

Neighborhood environments and cardiovascular risk factors in the Paris Metropolitan area

The RECORD Cohort Study



Basile CHAIX
Equipe DS3

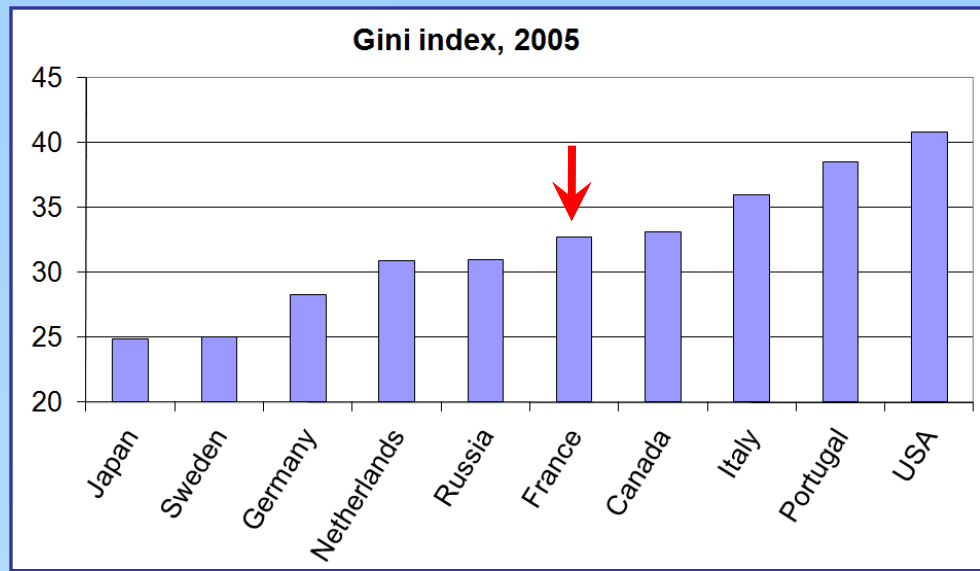
www.record-study.org



France among industrialized countries:

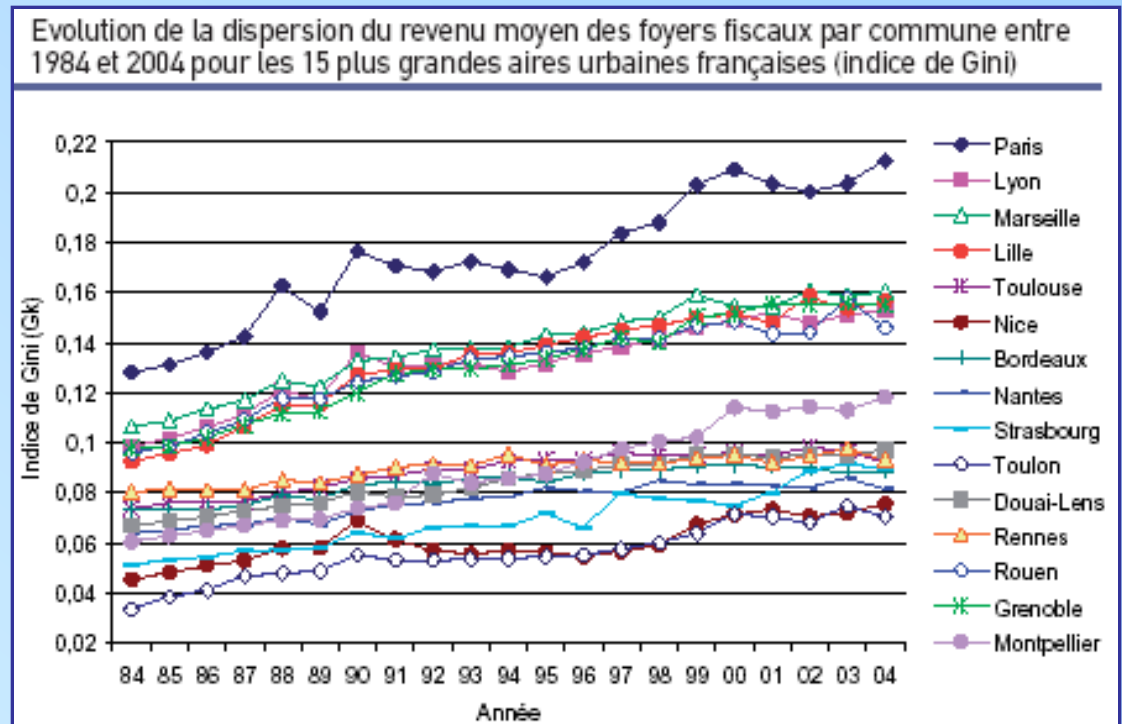
Classical Gini between 1984 and 2004

Modest increase in overall social disparities



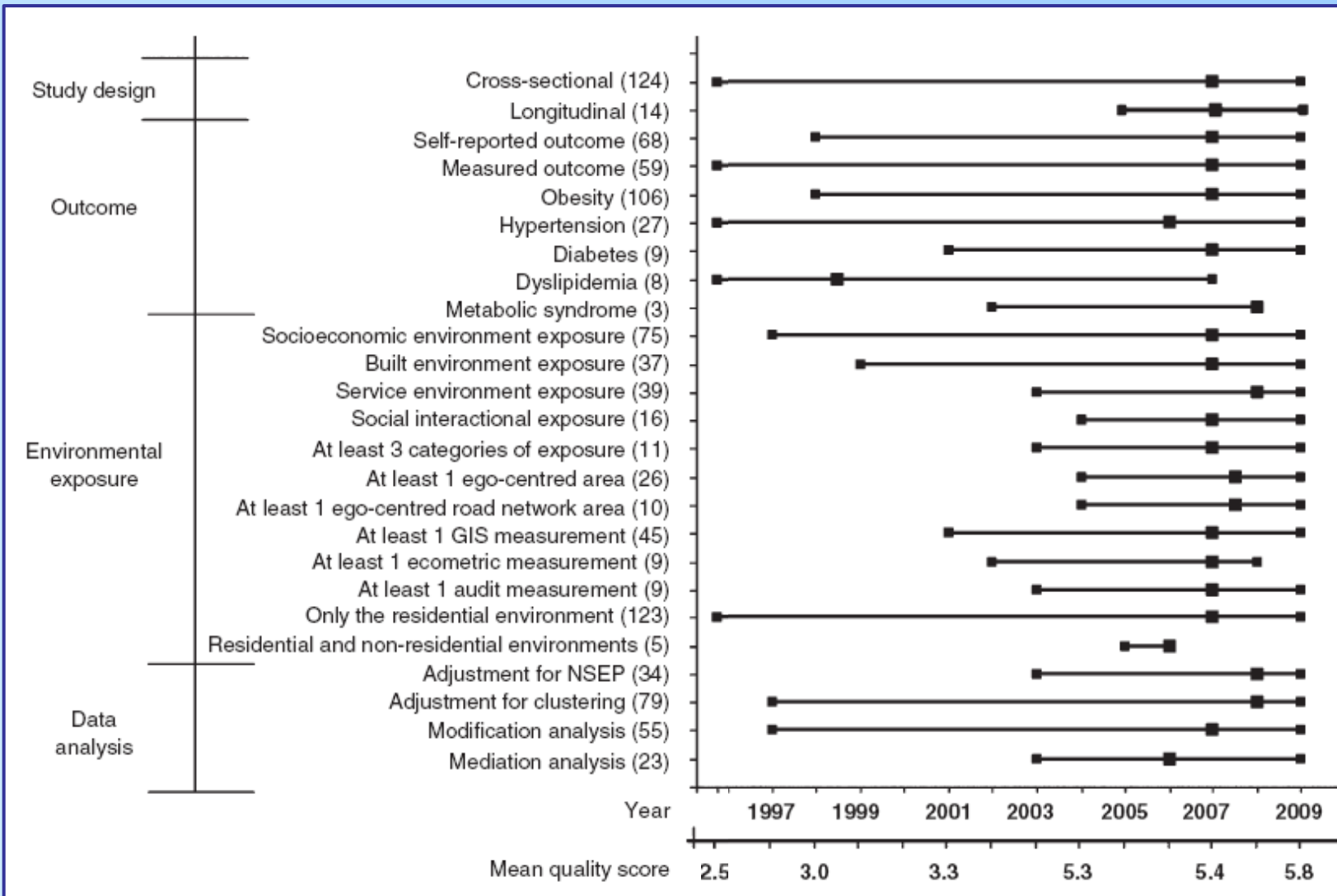
Spatial Gini between 1984 and 2004

Strong increase in socio-spatial segregation



NEIGHBORHOOD ENVIRONMENTS AND CARDIOMETABOLIC RISK FACTORS

- 131 studies published between 1985 and 2009



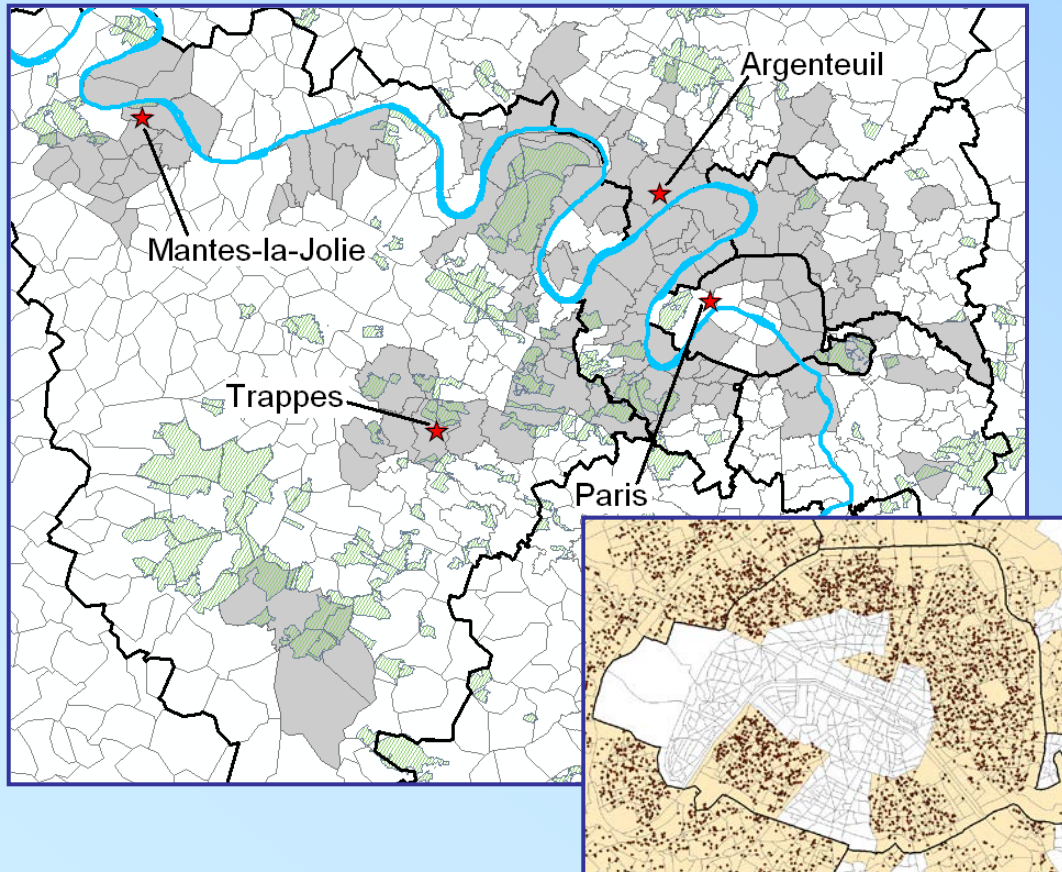
Leal & Chaix, Obesity Reviews, 2011

RECORD : STUDY TERRITORY & DATA

Recruitment during general health checkups

- **7290** participants (30–79 years)

111 municipalities + 10 districts of Paris
= 1915 different neighborhoods



RECORD Study, wave 1

Biological data

Paramedical examinations

Medical questionnaires

Address & contact info 

RECORD questionnaire

Geocoding of participants

Environmental data

Healthcare use (SNIIR-AM)

