Data mining and time-series analysis as two complementary approaches to study body temperature in obesity

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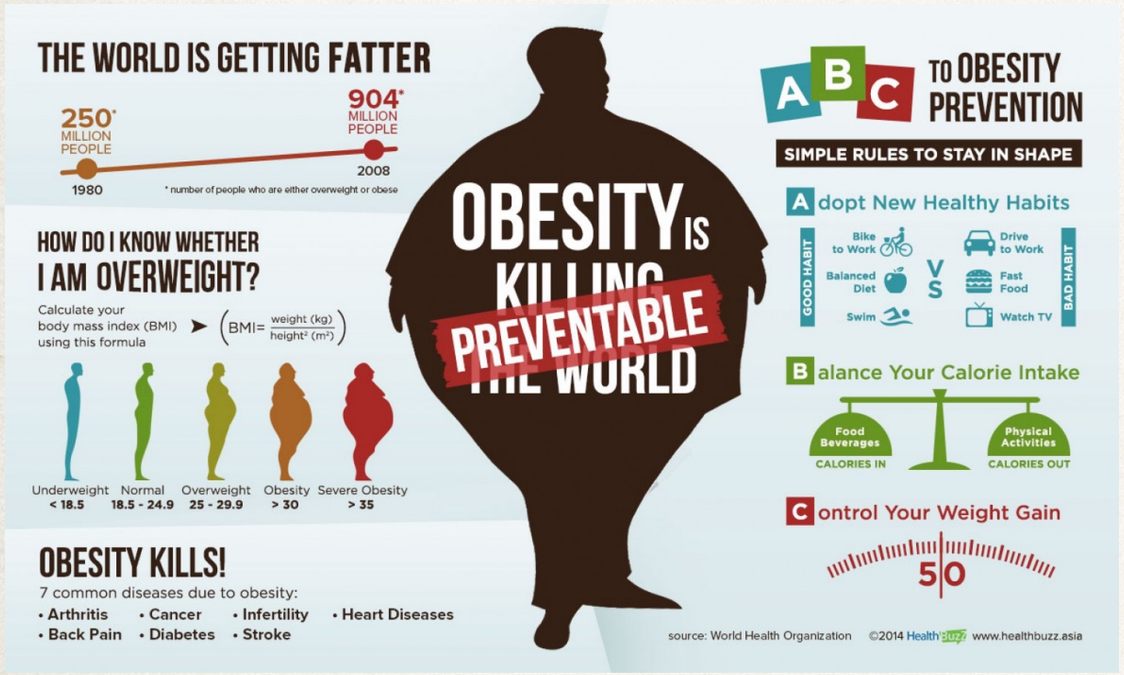
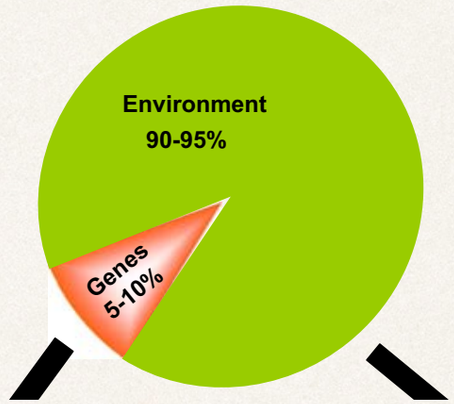
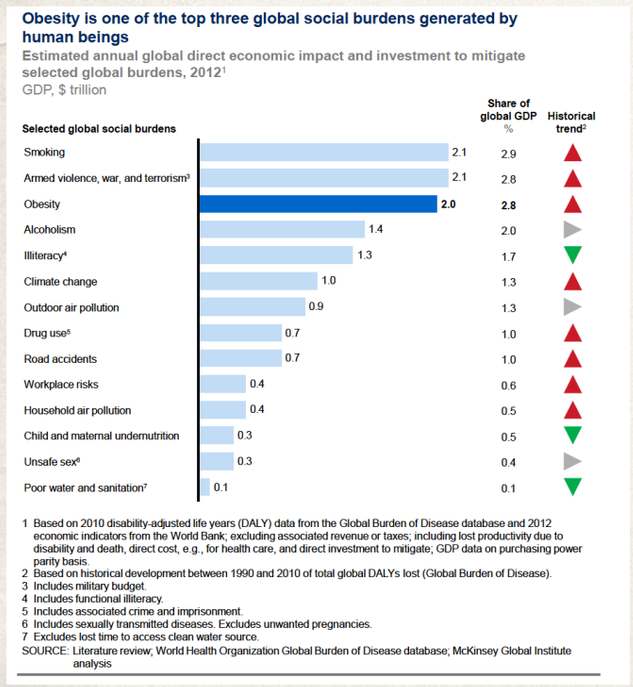
The Problem:
The Obesity Pandemic



