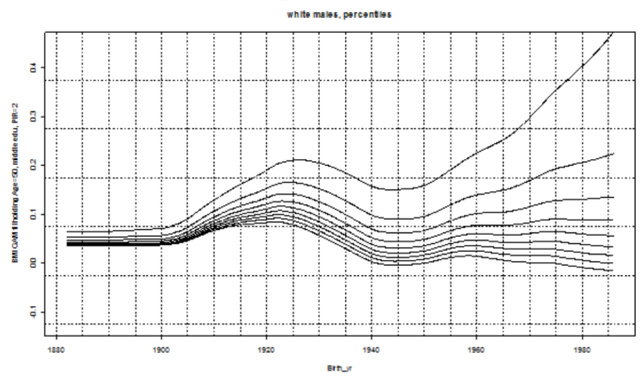


BMI Deciles
90th
50th
10th

What factors (behaviours) are at the root of these differences?

Radical differences!

Rate of change of deciles trends

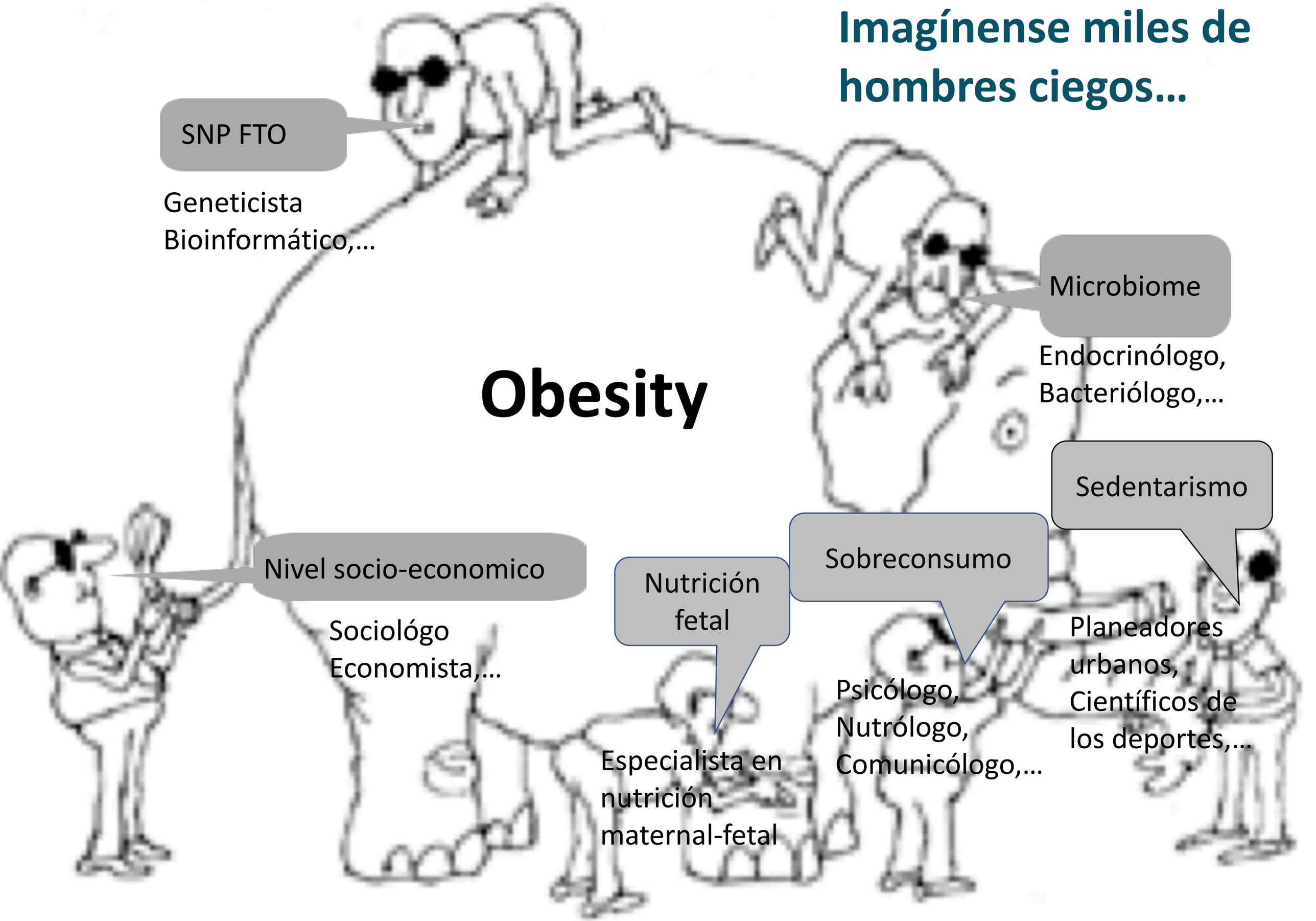


Remember: Evolution likes diversity

Komlos, J., & Brabec, M. (2010). The Trend of Mean BMI Values of US Adults, Birth Cohorts 1882-1986 Indicates that the Obesity Epidemic Began Earlier than Hitherto Thought. doi: 10.3386/w15862

Why are we failing to control it?

Imagínense miles de hombres ciegos…



Imagínense miles de hombres ciegos…

Escolaridad

Propaganda de la industria alimentaria

Sobreconsumo

Nivel socio-económico

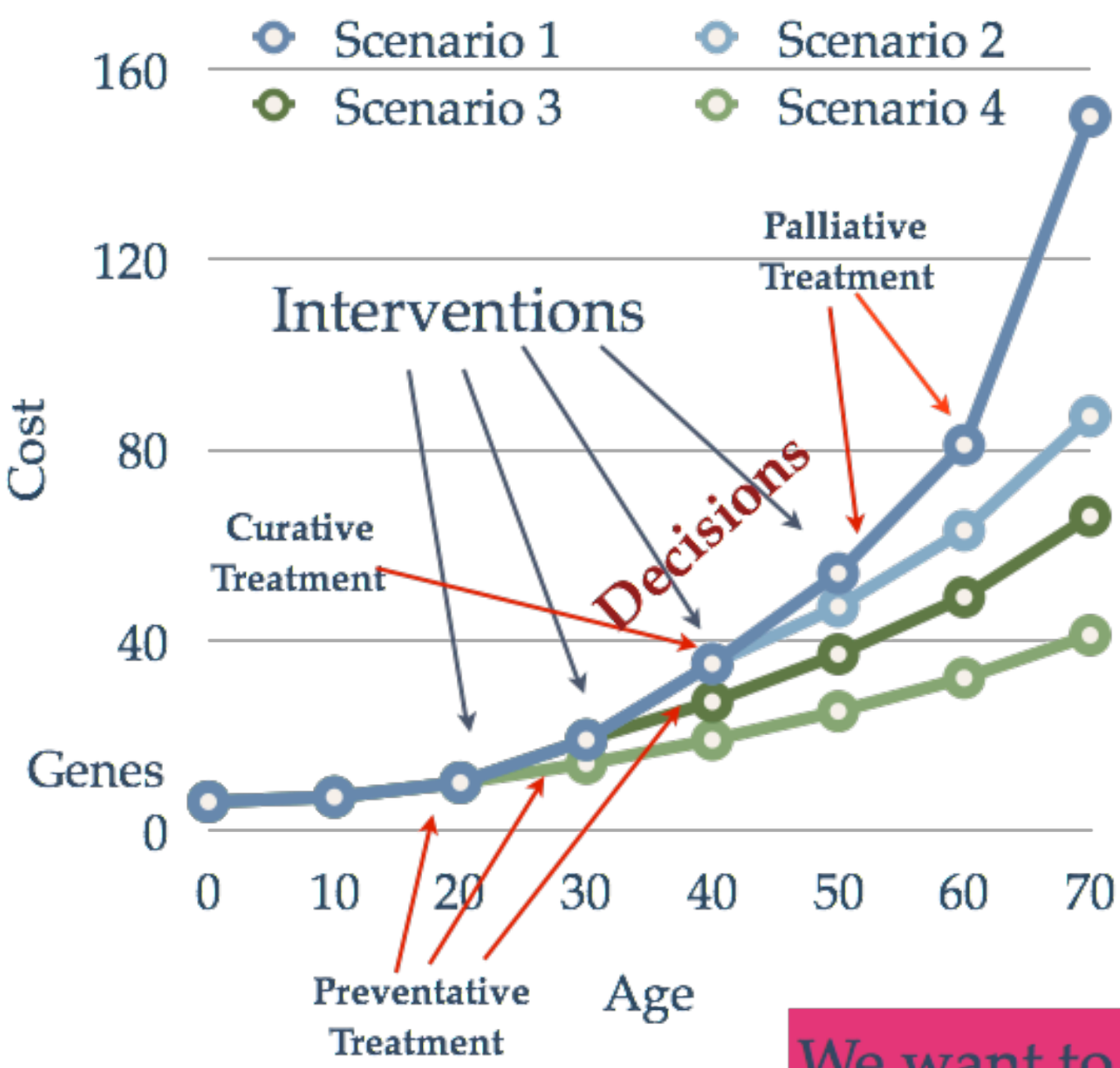
Factores evolutivos

Disponibilidad de comida

Depression

Obesity (health) is dynamic and adaptive

Associated with behaviour and decision making



Scenario 1: Onset of obesity at 20
Continued obesity and onset of metabolic syndrome at 40
Onset of diabetes at 50
Onset of renal failure at 60
Death at 70

Scenario 2: Onset of obesity at 20
Continued obesity and onset of metabolic syndrome at 40
Onset of diabetes at 50
Adequate control and treatment of comorbilities at 60
Bad health and high cost at 70

Scenario 3: Overweight at 20
Obesity at 40
Onset metabolic syndrome at 50
Onset of diabetes at 60
Continued diabetes but no serious comorbilities at 60
Ill health and moderate cost at 70

Scenario 4: Overweight at 30
Obesity at 50
Onset of metabolic syndrome at 60
Onset of diabetes at 70 but relative health

We want to predict and understand "histories"

And what's more important?
Nature or Nurture or "Niche"?

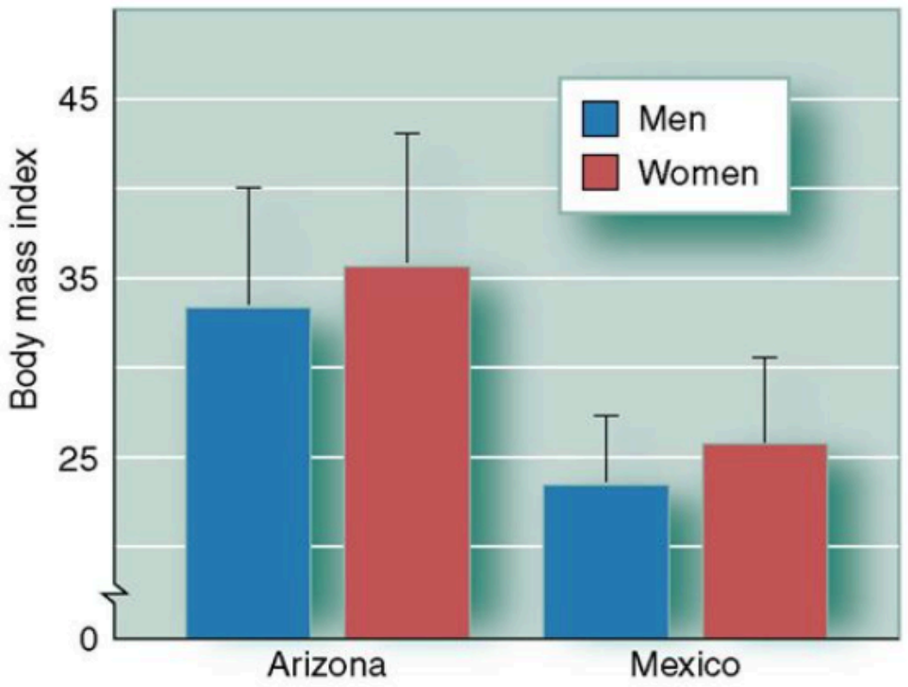
Nature versus nurture versus environment

Nature?

TABLE 2
Intraclass twin correlations (and 95% CIs) for BMI and waist circumference SD scores[1]

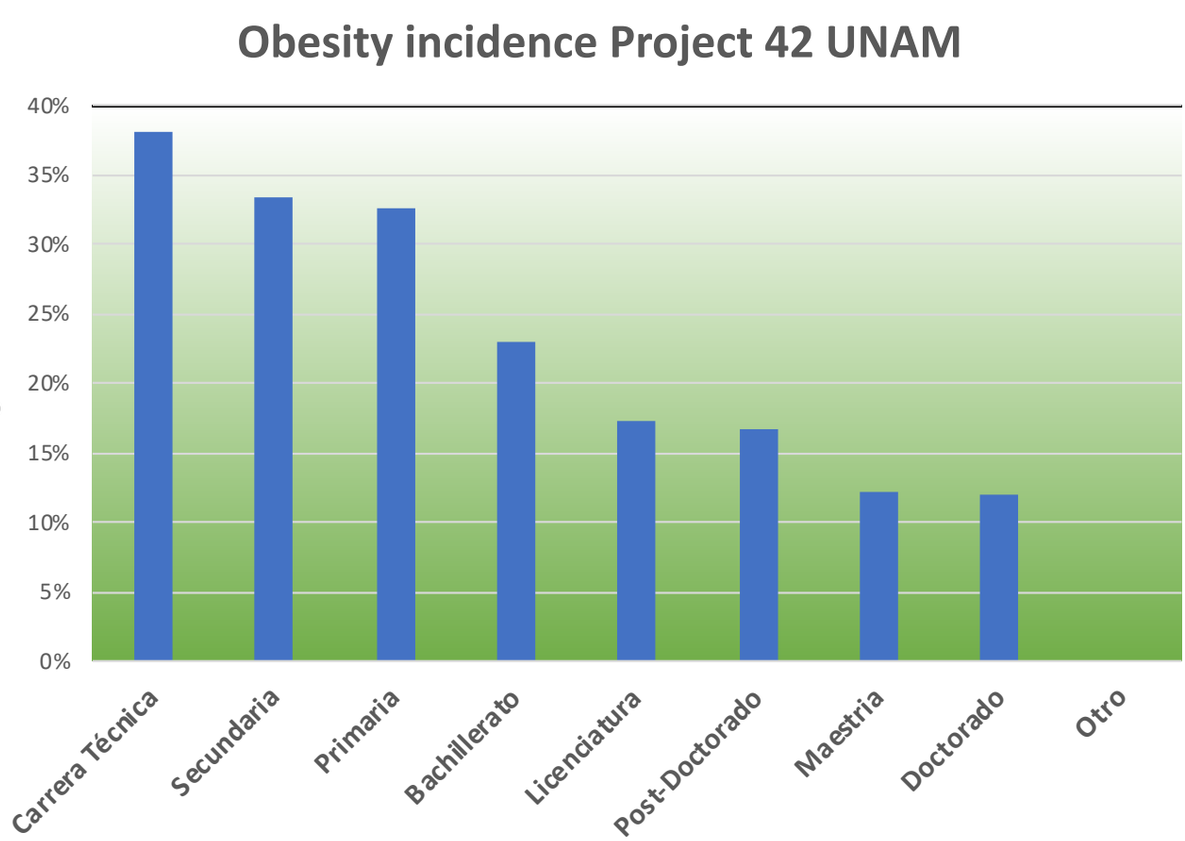
Measure	MZall (n = 1813)	DZall (n = 3279)	DZss (n = 1658)	DZos (n = 1621)
BMI	0.86 (0.85, 0.87)	0.49 (0.47, 0.51)	0.51 (0.48, 0.53)	0.47 (0.45, 0.50)
Waist	0.85 (0.84, 0.86)	0.48 (0.46, 0.50)	0.51 (0.49, 0.54)	0.45 (0.42, 0.48)

[1]MZall, monozygotic twins; DZall, dizygotic same-sex and opposite-sex twins; DZss, same-sex dizygotic twins; twins; DZM, dizygotic male twins; DZF, dizygotic female twins. All values were significant, $P < 0.001$.



The BMI for Pima Indian men and women living in Arizona and in northern Mexico (2006)

Nurture + environment?



Independently of how much nature and how much nurture…
Its due to Energy disequilibrium = more “in” than “out”

Behaviour
in a given environment controls how much and what

But… Energy is Conserved

This has to hold for ALL processes over ALL time scales

Energy “in”
Food
$E_{in}(t)$

How do we measure this?

=

Energy “out”

How do we measure this?

Metabolized
$\alpha E_{in}(t)$

Non-metabolized
$(1 - \alpha)E_{in}(t)$

Energy “needed”

How do we measure this?

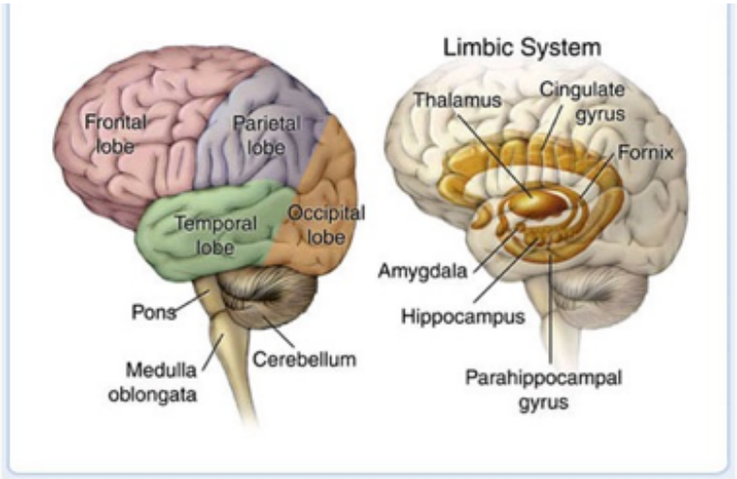
And what does ”Needed” mean anyway?

You can't gain weight without an associated set of decisions/actions that correspond to a behaviour

1. What are some of those behaviours?
2. How do we quantify/measure them?
3. What are risk factors for those behaviours?
4. How plastic are they?
5. How do we model them?
6. How do we change them? MCII?

And for all this we need data. Lots of them!
It'd also be nice to have a theoretical paradigm that covers all this…

The Conductome



Here we neither know the ”World” nor the algorithm P(|) nor the payoff from our prediction and action

This…

$$P(C(t) \mid \underline{X}(t))$$

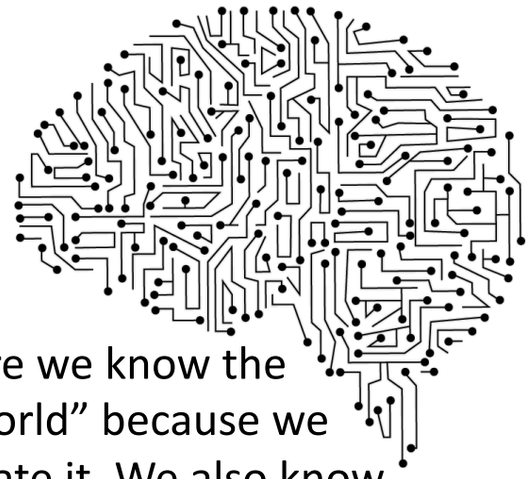
Decision/Action **The “World”**

is the

CONDUCTOME

“World” + algorithm +payoff

The Conductome also implicitly represents a Prediction Model where the prediction is that the decision/action will lead to some benefit.