Hospitalizations (PMSI)

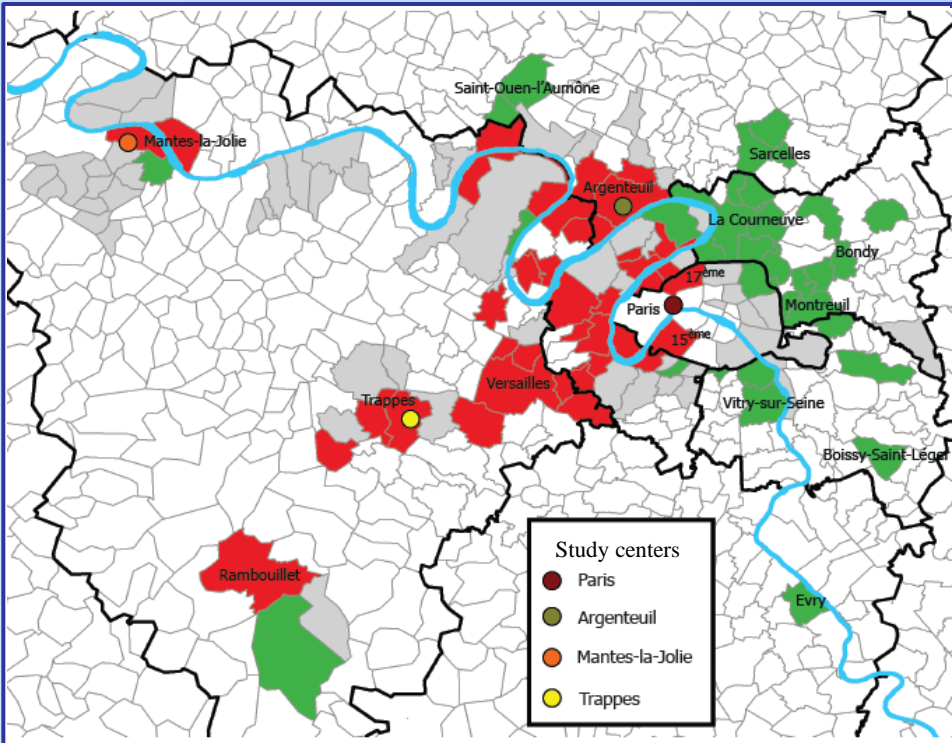
Mortality (Insee, CepiDC)

Professional career (CNAV)

NEIGHBORHOOD-RELATED SELECTION

Multilevel Poisson model for participation of populations in the RECORD Cohort Study

Relatively large variance between neighborhoods



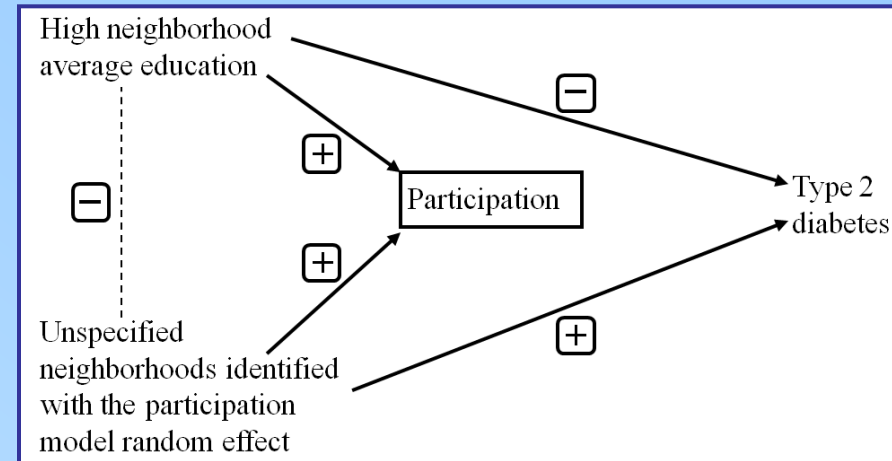
Rate of participation in the RECORD Study estimated from age/sex adjusted multilevel models

- High participation (+25% and more)
- Low participation (-25% and more)
- Intermediary participation
- Out of study territory

	PRR* (95% CI)
Individual education (vs. low)	
Medium	1.90 (1.74, 2.08)
High	4.25 (3.87, 4.67)
Distance to the center (vs. long)	
Medium-long	1.19 (1.09, 1.30)
Medium-short	1.45 (1.32, 1.58)
Short	1.75 (1.60, 1.91)
Median income (vs. low)	
Medium-low	1.20 (1.09, 1.32)
Medium-high	1.29 (1.14, 1.45)
High	1.39 (1.20, 1.60)
Mean real estate prices (vs. low)	
Medium-low	1.10 (1.00, 1.21)
Medium-high	1.11 (1.00, 1.24)
High	1.23 (1.09, 1.39)
% looking for work (vs. low)	
Medium-low	1.01 (0.93, 1.10)
Medium-high	1.18 (1.06, 1.31)
High	1.31 (1.15, 1.47)
% of area with buildings (vs. high)	
Medium-high	1.13 (1.03, 1.23)
Medium-low	1.26 (1.14, 1.39)
Low	1.37 (1.23, 1.51)
Building height (vs. high)	
Medium-high	1.11 (1.03, 1.21)
Medium-low	1.27 (1.16, 1.39)
Low	1.27 (1.15, 1.40)

Neighborhood education and type 2 diabetes

- No bias related to the contextual determinants of participation
- Residual spatial variations in participation appeared to bias the association of interest



Joint estimation of the 2 models through MCMC:

Model for participation

$$\text{Log}(\lambda_{ij}) = \beta_0 + \sum \beta_i X_i + s_j$$

Model for diabetes

$$\text{Logit}(p_{ij}) = \beta'_0 + \sum \beta'_i X_i + \gamma s_j + u_j$$

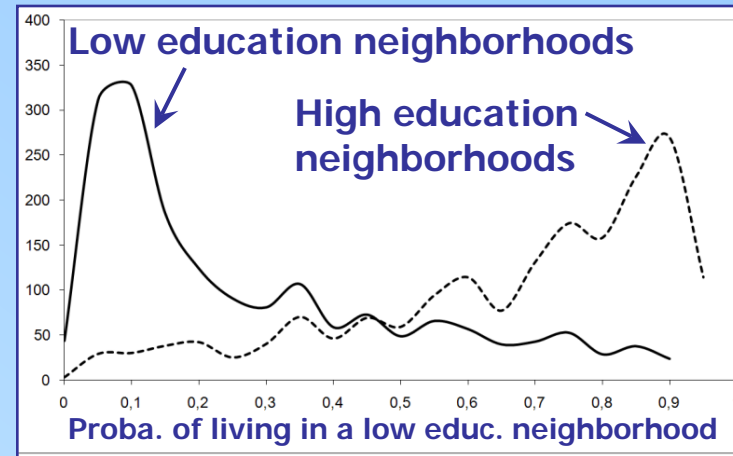
	Initial model		Model with correction	
Neighborhood education (vs. high)	OR	(95% CrI)	OR	(95% CrI)
Medium-high	1.05	(0.70 – 1.56)	1.01	(0.68 – 1.48)
Medium-low	1.19	(0.80 – 1.75)	1.15	(0.78 – 1.69)
Low	1.56	(1.06 – 2.31)	1.44	(0.98 – 2.13)

CONTEXT, BMI & WAIST CIRCUMFERENCE

Associations with neighborhood socioeconomic status adjusted for individual socioeconomic characteristics

- based on excessive extrapolations?
- inferences without empirical support?

Propensity score = probability of living in a low education neighborhood



↓
Propensity score matching:

55% reduction in sample size

	Models for BMI (kg/m ²)	Models for waist circumference (cm)
Classical approach		
Neighborhood education (vs. high)		
Medium-high	+0.21 (-0.07; +0.49)	+0.35 (-0.38; +1.10)
Medium-low	+0.39 (+0.10; +0.68)	+0.70 (-0.06; +1.47)
Low	+1.35 (+1.03; +1.66)	+3.10 (+2.27; +3.93)
Propensity score matching		
Neighborhood education (vs. high)		
Medium-high	+0.15 (-0.12; +0.42)	+0.23 (-0.52; +0.99)
Medium-low	+0.26 (-0.06; +0.59)	+0.71 (-0.13; +1.55)
Low	+1.37 (+0.94; +1.80)	+3.32 (+2.13; +4.51)

NEIGHBORHOODS & WAIST CIRCUMFERENCE

After adjustment for individual and neighborhood socioeconomic status, waist circumference was larger when (nearby the dwelling):

- building density was low
- street connectivity was low
- the number of shops selling fruits/vegetables was low
- the density of healthcare services was low
- the density of local destinations was low

... but it is difficult to disentangle the different “effects”

Correlation among the neighborhood variables

	Built surface	Street connectivity	Fruits & vegetables	Healthcare services
Built surface	-	0,56	0,73	0,83
Street connectivity		-	0,43	0,55
Fruits & veggies			-	0,68
Healthcare services				-

**Leal & Chaix,
ongoing
work**

NEIGHBORHOODS & WAIST CIRCUMFERENCE

“Neighborhood characteristics-matched analyses”:

Associations between the food environment and waist circumference analyzed within pairs of participants exposed to a similar density of destinations

Statistical unit of analysis: Pairs of participants similarly exposed to neighborhood characteristic A

ΔWC regressed on ΔRS and ΔNB

where : ΔWC : difference in waist circumference in the pair

ΔRS : difference in a risk score in the pair

ΔNB : difference in the neighborhood characteristic of interest (B) in the pair

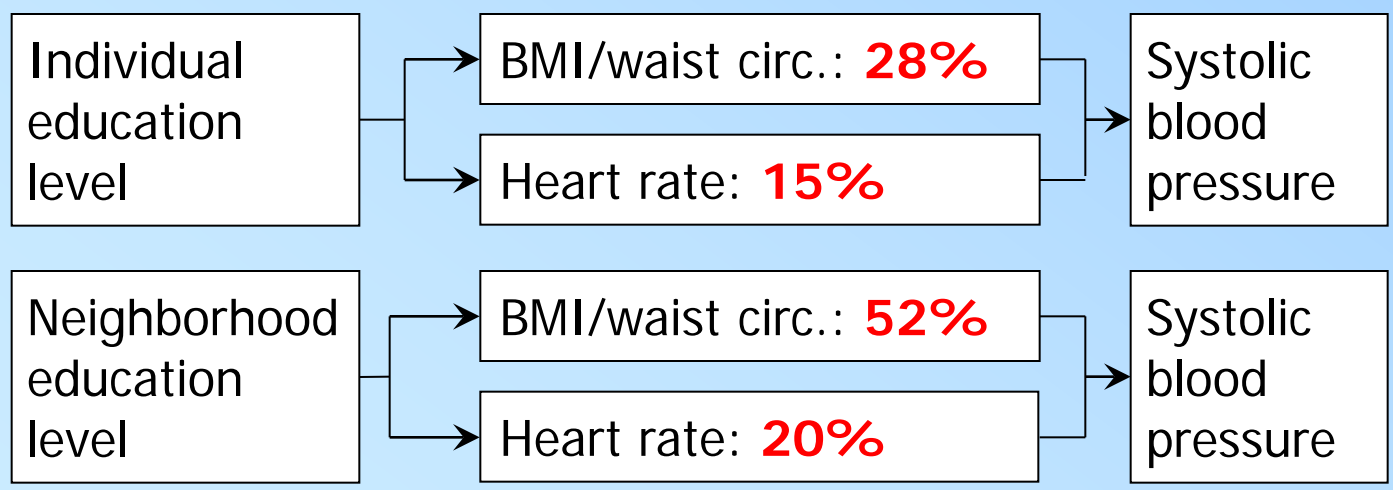
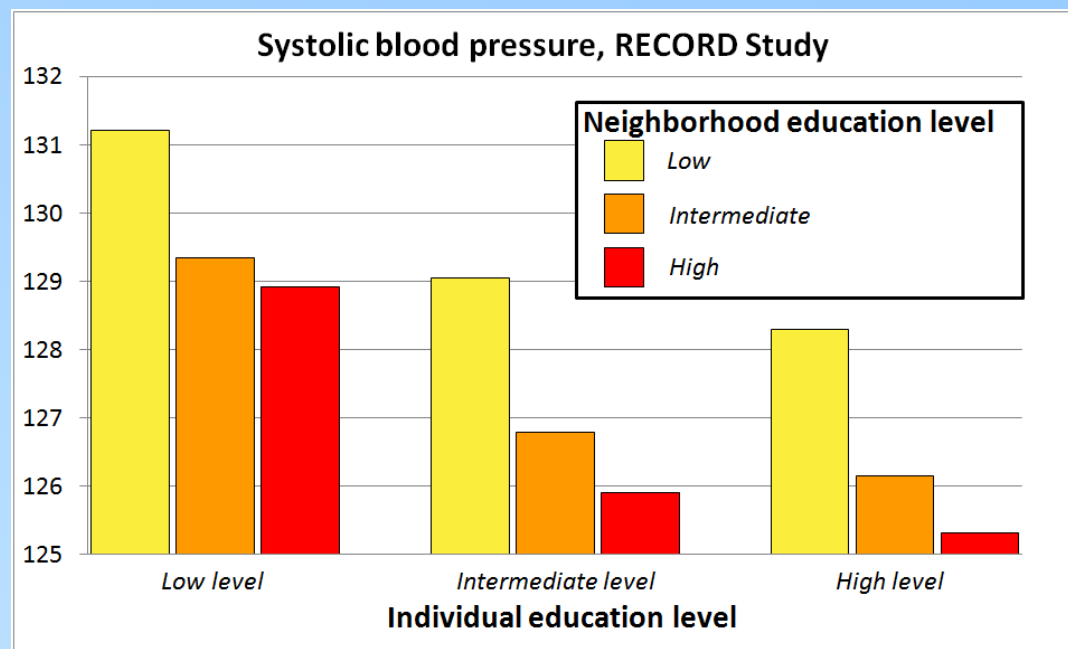
Conclusion:

- difficult to disentangle the “effects” of the different exposures
- perhaps one variable remained associated within matched pairs: the density of shops selling fruits/vegetables

NEIGHBORHOODS AND BLOOD PRESSURE

Message 1 : Disparities in blood pressure related to both individual education and neighborhood education

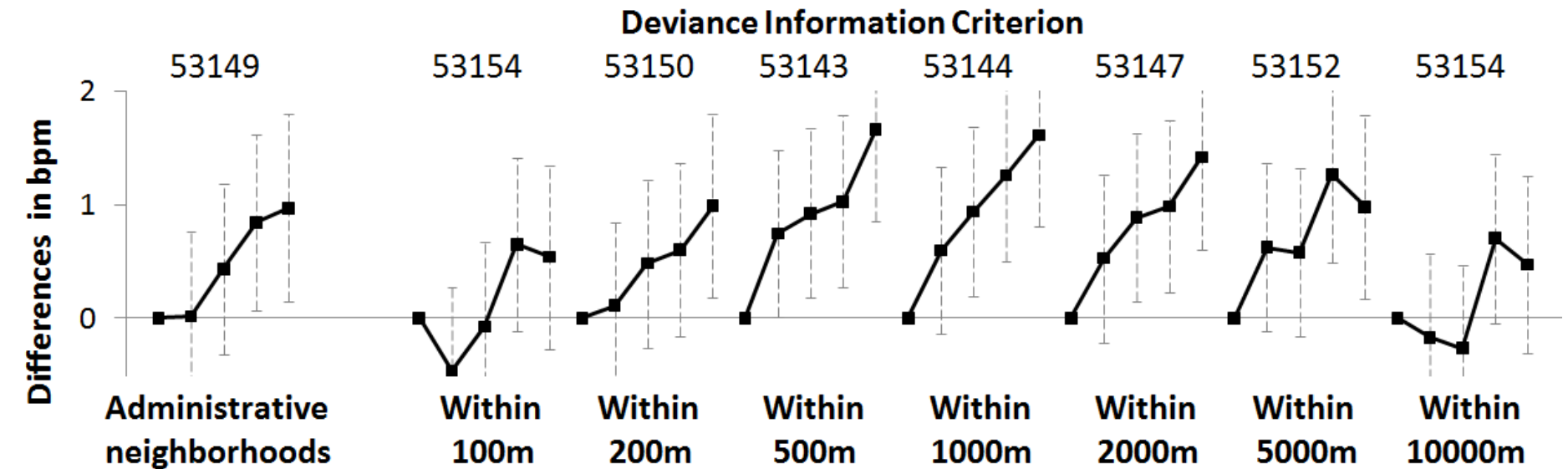
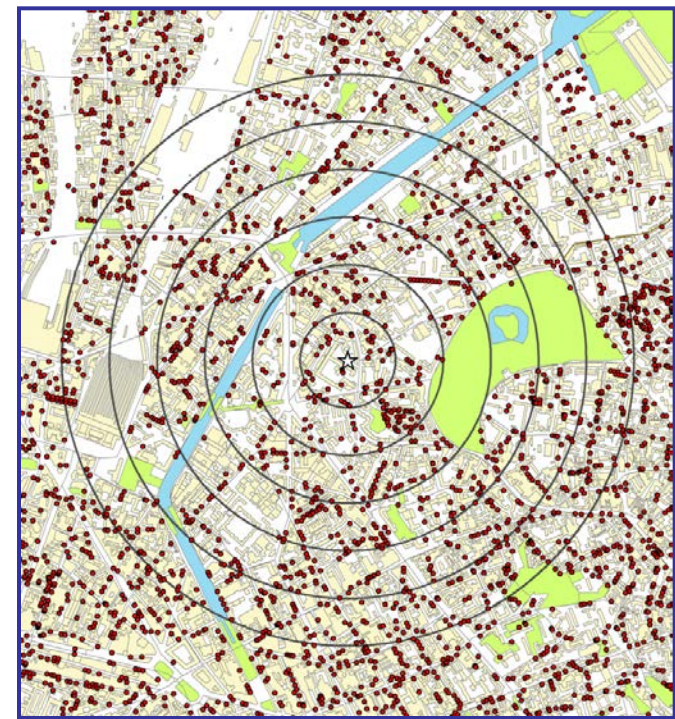
Message 2 : Disparities in body weight and fat were strong enough to generate blood pressure differences between neighborhoods