Obesity, type 2 diabetes, heart disease, strokes etc. are diseases associated with "lifestyle" and arise partly from **nature** and partly from **nurture**





Nature: Genetic susceptibilities are known to play an important role - multi-genic.

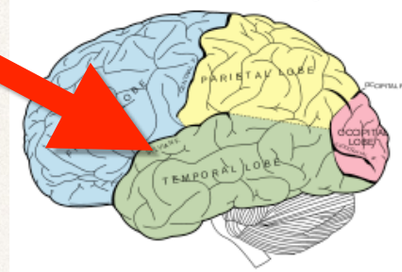
Nurture: They are **behavioral** diseases, i.e. diseases arising from **decision making**.

Human behavior and physiology is complex and requires "deep data".

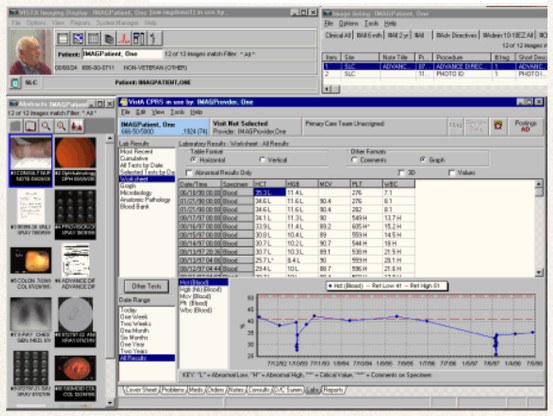
Deep Data and the Data Revolution

A revolution in the generation of data

Human brain
10-100 Terrabytes



All the books in the world 30-50 Terrabytes

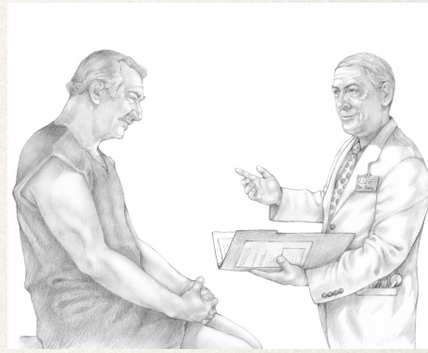


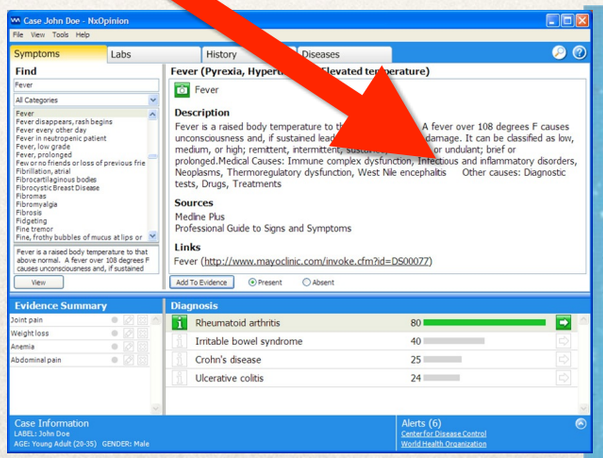
1 human genome
= 1GB (200)
CT image
= 10MB
MRI image
= 40MB

