



## **Built Environment**

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# Disclosure

- None.

« Obesity is the result of people responding normally to the obesogenic environment they find themselves in. »

*Swinburn et al. Lancet 2011*



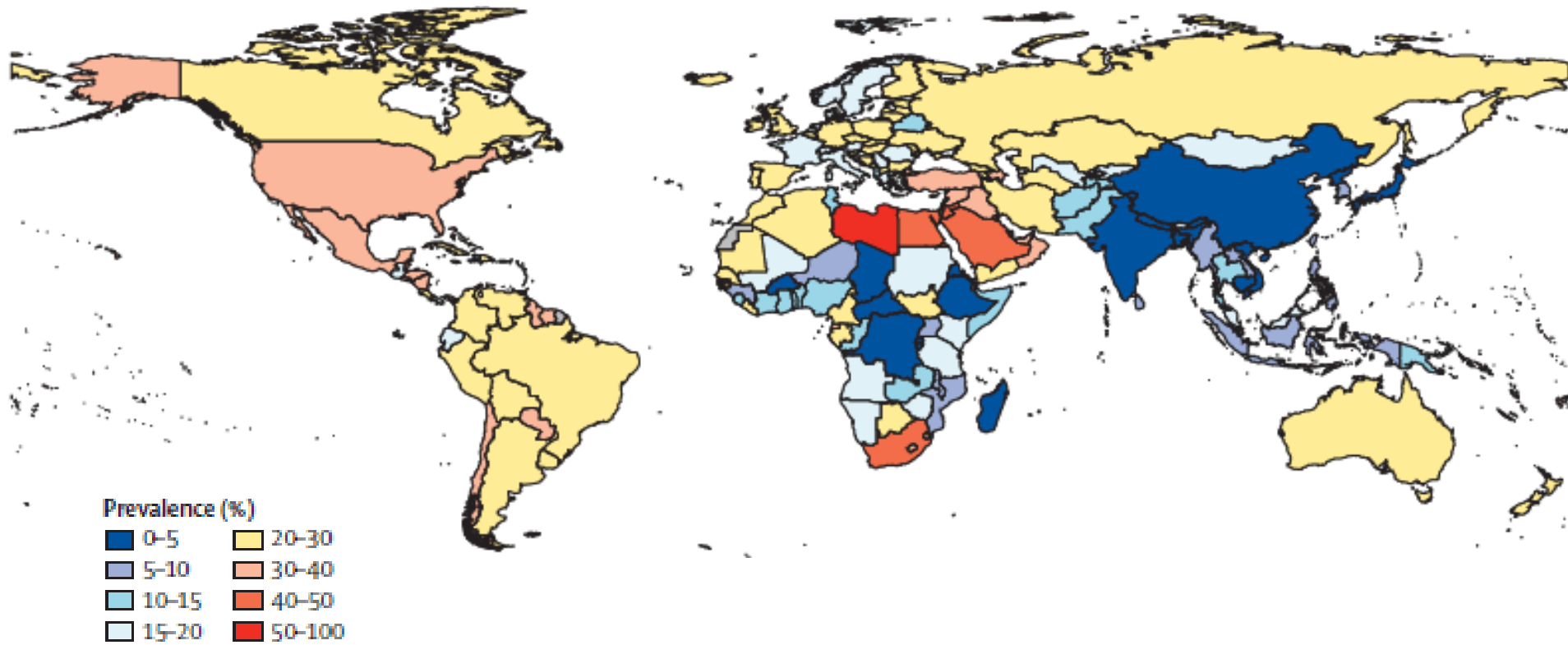
**14 Juillet  
1789**

**Prise de la  
Bastille**



# Spatial variation of high BMI

## Obesity prevalence at country level

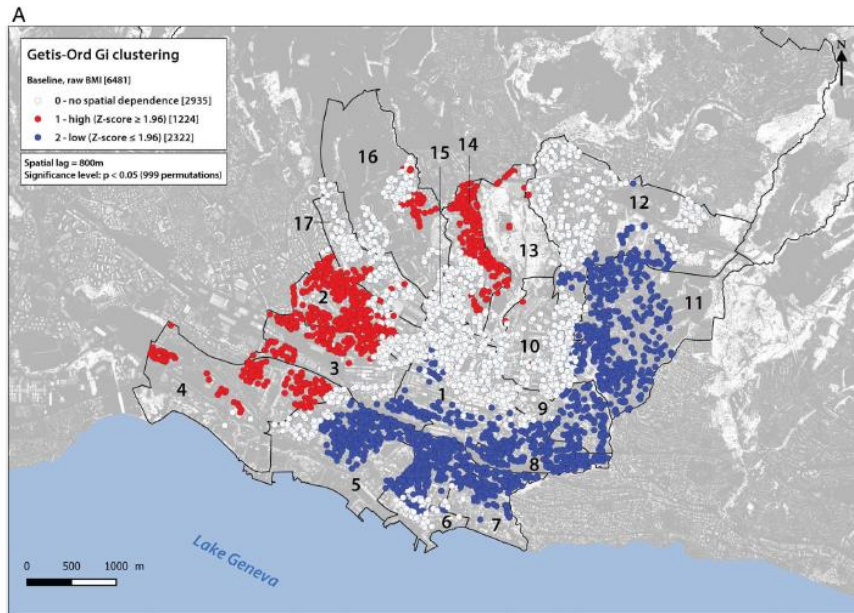


Age-standardised prevalence of obesity, women  $\geq 20$  y, 2013

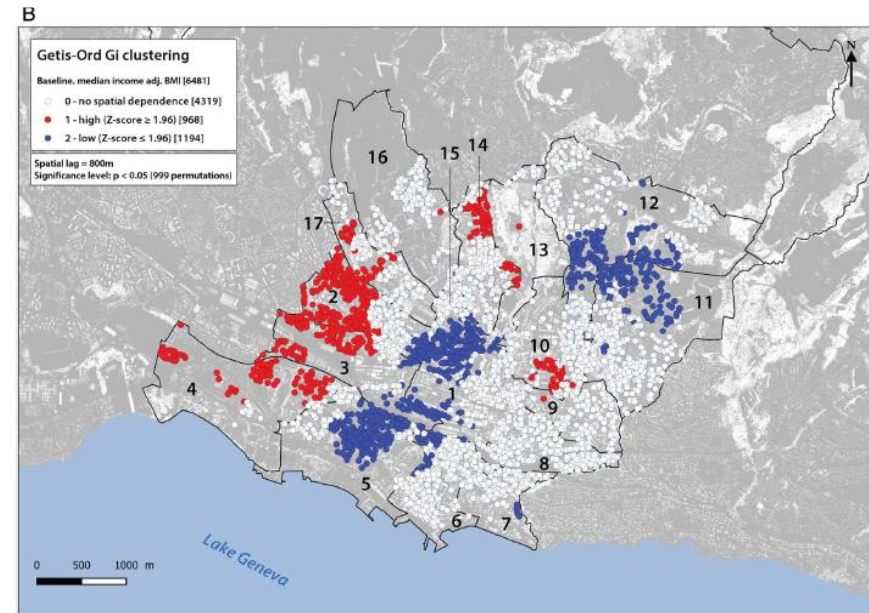
*Ng et al. Lancet 2014*

# Spatial variation of high BMI

## “Neighborhood effect “ (clustering) at city level



Hot spots (red = high BMI)  
Northwest and western districts



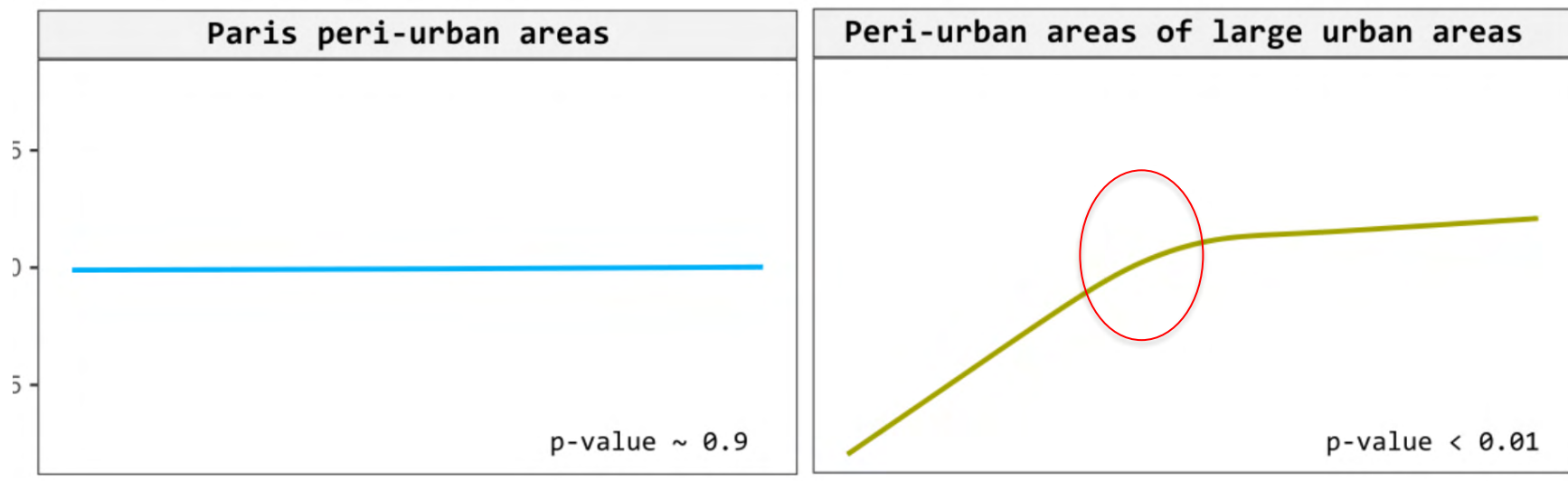
With adjustment  
for median income

**GeoCoLaus population –based study,  
n= 6,841, 35-74 y**

*Joost et al. BMJ Open 2016*

# Association between deprivation and overweight (%)

NutriNet-Santé

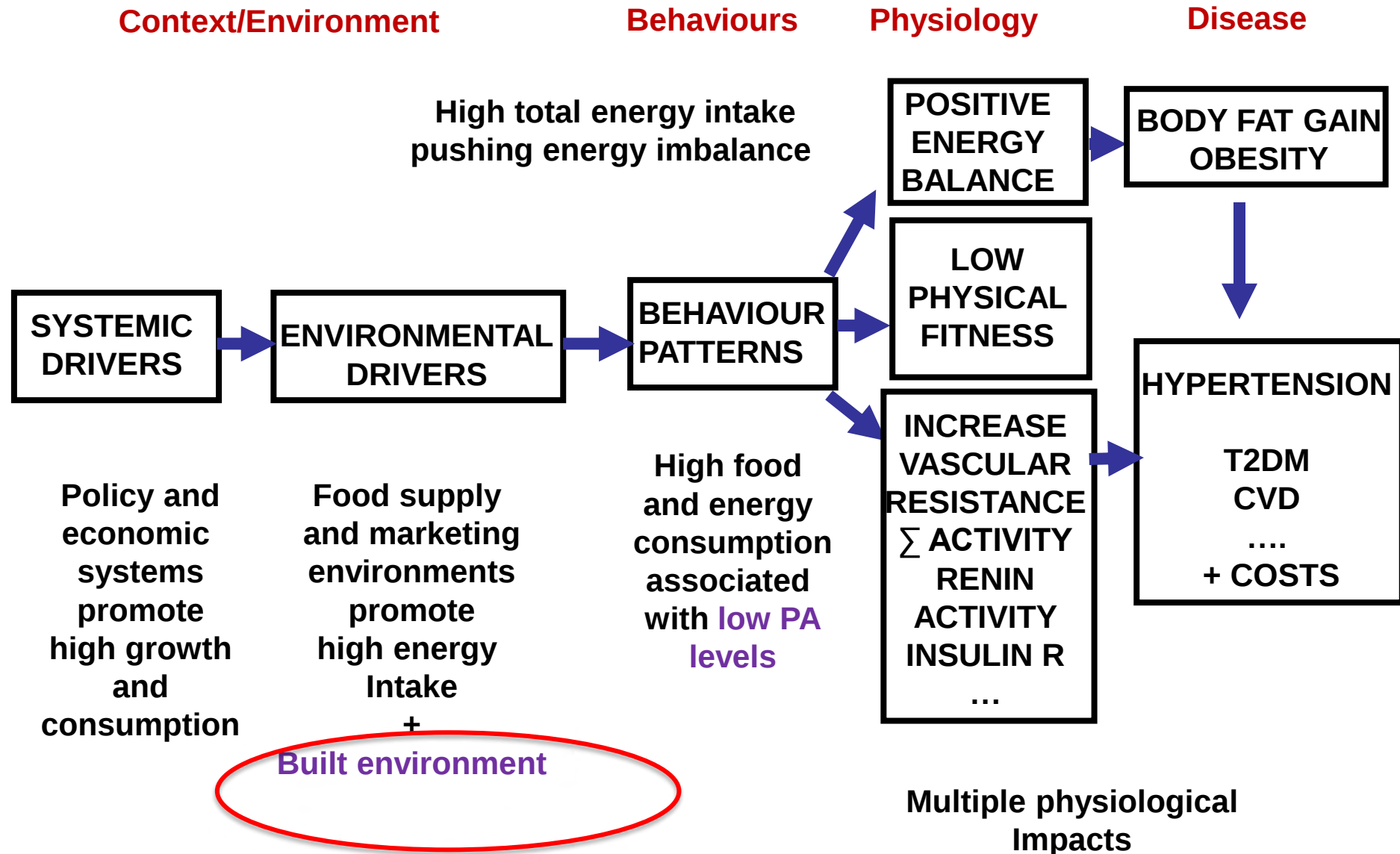