Socioeconomic status and resting heart rate

Neighborhood education level

- 2006 population census geocoded at the building level
- % of high educated residents in circular areas of different radiuses



Model adjusted for individual sociodemographic factors

AN INTEGRATIVE VIEW OF THE ENVIRONMENT

Account for the different dimensions of neighborhood environments:

Neighborhood dimensions

- Socioeconomic
- Physical
- Services
- Social interactions
- Symbolic

Measurement approaches

- Aggregation of data
- Geographic information systems
- Econometric approaches

Sociodemographic structure of neighborhoods

- Socioeconomic level
- Population density
- Neighborhood population turnover
- Ethnic/cultural origins

Physical environment

- **Built environment**
 - Urban & land use planning
 - Built forms
 - Street network configuration
- Maintenance, cleanness
- Vegetation, esthetics
- Traffic, air quality, noise
- **Natural environment**

Services & facilities

- Sport facilities
- Food environment
- Public transportation
- Healthcare services
- Density of destinations

Social-interactive environment

- **Networks of neighbors**
 - weak ties ≠ strong ties
 - formal ≠ informal
 - ↔ Associations
 - ↔ Collective efficacy
 - ↔ Behavioral norms
 - ↔ Delinquency, criminality

Symbolic environment

- Territorial identities
- ↔ Reputation of the place
- ↔ Stigma

WALKING BEHAVIOR

Walking time over the previous 7 days

→ type of walking:

- utilitarian walking

- work
- shopping
- other

- recreational walking

→ location of walking:

- in the neighborhood
- out of the neighborhood

Inserm
Institut national de la santé et de la recherche médicale

UNIVERSITÉ PIERRE & MARIE CURIE
LA SCIENCE À PARIS

IPC

Questionnaire RECORD

« Environnement résidentiel et maladie coronaire »

27. Au cours des 7 derniers jours, combien de temps au total en heures et minutes avez-vous marché :

a. pour aller à votre travail ou en revenir :

- **dans votre quartier :** au total | | h | | mn de marche les 7 derniers jours
- **en dehors de votre quartier :** au total | | h | | mn de marche les 7 derniers jours

b. pour faire des courses (alimentaires ou non) :

- **dans votre quartier :** au total | | h | | mn de marche les 7 derniers jours
- **en dehors de votre quartier :** au total | | h | | mn de marche les 7 derniers jours

c. pour vous rendre à un autre endroit (activité culturelle ou sportive, chez des amis, etc.)

- **dans votre quartier :** au total | | h | | mn de marche les 7 derniers jours
- **en dehors de votre quartier :** au total | | h | | mn de marche les 7 derniers jours

d. pour de simples promenades ou faire de l'exercice (seul ou accompagné, avec un animal de compagnie ou non) :

- **dans votre quartier :** au total | | h | | mn de marche les 7 derniers jours
- **en dehors de votre quartier :** au total | | h | | mn de marche les 7 derniers jours

DIMENSION : PHYSICAL ENVIRONMENT

- Proportion of the area covered by buildings
- Mean height of buildings
- Area of parks and green spaces
- Presence of a lake, river, etc.
- Density of street intersections
- Mean street block length
- Ratio of the numbers of street segments to street intersections
- Route directness
- Highway nearby the dwelling
- Road traffic-related pollution (nitrogen dioxide)
- Air traffic exposure area
- Presence of a waste treatment facility nearby
- Neighborhood active living potential
- Deterioration of the physical environment

DIMENSION : SERVICE ENVIRONMENT

- Density of destinations
- Presence of monuments
- Number of public transportation lines
- Proportion of traffic by public transportation rather than by car
- Presence of a shopping mall

DIMENSION : SOCIAL INTERACTIONS

- School violence
- Social cohesion
- Shared feeling of insecurity
- Stressful social interactions
- Hostility and lack of trust among neighbors

DIMENSION : SYMBOLIC ENVIRONMENT

- Stigmatization of the neighborhood

ECOMETRIC EVALUATION

Neighborhood active living potential

Item A: lack of outdoor spaces to practice sports

Item B: unpleasant environment to walk

Item C: lack of green spaces nearby

Deterioration of the physical environment

Item A: building fronts deteriorated

Item B: lack of maintenance of public facilities

Item C: trash and garbage on the street

Item D: vandalism and graffiti

Deteriorated social environment

Item A: victim of a robbery or aggression

Item B: perceived safety in the neighborhood

Item C: neighbors are kind and polite

Item D: incivilities, aggressive behavior

Item E: excessive noise of the neighbors

Social cohesion

Item A: neighbors are helpful to each other

Item B: collective identity, sense of community

Item C: residents act together to solve neighborhood problems

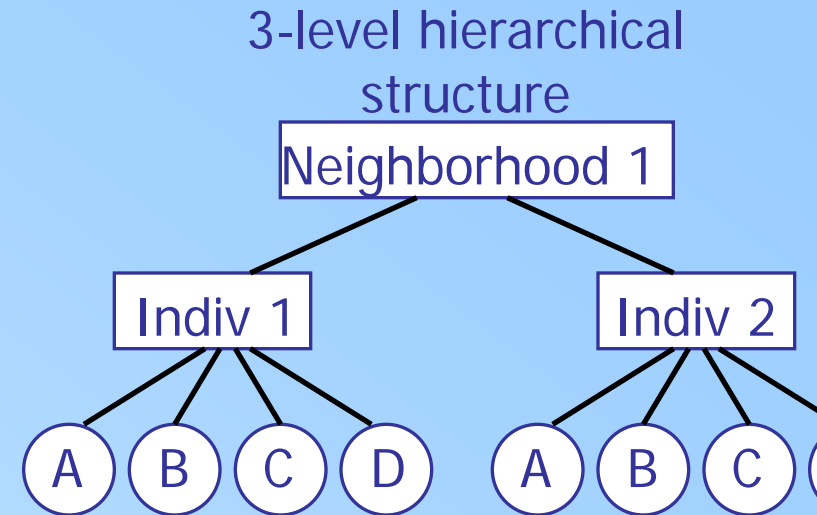
Item D: this is a close-knit neighborhood