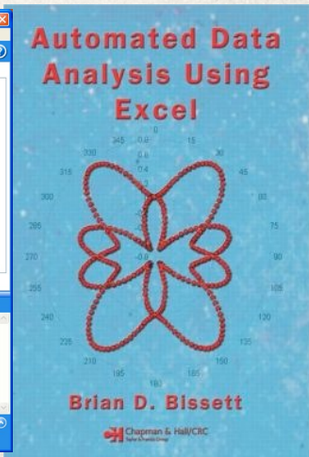
In electronic form
1 zettabyte

A revolution in data storage

A revolution in data analysis







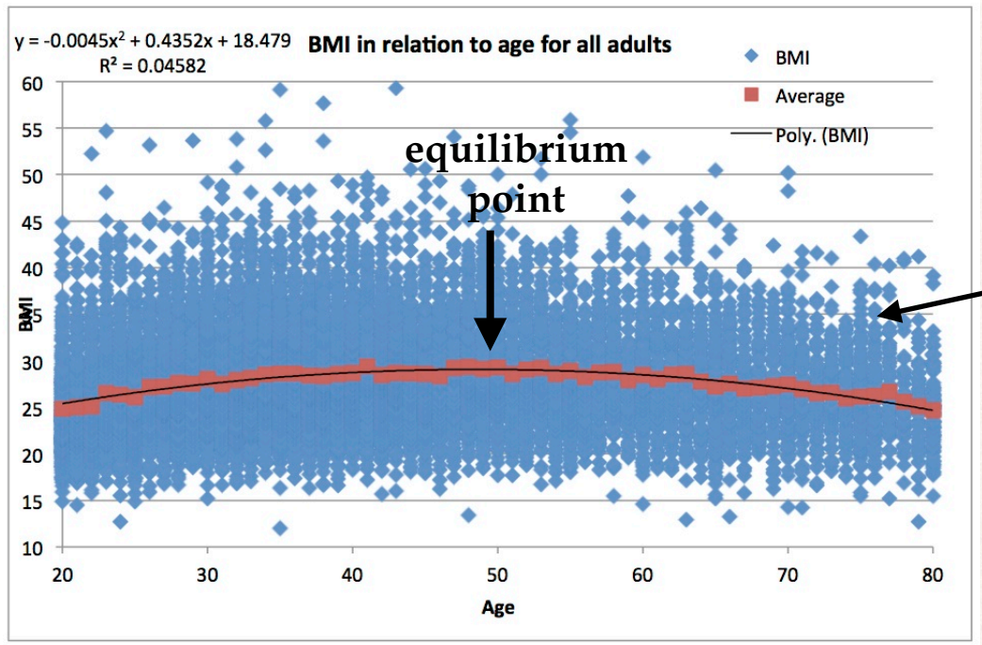
The Data

- **Study 1**: Population - 1076 academics and staff of the Universidad Nacional Autonoma de Mexico
  - Measurement: Axilliary temperature was taken at a single time moment between 9am and 11am by qualified medical practitioners using a standard thermometer and registered visually to 0.1C accuracy.
    - Notes: Participants were seated and had fasted for at least 8 hours. Measurements were taken in different buildings of the university and as much as possible it was attempted to recreate the same conditions in each session. Typically, 20-30 subjects were tested that daily in a three hour session. For BMI, weight was measured using a standard scale and height using a stadiometer. Both measurements were taken by qualified medical professionals and in the same session temperature was measured.
- **Study 2**: Population - 22 male young adult volunteers (20-40yo) from the general university population.
  - Measurement: Wrist temperature continuously measured for one week using a Thermocron iButton with a sampling frequency of 1/3min, a resolution of 0.0625C and an accuracy of 0.5C.
    - Notes: Climatic season (rainy season August-October 2016) The model DS1922L was fixed to the non-dominant wrist using medical tape. Weight and height were recorded. In this pilot study, we focused on males because in females the timing of the 1-week monitoring period with respect to the monthly menstrual cycle is important and requires a separate investigation.