Level of neighbourhood deprivation (from least to most deprived)

# Living environment

- Built environment (BE) / physical environment
  - Buildings, transport infrastructure, green space, recreational equipments, food outlets...
- Food environment
- Natural environment
- Social / cultural environment
- Policy / regulatory environment

# Determinants – Framework



*Adapted from Swinburn et al. Lancet 2011*

# Topic:

Can we define/quantify the role of the living/built environment in relation with (physical activity and) obesity, and what could be the implications regarding obesity prevention?

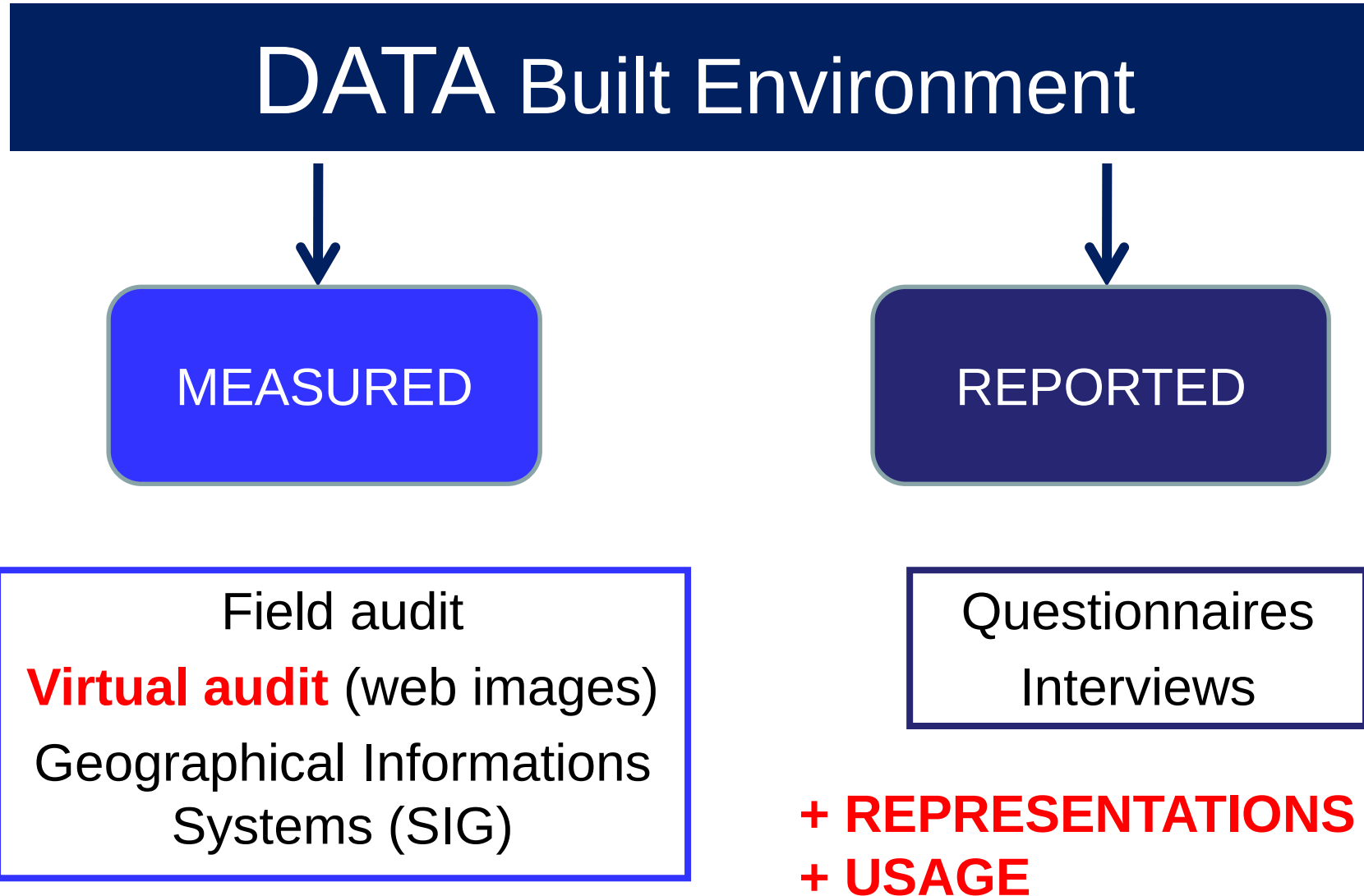
# Questions

- Observations
  - Links between built environment, physical activity and obesity
- Interventions
  - Changes in the built environment and effects on physical activity and obesity indicators
- Opportunities
  - Further understanding and interventions/policies

# Observations



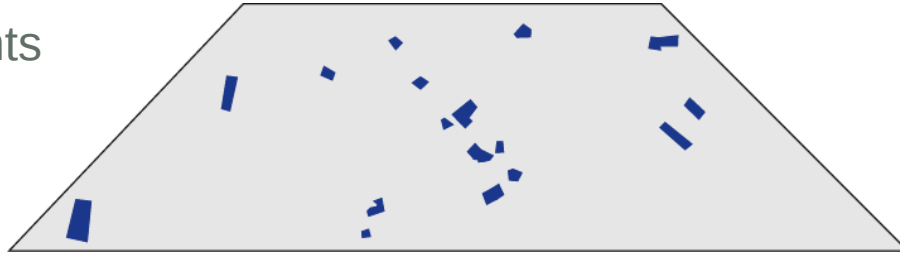
# Assessment of the environments - Methods