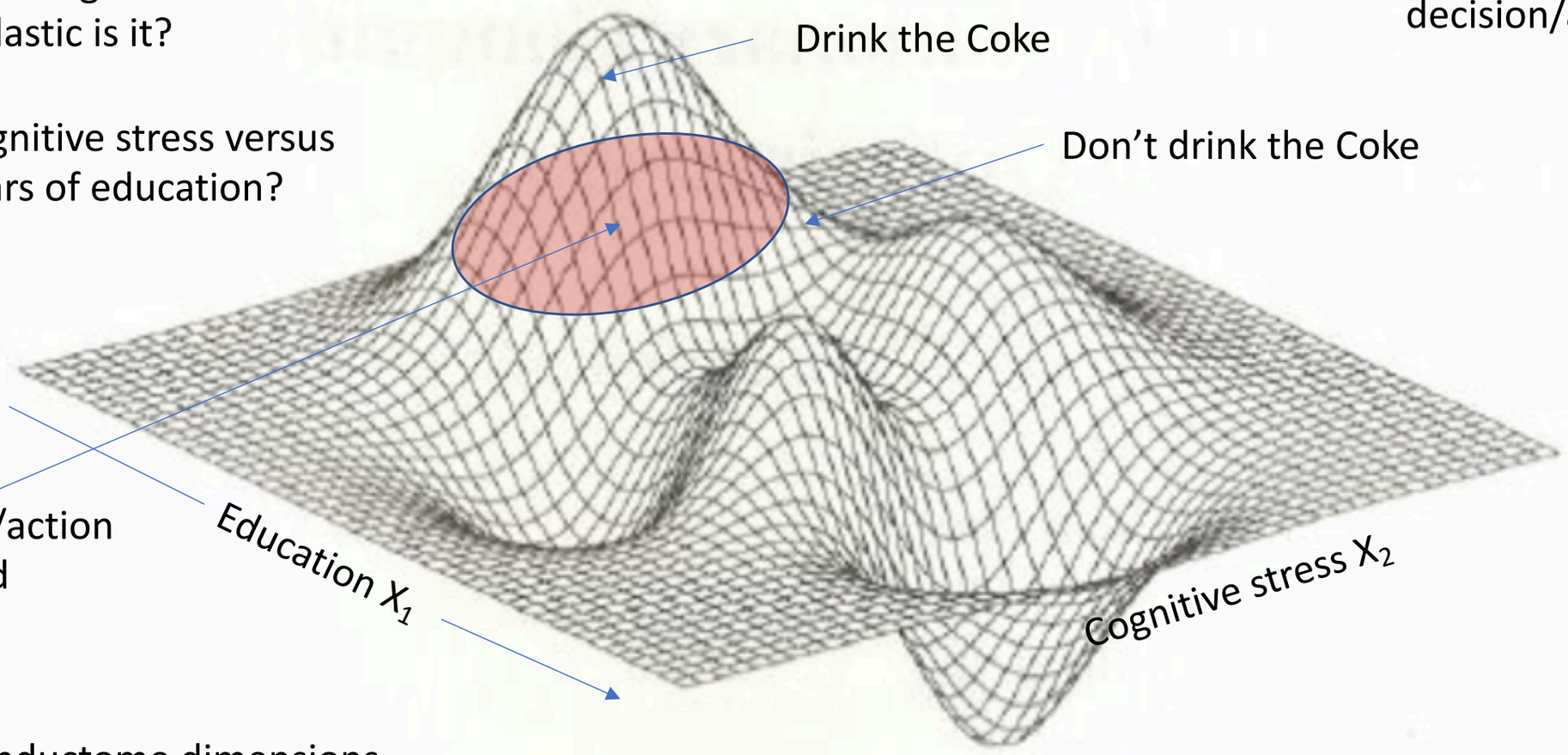
Here we know the ”World” because we create it. We also know the algorithm P(|) and the payoff from our prediction and action

The Conductome Landscape

The Conductome landscape is dynamic and adaptive. There is a landscape for every decision/action/behaviour

Behaviour change –
Just how plastic is it?

Reduce cognitive stress versus
5 more years of education?



(X_1, X_2) – Conductome dimensions

Project 42

Developing the Deepest Database for Obesity and Metabolic Disease

Phase I: (03-05/2014) 1,076 academics and non-academics from 12 institutions of the UNAM (ICN, IFC, FC, IB, II, IG, IF, IM, IIMAS)
2,524 variables - Genetic, epidemiological, physiological,…
Epidemiological: Personal (81), Personal history (130), Family History (548), Self-health evaluation (226), Nutrition (220), Lifestyle (390), Health knowledge (293); Genetic (772); Anthropometric and physiological (49).

Phase II: (2017-2018) 840 undergraduate students of the Fac. Med. UNAM
Adding psychological variables and actigraphy. Involvement of the ISSTE - 99 diabetics.

Phase III: (01/2019-02/2020) Design and Implementation of a Machine learning based Analytics Platform to be publicly available to analyse the data from Project 42

Phase IV: (08-10/2019) Follow up of the 1,076 de Phase I (310), incorporation of new participants (855) and implementation of WOOP intervention. Another blood sample, added psychological variables

Phase V: (11/2019-05/2020) Extension to 200 academics and non-academics of the UNAM Campus Juraquilla
Incorporation of fMRI protocols.

Phase VI: (02/2020-02/2022) Extension to 1000 students of the Fac. Med., Fac. Psic., FES Zaragosa UNAM and Univ. Iberoamericana. Comparison low lifestyles and physiological health. Development of Machine learning models for activity identification.

A	B	C	D	E	F	G	H	I	J
Variable	**Valor**	**Epsilon**	**Nx**	**Nxc**	**N**	**Nc**	**Pc**	**Pcx**	**Descripción**
AAedad	1	-4.1765	122	7	1076	228	0.2119	0.0574	Edad : 19 - 27
AAedad	2	-2.7892	145	17	1076	228	0.2119	0.1172	Edad : 28 - 32
AAedad	3	0.1580	138	30	1076	228	0.2119	0.2174	Edad : 33 - 37
AAedad	4	2.2954	133	39	1076	228	0.2119	0.2932	Edad : 38 - 42
AAedad	5	1.8754	137	38	1076	228	0.2119	0.2774	Edad : 43 - 47
AAedad	6	1.4875	128	34	1076	228	0.2119	0.2656	Edad : 48 - 52
AAedad	7	1.6079	134	36	1076	228	0.2119	0.2687	Edad : 53 - 58
AAedad	8	-0.5093	139	27	1076	228	0.2119	0.1942	Edad : 59 - 81
Aestado	DF	-0.2242	981	205	1076	228	0.2119	0.2090	Estado : DF
Aestado	EMex	0.7328	86	21	1076	228	0.2119	0.2442	Estado : Estado de México
Aestado	Guan	-0.5185	1	0	1076	228	0.2119	0.0000	Estado : Guanajuato
Aestado	Hid	-0.7333	2	0	1076	228	0.2119	0.0000	Estado : Hidalgo
Aestado	Mich	1.9285	1	1	1076	228	0.2119	1.0000	Estado : Michoacan
Aestado	Mor	0.1865	4	1	1076	228	0.2119	0.2500	Estado : Morelos
Aestado	Pue	-0.5185	1	0	1076	228	0.2119	0.0000	Estado : Puebla
AIMC	1	-2.7438	28	0	1076	228	0.2119	0.0000	IMC calculado <18.5 : 1
AIMC	2	-10.6645	423	0	1076	228	0.2119	0.0000	IMC calculado 18.5-25 : 2
AIMC	3	-10.3315	397	0	1076	228	0.2119	0.0000	IMC calculado 25-30 : 3
AIMC	4	24.7727	165	165	1076	228	0.2119	1.0000	IMC calculado 30-35: 4
AIMC	5	12.9371	45	45	1076	228	0.2119	1.0000	IMC calculado 35-39 : 5
AIMC	6	8.1821	18	18	1076	228	0.2119	1.0000	IMC calculado >=40 : 6
Apuesto	Acade	-2.8129	234	32	1076	228	0.2119	0.1368	Puesto: Academico
Apuesto	Admin	1.2288	74	20	1076	228	0.2119	0.2703	Puesto: Personal Admnistrativo
Apuesto	Asi	0.1857	54	12	1076	228	0.2119	0.2222	Puesto: Asistente
Apuesto	Coo	-1.6397	10	0	1076	228	0.2119	0.0000	Puesto: Coordinador
Apuesto	E	-2.3817	52	4	1076	228	0.2119	0.0769	Puesto: Estudiante

Variable	Valor	Epsilon	Nx	Nxc	N	Nc	Pc	Pcx	Descripción
Abrazo	1	1.726919	6	3	1076	228	0.2119	0.5	Medida del brazo = 0 : 1
Abrazo	2	-7.3526447	246	5	1076	228	0.2119	0.0203	Medida del brazo (0,25] : 2
Abrazo	3	-4.6093617	294	30	1076	228	0.2119	0.102	Medida del brazo (25,27] : 3
Abrazo	4	-0.9549931	261	49	1076	228	0.2119	0.1877	Medida del brazo (27,29] : 4
Abrazo	5	12.532857	269	141	1076	228	0.2119	0.5242	Medida del brazo >= 29 : 5
Acintura	1	-6.9373884	179	0	1076	228	0.2119	0	Medida de cintura <= 80 : 1
Acintura	2	-5.7028106	181	7	1076	228	0.2119	0.0387	Medida de cintura (80,87) : 2
Acintura	3	-5.6636574	195	9	1076	228	0.2119	0.0462	Medida de cintura [87,91] : 3
Acintura	4	-4.0486085	187	17	1076	228	0.2119	0.0909	Medida de cintura (91, 97) : 4
Acintura	5	3.9869034	180	60	1076	228	0.2119	0.3333	Medida de cintura [97, 104) : 5
Acintura	6	20.18603	154	135	1076	228	0.2119	0.8766	Medida de cintura >=104 : 6
Apeso	1	-4.1481981	64	0	1076	228	0.2119	0	Medida del peso <= 50 : 1
Apeso	2	-6.8594378	175	0	1076	228	0.2119	0	Medida del peso (50, 57] : 2
Apeso	3	-6.2619858	173	3	1076	228	0.2119	0.0173	Medida del peso (57, 63] : 3
Apeso	4	-4.3473453	164	12	1076	228	0.2119	0.0732	Medida del peso (63, 68] : 4
Apeso	5	-1.2457714	168	29	1076	228	0.2119	0.1726	Medida del peso (68, 74] : 5
Apeso	6	4.9049874	166	61	1076	228	0.2119	0.3675	Medida del peso (74, 82] : 6
Apeso	7	16.680629	166	123	1076	228	0.2119	0.741	Medida del peso >82 : 7
Atalla	1	4.9555267	105	43	1076	228	0.2119	0.4095	Medida de estatura < 1.5 : 1
Atalla	2	-0.5645166	409	82	1076	228	0.2119	0.2005	Medida de estatura [1.5,1.6) : 2
Atalla	3	-1.1460552	353	66	1076	228	0.2119	0.187	Medida de estatura [1.6, 1.7) : 3
Atalla	4	-0.8280514	182	34	1076	228	0.2119	0.1868	Medida de estatura [1.7,1.8) : 4
Atalla	5	-1.2815154	27	3	1076	228	0.2119	0.1111	Medida de estatura [1.8, 1.9) : 5
Atalla	6	-1.2701211	6	0	1076	228	0.2119	0	Medida de estatura >= 1.9 : 6
Atemp	1	1.9275253	3	2	1076	228	0.2119	0.6667	Medida de temperatura <=30 : 1
Atemp	2	-1.605104	68	9	1076	228	0.2119	0.1324	Medida de temperatura (30, 35.5] : 2

Variable	Valor	epsilon	Nx	Nxc	N	Nc	Pc	Pcx	Descripción	
Aami_edadpp	1	-0.57626	175	34	1075	228	0.21209302	0.19428571	Edad promedio de amigos cercanos <= 25 años :	1
Aami_edadpp	2	-1.95946	93	12	1075	228	0.21209302	0.12903226	Edad promedio de amigos cercanos (25,28] años :	2
Aami_edadpp	3	-2.17087	98	12	1075	228	0.21209302	0.12244898	Edad promedio de amigos cercanos (28,31] años :	3
Aami_edadpp	4	0.405961	87	20	1075	228	0.21209302	0.22988506	Edad promedio de amigos cercanos (31,34] años :	4
Aami_edadpp	5	-0.1976	74	15	1075	228	0.21209302	0.2027027	Edad promedio de amigos cercanos (34,36] años :	5
Aami_edadpp	6	1.008639	90	23	1075	228	0.21209302	0.25555556	Edad promedio de amigos cercanos (36,39] años :	6
Aami_edadpp	7	2.838212	97	32	1075	228	0.21209302	0.32989691	Edad promedio de amigos cercanos (39,43] años :	7
Aami_edadpp	8	1.242397	103	27	1075	228	0.21209302	0.26213592	Edad promedio de amigos cercanos (43,47] años :	8
Aami_edadpp	9	-0.63709	107	20	1075	228	0.21209302	0.18691589	Edad promedio de amigos cercanos (47,52] años :	9
Aami_edadpp	10	-0.28064	90	18	1075	228	0.21209302	0.2	Edad promedio de amigos cercanos (52,59] años :	10
Aami_edadpp	11	0.645939	61	15	1075	228	0.21209302	0.24590164	Edad promedio de amigos cercanos > 59 años :	11
Aamigos_diab	0	-0.63445	938	191	1075	228	0.21209302	0.20362473	Número de amigos diabeticos	
Aamigos_diab	1	2.145029	104	31	1075	228	0.21209302	0.29807692	Número de amigos diabeticos	
Aamigos_diab	2	-1.20629	26	3	1075	228	0.21209302	0.11538462	Número de amigos diabeticos	
Aamigos_diab	3	-1.03766	4	0	1075	228	0.21209302	0	Número de amigos diabeticos	
Aamigos_diab	4	2.72577	2	2	1075	228	0.21209302	1	Número de amigos diabeticos	
Aamigos_diab	5	1.927411	1	1	1075	228	0.21209302	1	Número de amigos diabeticos	
Aamigos_sobre	0	0.289564	413	90	1075	228	0.21209302	0.21791768	Número de amigos con sobrepeso	
Aamigos_sobre	1	-0.04007	322	68	1075	228	0.21209302	0.21118012	Número de amigos con sobrepeso	
Aamigos_sobre	2	0.616345	182	42	1075	228	0.21209302	0.23076923	Número de amigos con sobrepeso	
Aamigos_sobre	3	-1.56993	90	13	1075	228	0.21209302	0.14444444	Número de amigos con sobrepeso	
Aamigos_sobre	4	0.199689	40	9	1075	228	0.21209302	0.225	Número de amigos con sobrepeso	
Aamigos_sobre	5	0.84319	13	4	1075	228	0.21209302	0.30769231	Número de amigos con sobrepeso	
Aamigos_sobre	6	-0.6026	8	1	1075	228	0.21209302	0.125	Número de amigos con sobrepeso	
Aamigos_sobre	7	-0.2722	6	1	1075	228	0.21209302	0.16666667	Número de amigos con sobrepeso	
Aamigos_sobre	8	-0.51883	1	0	1075	228	0.21209302	0	Número de amigos con sobrepeso	

Variable	Valor	Epsilon	Nx	Nxc	N	Nc	Pc	Pxc	Descripción
Aedad_asma	0	-0.03096	1026	217	1076	228	0.2119	0.2115	Sin ser diagnosticados con asma
Aedad_asma	1	-0.68949	31	5	1076	228	0.2119	0.16129	Edad en que fueron diagnosticados con asma (0,18] : 1
Aedad_asma	2	0.51471	3	1	1076	228	0.2119	0.33333	Edad en que fueron diagnosticados con asma (18,25] : 2
Aedad_asma	3	1.23153	11	4	1076	228	0.2119	0.36364	Edad en que fueron diagnosticados con asma (25,40] : 3
Aedad_asma	4	0.18649	4	1	1076	228	0.2119	0.25	Edad en que fueron diagnosticados con asma (40,55] : 4
Aedad_asma	5	-0.51852	1	0	1076	228	0.2119	0	Edad en que fueron diagnosticados con asma (55,70] : 5
Aedad_cardi	0	-0.27232	1022	213	1076	228	0.2119	0.20841	Sin ser diagnosticados con problemas cardiacos
Aedad_cardi	1	-1.71975	11	0	1076	228	0.2119	0	Edad en que fueron diagnosticados con problemas cardiacos (0,1
Aedad_cardi	2	1.41002	4	2	1076	228	0.2119	0.5	Edad en que fueron diagnosticados con problemas cardiacos (18,
Aedad_cardi	3	1.10819	19	6	1076	228	0.2119	0.31579	Edad en que fueron diagnosticados con problemas cardiacos (25,
Aedad_cardi	4	2.20261	13	6	1076	228	0.2119	0.46154	Edad en que fueron diagnosticados con problemas cardiacos (40,
Aedad_cardi	5	-0.27111	6	1	1076	228	0.2119	0.16667	Edad en que fueron diagnosticados con problemas cardiacos (55,
Aedad_cardi	6	-0.51852	1	0	1076	228	0.2119	0	Edad en que fueron diagnosticados con problemas cardiacos > 70
Aedad_cmama	0	-0.06603	1066	225	1076	228	0.2119	0.21107	Sin ser diagnosticados con cancer de mama
Aedad_cmama	1	-0.51852	1	0	1076	228	0.2119	0	Edad en que fueron diagnosticados con cancer de mama (0,18] :
Aedad_cmama	3	-0.7333	2	0	1076	228	0.2119	0	Edad en que fueron diagnosticados con cancer de mama (25,40]
Aedad_cmama	4	1.02927	5	2	1076	228	0.2119	0.4	Edad en que fueron diagnosticados con cancer de mama (40,55]
Aedad_cmama	5	0.99704	2	1	1076	228	0.2119	0.5	Edad en que fueron diagnosticados con cancer de mama (55,70]
Aedad_coles	0	-0.65591	781	158	1076	228	0.2119	0.2023	Sin ser diagnosticados con colesterol alto
Aedad_coles	1	-1.37189	7	0	1076	228	0.2119	0	Edad en que fueron diagnosticados con colesterol alto (0,18] :
Aedad_coles	2	0.69821	22	6	1076	228	0.2119	0.27273	Edad en que fueron diagnosticados con colesterol alto (18,25] :
Aedad_coles	3	1.66656	100	28	1076	228	0.2119	0.28	Edad en que fueron diagnosticados con colesterol alto (25,40] :
Aedad_coles	4	0.08299	135	29	1076	228	0.2119	0.21481	Edad en que fueron diagnosticados con colesterol alto (40,55] :
Aedad_coles	5	0.18953	31	7	1076	228	0.2119	0.22581	Edad en que fueron diagnosticados con colesterol alto (55,70] :
Aedad_colon	0	-0.05882	1075	227	1076	228	0.2119	0.21116	Sin ser diagnosticado con problemas de colon
Aedad_colon	4	1.92855	1	1	1076	228	0.2119	1	Edad en que fueron diagnosticados con problemas de colon (40,5

Variable	Valor	Epsilon	Nx	Nxc	N	Nc	Pc	Pxc	Descripción
Acal_agua	-1	2.8756	453	121	1076	228	0.212	0.267	No sabe el número de calorías que tiene el agua : -1
Acal_agua	0	-2.4813	567	96	1076	228	0.212	0.169	El agua contiene 0 calorías : 0
Acal_agua	1	-0.3396	27	5	1076	228	0.212	0.185	El agua contiene de 1 a 20 calorias : 1
Acal_agua	2	-0.0659	29	6	1076	228	0.212	0.207	El agua contiene más de 20 calorias : 2
Acal_hamb	-1	0.7938	705	158	1076	228	0.212	0.224	No sabe cuantas calorías tiene una hamburguesa : -1
Acal_hamb	0	-0.8981	3	0	1076	228	0.212	0	Las hamburguesas contienen 0 calorías : 0
Acal_hamb	1	0.684	18	5	1076	228	0.212	0.278	Las hamburguesas contienen [1, 100) calorías : 1
Acal_hamb	2	-0.6033	61	11	1076	228	0.212	0.18	Las hamburguesas contienen [100-350] calorías : 2
Acal_hamb	3	-1.5537	67	9	1076	228	0.212	0.134	Las hamburguesas contienen (350,500] calorías : 3
Acal_hamb	4	-0.8842	71	12	1076	228	0.212	0.169	Las hamburguesas contienen (500-1000) calorías : 4
Acal_hamb	5	0.3754	74	17	1076	228	0.212	0.23	Las hamburguesas contienen [1000,15000) calorías : 5
Acal_hamb	6	-0.0881	77	16	1076	228	0.212	0.208	Las haburguesas contienen >= 15000 calorías : 6
Acal_jugo	-1	1.0148	808	183	1076	228	0.212	0.226	No sabe el número de calorías que tiene el jugo de naranja : -1
Acal_jugo	0	0.1865	4	1	1076	228	0.212	0.25	El jugo de naranja contiene 0 calorías :
Acal_jugo	1	0.3885	29	7	1076	228	0.212	0.241	El jugo de naranja contiene (0,100) calorías : 1
Acal_jugo	2	-1.4798	36	4	1076	228	0.212	0.111	El jugo de naranja contiene [100, 200) calorías :
Acal_jugo	3	-1.7161	99	14	1076	228	0.212	0.141	El jugo de naranja contiene [200, 500) calorías :
Acal_jugo	4	0.0904	60	13	1076	228	0.212	0.217	El jugo de naranja contiene [500,1000) calorías :
Acal_jugo	5	-0.9579	40	6	1076	228	0.212	0.15	El jugo de naranja contiene mas de 1000 calorías : 5
Acal_ref	-1	0.9476	775	175	1076	228	0.212	0.226	No sabe cuantas calorías tiene un vaso de refresco : -1
Acal_ref	0	-0.8981	3	0	1076	228	0.212	0	El refreco tiene 0 calorias : 0
Acal_ref	1	0.4568	24	6	1076	228	0.212	0.25	El refresco tiene (0,100) calorías : 1
Acal_ref	2	-1.3887	22	2	1076	228	0.212	0.091	El refresco tiene [100,200) calorías : 2
Acal_ref	3	-0.3352	96	19	1076	228	0.212	0.198	El refresco tiene [200,500) calorías : 3
Acal_ref	4	-1.2275	72	11	1076	228	0.212	0.153	El refresco tiene [500, 1000) calorías : 4
Acal ref	5	-0.7474	84	15	1076	228	0.212	0.179	El refresco tiene mas de 1000 calorías : 5