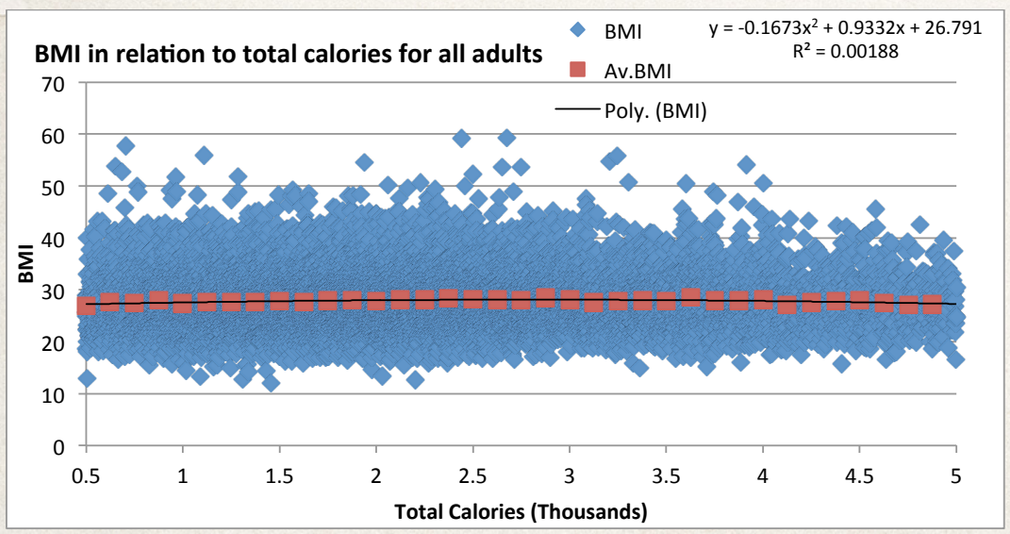
The Hypothesis:

You aren't what you eat you become what you eat but…

Epidemiological data from ENSANUT 2006

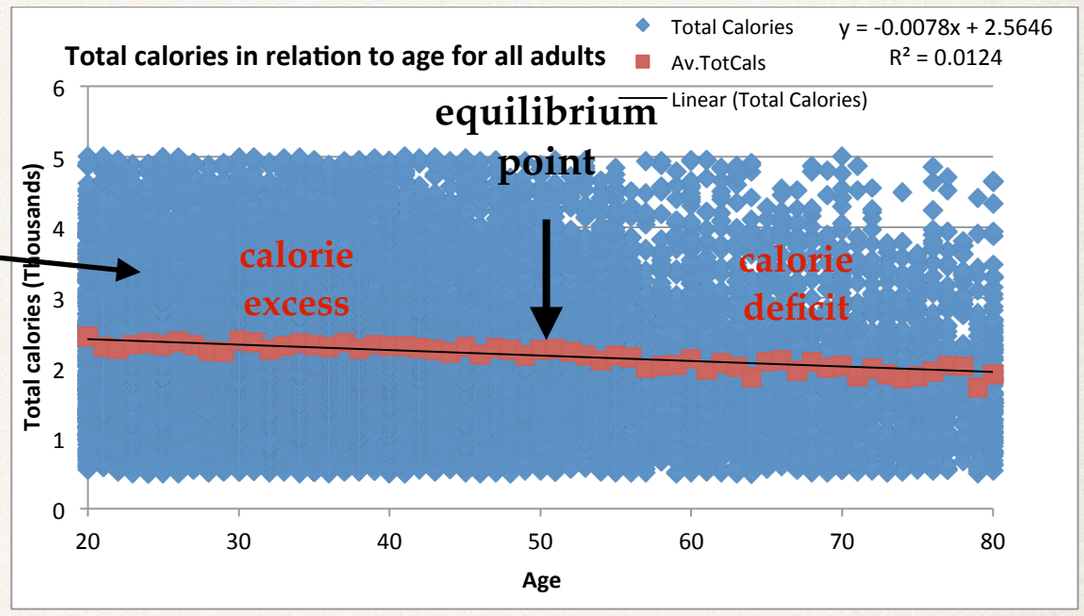


We get fatter then we get thinner



The obese eat as much as the thin

Its not "noise" its multifactoriality



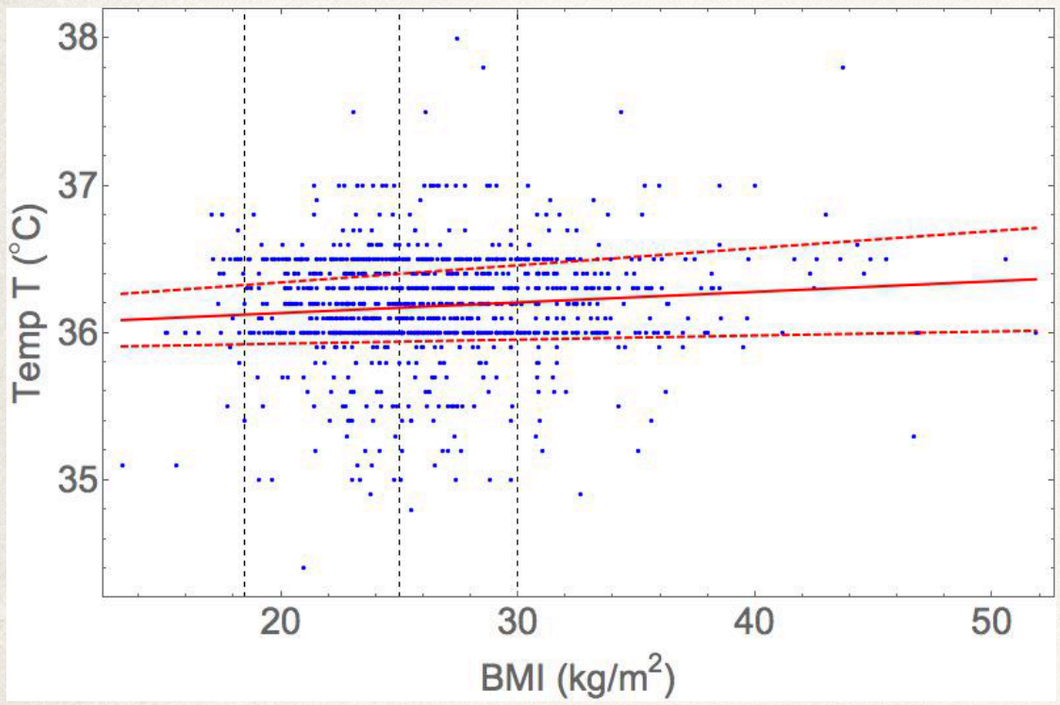
We eat less the older we get

The data shows an overconsumption of 200-300 Cals/day at age 20-30. 8 Cal/day is enough (naively through the famous/infamous 3500 cal rule) to generate the observed increase in BMI. **Where do the other calories go?**

Why aren't we even fatter?

Do you become what you eat?