# Geography tools

## Geographical information system (GIS)

Equipments



Infrastructures  
transport



Urban form



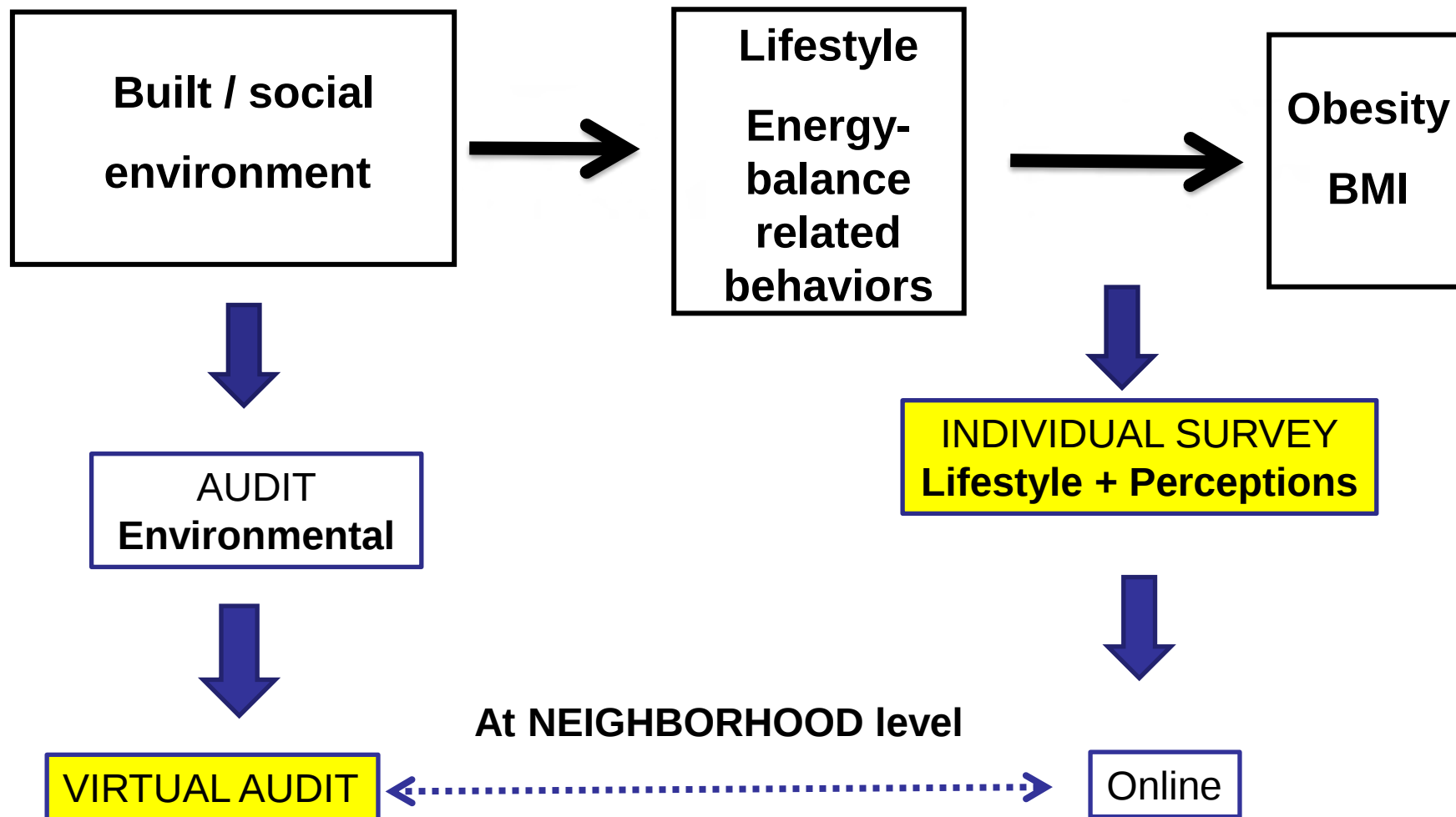
Population density,  
SES, safety, ....

**+ ADDRESS**



Proximity, density

# Neighborhood audit + individual survey across 5 European regions - SPOTLIGHT



# 5 urban zones in 5 European countries

SPOTLIGHT Project (EU FP7)



# Neighborhood sampling

## SPOTLIGHT

5 urban zones / countries: BE, FR, HU, NL, UK

Random sampling

2 variables : **SES** (median income), **residential density**

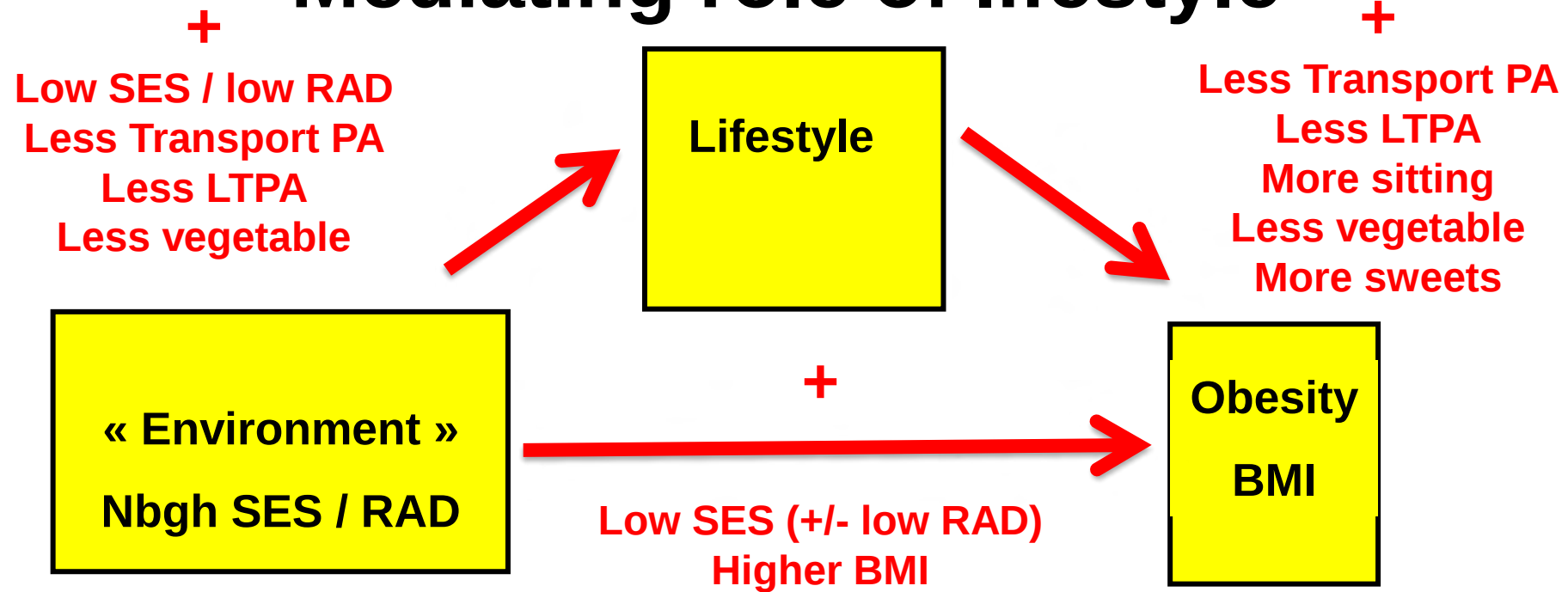
4 neighborhood type: high/low SES, density

3 neighborhoods by type

⇒ 12 neighborhoods by country

**Total: 60 neighborhoods**

# Mediating role of lifestyle



Multiple mediation  
models with  
High SES/high RAD  
as ref

|                       |                      |              |
|-----------------------|----------------------|--------------|
| <i>Transport PA</i>   | 0.033 (0.017)        | 6.3          |
| <i>Leisure PA</i>     | 0.026 (0.012)        | 5.0          |
| <i>Vegetable</i>      | 0.041 (0.018)        | 7.9          |
| <b>Total mediated</b> | <b>0.100 (0.028)</b> | <b>19.2%</b> |

Beta coefficients (SE)

% mediated

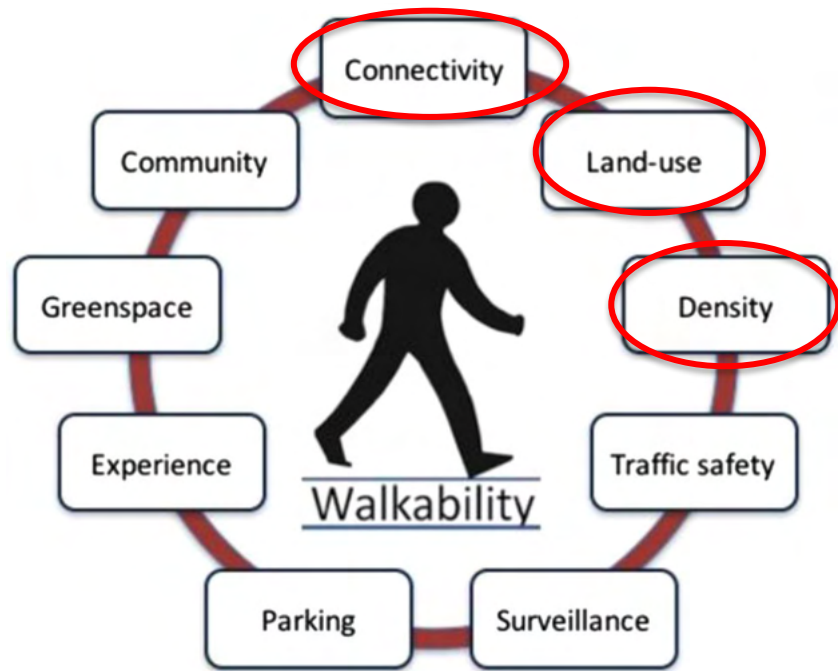
# So...

- General characteristics of neighborhood environments such as SES and residential density appear related to lifestyle and obesity.
- What are the detailed characteristics of neighborhood environments that are related to lifestyle and obesity?

# Physical activity-related built environment features associated with weight status / obesity - Review of reviews

| Variable                             | N reviews | % results in favour |
|--------------------------------------|-----------|---------------------|
| Land-use mix                         | 10        | 80                  |
| Aesthetics                           | 4         | 75                  |
| Availability parks /playgrounds      | 11        | 55                  |
| Walkability                          | 11        | 47                  |
| Availability recreational facilities | 9         | 45                  |
| Population density                   | 8         | 38                  |