Variable	Valor	Epsilon	Nx	Nxc	N	Nc	Pc	Pxc	Descripción
Ahba	1	-2.62561	910	160	1074	227	0.2114	0.1758	HBA (valor para diagnosticar la diabetes) <= 5.6 : 1 - Normal o r
Ahba	2	5.600193	100	44	1074	227	0.2114	0.44	HBA (valor para diagnosticar la diabetes) (5.6, 6.4] : 2 - Pre diabéti
Ahba	3	2.900328	64	23	1074	227	0.2114	0.3594	HBA (valor para diagnosticar la diabetes) >6.4 : 3 - Compatibl
Ainsulina	1	-8.50928	485	26	1074	227	0.2114	0.0536	Insulina < 6.0 : 1 - Normal
Ainsulina	2	-0.31677	91	18	1074	227	0.2114	0.1978	Insulina (6.0, 7.0) : 2
Ainsulina	3	0.798506	214	50	1074	227	0.2114	0.2336	Insulina [7.0, 9.9] : 3 Deseable
Ainsulina	4	1.616042	97	27	1074	227	0.2114	0.2784	Insulina [10, 12.6) : 4
Ainsulina	5	11.90673	187	106	1074	227	0.2114	0.5668	Insulina >= 12.6 : 5 - Diabetes
Aldlc_res	1	-0.32836	101	20	1074	227	0.2114	0.198	LDLC < 79 : 1
Aldlc_res	2	1.283815	184	46	1074	227	0.2114	0.25	LDLC [79, 100) : 2
Aldlc_res	3	-1.36628	198	34	1074	227	0.2114	0.1717	LDLC [100, 115] : 3
Aldlc_res	4	-0.63123	187	36	1074	227	0.2114	0.1925	LDLC (115, 130] : 4
Aldlc_res	5	1.378526	199	50	1074	227	0.2114	0.2513	LDLC (130, 150] : 5
Aldlc_res	6	-1.17115	156	27	1074	227	0.2114	0.1731	LDLC (150, 180] : 6
Aldlc_res	7	1.42982	17	6	1074	227	0.2114	0.3529	LDLC (180, 189] : 7
Aldlc_res	8	0.378576	16	4	1074	227	0.2114	0.25	LDLC (189, 200] : 8
Aldlc_res	9	-0.44392	7	1	1074	227	0.2114	0.1429	LDLC (200, 220] : 9
Aldlc_res	10	0.896268	9	3	1074	227	0.2114	0.3333	LDLC [>= 220 : 10
chol_com	ALTO	-0.37921	12	2	1074	227	0.2114	0.1667	chol = 201 : Alto
chol_com	LTO CRITIC	0.301357	512	111	1074	227	0.2114	0.2168	chol > 202 : Alto crítico
chol_com		-0.23475	550	114	1074	227	0.2114	0.2073	chol < 100 : Normal
crs_com	LTO CRITIC	-0.26814	6	1	1074	227	0.2114	0.1667	crs [7.1, 1.31] : Alto critico
crs_com	AJO CRITIC	-0.73213	2	0	1074	227	0.2114	0	crs [0.35, 0.38] : Bajo critico
crs_com		0.051829	1066	226	1074	227	0.2114	0.212	crs [0.42, 9.65] : Normal
glu_com	ALTO	2.73168	6	4	1074	227	0.2114	0.6667	glu = 110 : Alto
glu_com	LTO CRITIC	3.648645	114	40	1074	227	0.2114	0.3509	glu [111.418] : Alto critico

Variable	Valor	Epsilon	Nx	Nxc	N	Nc	Pc	Pxc	Descripción
Aestatura	1	4.801461	91	38	1076	228	0.2119	0.4176	Estatura que estima tener el encuestado < 1.5 : 1
Aestatura	2	-0.92449	399	77	1076	228	0.2119	0.193	Estatura que estima tener el encuestado [1.5, 1.6) : 2
Aestatura	3	-1.09413	366	69	1076	228	0.2119	0.1885	Estatura que estima tener el encuestado [1.6, 1.7) : 3
Aestatura	4	0.143796	185	40	1076	228	0.2119	0.2162	Estatura que estima tener el encuestado [1.7, 1.8) : 4
Aestatura	5	-1.63546	32	3	1076	228	0.2119	0.0938	Estatura que estima tener el encuestado [1.8, 1.9) : 5
Aestatura	6	-0.7333	2	0	1076	228	0.2119	0	Estatura que estima tener el encuestado [1.9, 2.0) : 6
Aestatura	7	1.928548	1	1	1076	228	0.2119	1	Estatura que estima tener el encuestado > 2.0) : 7
Apeso	1	-3.77209	62	1	1076	228	0.2119	0.0161	Peso que estima tener el encuestado <= 50 : 1
Apeso	2	-4.05811	79	2	1076	228	0.2119	0.0253	Peso que estima tener el encuestado (50, 55) : 2
Apeso	3	-5.74441	132	1	1076	228	0.2119	0.0076	Peso que estima tener el encuestado [55, 60) : 3
Apeso	4	-5.1211	172	9	1076	228	0.2119	0.0523	Peso que estima tener el encuestado [60, 65) : 4
Apeso	5	-1.86651	142	21	1076	228	0.2119	0.1479	Peso que estima tener el encuestado [65, 70) : 5
Apeso	6	-2.34173	138	18	1076	228	0.2119	0.1304	Peso que estima tener el encuestado [70, 75) : 6
Apeso	7	0.84116	106	26	1076	228	0.2119	0.2453	Peso que estima tener el encuestado [75, 80) : 7
Apeso	8	8.123762	143	70	1076	228	0.2119	0.4895	Peso que estima tener el encuestado [80, 90) : 8
Apeso	9	14.14686	102	80	1076	228	0.2119	0.7843	Peso que estima tener el encuestado >= 90 : 9
condi_act	1	5.045429	44	23	1076	228	0.2119	0.5227	¿Cómo consideras tu condición física actual? 1 : Muy mala
condi_act	2	5.865344	189	73	1076	228	0.2119	0.3862	¿Cómo consideras tu condición física actual? 2 : Mala
condi_act	3	-0.57931	429	86	1076	228	0.2119	0.2005	¿Cómo consideras tu condición física actual? 3 : Regular
condi_act	4	-4.18504	355	43	1076	228	0.2119	0.1211	¿Cómo consideras tu condición física actual? 4 : Buena
condi_act	5	-2.94241	57	3	1076	228	0.2119	0.0526	¿Cómo consideras tu condición física actual? 5 : Muy buena
condi_act	8	-0.7333	2	0	1076	228	0.2119	0	¿Cómo consideras tu condición física actual? 8 : No quiero re
condi1	1	3.176688	41	17	1076	228	0.2119	0.4146	¿Cómo consideras tu condición física hace un año? 1 : Muy n
condi1	2	4.71648	180	64	1076	228	0.2119	0.3556	¿Cómo consideras tu condición física hace un año? 2 : Mala
condi1	3	0.133941	396	85	1076	228	0.2119	0.2146	¿Cómo consideras tu condición física hace un año? 3 : Regula
condi1	4	-2.65254	367	57	1076	228	0.2119	0.1553	¿Cómo consideras tu condición física hace un año? 4 : Buena

Epsilon	# participantes	# obesos	Proporcion obesos	Puesto
-2.81	234	32	13.68%	Academico
1.23	74	20	27.03%	Personal Admnistrativo
0.19	54	12	22.22%	Asistente
-1.64	10	0	0.00%	Coordinador
-2.38	52	4	7.69%	Estudiante
-3.58	81	4	4.94%	Estudiante Doctorado
-2.05	71	8	11.27%	Estudiante Maestria
2.03	110	32	29.09%	Intendencia
-0.53	85	16	18.82%	Investigador
0.51	3	1	33.33%	Investigador Emerito
2.41	96	30	31.25%	Jefe de Area
2.06	48	16	33.33%	Laboratorista
3.53	67	26	38.81%	Secretaria
0.30	57	13	22.81%	Técnico
2.85	34	14	41.18%	Vigilante

Epsilon	# participantes	# obesos	Proporcion obesos	Puesto
-2.81	234	32	13.68%	Academico
1.23	74	20	27.03%	Personal Admnistrativo
0.19	54	12	22.22%	Asistente
-1.64	10	0	0.00%	Coordinador
-2.38	52	4	7.69%	Estudiante
-3.58	81	4	4.94%	Estudiante Doctorado
-2.05	71	8	11.27%	Estudiante Maestria
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3.53	67	26	38.81%	Secretaria
0.30	57	13	22.81%	Técnico
2.85	34	14	41.18%	Vigilante

Epsilon	# participantes	# obesos	Proporcion obesos	Edad
-4.18	122	7	5.74%	19 - 27
-2.79	145	17	11.72%	28 - 32
0.16	138	30	21.74%	33 - 37
2.30	133	39	29.32%	38 - 42
1.88	137	38	27.74%	43 - 47
1.49	128	34	26.56%	48 - 52
1.61	134	36	26.87%	53 - 58
-0.51	139	27	19.42%	59 - 81

Epsilon	# participantes	# obesos	Proporcion obesos	Puesto
-2.81	234	32	13.68%	Academico
1.23	74	20	27.03%	Personal Admnistrativo
0.19	54	12	22.22%	Asistente
-1.64	10	0	0.00%	Coordinador
-2.38	52	4	7.69%	Estudiante
-3.58	81	4	4.94%	Estudiante Doctorado
-2.05	71	8	11.27%	Estudiante Maestria
2.03	110	32	29.09%	Intendencia
-0.53	85	16	18.82%	Investigador
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2.41	96	30	31.25%	Jefe de Area
2.06	48	16	33.33%	Laboratorista
3.53	67	26	38.81%	Secretaria
0.30	57	13	22.81%	Técnico
2.85	34	14	41.18%	Vigilante

Epsilon	# participantes	# obesos	Proporcion obesos	Edad
-4.18	122	7	5.74%	19 - 27
-2.79	145	17	11.72%	28 - 32
0.16	138	30	21.74%	33 - 37
2.30	133	39	29.32%	38 - 42
1.88	137	38	27.74%	43 - 47
				2
				8
				1

Epsilon	# participantes	# obesos	Proporcion obesos	Estatura en m
4.96	105	43	40.95%	< 1.5 : 1
-0.56	409	82	20.05%	[1.5,1.6) : 2
-1.15	353	66	18.70%	[1.6, 1.7) : 3
-0.83	182	34	18.68%	[1.7,1.8) : 4
-1.28	27	3	11.11%	[1.8, 1.9) : 5
-1.27	6	0	0.00%	>= 1.9 : 6

Epsilon	# participantes	# obesos	Proporcion obesos	Puesto
-2.81	234	32	13.68%	Academico
1.23	74	20	27.03%	Personal Admnistrativo
0.19	54	12	22.22%	Asistente
-1.64	10	0	0.00%	Coordinador
-2.38	52	4	7.69%	Estudiante
-3.58	81	4	4.94%	Estudiante Doctorado
-2.05	71	8	11.27%	Estudiante Maestria
2.03				
-0.53				
0.51				
2.41				
2.06				
3.53				
0.30				
2.85				

Epsilon
-4.18

# participantes	# obesos	Proporcion obesos	Edad
122	7	5.74%	19 - 27
45	17	11.72%	28 - 32
38	30	21.74%	33 - 37
33	39	29.32%	38 - 42
37	38	27.74%	43 - 47
			52
			8
			1

Enfermedad	Epsilon	# participantes	# obesos	Proporcion obesos
No le han diagnosticado asma	-0.03	1026	217	21.15%
Le han dignosticado asma	0.14	50	11	22.00%
No le han diagnosticado problemas cardiacos	-0.27	1022	213	20.84%
Le han diagnosticado problemas cardiacos	1.18	54	15	27.78%
No le han diagnosticado cancer de mama	-0.07	1066	225	21.11%
Le han diagnosticado cancer de mama	0.68	10	3	30.00%
No le han diagnosticado colesterol alto	-0.66	781	158	20.23%
Le han diagnosticado colesterol alto	1.07	295	70	23.73%
No le han diagnosticado cancer de colon	-0.06	1075	227	21.12%
Le han diagnosticado cancer de colon	1.93	1	1	100.00%
No le han diagnosticado otra enfermedad	-0.01	1067	226	21.18%
Le han diagnosticado otra enfermedad	0.08	9	2	22.22%
No le han diagnosticado cancer de prostata	-0.01	1072	227	21.18%
Le han diagnosticado cancer de prostata	0.19	4	1	25.00%
No sabe si le han diagnosticado diabetes	-0.55	1030	211	20.49%
Le han diagnosticado diabetes	2.72	45	17	37.78%
No le han diagnosticado hipertensión	-2.46	943	169	17.92%
Le han diagnosticado hipertensión	6.54	133	59	44.36%
No le han diagnosticado problemas neuronales	0.00	1057	224	21.19%
Le han diagnosticado problemas neuronales	-0.01	19	4	21.05%
No sabe si le han diagnosticado obesidad	-7.55	741	73	9.85%
Le han diagnosticado obesidad	11.32	333	155	46.55%
No sabe si le han diagnosticado prediabetes	-0.42	993	205	20.64%
Le han diagnosticado prediabetes	1.72	79	23	29.11%
No le han diagnosticado problemas pulmonares	-0.30	1057	220	20.81%
Le han diagnosticado problemas pulmonares	2.23	19	8	42.11%
No le han diagnosticado problemas renales	-0.13	1065	224	21.03%
Le han diagnosticado problemas renales	1.23	11	4	36.36%
No le han diagnosticado problemas de retinopatia	0.05	1059	225	21.25%
Le han dignosticado problemas de retinopatia	-0.36	17	3	17.65%
No le han diagnosticado trigliceridos altos	-0.84	772	154	19.95%
Le han diagnosticado trigliceridos altos	1.35	304	74	24.34%

obesos	Proporcion obesos	Estatura en m
43	40.95%	< 1.5 : 1
82	20.05%	[1.5,1.6) : 2
66	18.70%	[1.6, 1.7) : 3
34	18.68%	[1.7,1.8) : 4
3	11.11%	[1.8, 1.9) : 5
0	0.00%	>= 1.9 : 6

Epsilon	# participantes	# obesos	Proporcion obesos	Puesto
-2.81	234	32	13.68%	Academico
1.23	74	20	27.03%	Personal Admnistrativo
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-2.05	71	8	11.27%	Estudiante Maestria

Epsilon	# participantes	# obesos	Proporcion obesos	Edad
-4.18	122	7	5.74%	19 - 27
	45	17	11.72%	28 - 32
	38	30	21.74%	33 - 37
	33	39	29.32%	38 - 42
	37	38	27.74%	43 - 47
				52
	obesos	Proporcion obesos	Estatura en m	
	43	40.95%	< 1.5 : 1	

Enfermedad	Epsilon	# participantes	# obesos	Proporcion obesos
No le han diagnosticado asma	-0.03	1026	217	21.15%
Le han dignosticado asma	0.14	50	11	22.00%
No le han diagnosticado problemas cardiacos	-0.27	1022	213	20.84%
Le han diagnosticado problemas cardiacos	1.18	54	15	27.78%
No le han diagnosticado cancer de mama	-0.07	1066	225	21.11%
Le han diagnosticado cancer de mama	0.68	10	3	30.00%
No le han diagnosticado colesterol alto	-0.66	781	158	20.23%
Le han diagnosticado colesterol alto	1.07	295	70	23.73%
No le han diagnosticado cancer de colon	-0.06	1075	227	21.12%
Le han diagnosticado cancer de colon	1.93	1	1	100.00%
No le han diagnosticado otra enfermedad				
Le han diagnosticado otra enfermedad				
No le han diagnosticado cancer de prosta				
Le han diagnosticado cancer de prostata				
No sabe si le han diagnosticado diabetes				
Le han diagnosticado diabetes				
No le han diagnosticado hipertensión				
Le han diagnosticado hipertensión				
No le han diagnosticado problemas neuro				
Le han diagnosticado problemas neuronales	-0.01	19	4	21.05%
No sabe si le han diagnosticado obesidad	-7.55	741	73	9.85%
Le han diagnosticado obesidad	11.32	333	155	46.55%
No sabe si le han diagnosticado prediabetes	-0.42	993	205	20.64%
Le han diagnosticado prediabetes	1.72	79	23	29.11%
No le han diagnosticado problemas pulmonares	-0.30	1057	220	20.81%
Le han diagnosticado problemas pulmonares	2.23	19	8	42.11%
No le han diagnosticado problemas renales	-0.13	1065	224	21.03%
Le han diagnosticado problemas renales	1.23	11	4	36.36%
No le han diagnosticado problemas de retinopatia	0.05	1059	225	21.25%
Le han dignosticado problemas de retinopatia	-0.36	17	3	17.65%
No le han diagnosticado trigliceridos altos	-0.84	772	154	19.95%
Le han diagnosticado trigliceridos altos	1.35	304	74	24.34%

Número de amigos cercanos	Epsilon	# participantes	# obesos	Proporcion obesos
Cero	2.35	93	29	31.18%
Uno	2.08	74	23	31.08%
Mas que 1	-1.35	908	176	19.38%

Epsilon	# participantes	# obesos	Proporcion obesos	Puesto
-2.81	234	32	13.68%	Academico
1.23	74	20	27.03%	Personal Admnistrativo
0.19	54	12	22.22%	Asistente
-1.64	10	0	0.00%	Coordinador
-2.38	52	4	7.69%	Estudiante
-3.58	81	4	4.94%	Estudiante Doctorado
-2.05	71	8	11.27%	Estudiante Maestria

Epsilon	# participantes	# obesos	Proporcion obesos	Edad
-4.18	122	7	5.74%	19 - 27
2.03	145	17	11.72%	28 - 32
-0.53	138	30	21.74%	33 - 37
0.51	133	39	29.32%	38 - 42
2.41	137	38	27.74%	43 - 47
2.06	128	34	26.56%	48 - 52
3.53	108	44	40.74%	53 - 58
0.30	143	43	40.95%	59 - 61
2.85	21	1	4.76%	62 - 71

Enfermedad	Epsilon	# participantes	# obesos	Proporcion obesos
No le han diagnosticado asma	-0.03	1026	217	21.15%
Le han dignosticado asma	0.14	50	11	22.00%
No le han diagnosticado problemas cardiacos	-0.27	1022	213	20.84%
Le han diagnosticado problemas cardiacos	1.18	54	15	27.78%
No le han diagnosticado cancer de mama	-0.07	1066	225	21.11%
Le han diagnosticado cancer de mama	0.68	10	3	30.00%
No le han diagnosticado colesterol alto	-0.66	781	158	20.23%
Le han diagnosticado colesterol alto	1.07	295	70	23.73%
No le han diagnosticado cancer de colon	-0.06	1075	227	21.12%
Le han diagnosticado cancer de colon	1.93	1	1	100.00%
No le han diagnosticado otra enfermedad				
Le han diagnosticado otra enfermedad				
No le han diagnosticado cancer de prosta				
Le han diagnosticado cancer de prostata				
No sabe si le han diagnosticado diabetes				
Le han diagnosticado diabetes				
No le han diagnosticado hipertensión				
Le han diagnosticado hipertensión				
No le han diagnosticado problemas neuro				
Le han diagnosticado problemas neuronales				
No sabe si le han diagnosticado obesidad				
Le han diagnosticado obesidad				
No sabe si le han diagnosticado prediabetes				
Le han diagnosticado prediabetes				
No le han diagnosticado problemas pulmonares				
Le han diagnosticado problemas pulmonares				
No le han diagnosticado problemas renales				
Le han diagnosticado problemas renales				
No le han diagnosticado problemas de retinopa				
Le han dignosticado problemas de retinopatia	-0.36	17	3	17.65%
No le han diagnosticado trigliceridos altos	-0.84	772	154	19.95%
Le han diagnosticado trigliceridos altos	1.35	304	74	24.34%

Estatura en m	Proporcion obesos
< 1.5 : 1	

Número de amigos cercanos	Epsilon	# participantes	# obesos	Proporcion obesos
Cero	2.35	93	29	31.18%
Uno	2.08	74	23	31.08%
Mas que 1	-1.35	908	176	19.38%