Relation between temperature and BMI

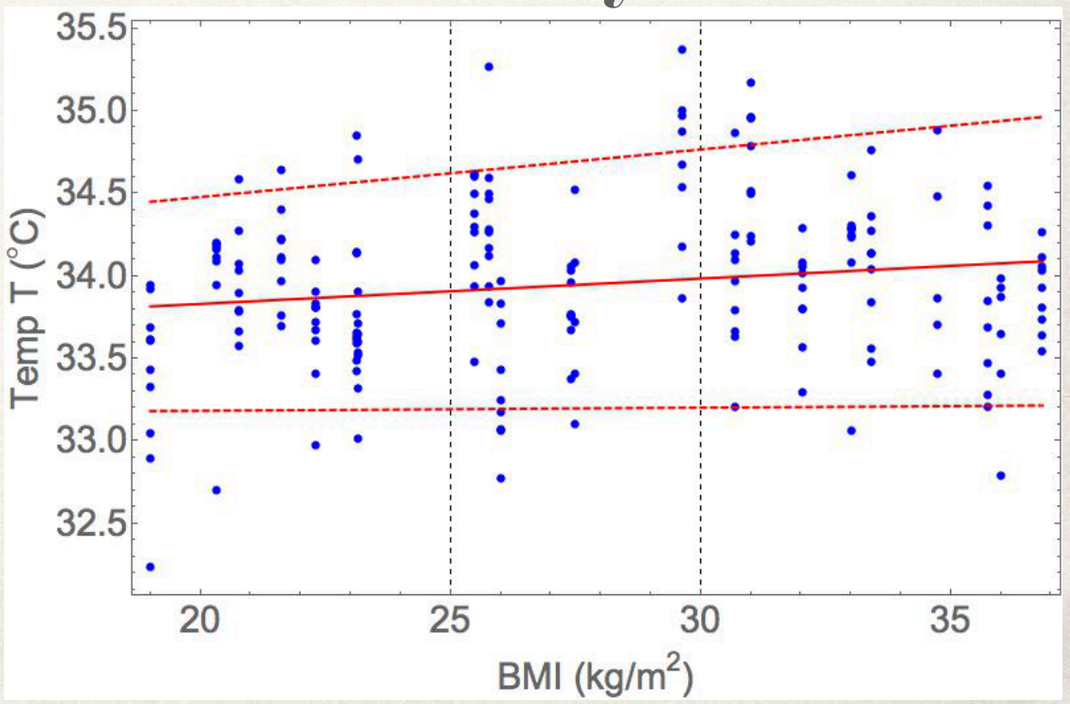


Study 1

	Study 1		Study 2	
	points	deciles	7-day mean	1-day mean
slope	0.0072	0.0067	0.0093	0.015
intercept	35.99	36.00	33.69	33.524
CI slope	0.0028	0.0024	-0.019	0.0019
	0.012	0.011	0.038	0.029
CI intercept	35.88	35.89	32.88	33.15
	36.11	36.12	34.51	33.90
tslope	3.18	3.56	0.68	2.25
tintercept	590.34	708.93	86.9	174.92
F	10.15	12.64	0.46	5.06
p	0.0015 (*)	0.0074 (*)	0.50	0.026 (*)
R2	0.0094	0.61	0.022	0.027

Body temperature found to increase with BMI using two different populations and two completely different measuring protocols

Study 2



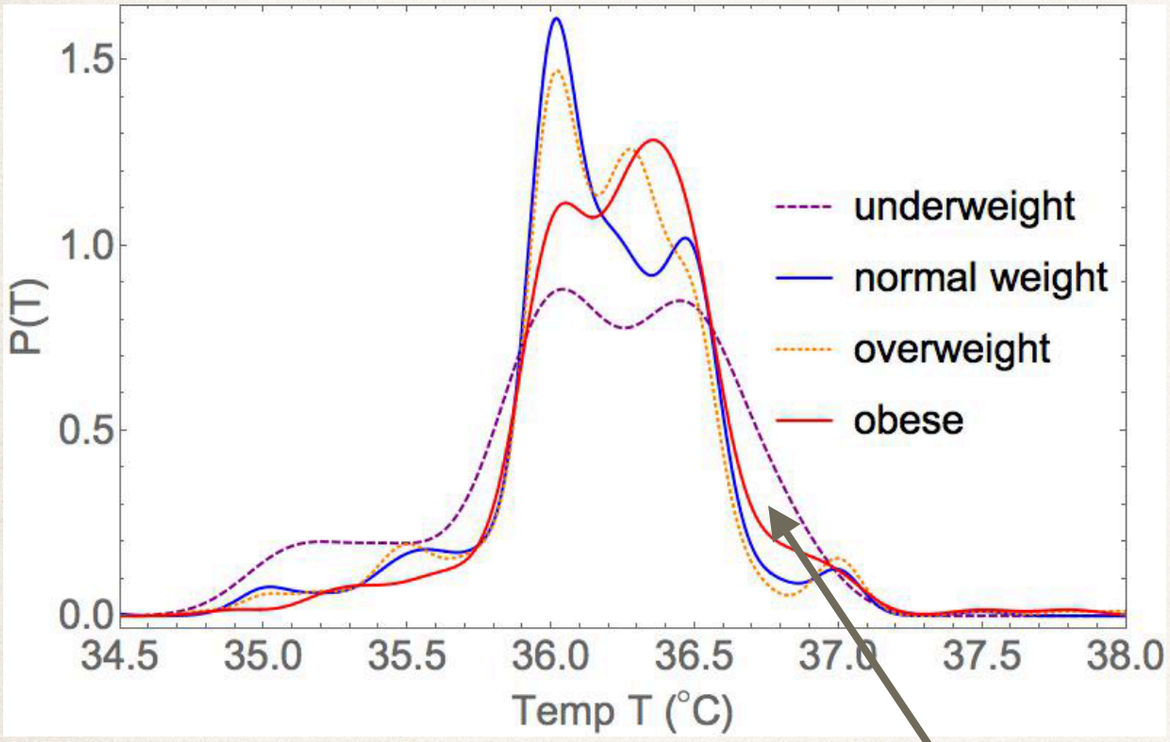
0.07°C doesn't sound like much, but...

can make a difference of 500-1200 cal per day in energy radiated!