Stigmatization

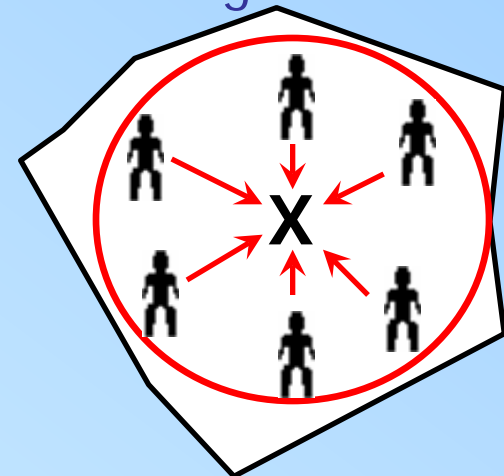
Item A: being ashamed of living in one's neighborhood

Item B: being judged negatively because of one's neighborhood

Item C: not proud of living in one's neighborhood



Residents as evaluators of their neighborhood



Proportion of walking devoted to recreational walking

Odds ratios for devoting a larger share of one's walking activity to recreational walking (OR, 95% CI, ordinal model)

% of residents born in a low development country (vs. high)	
Medium high	1.15 (1.02 ; 1.29)
Medium low	1.11 (0.98 ; 1.26)
Low	1.25 (1.09 ; 1.44)
Neighborhood active living potential (vs. low)	
Medium low	0.99 (0.88 ; 1.12)
Medium high	1.04 (0.92 ; 1.17)
High	1.25 (1.09 ; 1.43)
Exposure to air traffic	0.84 (0.74 ; 0.96)

- Socioeconomic
- Physical
- Services
- Social interactions
- Symbolic

Probability to report recreational walking over the previous 7 days

Relative risk for reporting recreational walking (RR, 95% CI, binomial regression)

% of educated residents (vs. low)	
Medium low	1.18 (0.99 ; 1.40)
Medium high	1.18 (0.99 ; 1.40)
High	1.25 (1.04 ; 1.51)
Exposure to air traffic	0.84 (0.74 ; 0.96)

Proportion of recreational walking within the neighborhood (among walkers)

Odds ratios for walking more in proportion in one's residential neighborhood (OR, 95% CI, ordinal model)

Area of parks and green spaces (vs. weak)

Medium weak	1.09 (0.94 ; 1.26)
Medium large	1.08 (0.93 ; 1.25)
Large	1.34 (1.15 ; 1.55)

Neighborhood active living potential (vs. low)

Medium low	1.00 (0.87 ; 1.16)
Medium high	1.24 (1.06 ; 1.44)
High	1.37 (1.15 ; 1.62)

Number of transportation lines (vs. low)

Medium low	1.17 (1.00 ; 1.36)
Medium high	1.11 (0.96 ; 1.27)
High	1.23 (1.07 ; 1.43)

Stigmatization of the neighborhood (vs. high)

Medium high	1.10 (0.95 ; 1.27)
Medium low	1.16 (0.99 ; 1.36)
Low	1.25 (1.06 ; 1.48)

- Socioeconomic
- Physical
- Services
- Social interactions
- Symbolic

Time of utilitarian walking over the previous 7 days

Differences in utilitarian walking times (in minutes, 95% CI, linear model)

Real estates prices in the neighborhood (vs. high)

Medium high	+10 (-17 ; +36)
Medium low	+29 (+2 ; +56)
Low	+39 (+10 ; +68)

Density of road traffic (NO₂) (vs. low)

Medium low	+40 (+12 ; +67)
Medium high	+31 (-5 ; +67)
High	+53 (+11 ; +95)

Proportion of traffic in the area by public transportation rather than by car (vs. low)

Medium low	+23 (-5 ; +51)
Medium high	+32 (-3 ; +67)
High	+50 (+4 ; +97)

Density of destinations (vs. low)

Medium low	+11 (-16 ; +38)
Medium high	+40 (+7 ; +74)
High	+68 (+25 ; +111)

- Socioeconomic
- Physical
- Services
- Social interactions
- Symbolic

THE FOOD ENVIRONMENT

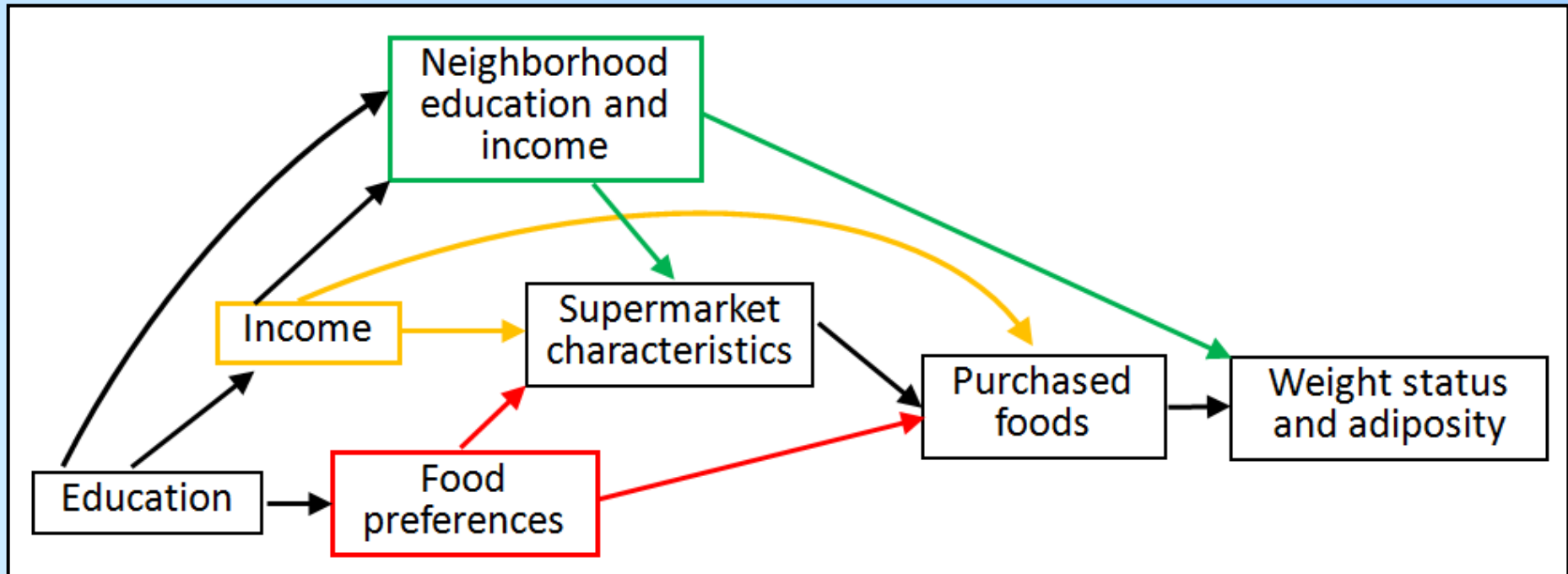
- Small, medium, or large supermarkets (brand, address) where participants did most of their food shopping:
- **1097** supermarkets for **7131** participants