Porcentaje del circulo social que tiene sobrepeso	Epsilon	# participantes	# obesos	Proporcion obesos
0-25%	-1.88	511	91	17.81%
25-50%	0.50	313	70	22.36%
50-75%	0.83	190	45	23.68%
75-100%	2.84	61	22	36.07%

Epsilon	# participantes	# obesos	Proporcion obesos	Puesto
-2.81	234	32	13.68%	Academico
1.23	74	20	27.03%	Personal Admnistrativo
0.19	54	12	22.22%	Asistente
-1.64	10	0	0.00%	Coordinador
-2.38	52	4	7.69%	Estudiante
-3.58	81	4	4.94%	Estudiante Doctorado
-2.05	71	8	11.27%	Estudiante Maestria

Epsilon	# participantes	# obesos	Proporcion obesos	Edad
-4.18	122	7	5.74%	19 - 27
2.03	45	17	11.72%	28 - 32
-0.53	138	30	21.74%	33 - 37
0.51	133	39	29.32%	38 - 42
2.41	137	38	27.74%	43 - 47
2.06	128	34	26.56%	48 - 52
3.53	10	4	40.00%	53 - 58
0.30	43	17	39.53%	59 - 61
2.85	43	17	40.95%	

Enfermedad	Epsilon	# participantes	# obesos	Proporcion obesos
No le han diagnosticado asma	-0.03	1026	217	21.15%
Le han dignosticado asma	0.14	50	11	22.00%
No le han diagnosticado problemas cardiacos	-0.27	1022	213	20.84%
Le han diagnosticado problemas cardiacos	1.18	54	15	27.78%
No le han diagnosticado cancer de mama	-0.07	1066	225	21.11%
Le han diagnosticado cancer de mama	0.68	10	3	30.00%
No le han diagnosticado colesterol alto	-0.66	781	158	20.23%
Le han diagnosticado colesterol alto	1.07	295	70	23.73%
No le han diagnosticado cancer de colon	-0.06	1075	227	21.12%
Le han diagnosticado cancer de colon	1.93	1	1	100.00%
No le han diagnosticado otra enfermedad				
Le han diagnosticado otra enfermedad				
No le han diagnosticado cancer de prosta				
Le han diagnosticado cancer de prostata				
No sabe si le han diagnosticado diabetes				
Le han diagnosticado diabetes				
No le han diagnosticado hipertensión				
Le han diagnosticado hipertensión				
No le han diagnosticado problemas neurc				
Le han diagnosticado problemas neuronales				

Estatura en m	Proporcion obesos
< 1.5 : 1	

Número de amigos cercanos	Epsilon	# participantes	# obesos	Proporcion obesos
Cero	2.35	93	29	31.18%
Uno	2.08	74	23	31.08%
Mas que 1	-1.35	908	176	19.38%

Porcentaje del circulo social	# participantes	# obesos	Proporcion obesos
	511	91	17.81%
	313	70	22.36%
	190	45	23.68%
	61	22	36.07%

¿Cómo consideras que es tu salud actualmente?	Epsilon	# participantes	# obesos	Proporcion obesos
1 : Muy mala	1.15	15	5	33.33%
2 : Mala	5.15	60	29	48.33%
3 : Regular	4.41	366	112	30.60%
4 : Buena	-3.76	536	78	14.55%
5 : Muy buena	-4.30	95	3	3.16%

Epsilon	# participantes	# obesos	Proporcion obesos	Puesto
-2.81	234	32	13.68%	Academico
1.23	74	20	27.03%	Personal Admnistrativo
0.19	54	12	22.22%	Asistente
-1.64	10	0	0.00%	Coordinador
-2.38	52	4	7.69%	Estudiante
-3.58	81	4	4.94%	Estudiante Doctorado
-2.05	71	8	11.27%	Estudiante Maestria

Epsilon	# participantes	# obesos	Proporcion obesos	Edad
-4.18	122	7	5.74%	19 - 27
	45	17	11.72%	28 - 32
	138	30	21.74%	33 - 37
	133	39	29.32%	38 - 42
	137	38	27.74%	43 - 47
				52
				8
				1

Enfermedad	Epsilon	# participantes	# obesos	Proporcion obesos
No le han diagnosticado asma	-0.03	1026	217	21.15%
Le han dignosticado asma	0.14	50	11	22.00%
No le han diagnosticado problemas cardiacos	-0.27	1022	213	20.84%
Le han diagnosticado problemas cardiacos	1.18	54	15	27.78%
No le han diagnosticado cancer de mama	-0.07	1066	225	21.11%
Le han diagnosticado cancer de mama	0.68	10	3	30.00%
No le han diagnosticado colesterol alto	-0.66	781	158	20.23%
Le han diagnosticado colesterol alto	1.07	295	70	23.73%
No le han diagnosticado cancer de colon	-0.06	1075	227	21.12%
Le han diagnosticado cancer de colon	1.93	1	1	100.00%
No le han diagnosticado otra enfermedad				
Le han diagnosticado otra enfermedad				
No le han diagnosticado cancer de prosta				
Le han diagnosticado cancer de prostata				
No sabe si le han diagnosticado diabetes				
Le han diagnosticado diabetes				
No le han diagnosticado hipertensión				
Le han diagnosticado hipertensión				
No le han diagnosticado problemas neuro				
Le han diagnosticado problemas neuronales				

obesos	Proporcion obesos	Estatura en m
43	40.95%	< 1.5 : 1

Número de amigos cercanos	Epsilon	# participantes	# obesos	Proporcion obesos
Cero	2.35	93	29	31.18%
Uno	2.08	74	23	31.08%
Mas que 1	-1.35	908	176	19.38%

¿Cómo consideras que es tu salud actualmente?	Epsilon	# participantes	# obesos	Proporcion obesos
1 : Muy mala	1.15	15	5	33.33%
2 : Mala				
3 : Regular				
4 : Buena				
5 : Muy buena				

Porcentaje del circulo social

	# participantes	# obesos	Proporcion obesos
	511	91	17.81%
	313	70	22.36%
	190	45	23.68%

¿Qué acciones le gustaría tomar resp	Epsilon	# participantes	Proporcion poblacion	# obesos	Probabilidad obesidad	Proporcion obesos
Bajar de peso	5.25	771	71.65%	223	28.92%	97.81%
Esta contento con su peso	-7.54	239	22.21%	3	1.26%	1.32%
Subir de peso	-3.50	63	5.86%	2	3.17%	0.88%
No sabe	-0.90	3	0.28%	0	0.00%	0.00%

Epsilon	# participantes	# obesos	Proporcion obesos	Puesto
-2.81	234	32	13.68%	Academico
1.23	74	20	27.03%	Personal Admnistrativo
0.19	54	12	22.22%	Asistente
-1.64	10	0	0.00%	Coordinador
-2.38	52	4	7.69%	Estudiante
-3.58	81	4	4.94%	Estudiante Doctorado
-2.05	71	8	11.27%	Estudiante Maestria

Epsilon	# participantes	# obesos	Proporcion obesos	Edad
-4.18	122	7	5.74%	19 - 27
2.03	145	17	11.72%	28 - 32
-0.53	138	30	21.74%	33 - 37
0.51	133	39	29.32%	38 - 42
2.41	137	38	27.74%	43 - 47

Enfermedad	Epsilon	# participantes	# obesos	Proporcion obesos
No le han diagnosticado asma	-0.03	1026	217	21.15%
Le han dignosticado asma	0.14	50	11	22.00%
No le han diagnosticado problemas cardiacos	-0.27	1022	213	20.84%
Le han diagnosticado problemas cardiacos	1.18	54	15	27.78%
No le han diagnosticado cancer de mama	0.07	1066	225	21.11%
Le ha				
No le				
Le ha				
No le				
Le ha				
No le				
Le ha				
No le				
Le ha				
No s				
Le han diagnosticado diabetes				
No le han diagnosticado hipertensión				
Le han diagnosticado hipertensión				
No le han diagnosticado problemas neuro				
Le han diagnosticado problemas neuronales				

¿Cómo consideras tu peso actual?	Epsilon	# participantes	Proporcion poblacion	# obesos	Probabilidad obesidad	Proporcion obesos
Muy malo	-1.47	8	0.74%	0	0.00%	0.00%
Malo	-3.70	51	4.74%	0	0.00%	0.00%
Regular	-9.66	419	38.94%	8	1.91%	3.51%
Bueno	4.65	514	47.77%	152	29.57%	66.67%
Muy bueno	13.97	80	7.43%	68	85.00%	29.82%

Cero	2.35	93	29	31.18%
Uno	2.08	74	23	31.08%
Mas que 1	-1.35	908	176	19.38%

Porcentaje del circulo social	# participantes	# obesos	Proporcion obesos
	511	91	17.81%
	313	70	22.36%
	190	45	23.68%

¿Cómo consideras que es tu salud actualmente?	Epsilon	# participantes	# obesos	Proporcion obesos
1 : Muy mala	1.15	15	5	33.33%
2 : Mala				
3 : Regular				
4 : Buena				
5 : Muy buena				

¿Qué acciones le gustaría tomar respe	Epsilon	# participantes	Proporcion poblacion	# obesos	Probabilidad obesidad	Proporcion obesos
Bajar de peso	5.25	771	71.65%	223	28.92%	97.81%
Esta contento con su peso	-7.54	239	22.21%	3	1.26%	1.32%
Subir de peso	-3.50	63	5.86%	2	3.17%	0.88%
No sabe	-0.90	3	0.28%	0	0.00%	0.00%

Epsilon	# participantes	# obesos	Proporcion obesos	Puesto
-2.81	23			
1.23	74			
0.19	54			
-1.64	10			
-2.38	52			
-3.58	81			
-2.05	71			
2.03				
-0.53				
0.51				
2.41				
2.06				
3.53				
0.30				
2.85				

¿Cuántas calorías hay en un litro de agua?	Epsilon	# participantes	Proporcion poblacion	# obesos	Probabilidad obesidad	Proporcion obesos
No sabe el número de calorías que tiene el agua	2.88	453	42.10%	121	26.71%	53.07%
El agua contiene 0 calorías	-2.48	567	52.70%	96	16.93%	42.11%
El agua contiene de 1 a 20 calorias	-0.34	27	2.51%	5	18.52%	2.19%
El agua contiene más de 20 calorias	-0.07	29	2.70%	6	20.69%	2.63%

Enfermedad							
No le han dia							
Le han digno							
No le han dia							
Le han diagnosticado problemas cardiacos	1.18	54	15	27.78%	37	38	27.74%	43 - 47
No le							
Le ha							
No le							
Le ha							
No le							
Le ha							
No le							
Le ha							
No s							
Le han diagnosticado diabetes							
No le han diagnosticado hipertensión							
Le han diagnosticado hipertensión							
No le han diagnosticado problemas neuro							
Le han diagnosticado problemas neuronales							

¿Cómo consideras tu peso actual?	Epsilon	# participantes	Proporcion poblacion	# obesos	Probabilidad obesidad	Proporcion obesos
Muy malo	-1.47	8	0.74%	0	0.00%	0.00%
Malo	-3.70	51	4.74%	0	0.00%	0.00%
Regular	-9.66	419	38.94%	8	1.91%	3.51%
Bueno	4.65	514	47.77%	152	29.57%	66.67%
Muy bueno	13.97	80	7.43%	68	85.00%	29.82%

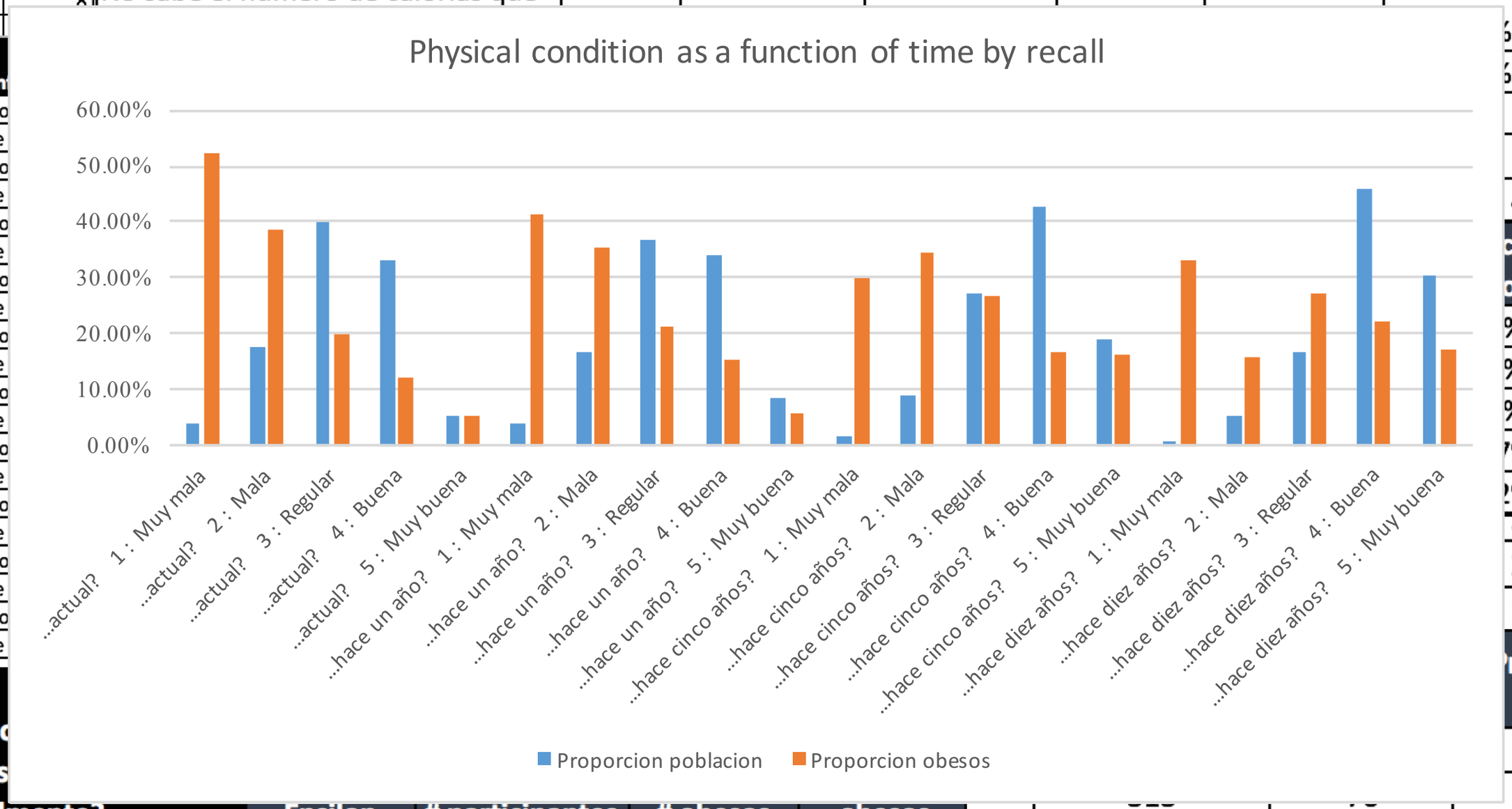
Porcentaje del circulo social		# participantes	# obesos	Proporcion obesos
Cero	2.35	93	29	31.18%
Uno	2.08	74	23	31.08%
Mas que 1	-1.35	908	176	19.38%

¿Cómo consideras que es tu salud actualmente?	Epsilon	# participantes	# obesos	Proporcion obesos		# participantes	# obesos	Proporcion obesos
1 : Muy mala	1.15	15	5	33.33%		511	91	17.81%
2 : Mala						313	70	22.36%
3 : Regular						190	45	23.68%
4 : Buena								
5 : Muy buena								

¿Qué acciones le gustaría tomar resp	Epsilon	# participantes	Proporcion poblacion	# obesos	Probabilidad obesidad	Proporcion obesos
Bajar de peso	5.25	771	71.65%	223	28.92%	97.81%
Esta contento con su peso	-7.54	239	22.21%	3	1.26%	1.32%
Subir de peso	-3.50	63	5.86%	2	3.17%	0.88%
No sabe	-0.90	3	0.28%	0	0.00%	0.00%

Epsilon	# participantes	# obesos	Proporcion obesos	Puesto
-2.81	23			
1.23	74			
0.19	54			
-1.64	10			
-2.38	52			
-3.58	81			
-2.05				
2.03				
-0.53				
0.51				
2.41				
2.06				
3.53				
0.30				
2.85				

¿Cuántas calorías hay en un litro de agua?	Epsilon	# participantes	Proporcion poblacion	# obesos	Probabilidad obesidad	Proporcion obesos
No sabe el número de calorías que						



¿Cómo es tu s actualmente?	Epsilon	# participantes	# obesos	obesos
1 : Muy mala	1.15	15	5	33.33%
2 : Mala				
3 : Regular				
4 : Buena				
5 : Muy buena				

¿Qué acciones le gustaría tomar respe	Epsilon	# participantes	Proporcion poblacion	# obesos	Probabilidad obesidad	Proporcion obesos
Bajar de peso	5.25	771	71.65%	223	28.92%	97.81%
Esta contento con su peso	-7.54	239	22.21%	3	1.26%	1.32%
Subir de peso	-3.50	63	5.86%	2	3.17%	0.88%
No sabe	-0.90	3	0.28%	0	0.00%	0.00%