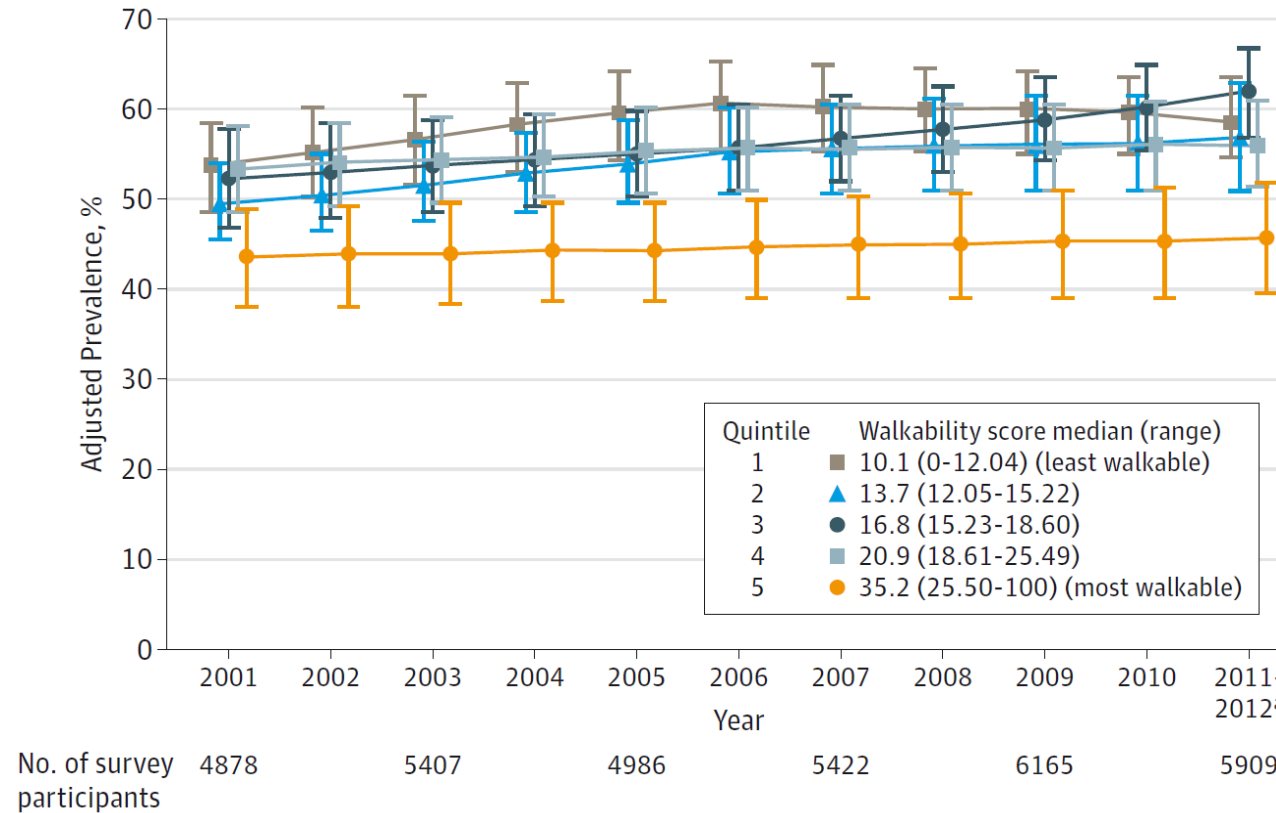
# Walking in context: Walkability



*Zuniga-Teran et al.  
Frontiers Architectural Res 2017*

*BE and health research group  
Columbia university NYC*

# Walkability – Prevalence (%) of overweight



**Canada Census, adults 30-64 y,  
urban, London, Ottawa, Toronto, Hamilton, 2001-12**  
Adj. age, sex, median income, ethnicity

Creatore et al. *JAMA* 2016

# Virtual audit: Google Street View

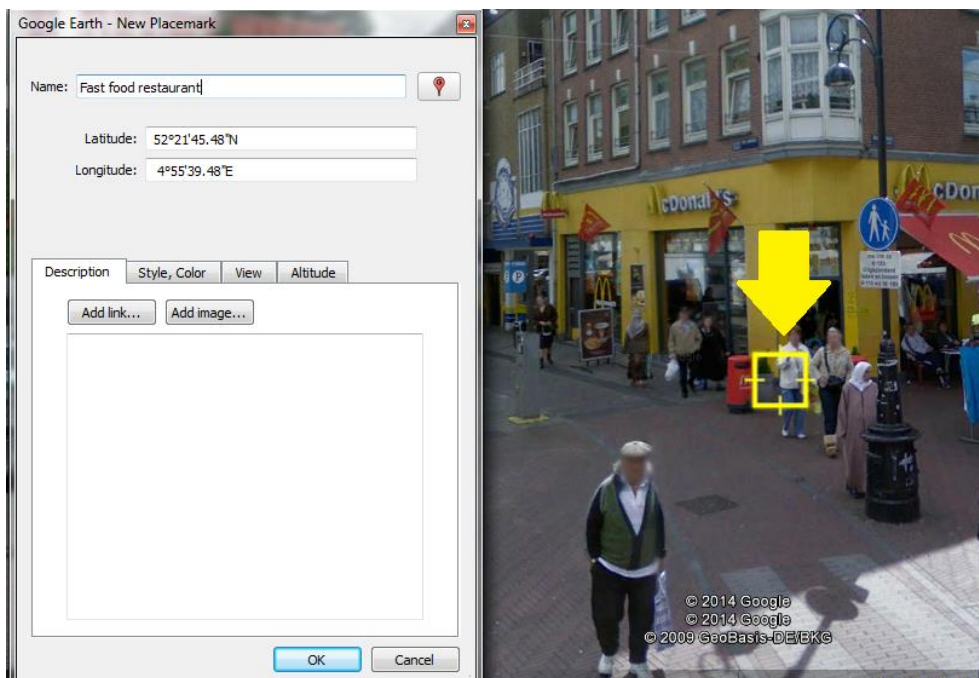
2007 – mobile mapping system – panoramic view at street level



**Boulevard Vincent Auriol, Paris 75013, France**

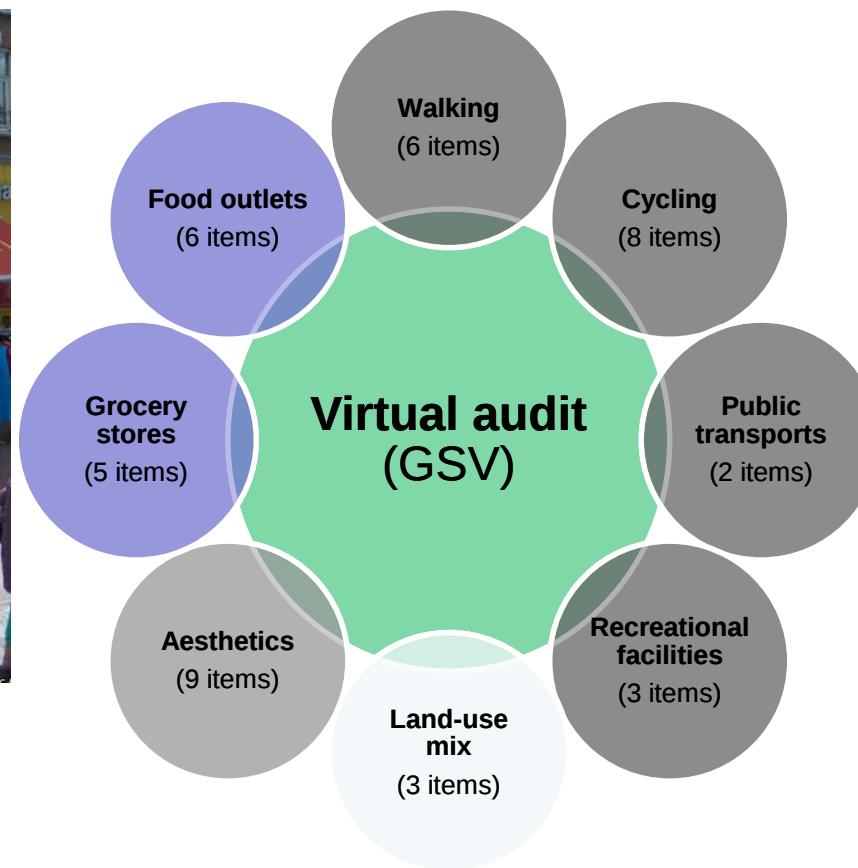
# Virtual audit tool SPOTLIGHT

## Eating and physical activity habits



Data input form  
using Open Office  
with drop-down menus

Standard Operating Procedures (SOP)



8 dimensions - 42 characteristics/items

# Virtual audit vs. Field audit

| Presence                            | Agreement     |
|-------------------------------------|---------------|
| <b>Food outlets</b>                 | <b>99.9 %</b> |
| <b>Public transport</b>             | <b>98.9 %</b> |
| <b>Physical activity facilities</b> | <b>97.1 %</b> |
| <b>Walking related items</b>        | <b>97.0 %</b> |
| <b>Cycling related items</b>        | <b>94.4 %</b> |
| <b>Aesthetics</b>                   | <b>87.3 %</b> |
| <b>Overall</b>                      | <b>95.6 %</b> |

128 street segments randomly sampled in  
4 **Dutch** urban neighbourhoods

Bethlehem et al. *IJHG* 2015

# Neighborhood sampling and audit

## SPOTLIGHT

5 urban zones / countries: BE, FR, HU, NL, UK

Random sampling

2 variables : **SES** (median income), **residential density**

4 neighborhood type: high/low SES, density

3 neighborhoods by type

⇒ 12 neighborhoods by country

**Total: 60 neighborhoods**



**4,486 street segments**

**Virtual audit (manual)**

# Physical neighborhood factors (Virtual audit) related to BMI / overweight

## SPOTLIGHT

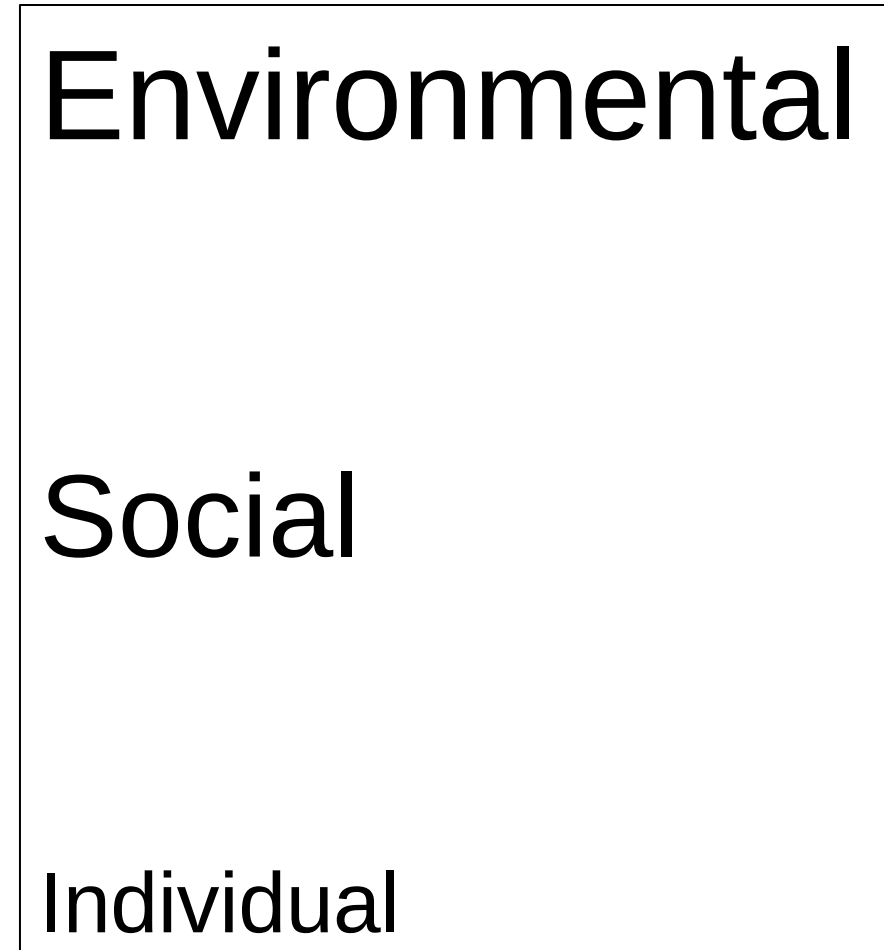
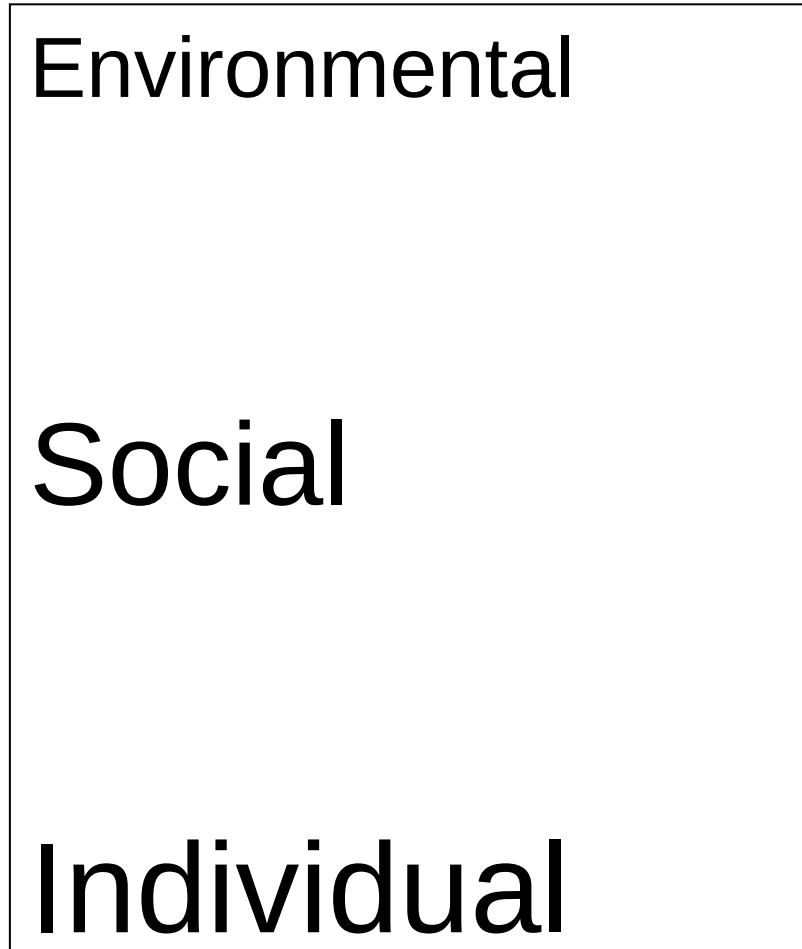
- Presence of recreational facilities NS
- **Features of active transportation environment ++**
- Neighborhood aesthetics NS
- Food retail environment index NS