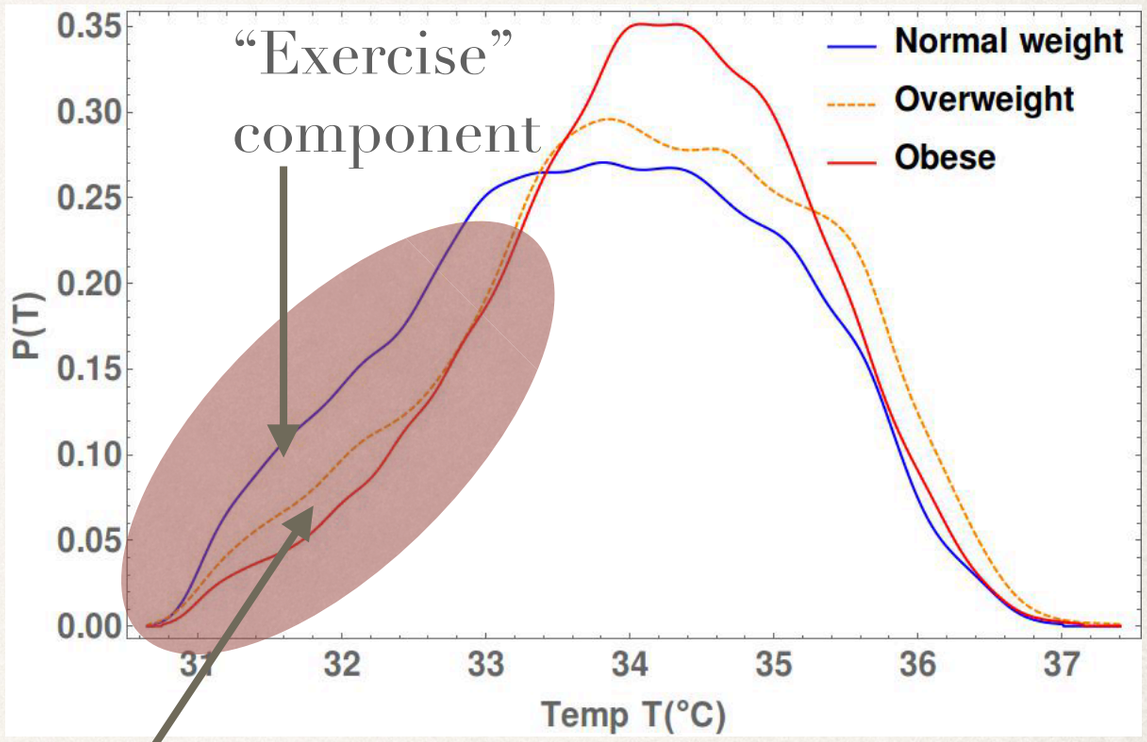
Differences in the protocols…

Higher moments

Study 1



Study 2



Transverse

Longitudinal

Less/More
Variance/kurtosis

Conclusions

- Obesity is probably the world's number one health problem which, in spite of a huge investment in research and public health initiatives, is still increasing

- It is representative of a Complex Adaptive System with a highly multifactorial, multiscale set of risk factors

- Digital health technology offers a tremendous opportunity, especially in conjunction with traditional methods, to measure physiological and behavioural parameters

- Temperature, in spite of being a standard physiological variable, is not as well understood as it should be and especially its link to obesity

- We hypothesis that the obesity epidemic is not as severe as it should be and that the obese have higher temperatures as a way to offset consumption against weight gain

- Our multi-population, multi-protocol study is consistent with this hypothesis