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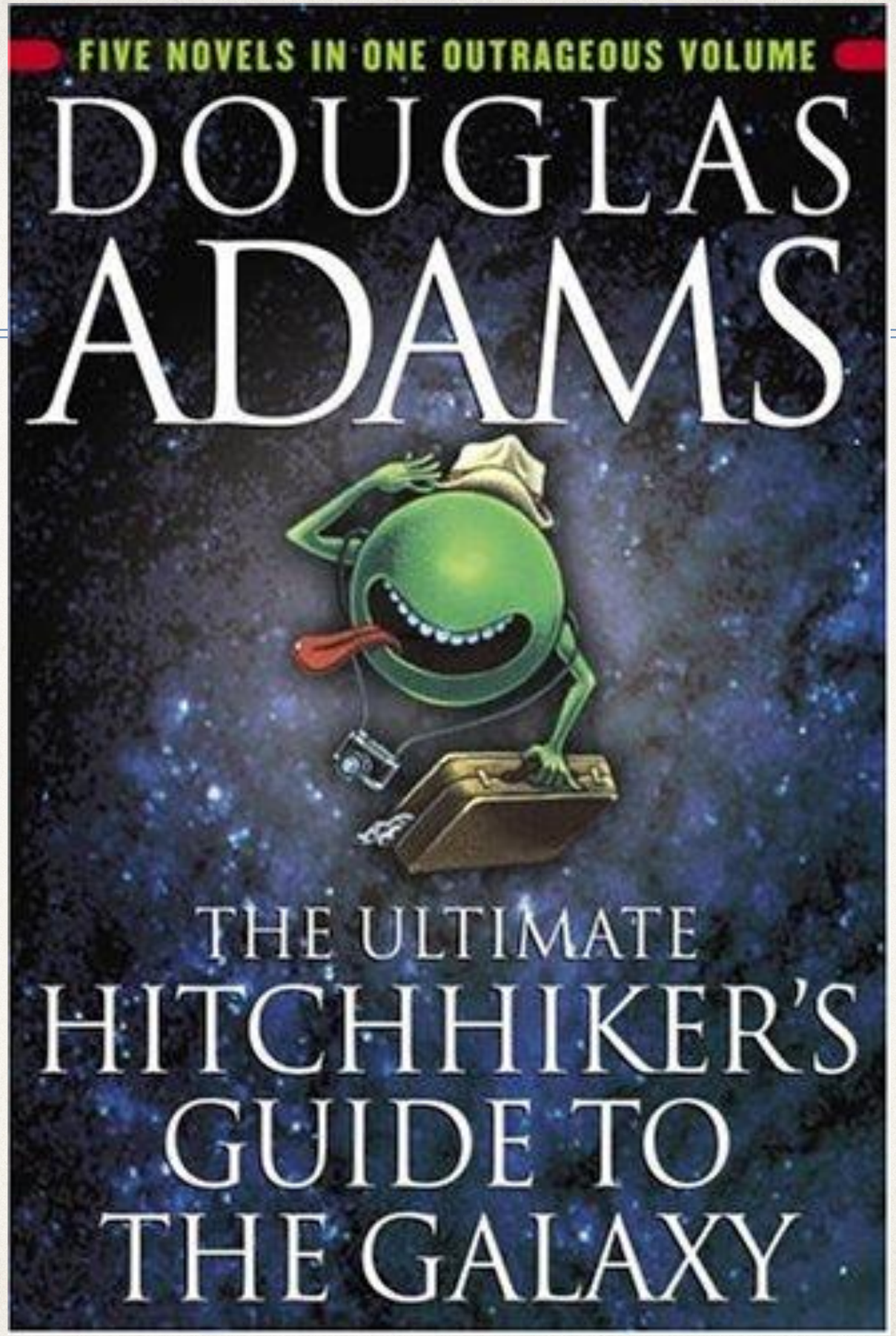
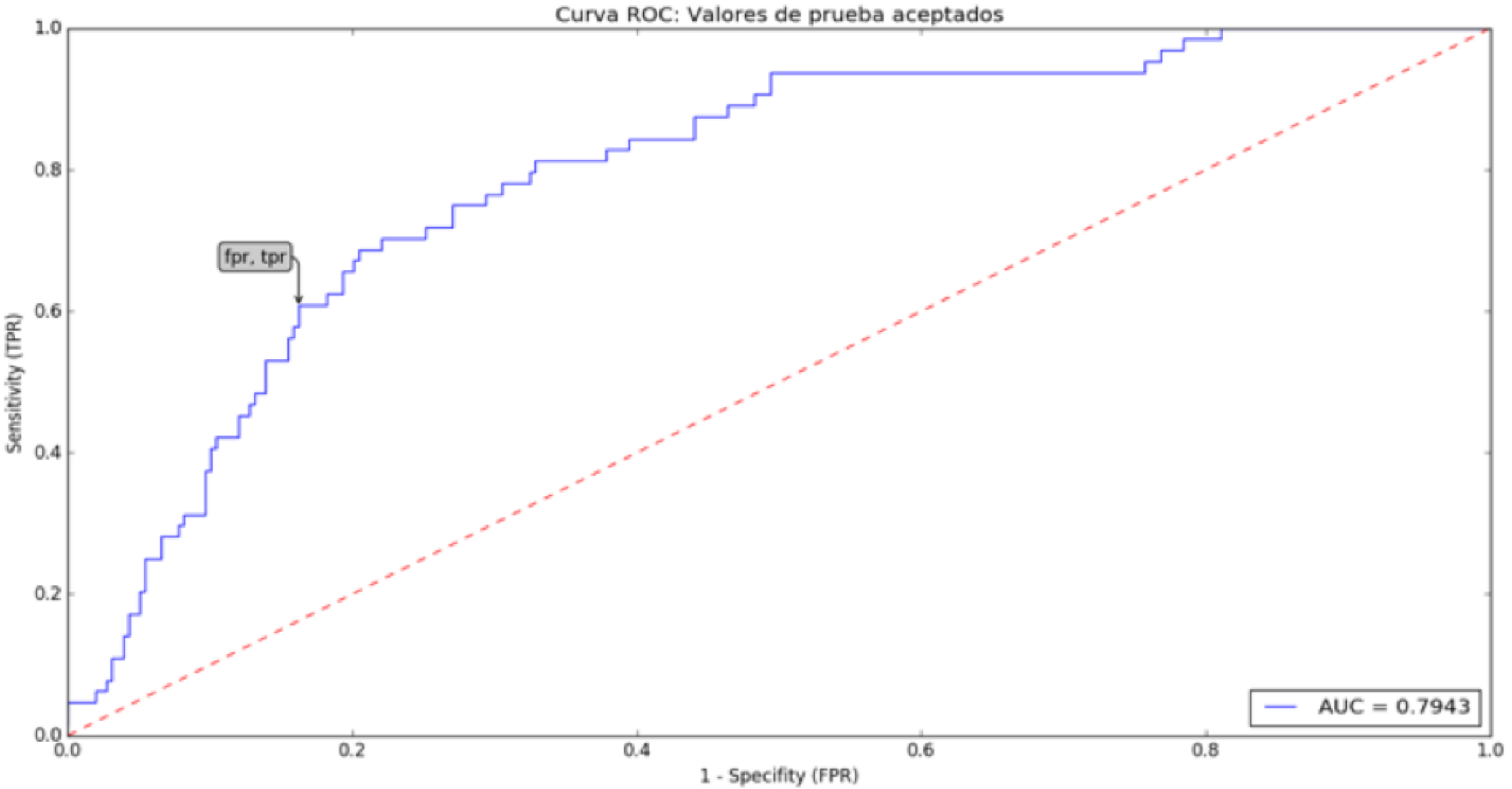
rcion sos
31.18%
31.08%
19.38%
17.81%
22.36%
23.68%

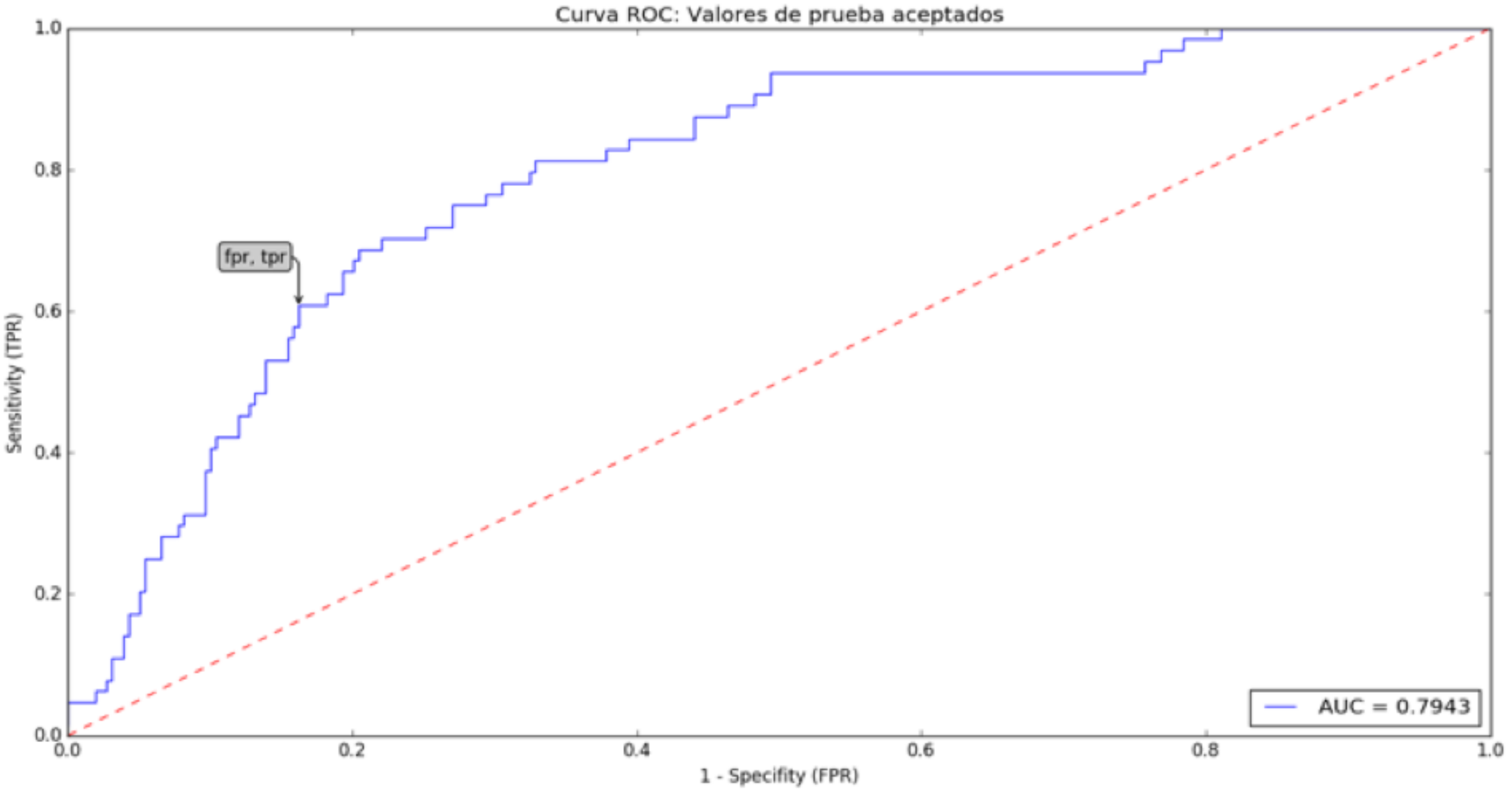
Proporcion obesos
190	45

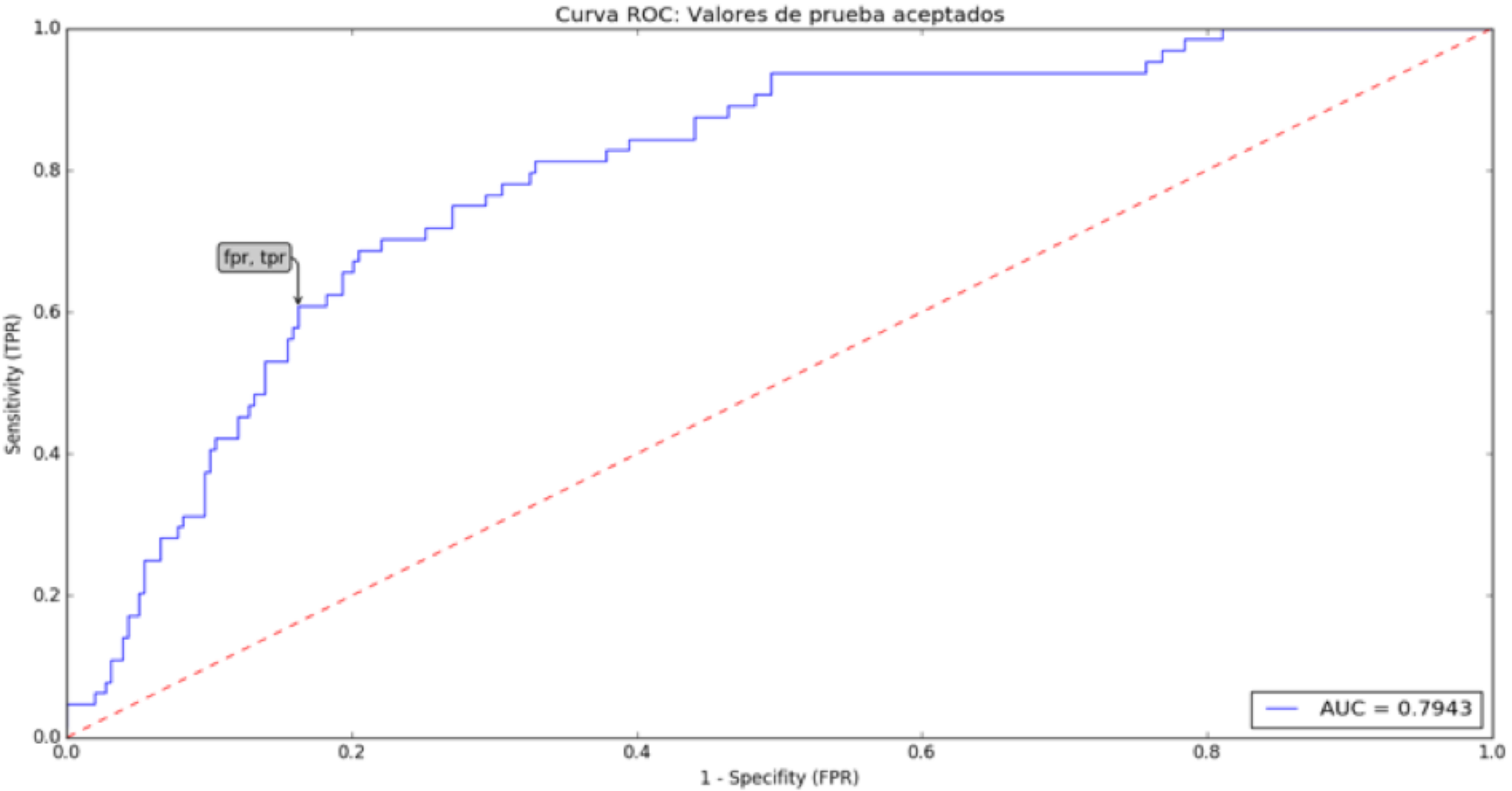

FIVE NOVELS IN ONE OUTRAGEOUS VOLUME
DOUGLAS ADAMS
THE ULTIMATE
HITCHHIKER'S GUIDE TO THE GALAXY

THE ULTIMATE ANSWER
TO LIFE, THE UNIVERSE
AND EVERYTHING IS

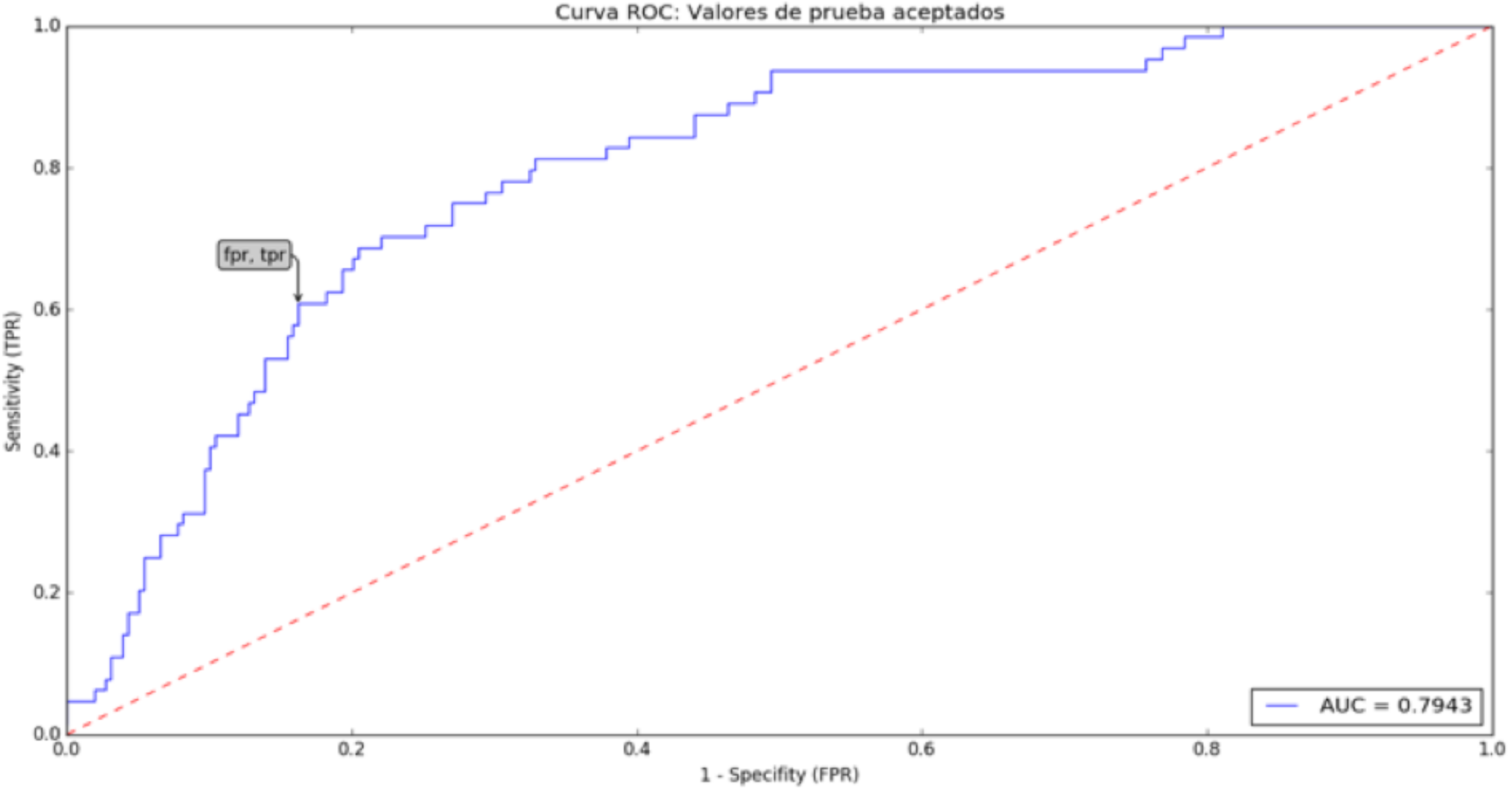

42


Curva ROC: Valores de prueba aceptados
Sensitivity (TPR)
1 - Specifity (FPR)
fpr, tpr
AUC = 0.7943
0.0
0.2
0.4
0.6
0.8
1.0


Curva ROC: Valores de prueba aceptados
Sensitivity (TPR)
1 - Specifity (FPR)
fpr, tpr
AUC = 0.7943
0.0
0.2
0.4
0.6
0.8
1.0


Curva ROC: Valores de prueba aceptados
Sensitivity (TPR)
1 - Specifity (FPR)
fpr, tpr
AUC = 0.7943
0.0
0.2
0.4
0.6
0.8
1.0

= 42



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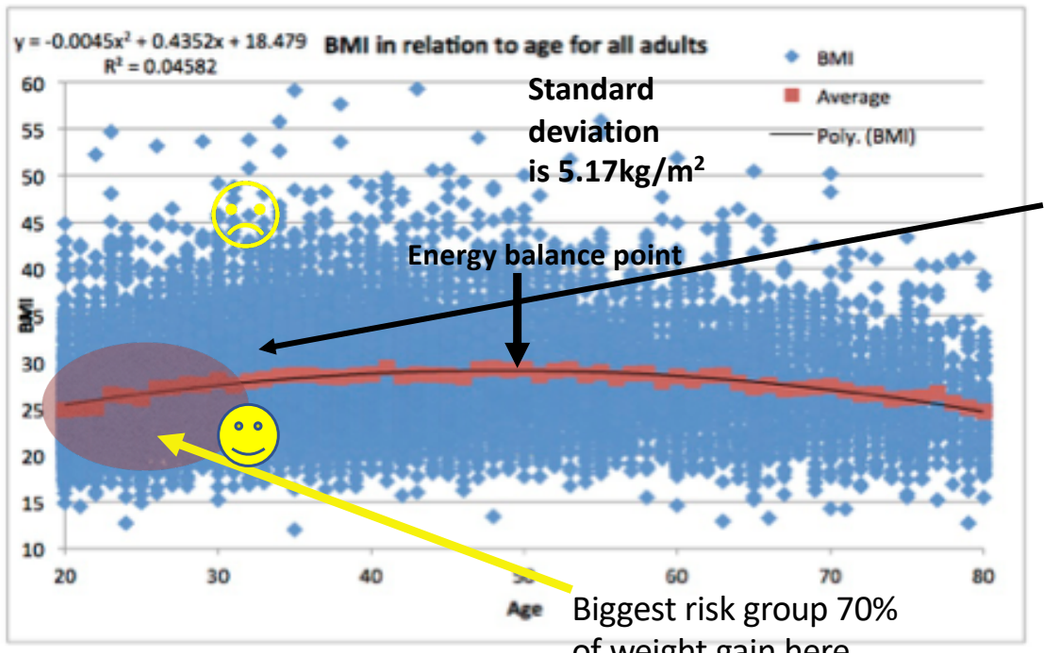
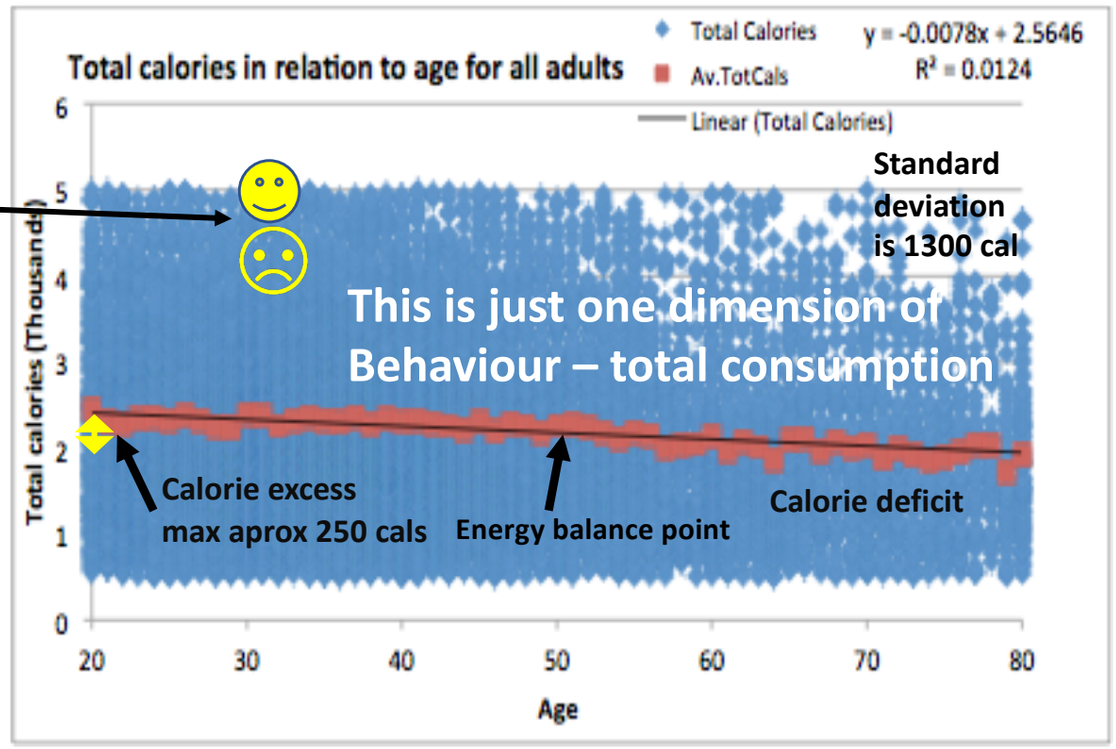
Predictive model for obesity… The Conductome

2. Consumption...

You aren´t what you eat you become what you eat



This isn't noise its multifactoriality



Epidemiological data from ENSANUT 2006

Regression of BMI change versus calorie excess

	Variable(s)	Unstd. B	Std. Error	t	f	R^2	Sig	Lower	Upper
Moving Av.					29.236	0.343	0		
BMI Change	Constant	-1.954	0.362	-5.392			0	-2.68	-1.228
ALL	Total_Cals	0.904	0.167	5.407			0	0.569	1.239
	Variable(s)	Unstd. B	Std. Error	t	f	R^2	Sig	Lower	Upper
Moving Av.					13.397	0.193	0.001		
BMI Change	Constant	-1.625	0.444	-3.656			0.001	-2.515	-0.734
Men	Total_Cals	0.724	0.198	3.66			0.001	0.328	1.121
	Variable(s)	Unstd. B	Std. Error	t	f	R^2	Sig	Lower	Upper
Moving Av.					22.429	0.286	0		
BMI Change	Constant	-1.754	0.372	-4.711			0	-2.5	-1.008
Women	Total_Cals	0.833	0.176	4.736			0	0.481	1.185

This gradually decreasing calorie excess seems to be the motor for the population level increase in BMI

The Challenge of Measuring ”Real World” Energy Imbalance:

Some Phenomenological Observations

1) Population Energy Balance is a truly Emergent phenomenon

Why?