# Social neighborhood factors (Self-report) related to BMI / overweight

## SPOTLIGHT

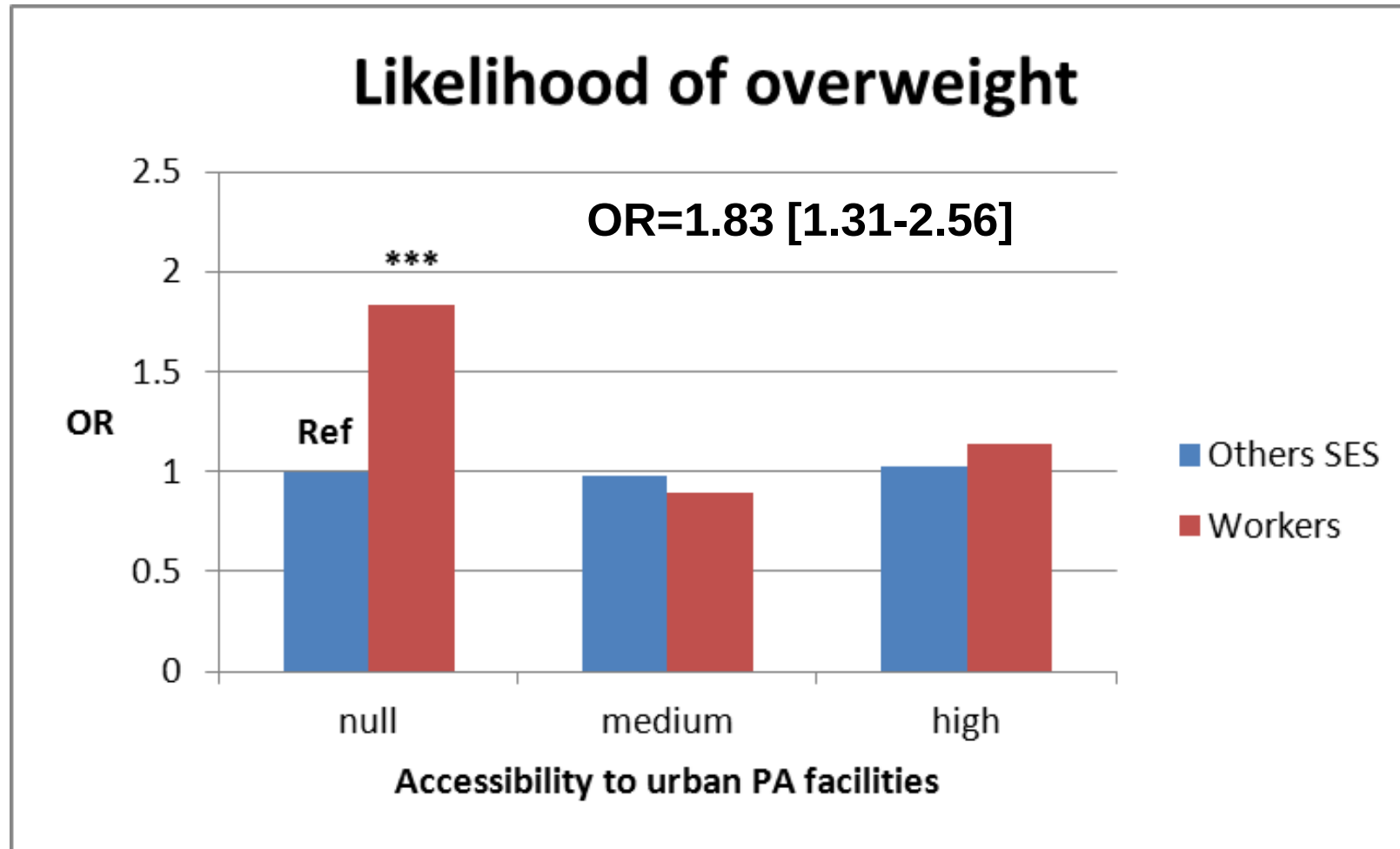
- **Moderate or high social network** +++
- **Moderate or high social cohesion** +++
- **High to very high social trust** +++
- **High SES** +++
- **Perceived crime** NS

# Relative importance of determinants



# Spatial accessibility to sports facilities

Interaction with SES



3327 students – 12 y – Bas-Rhin, France

Simon C et al. *Int J Obes* 2012

# Longitudinal studies

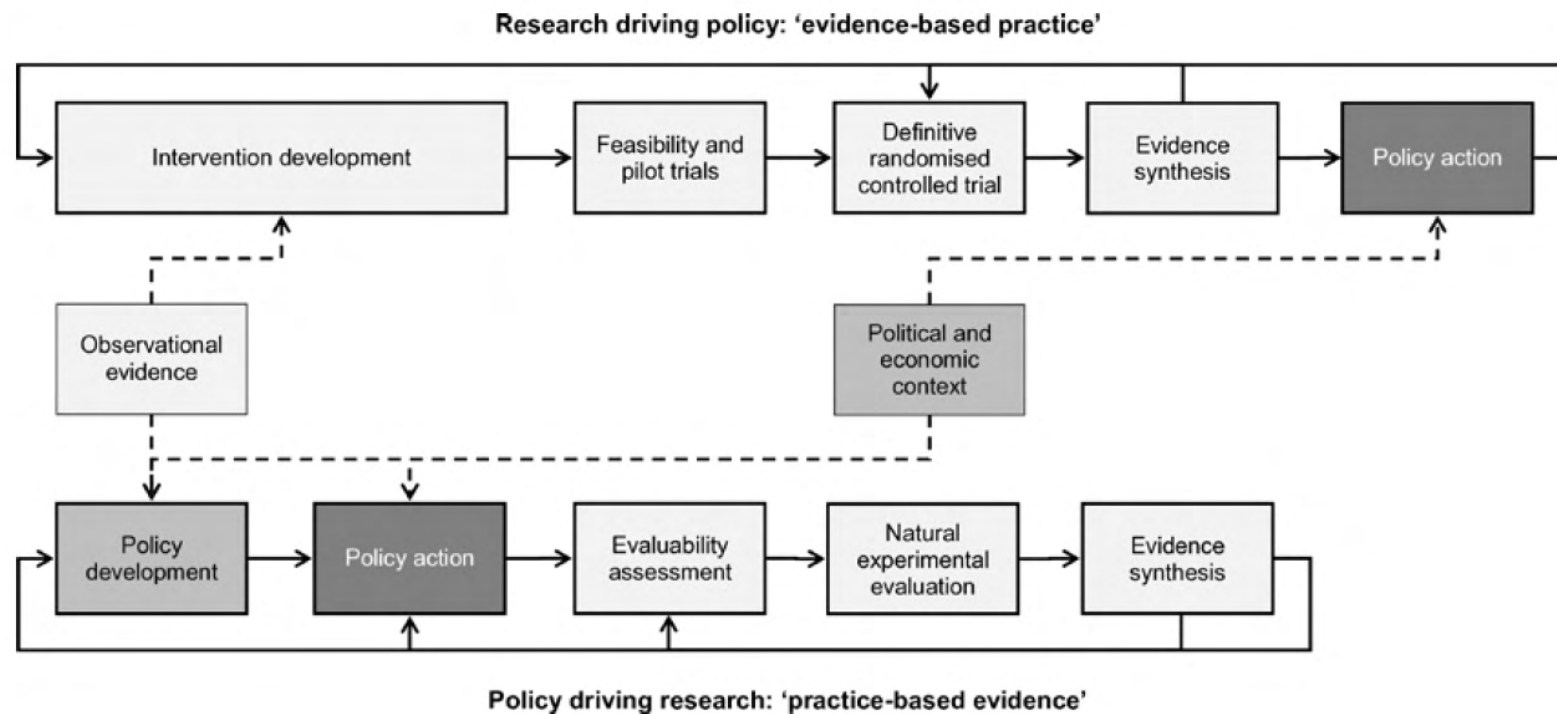
## Systematic review and meta-analysis

| BE Characteristics                                                       | Obesity | T2D | HTA |
|--------------------------------------------------------------------------|---------|-----|-----|
| <b><i>Walkability</i></b>                                                | +++     | +++ | +++ |
| Objective measures                                                       | +++     | +++ | +++ |
| <i>Recreational equipment</i>                                            | +++     |     |     |
| Green space, parks                                                       | NS      |     |     |
| <i>Urban sprawl</i>                                                      | +++     |     |     |
| <i>Destinations</i><br>(public transport, shops...)                      | NS      |     |     |
| <i>Road characteristics</i><br>(street connectivity, traffic, safety...) | NS      |     |     |