2) Maximum calorie excess is 250 cal but the population level std dev is 1300 cal

3) Calorie excess changes by only 8 calories per year

4) Average BMI increase per year is 0.15kg/m^2 (400g) but the population level std dev is 5.17kg/m^2

5) For an excess of 250 cal one expects a yearly increase of 13kg
Over a 30 year period the excess is over 1,000,000. Using the 3500 cal/pound rules this should correspond to an increase of 140kg!

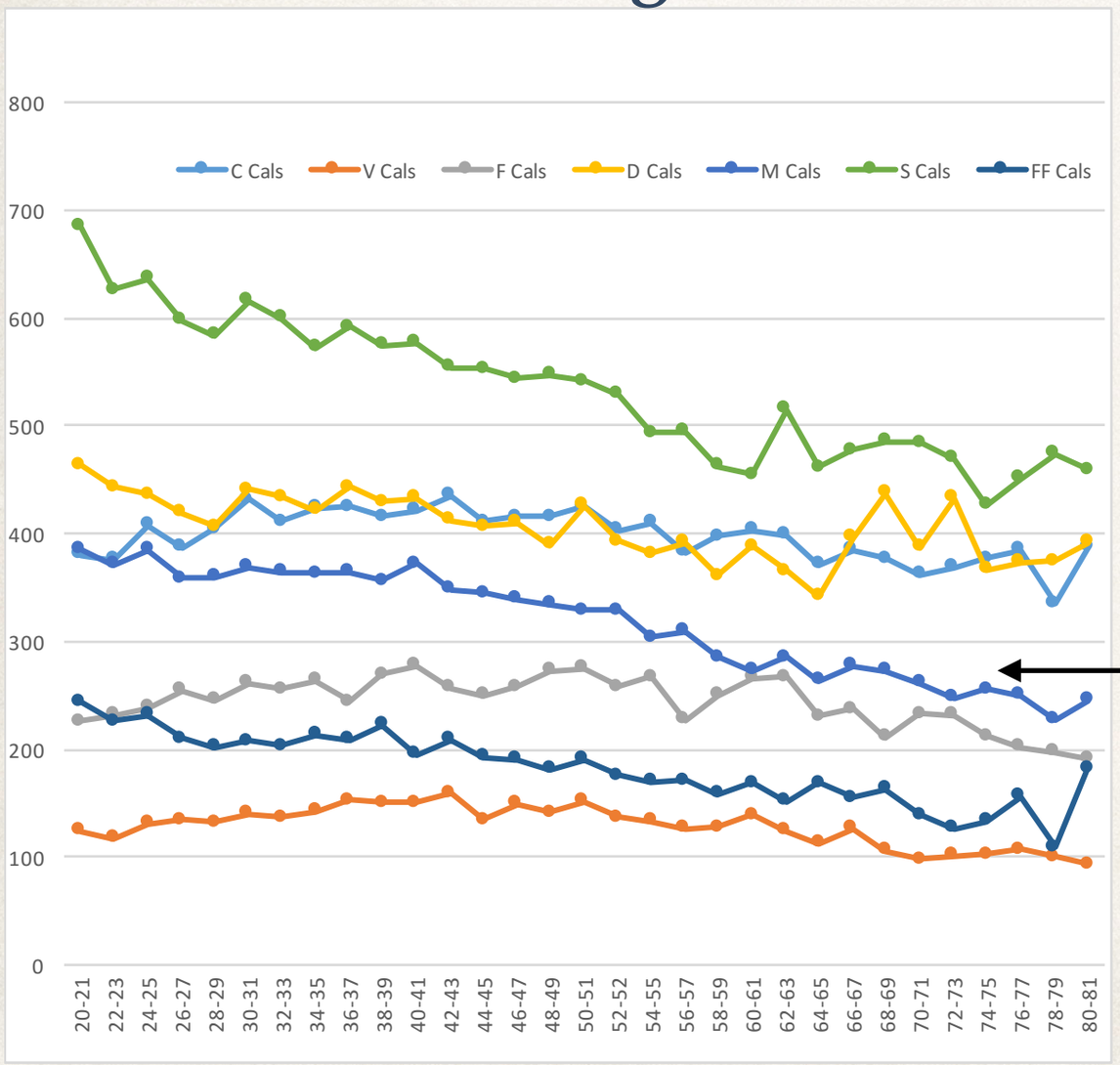
6) We should be even fatter! Where do all the calories go?

The Conductome: Consumption
We "Decide" to eat the "wrong" things

Epidemiological data from ENSANUT 2006

	Edad 20	Edad 50	Edad 80	Diff 50 20	Diff 80 20	Diff 80 50	Edad 20	Edad 50	Edad 80
S	650	540	460	16.92%	29.23%	14.81%	26.75%	23.38%	24.73%
FF	230	185	140	19.57%	39.13%	24.32%	9.47%	8.01%	7.53%
M	370	330	240	10.81%	35.14%	27.27%	15.23%	14.29%	12.90%
D	450	415	370	7.78%	17.78%	10.84%	18.52%	17.97%	19.89%
F	230	270	200	-17.39%	13.04%	25.93%	9.47%	11.69%	10.75%
V	120	150	90	-25.00%	25.00%	40.00%	4.94%	6.49%	4.84%
C	380	420	360	-10.53%	5.26%	14.29%	15.64%	18.18%	19.35%
	2430	2310	1860	4.94%	23.46%	19.48%			

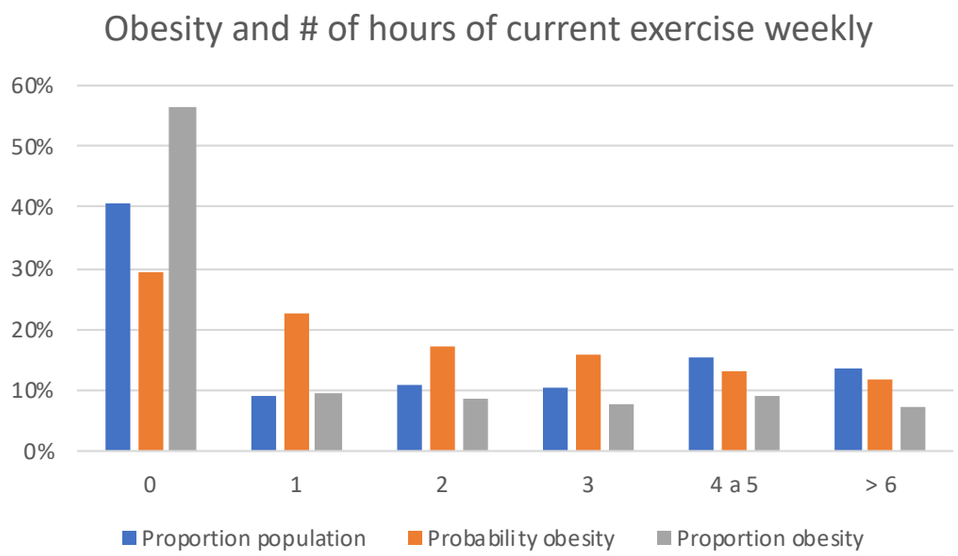
The motor changes its fuel…



The fuel mix at age 20 consists of 51.5% sugars, junk food and meat and 30% fruit, vegetables and cereals. At age 50 its 45.5% and 36.5%.

Accelerated reduction in meat consumption in the aged

2. Exercise ...

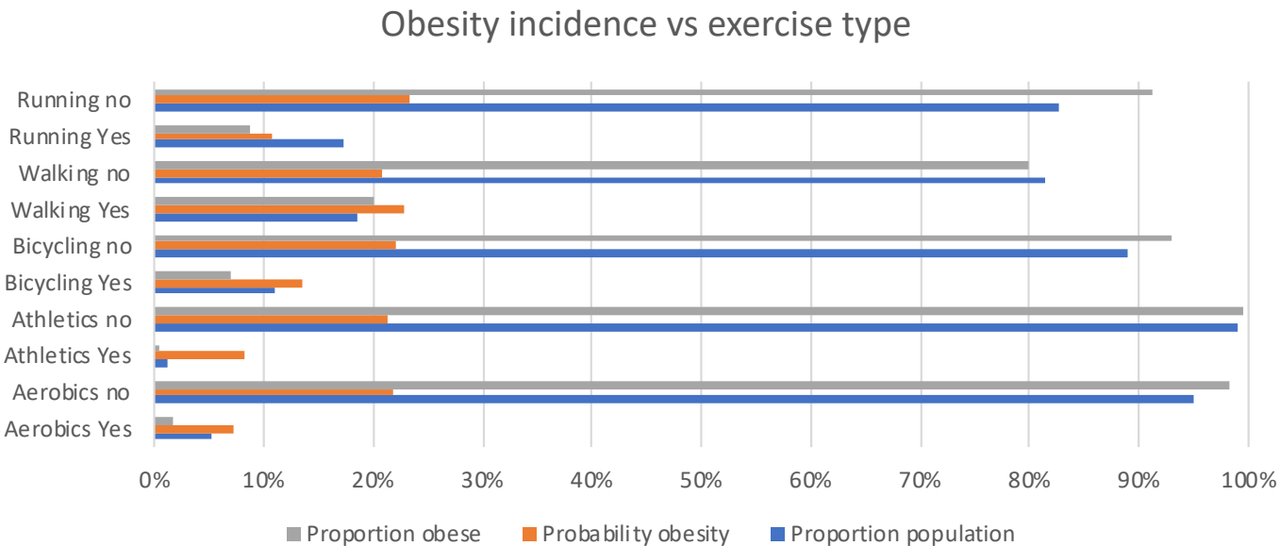


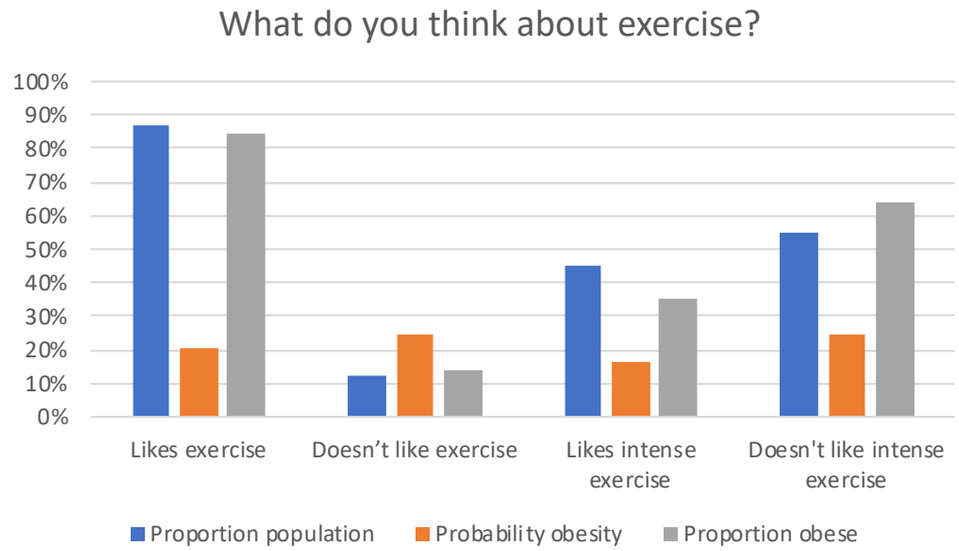
Obesity % versus historical exercise behavior
A > recommended exercise, B < recommended, * don't care;
(30y, 20y, 10y, 5y, 1y, now)

History	ϵ	N_x	N_{cx}	%	score
A*A*BB	3.56	94	38	40.43	0.73
AAA*B	3.55	91	37	40.66	0.74
AA**BB	3.53	113	44	38.94	0.67
AA**B*	3.40	131	49	37.40	0.60
A***BB	3.23	137	50	36.50	0.57
*A***A	-3.27	157	21	13.38	-0.75
**AAA	-3.27	157	21	13.38	-0.75
AA**AA	-3.51	103	10	9.71	-1.11
A**AA	-3.61	134	15	11.19	-0.95
***AA	-3.76	193	25	12.95	-0.79

Its worse to have had good habits and lost them than never to have had them

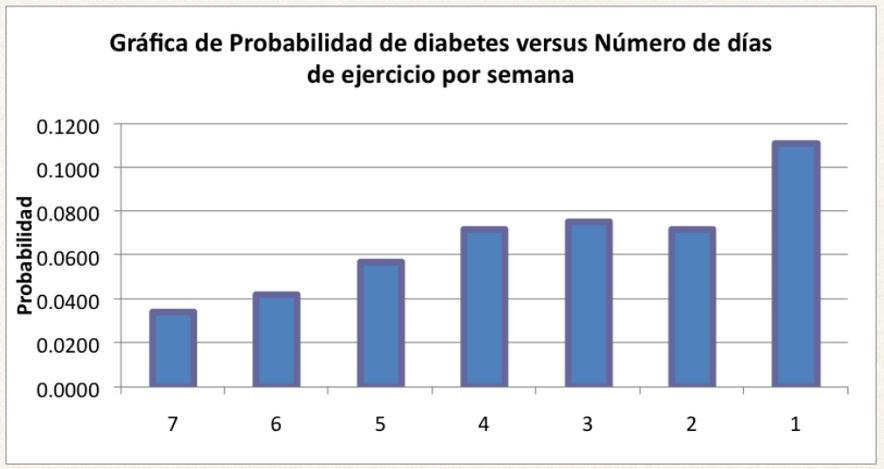
How many dimensions do we need to describe our decision making/actions and behavior with respect to exercise?

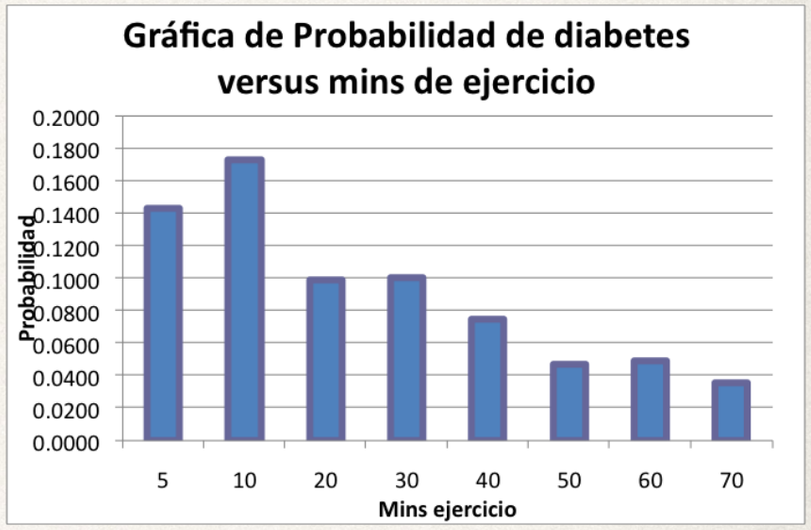




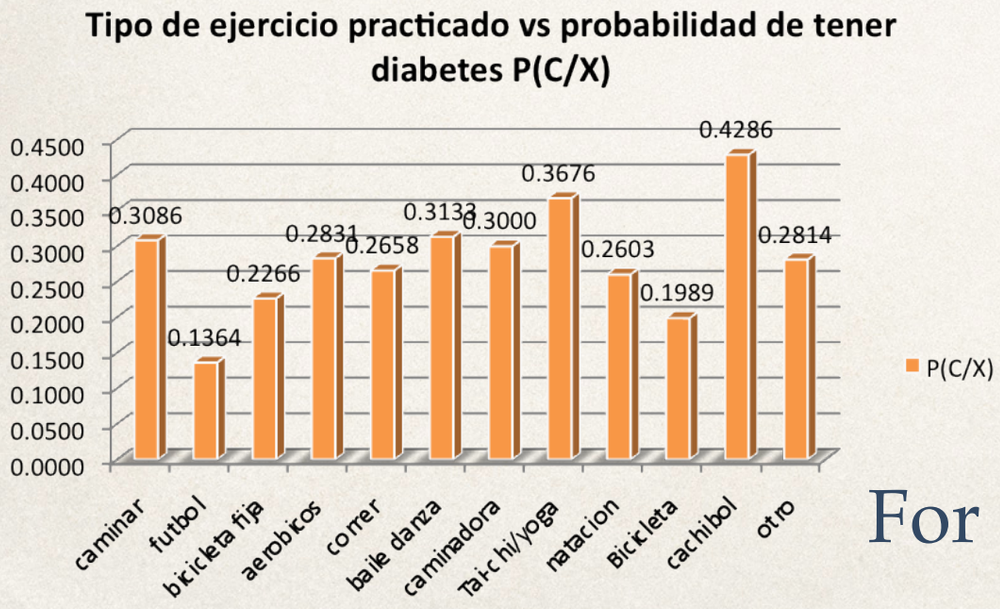
The Conductome: Exercise

We "Decide" when to exercise, what type, how often,…

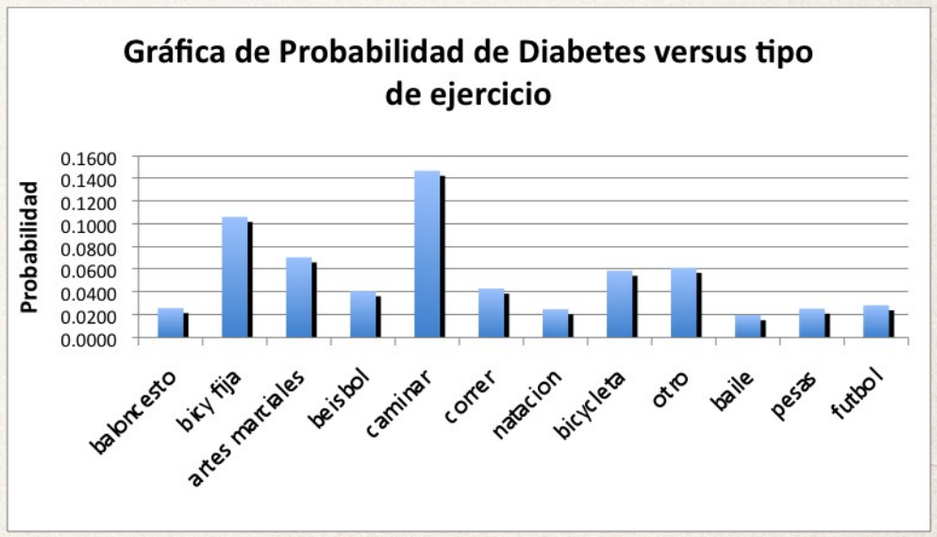




For men 20-59 de PREVENIMSS 2006

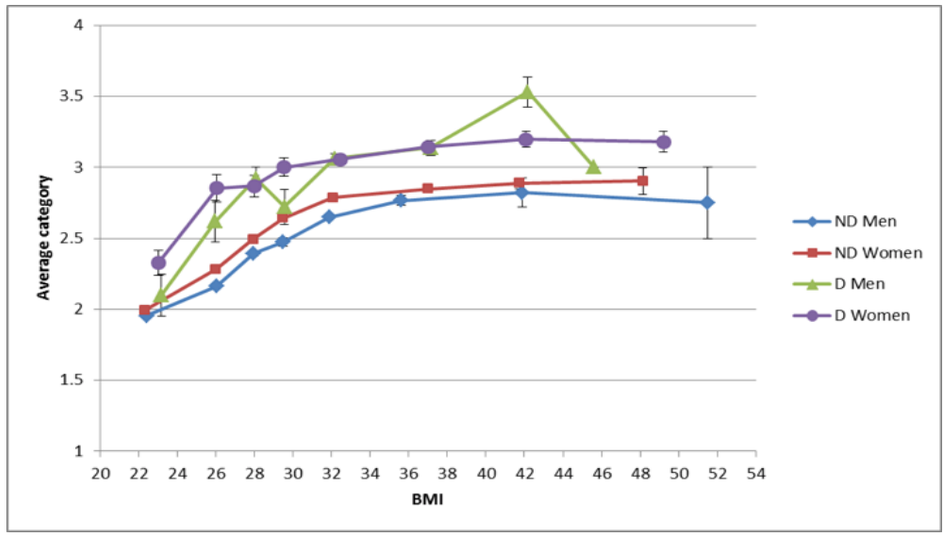


For seniors > 59



Is it riskier to walk than do nothing?