# Interventions



# « Natural » experiments



# Urban transformations

New light rail transit line opened in Charlotte (NC, USA)  
Measures before (T1: 2006-2007) and after (T2: 2008) opening



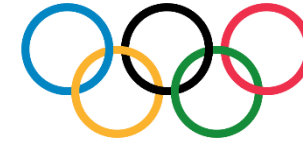
| Changes<br>(T2-T1) | Estimate<br>B (95% CI)<br>Odds Ratio (95% CI) | P            |
|--------------------|-----------------------------------------------|--------------|
| <b>BMI</b>         | <b>-1.18 (-2.22; -0.13)</b>                   | <b>0.015</b> |
| <b>Walking</b>     | 1.36 (0.39-4.73)                              | 0.48         |
| <b>Vigorous PA</b> | 3.32 (0.81-13.63)                             | 0.094        |

839 adults pre, 498 post, radius 1,6 km

MacDonald et al. *Am J Prev Med* 2010

# Moving to East Village

ENABLE Study – London 2012 Athlete's Village



| Variable                                              | Difference vs. ctrls (95% CI) | p           |
|-------------------------------------------------------|-------------------------------|-------------|
| <b>Steps (n / d)</b>                                  | <b>154 (-231 – 539)</b>       | <b>0.43</b> |
| <b>Total MVPA (min / d)</b>                           | <b>0.2 (-2.9 – 3.2)</b>       | <b>0.91</b> |
| <b>MVPA session <math>\geq</math> 10 min (min /d)</b> | <b>0.8 (-1.5 – 3.1)</b>       | <b>0.48</b> |
| <b>Sedentary time (min / d)</b>                       | <b>-4 (-17 – 7)</b>           | <b>0.25</b> |
| <b>BMI (kg /m<sup>2</sup>)</b>                        | <b>0.2 (-0.1 – 0.5)</b>       | <b>0.25</b> |
| <b>Body fat (%)</b>                                   | <b>0.1 (-0.5 – 0.6)</b>       | <b>0.80</b> |

877 adults (710 households) after 2 y  
441 (343) having moved

Nightingale et al. *Lancet Public Health* 2019

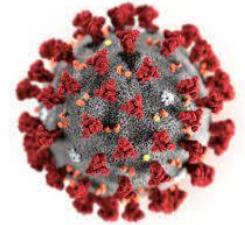
# Changes in weight and lifestyle during lockdown (2020)



Body weight during the lockdown (N=22,042)

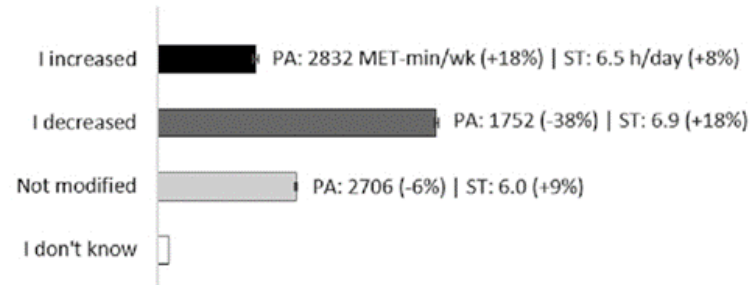
Weight loss for 23% : - 2.0 kg (SD: 1.4)

Weight gain for 35% : + 1.8 kg (SD: 1.3)

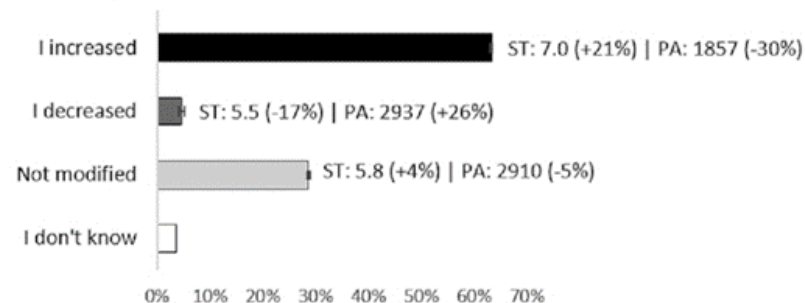


Physical activity (PA) and sedentary time (ST) during the lockdown  
(perceived changes: N=36,917 and quantitative estimation: PA, N=29,798 / ST, N=29,788)

## Physical activity level



## Sedentary time



Energy intake in April 2020 during the lockdown  
(N=10,617)

1828 kcal/day (SD: 474)

Compared to energy intakes in April in 2017-2019  
( $\Delta\%$  compared to usual > 10%, N=1,548)



**Increase for 25% :**

+ 468 kcal/day (SD: 274), i.e. + 26%

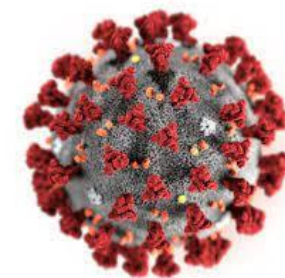


**Decrease for 33% :**

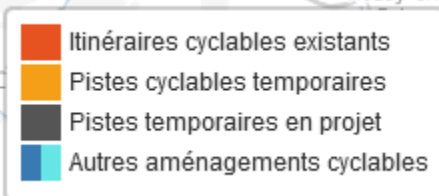
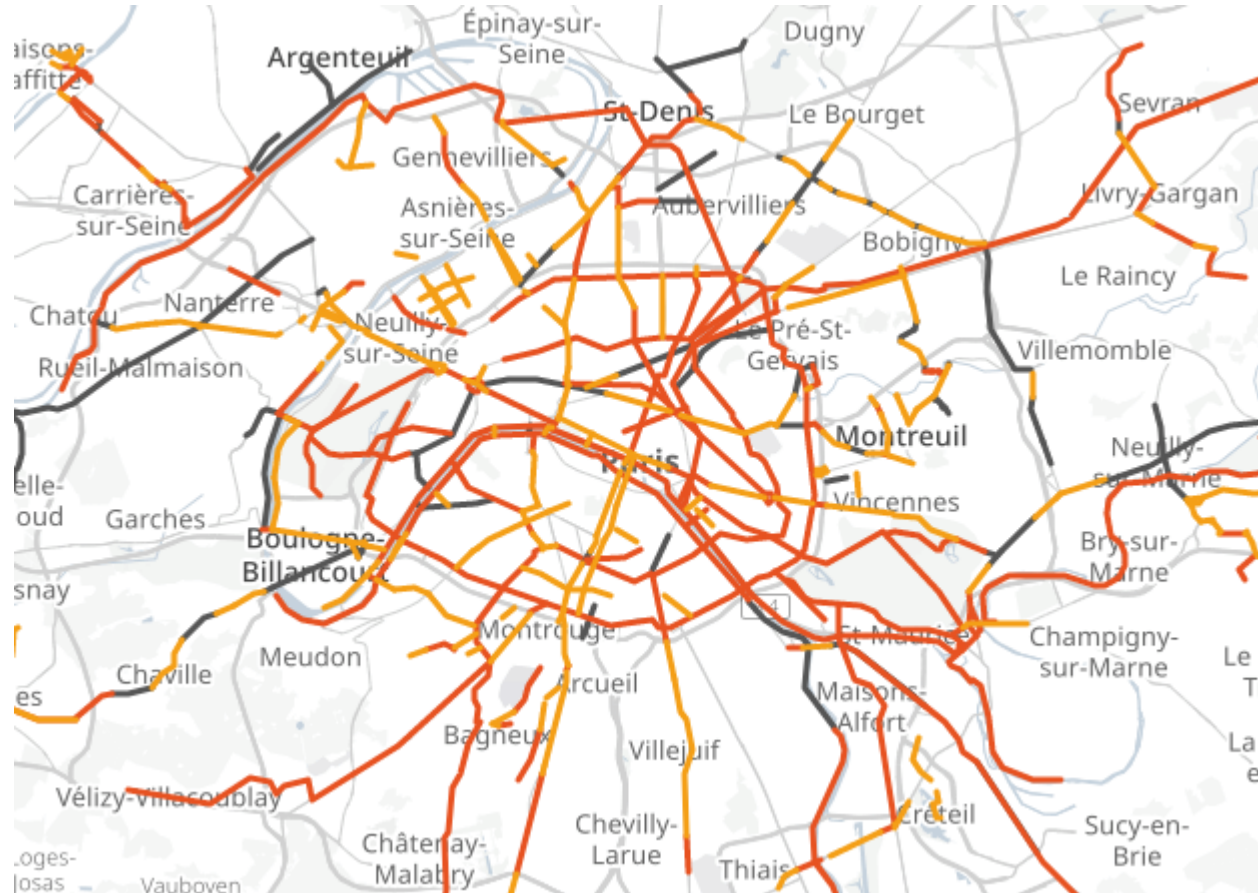
- 510 kcal/day (SD: 267), i.e. - 23%

NutriNet Santé cohort  
n = 29,798 for PA  
n = 10,617 for energy intakes

Deschasaux et al. *Am J Clin Nutr* 2021



# « Coronapistes » - Greater Paris and Ile de France



<https://velo-iledefrance.fr/accueil/cartecyclable/>

# Opportunities



# Opportunities

|                                  |             |                                                                                                     |
|----------------------------------|-------------|-----------------------------------------------------------------------------------------------------|
| <b>Assessment of environment</b> | New tools   | <b>Remote sensing by free geospatial services (eg. Google Street View)</b><br><b>Mental maps...</b> |
| <b>Assessment of behaviours</b>  | New tools   | <b>Wearables (movement sensors), webcams and large-scale imagery databases, EMA</b>                 |
| <b>Conduct of interventions</b>  | New designs | <b>Natural experiments</b>                                                                          |
| <b>Data analysis</b>             | New scale   | <b>Big data, IA</b>                                                                                 |

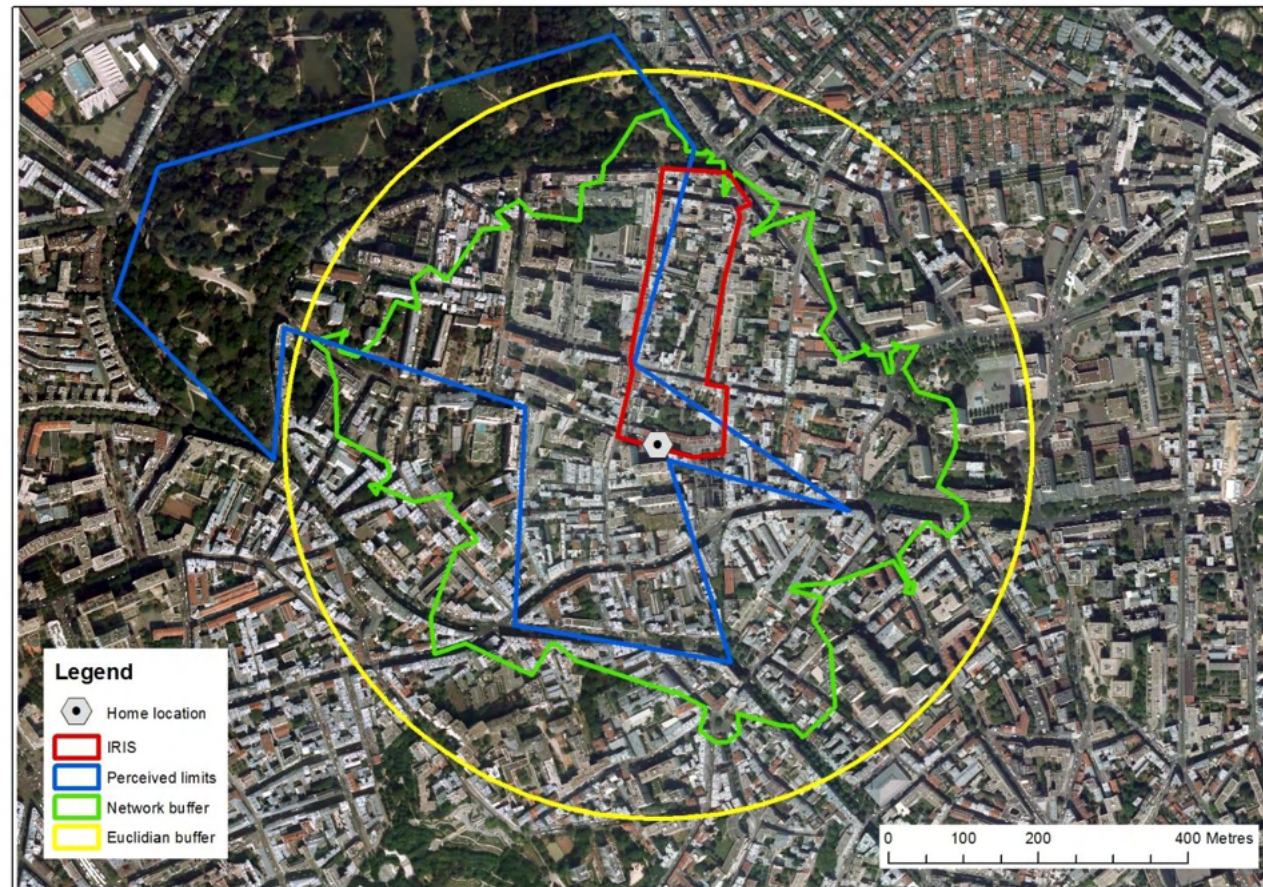
**Pre-defined boundaries do not match with neighborhood limits as perceived by residents**



- > Integrate in GIS

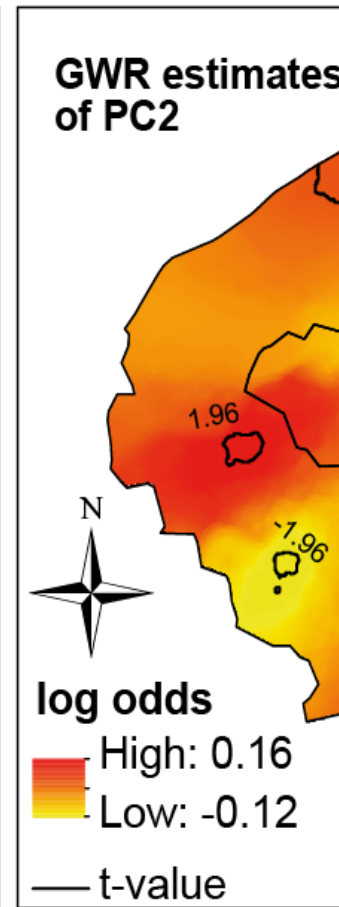
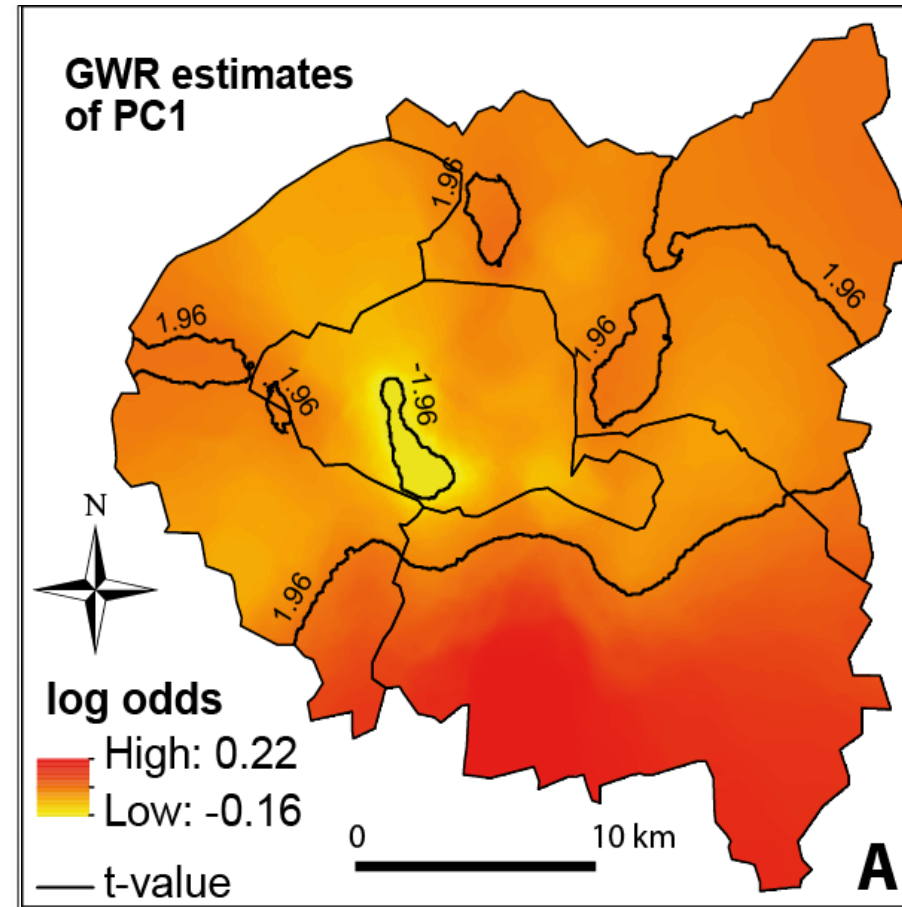
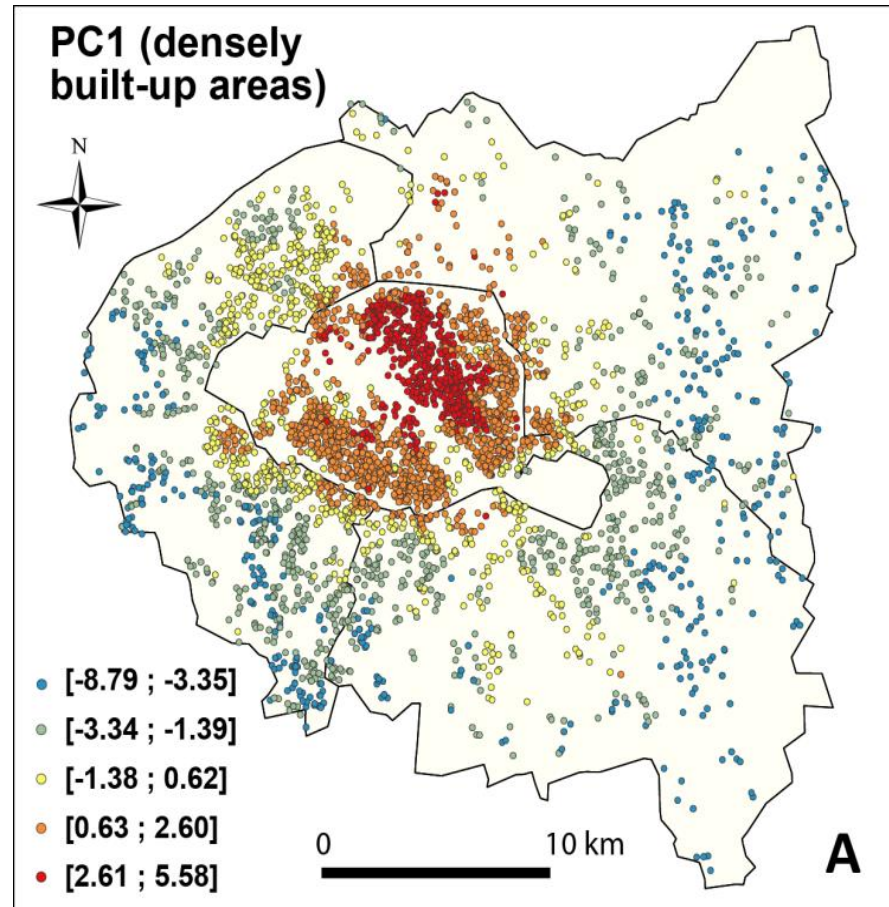
*H Charreire.*