3. And some risk factors… being short, being non-academic, looking at the world through rose-tinted glasses,…

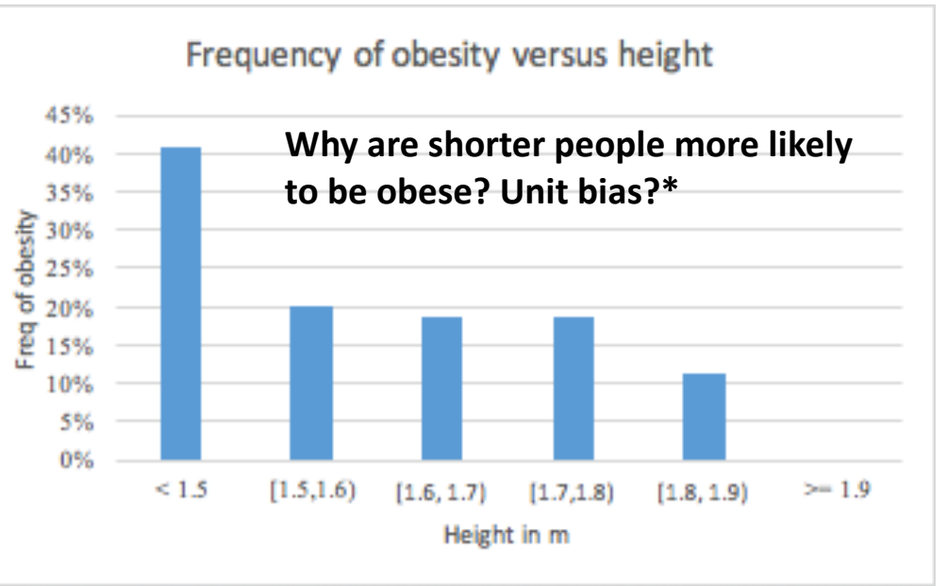


Probability to be an academic versus historical exercise behavior
A > recommended exercise, B < recommended, * don't care;
(30y, 20y, 10y, 5y, 1y, now)

History	ϵ	N_x	N_{cx}	%	score
*A***A	5.55	157	85	54.14	0.86
A**AA	5.21	134	73	54.48	0.88
AA**A	5.13	135	73	54.07	0.86
A*A*A	5.06	129	70	54.26	0.87
*A**A	4.97	165	85	51.52	0.76
*BBB**	-4.32	197	37	18.78	-0.77
**BB*	-4.40	267	55	20.60	-0.65
BBB	-4.41	207	39	18.84	-0.76
**BBB	-4.41	245	49	20.00	-0.69
**B*B	-4.55	260	52	20.00	-0.69

Effect of cognitive biases

- Self-serving
- Anchoring
- Unit



Big Mac meal
for a large person

Big Mac meal
for a short person

Torta Cubana
for a large person

Torta Cubana
for a short person

* Katherine Stephens

The Rational Conductome: The Information X(t)

- Do we have the information available to make a "rational" decision?

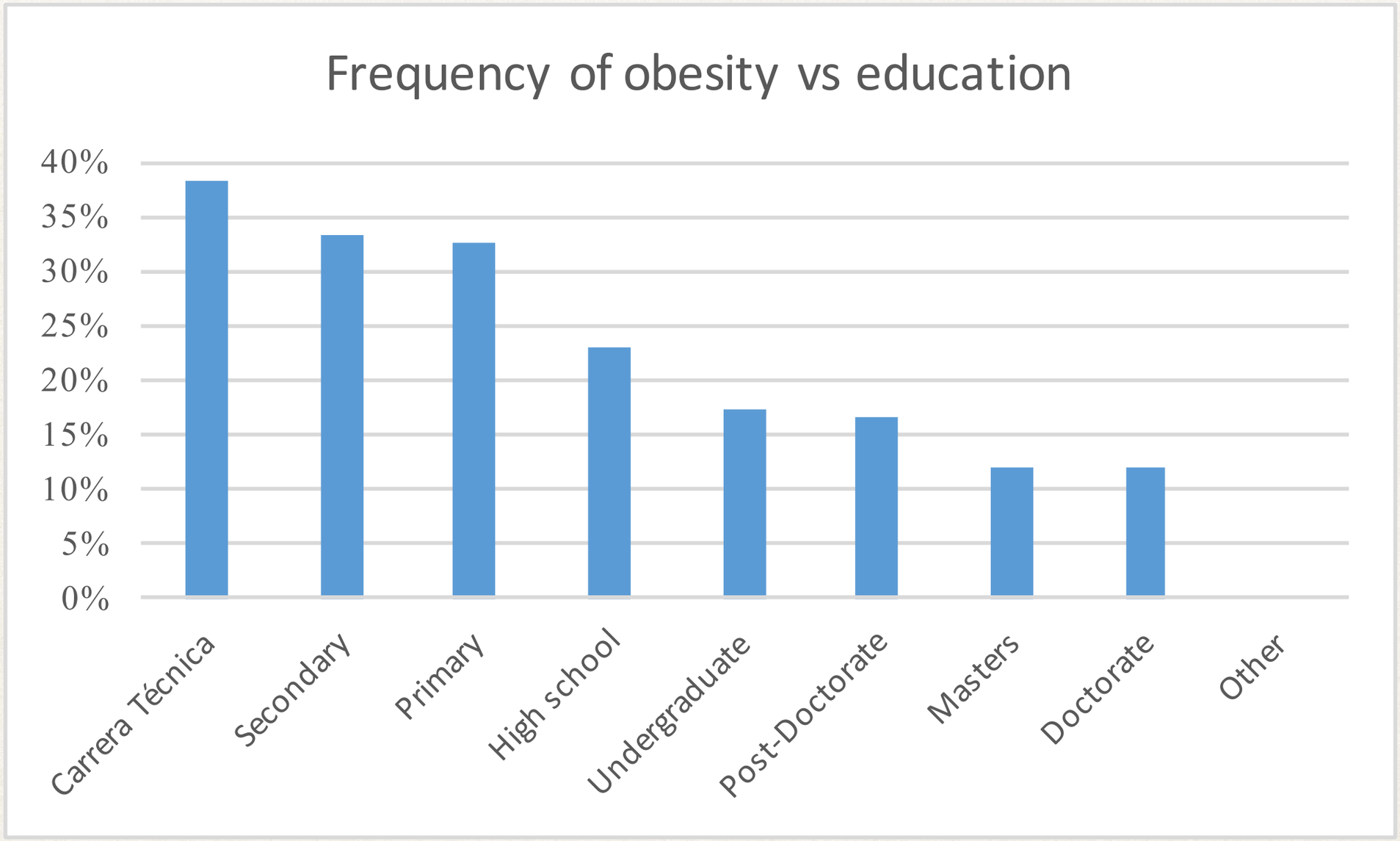
Pregunta	Epsilon	# participantes	Proporcion poblacion	# obesos	Probabilidad obesidad	Proporcion obesos
Hacer ejercicio no tiene importancia	0.51	3	0.28%	1	33.33%	0.44%
Hacer ejercicio es poco importante	-0.90	3	0.28%	0	0.00%	0.00%
Hacer ejercicio es importante	-1.45	115	10.69%	18	15.65%	7.89%
Hacer ejercicio es muy importante	0.56	953	88.57%	209	21.93%	91.67%

Pregunta	Epsilon	# participantes	Proporcion poblacion	# obesos	Probabilidad obesidad	Proporcion obesos
Si sabe del nuevo impuesto en alimentos de alta densidad	-0.81	814	75.72%	163	20.02%	71.49%
No sabe del nuevo impuesto en alimentos de alta densidad	1.47	261	24.28%	65	24.90%	28.51%

Pregunta	Epsilon	# participantes	Proporcion poblacion	# obesos	Probabilidad obesidad	Proporcion obesos
Si conoce el IMC para un peso normal	-3.07	141	13.12%	15	10.64%	6.58%
No conoce el IMC para un peso normal	1.21	934	86.88%	213	22.81%	93.42%

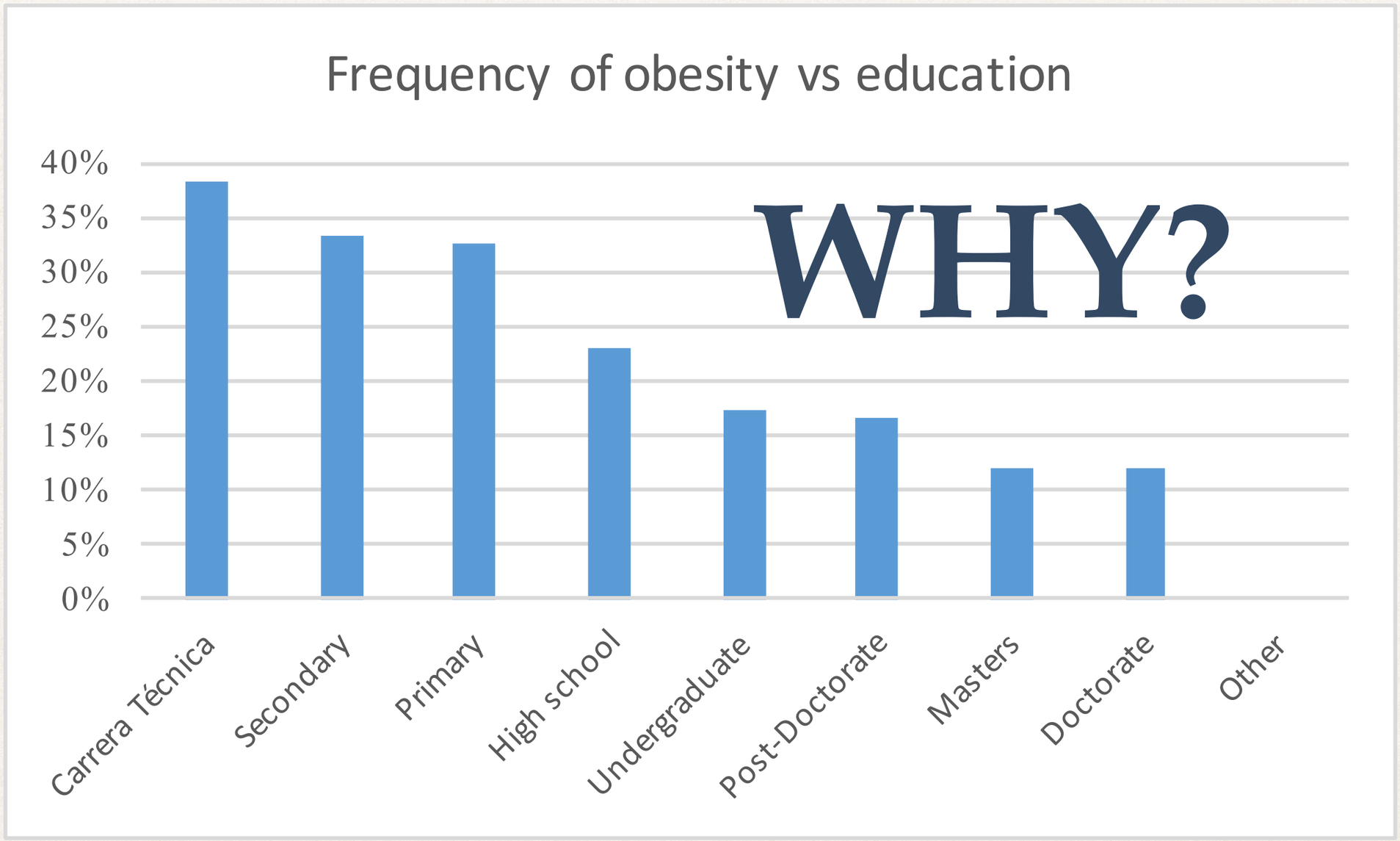
What information is necessary and what information, if any, is sufficient?

Education and the Conductome
What Decisions are Taken Differently?



UNAM 2014 Study: 1,076 participants

Education and the Conductome
What Decisions are Taken Differently?



UNAM 2014 Study: 1,076 participants

4. How plastic are they?

Estimates of Funding for Various Research, Condition, and Disease Categories NIH

Research/Disease Areas	FY 2016Actual (Dollars in millions)	2015 US Mortality	2015 US Prevalence (Standard deviation)
Cancer	5589.00	652,672	8.7% (0.20%)
Cardiovascular	2108.00	1,464,485	-
Chronic Obstructive Pulmonary Disease	97.00	292,471	6.2% (0.18%)
Diabetes 4/	1084.00	252,806	9.7% (0.22%)
Digestive Diseases	1745.00	-	-
Heart Disease	1289.00	1,202,319	11.7% (0.26%)
Heart Disease - Coronary Heart Disease	419.00	536,339	6.1% (0.17%)
Hypertension	224.00	427,631	27.0% (0.33%)
Inflammatory Bowel Disease	126.00	2,966	-
Obesity	965.00	39,590	30.0% (0.38%)
Stroke	308.00	234,867	-
	13,954	5,106,146	
% of total	17%	73%	
Physical Activity	392.00	-	-
Prevention	7566.00	-	-
Tobacco	299.00	-	-
Nutrition	1615.00	-	-
Basic Behavioral and Social Science	1804.00	-	-
Behavioral and Social Science	4137.00	-	-
	15,813		

Not very! Well, at least not the healthy behaviors

- So, there is ample evidence that we eat too much, too much of the wrong things and we don't exercise enough. These are all associated with "bad" decisions?

- Why do we make these decisions?

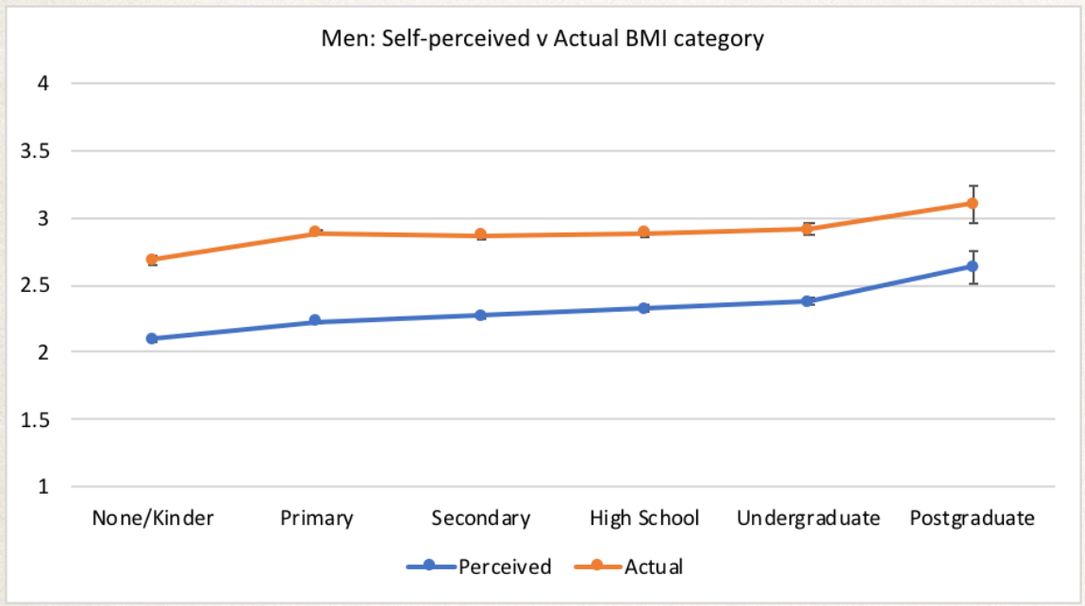
- Are our decisions rational? Depends on:

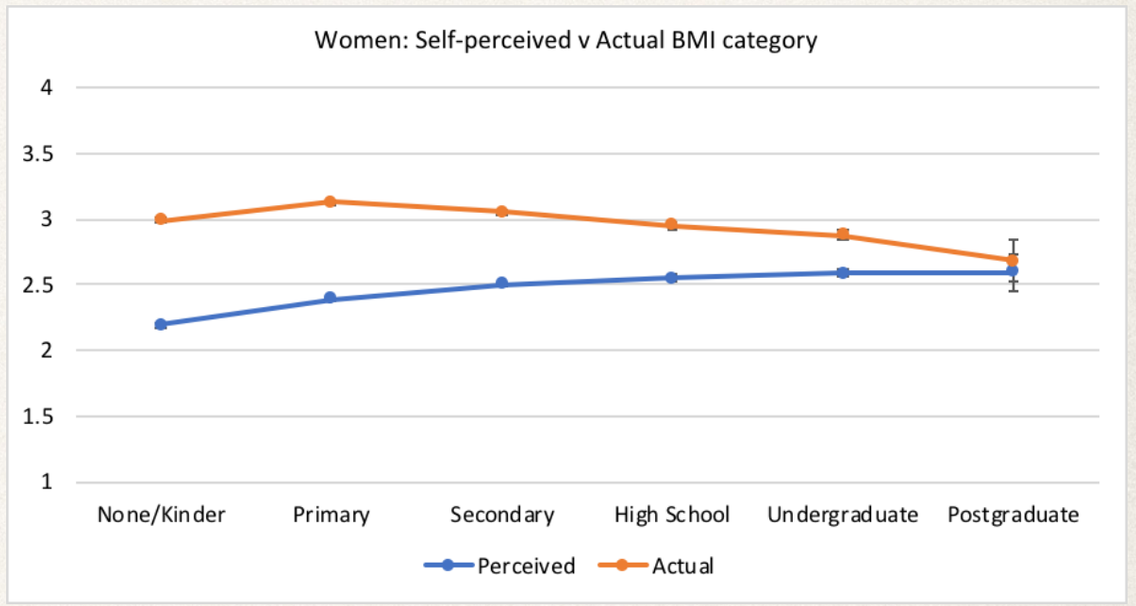
  - What value function our decision making is based on

  - What prediction/processing model P(|) we use

  - What information **X**(t) we have available

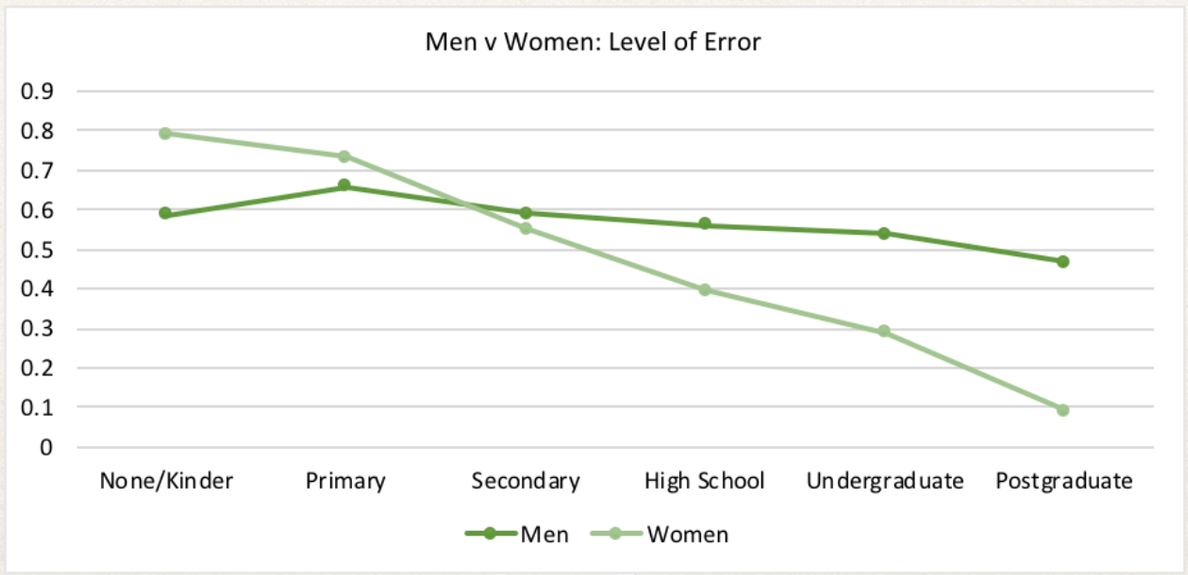
Perception, Educational Level and Gender





"Do you consider yourself to be…? 1) Overweight, 2) Obese, 3) Underweight, 4) Normal"

People of different educational levels have different models of themselves and their environment



Gender difference for BMI versus height

ENSANUT 2006

Perception, Educational Level and Gender

Misperception by linguistic concept

All BMI Obese	Education level (n; %)					
Self-Perception	None/Kinder	Primary	Secondary	High School	Undergraduate	Postgraduate
Obese	13; 2.3	87; 3.3	54; 5	29; 7.1	19; 7.4	1; 6.7
Overweight	338; 59.5	1845; 69.8	830; 77.4	326; 80.3	209; 81.3	13; 86.7
Normal	200; 35.2	672; 25.4	177; 16.5	50; 12.3	28; 10.9	1; 6.7
Underweight	17; 3	38; 1.4	12; 1.1	1; 0.2	1; 0.4	0; 0
BMI Obese Men	**Education level (n; %)**					
Self-Perception	None/Kinder	Primary	Secondary	High School	Undergraduate	Postgraduate
Obese	4; 3.7	14; 2.2	13; 4.6	10; 6.8	3; 2.5	1; 9.1
Overweight	65; 60.2	406; 62.8	196; 68.8	110; 75.3	98; 81.7	9; 81.8
Normal	38; 35.2	217; 33.5	69; 24.2	26; 17.8	18; 15	1; 9.1
Underweight	1; 0.9	10; 1.5	7; 2.5	0; 0	1; 0.8	0; 0
BMI Obese Women	**Education level (n; %)**					
Self-Perception	None/Kinder	Primary	Secondary	High School	Undergraduate	Postgraduate
Obese	9; 2	73; 3.7	41; 5.2	19; 7.3	16; 11.7	0; 0
Overweight	273; 59.3	1439; 72.1	634; 80.5	216; 83.1	111; 81	4; 100
Normal	162; 35.2	455; 22.8	108; 13.7	24; 9.2	10; 7.3	0; 0
Underweight	16; 3.5	28; 1.4	5; 0.6	1; 0.4	0; 0	0; 0

ENSANUT 2006

Number and percentage of actual BMI obese by self-perceived BMI category and educational level.

Perception, Educational Level and Gender

All	Education Level (n; %)					
Actual BMI	None/Kinder	Primary	Secondary	High School	Undergraduate	Postgraduate
Obese	13; 2.3	87; 3.3	54; 5	29; 7.1	19; 7.4	1; 6.7
Overweight	154; 19.5	1116; 34.7	652; 45.3	323; 50.1	213; 57	12; 66.7
Normal	543, 72.4	1621; 73.2	750; 70.1	315; 64.2	262; 77.5	14; 73.7
Underweight	11; 36.7	17; 34.7	20; 69	11; 64.7	5; 41.7	N/A
MEN	**Education Level (n; %)**					
Actual BMI	None/Kinder	Primary	Secondary	High School	Undergraduate	Postgraduate
Obese	4; 3.7	14; 2.2	13; 4.6	10; 6.8	3; 2.5	1; 9.1
Overweight	50; 18.1	364; 28.8	189; 34.1	104; 38.7	88; 45.8	7; 63.6
Normal	229; 74.8	753; 81	340; 77.3	132; 65	127; 84.1	7; 87.5
Underweight	4; 33.3	7; 38.9	3; 33.3	3; 42.9	3; 75	N/A
WOMEN	**Education Level (n; %)**					
Actual BMI	None/Kinder	Primary	Secondary	High School	Undergraduate	Postgraduate
Obese	9; 2	73; 3.7	41; 5.2	19; 7.3	16; 11.7	0; 0
Overweight	104; 20.3	752; 38.5	463; 52.4	219; 58.2	125; 68.7	5; 71.4
Normal	314; 70.7	868; 67.6	410; 65.1	183; 63.5	135; 72.2	7; 63.6
Underweight	7; 38.9	10; 32.3	17; 85	8; 80	2; 25	N/A

ENSANUT 2006

Number and percentage of participants correctly identifying their BMI category by educational level for all four standard BMI categories.

Perception and Action

1) “In the last year have you lost or gained weight?”

2) “Was this weight loss intentional?”

BMI Obese	**Education level (n; %)**					
Intention to lose	None/Kinder	Primary	Secondary	High School	Undergraduate	Postgraduate
All	17; 6.3	100; 7.1	61; 9.2	28; 10.9	24; 15.7	2; 25.0
Men	2; 3.9	23; 8.0	10; 6.4	10; 12.2	10; 16.1	1; 25.0
Women	15; 6.8	77; 6.8	51; 10.0	18; 10.3	14; 15.4	1; 25.0

ENSANUT 2006

Mis-perception has consequences

Do We Always Misperceive our Weight?

MHAS Study
Collaboration with INGER

	Self-Reported BMI				
Measured BMI (n; %)	Underweight	Normal	Overweight	Obese	Total
Underweight	4; 57.1	3; 42.9	0; 0.0	0; 0.0	7; 100.0
Normal	4; 1.8	178; 80.2	38; 17.1	2; 0.9	222; 100.0
Overweight	2; 0.5	81; 19.4	292; 69.9	43; 10.2	418; 100.0
Obese	0; 0.0	4; 1.4	71; 24.6	213; 73.9	288; 100.0

There are systematic misperceptions in terms of image and linguistic concept, but not numbers. Why?

Relevence of genetics

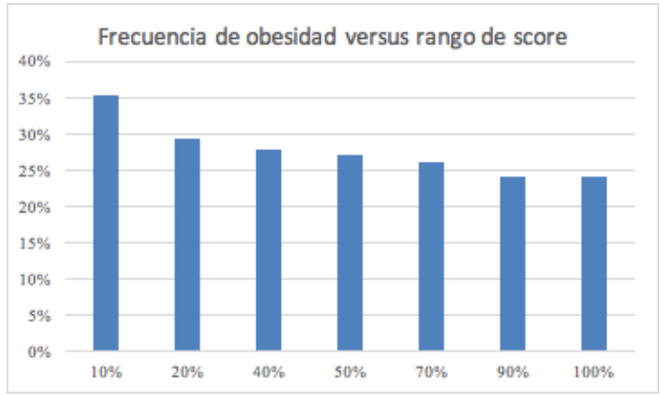
Driver	Value	Epsilon	P(C/X)	P(C)	N(X/C)	N(X)	N(C)	NTotal
rs2943641_A	2	2.9391	0.6000	0.2169	6	10	123	567
rs2972146_C	2	2.9391	0.6000	0.2169	6	10	123	567
rs2943650_G	2	2.9391	0.6000	0.2169	6	10	123	567
rs12629908_A	2	2.6981	0.3116	0.2169	43	138	123	567
rs870347_C	2	2.2200	0.2914	0.2169	44	151	123	567
rs1407434_G	0	2.1617	0.2841	0.2169	50	176	123	567
rs972283_A	2	2.1543	0.3085	0.2169	29	94	123	567
rs10496971_C	2	1.9688	0.3011	0.2169	28	93	123	567
rs2241766_C	1	1.9472	0.2741	0.2169	54	197	123	567
rs10885122_A	2	1.9426	0.5000	0.2169	4	8	123	567
rs2986742_G	2	1.9121	0.4545	0.2169	5	11	123	567
rs1799884_A	2	-2.0385	0.0000	0.2169	0	15	123	567
rs3943253_A	2	-2.0502	0.1364	0.2169	15	110	123	567
rs4607517_A	2	-2.1053	0.0000	0.2169	0	16	123	567
rs4880436_A	2	-2.1388	0.0870	0.2169	4	46	123	567
rs174537_C	2	-2.1927	0.0851	0.2169	4	47	123	567
rs174546_G	2	-2.1927	0.0851	0.2169	4	47	123	567
rs174550_A	2	-2.1927	0.0851	0.2169	4	47	123	567
rs972283_A	0	-2.3181	0.1521	0.2169	33	217	123	567
rs2073821_A	2	-2.3502	0.1170	0.2169	11	94	123	567
rs1513181_G	2	-2.3605	0.1250	0.2169	14	112	123	567
rs2237895_A	2	-2.3836	0.1308	0.2169	17	130	123	567
rs7803075_G	2	-2.4635	0.0847	0.2169	5	59	123	567
rs896854_A	0	-2.5528	0.1398	0.2169	26	186	123	567
rs7809589_C	2	-2.5964	0.1231	0.2169	16	130	123	567
rs1111875_A	0	-3.2065	0.1211	0.2169	23	190	123	567

Project UNAM: Genetic analysis of 568 participants

347 SNPs considered - Subsets with obesity, DM2, dislipidemias, hepatic; Collaboration with Dr. Samuel Canizales UNAM/INMEGEN

obesity (score = 0.904, predictive but rare)

obesity (score = 0.105, not so predictive but common)

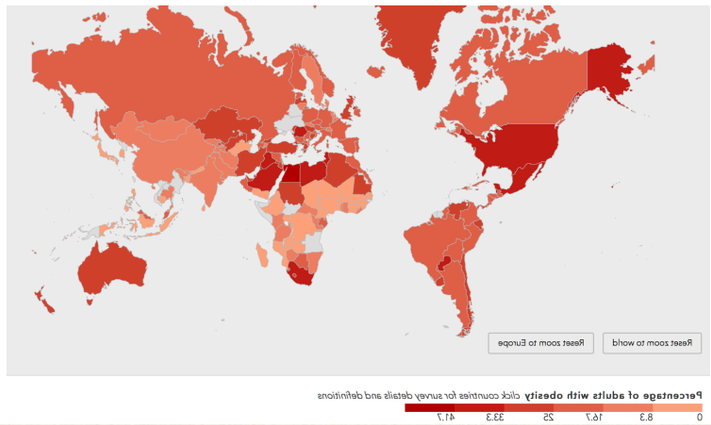


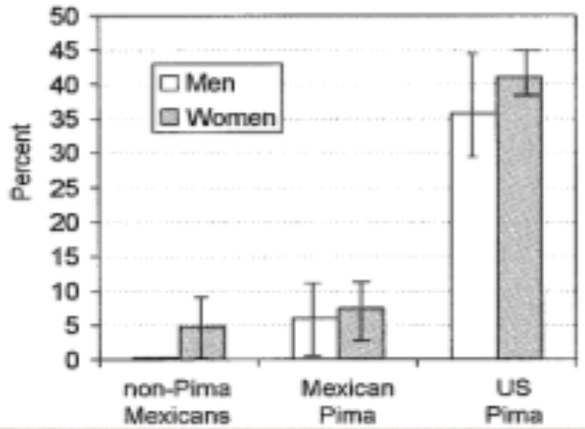
Where is the ”thrifty gene”?

What is the genetics of conduct?

The model doesn’t offer much predictability

consistent with:





Agent Based Models for the Study of Food Strategy in Obesogenic Environments

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Introduction

Obesity and Overweight are complex phenomena with genetic, endocrine and behavioral components (Bray 2007). The positive ***Energy Imbalance*** that gives place to overweight occurs when consuming more energy than is spent. Consuming food involves ***Decision Making*** restricted by availability of sources, time and competition. The main objective of a ***Food Strategy*** is survival of individuals and populations. Then avoid negative long-term energy imbalance is a priority.

An optimal strategy seeks energy balance. It can regulate consumption, perception and movement across the environment. Nonetheless the extended epidemic of obesity and overweight is evidence of a generalized deviation of an optimal energetic plan.

Johnson and Andrews (2010) suggest a prehistoric mutation of human ancestors to increase fat stores. Such that mechanism, originally a survival advantage against starvation, could explain partially the resilient tendency to overweight in ***Obesogenic Environments***. There is no accessible data to test directly such that hypothesis. However those inaccessible scenarios can be investigated in a generative manner by agent system simulations (Epstein 2006).

The aim of this work is to investigate the origin and development of bias in food strategies with ***Agent Based Modeling*** (ABM). The Agent Model presented here exhibits the competition between two kind of agents: A perceptive one (Type II) that can observe a larger local environment at an energetic cost and other that only can perceive for free the cell where is situated (Type I). Agents were provided with three capacities: To eat, to move and to reproduce themselves. Perceptive agents' strategy is more complex and can be considered cognitively superior. To measure system's performance we obtain in each simulation the extinction time (if is the case), the final fraction of agents of type I and the time when diversity is lost (if is the case).

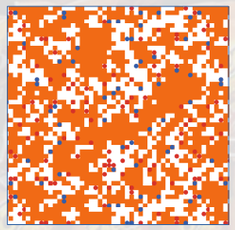
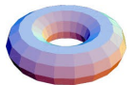


Figure 1. View of a typical simulation of ABM. This was implemented in NetLogo.

Design of Agents System

- Environment: 41 X 41Square Grid in a Thorus (PBCs), each cell can grow a ***source of energy***.
- Agents: Two types according food strategy: ***Perceptive*** and ***non-perceptive***.
- Agents have move, eat and intend to reproduce every time.
- Each time-step agents spent energy in a basal metabolism and in a cost of movement proportional to their energy. If the agent is perceptive pays a fixed cost of perception. Both agents consume the energetic sources in their consuption area.



Agent Type I (non-perceptive)

- Perceives only the cell where is placed
- Eat only the sources in the cell is placed (A = 1).
- Moves randomly to a neighbour cell

Agent Type II (perceptive)

- Perceives the cell where is placed and the first eight neighbours
- Eat only the sources in the cell is placed(A = 1).
- Moves to a neighbour cell with energetic sources available. It reduces uncertainty when looking for energy but it has a cost.

$$E_\alpha(t) = \begin{cases} \left(E_\alpha(t-1) - M_b + A^{(I)}E_s\right)\left(1 - C^{(m)}\right), & \text{if } \alpha \text{ is type I} \\ \left(E_\alpha(t-1) - M_b - \Delta M^{(p)} + A^{(II)}E_s\right)\left(1 - C^{(m)}\right), & \text{if } \alpha \text{ is type II} \end{cases}$$

Figure 2. Sketch of ABM environment, agent type I and II and Energy of agent at time t.

Parameters	Symbol
Basal Metabolism	M_b
Cost of Perception	$\overline{\Delta M}^{(p)}$
Cost of Movement	$\bar{C}^{(m)}$
Source Energy	E_s
Consumption Area	$A^{(I)}, A^{(II)}$

Table 1. Parameters and symbols of ABM.

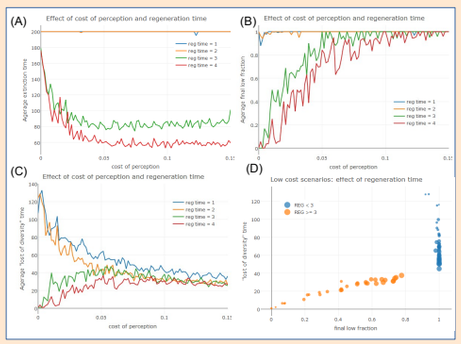


Figure 3. Effect of cost of perception and regeneration time in (A) average extinction time, (B) average final low fraction (type I fraction), (C) average time of lost of diversity and (D) comparison of rapid and slow regeneration on final fraction and lost of diversity time.

Figure 4. Effect of cost of movement and reproduction in (A) average final low fraction (type I fraction) and (B) histogram of final low fraction.

Effect of Cost of Perception and Regeneration of Sources

- Rapid regeneration of resources can make the population survive indefinitely (Fig. 3A). This also causes the scenarios with perceptual agents to disappear while slow regeneration allow diversity in the ensemble of simulations (Fig. 3B).
- Final stages where both type of strategies coexist are scarce. Most scenarios finish with homogeneous populations.
- Perceptive agents can live longer than non-perceptive only if the cost of perception is low (Fig. 3B). In those scenarios with rapid regeneration an increase in cost of perception makes the minority agents (perceptive) to dissapear faster. If regeneration is slow an increase on the cost makes the minority agents to dissapear a little bit more slowly (Fig. 4B).

Cost of movement and reproduction

- Reproduction consists in the division of an agent when it exceeds a limit of energy (20). It makes more pronounced the effect of the cost of movement in the final distribution of agents: This favors one of the two types depending on their value: If the cost of movement is lower than 0.02 agents type II are predominant. When is greater than 0.02 agents type I survive more oftenly (Fig. 4A).
- In general, reproduction changes changes the distribution of types in final states (Fig. 4B)
- The dynamics of the types distribution have a similar characteristic behavior: Cost of movement determines the final type of agent and reproduction helps the predominant agent (Fig. 5).

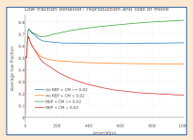


Figure 5. Effect of cost of movement and reproduction in the average fraction of type I agents at every generation.

References

Bray, G. A. (2007). ***The metabolic syndrome and obesity.*** Totowa, NJ: Humana Press.

Epstein, J. M. (2006). ***Generative social science: Studies in agent-based computational modeling***. Princeton University Press.

Johnson, R. J., & Andrews, P. (2010). ***Fructose, uricase, and the Back-to-Africa hypothesis***. Evolutionary Anthropology: Issues, News, and Reviews, 19(6), 250-257.

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Let's try and recreate the world of 200,000 years ago and see what behaviours were useful in environments then versus environments now.

Recreate environments with scarcity / plenty and find which adaptations are favoured / disfavoured

The Individual Conductome - the "Demand"

We can only gain weight if "energy in > energy out" - my choices

- How do we characterise the encounters we have with **potential** "energy in" events?
  - Frequency
  - Type - how do we classify them? - food/beverage type, "calories", portion size,…
- How do we characterise the encounters we have with **potential** "energy out" events?
  - Frequency
  - Type - how do we classify them? - involuntary/voluntary, estimate calories, stairs vs elevator, T-shirt/overcoat,
- How do we characterise our decision making for each **potential** encounter?
  - Eat/don't eat, hamburger/salad, large portion/small portion, stairs/elevator, t-shirt/overcoat,…
- There's also the question about "priming" for all these decision events - marketing propaganda, health warnings,…

The Individual/Organizational Conductome - the "Supply"

We can only gain weight if "energy in > energy out" - the environment —> choices of others

- How do we characterise the encounters we have with **potential** "energy in" events?
  - Frequency - widely available/scarce, 24 hours/restricted hours,…
  - Type - how do we classify them? - MacDonalds/street food/restaurant, only salads/only junk food, only large portions,…
- How do we characterise the encounters we have with **potential** "energy out" events?
  - Frequency - widely available/scarce, 24 hours/restricted hours, obligatory/voluntary,…
  - Type - how do we classify them? - involuntary/voluntary, estimate calories, stairs vs elevator, air conditioning/heating,
- How do we characterise the decision making of the "suppliers" for each **potential** encounter?
  - To make profits, to get more votes, Sell hamburgers/salads, large portion/small portion, stairselevator, t-shirt/overcoat,
- There's also the question about "controlling" the environment - taxes on high energy content food, food labeling, health messaging,…

Conclusions

- The Human Conductome is the entirety of factors which control human behavior: **Behaviour <— Strategies <— Decisions <— Predictions**
- It is extraordinarily multifactorial and adaptive. It requires big, deep data across multiple scales to understand it: genetics, epigenetics, physiology, psychology, neuroscience, epidemiology, sociology,… We don't have such data, but the Data Revolution is helping.
- A crucial ingredient of the Conductome is how we evaluate decisions, the different concepts of value and to understand why we make "bad" decisions.
- Another crucial ingredient is how we create a model of reality that may be substantially different from reality itself. Such deviations can have severe psychological, social and other health consequences.

The goal of Project 42 is to obtain and model data in order to better understand the Conductome and predict human behavior. We have a lot of interesting work to do over the coming months, years, decades, … We need a lot of help!

You're all invited!

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