# Limits of neighborhood



# Geographically weighted regression

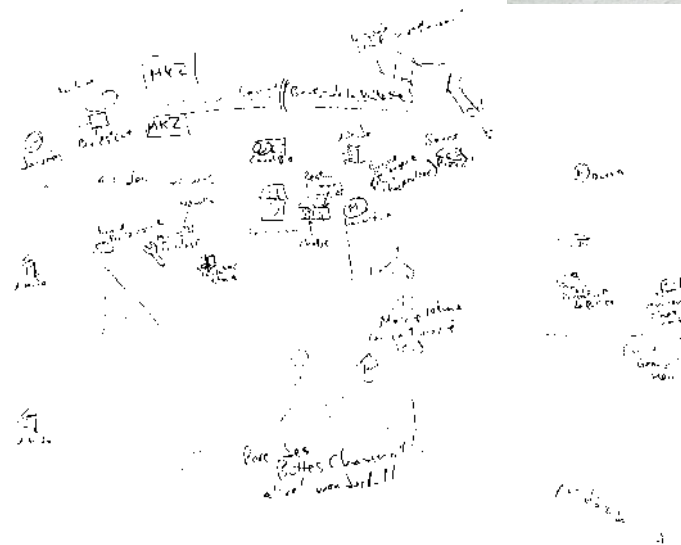
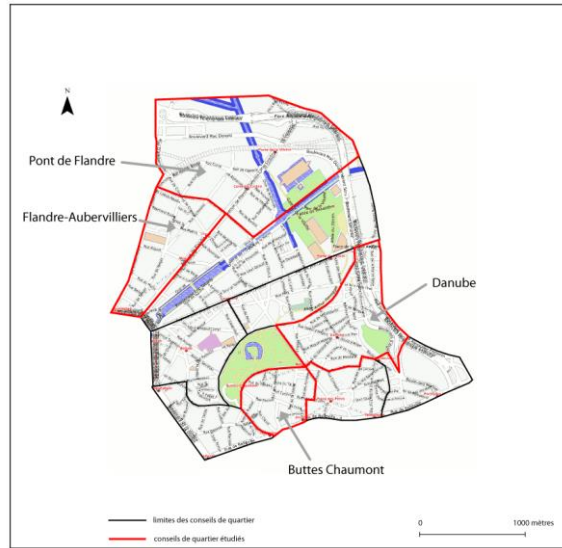
ACTI-Cités – Active commuting (n=4,164)



Red: Positive values of the log-odds positive relationships between explanatory variable and active commuting  
Yellow: negative relationships

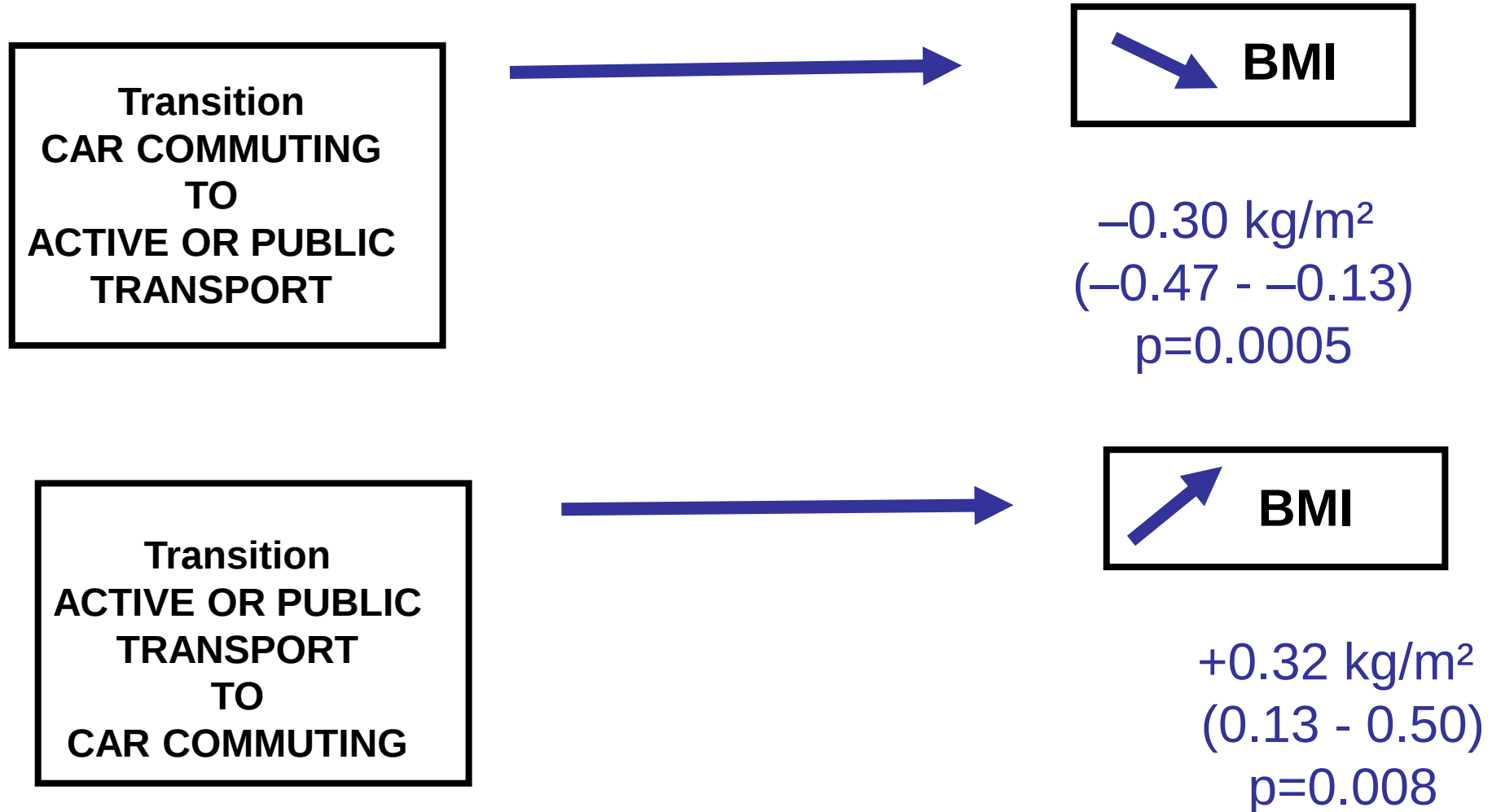
*Feuillet al. J Transport Health 2016*

# Perception of activity space



# Active or public transport and BMI change

UK Biobank – Longitudinal



N= 20 346 subjects, repeat assessment  
4.4 years

Flint et al. *Lancet Public Health* 2016

## PI Hélène Charreire – Inrae France



# ***Urban renewal projects in SAINT- DENIS and AUBERVILLIERS***

## ***Intervention and control neighborhoods***

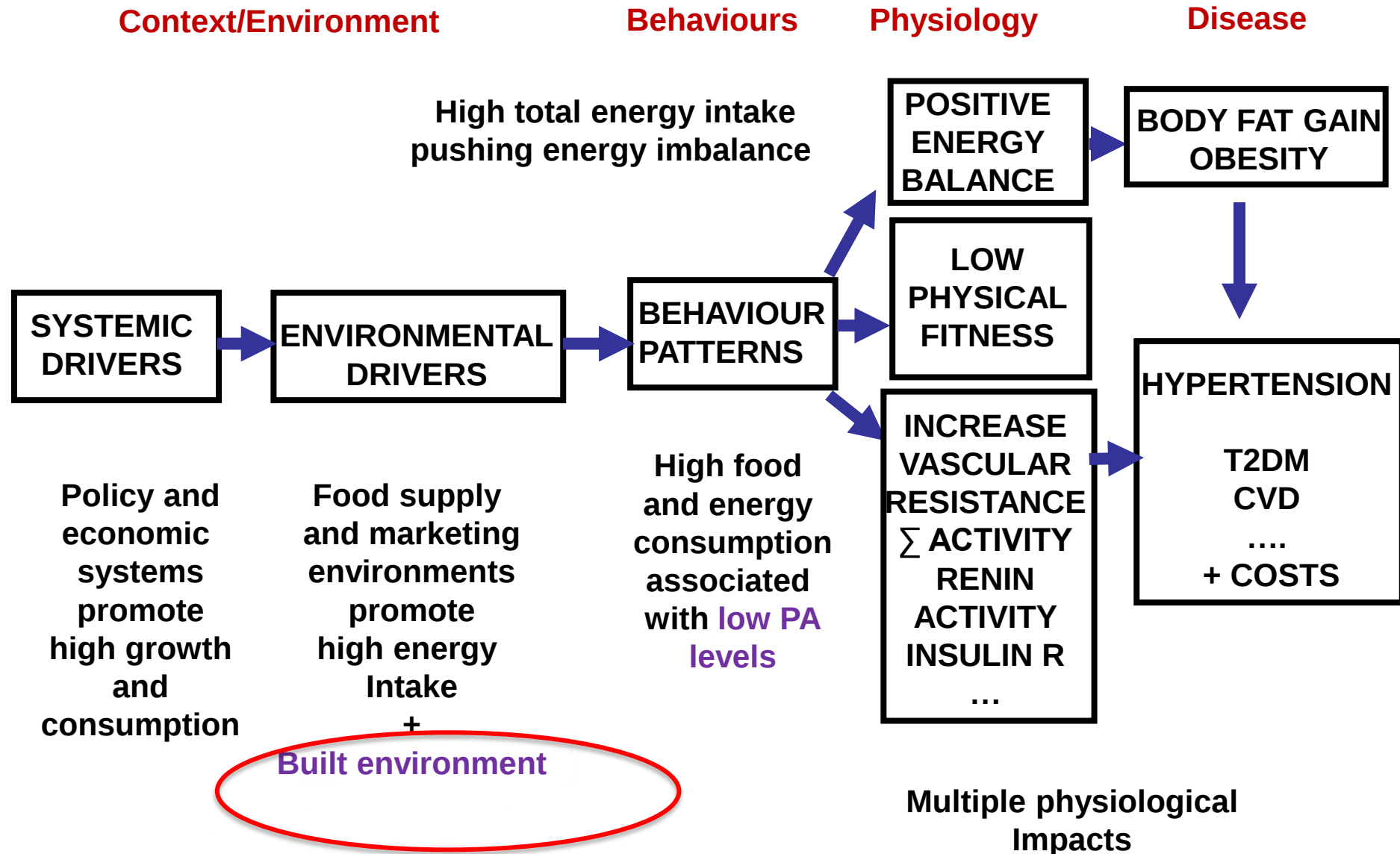


Representations /  
Usage

*Adapted from Usher, 2015 and Penchansky and Thomas, 1981*



# Determinants – Framework



*Adapted from Swinburn et al. Lancet 2011*

# @ Our health is a function of where we live



It is high time that built environments provide the quadruple boost towards health, environment, equity (or public good), and habitat.



# Teamwork



***H Charreire***  
***Inrae Montpellier***



***T Feuillet***  
***U Caen***



Thank you!

# Synthesis (tentative and personal) Evidence for a role in body weight gain

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|             | Physical<br>activity | Food intake |
|-------------|----------------------|-------------|
| Behaviour   | +                    | ++++        |
| Environment | ++                   | ±           |

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# So...

- To go further in our understanding of the association of the built environment with obesity, we would need
  - Track changes over time: longitudinal studies
  - Better assess how the built environment characteristics are perceived
  - Better assess how resources are used