Multilevel distribution of variance in body mass index

	Variance (95% CI)	p	% of total variance
<u>Model #1</u>			
Between-neighborhood variance	0.99 (0.71 – 1.47)	<0.0001	5.8%
<u>Model #2</u>			
Between-neighborhood variance	0.72 (0.46 – 1.26)	<0.0001	4.2%
Between-supermarket variance	0.42 (0.25 – 0.83)	0.0004	2.5%
			6.7%

(“cross-classified” multilevel model, adjusted for age and sex)

Associations between supermarket characteristics and weight status or abdominal fat may be confounded by individual/neighborhood factors



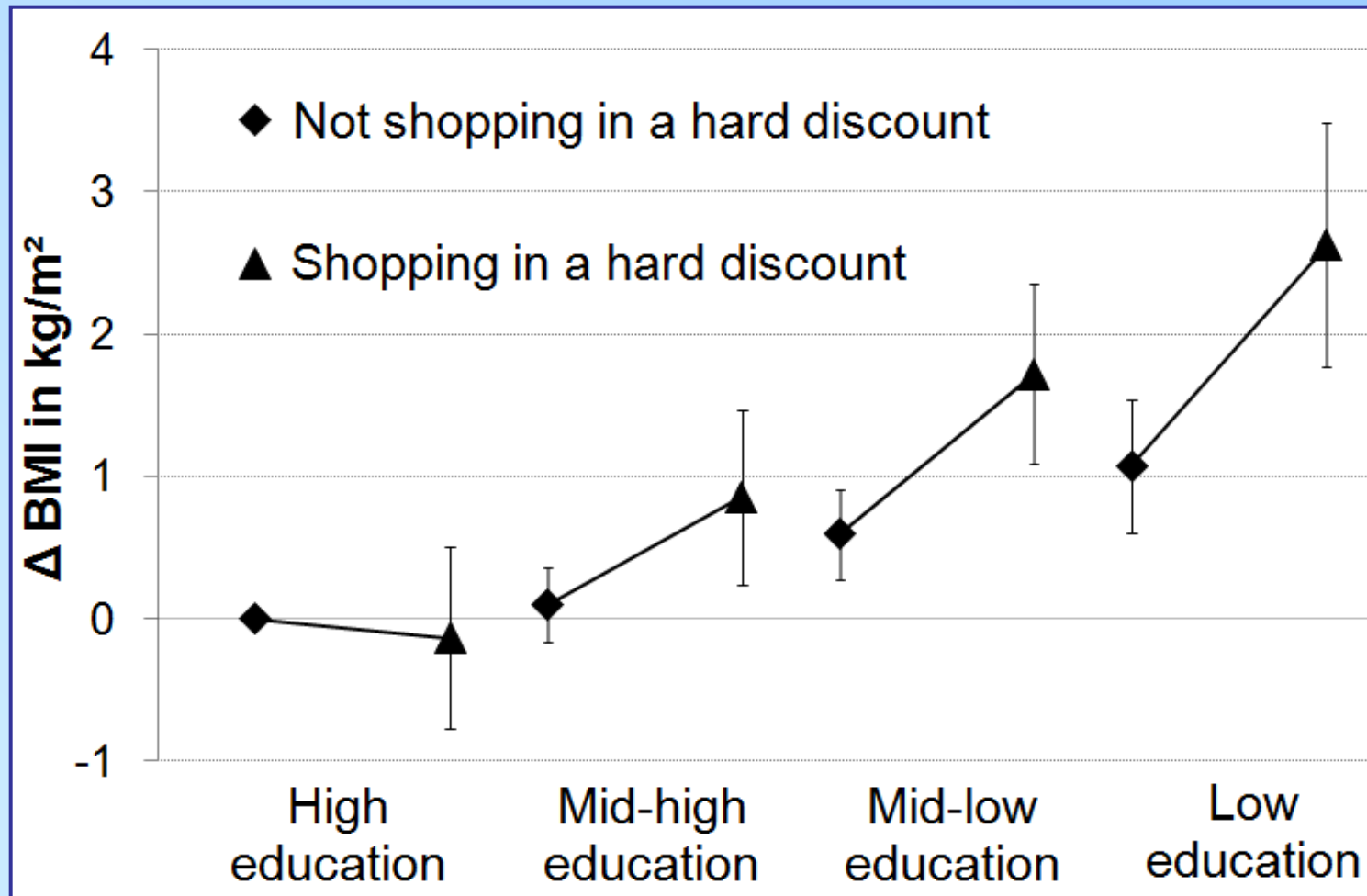
Brand	Δ BMI in kg/m ² (95% CI)	Δ waist circ. in cm (95% CI)
<u>Ref.:</u> Monoprix		
Aldi	+0.8 (-0.5 +2.2)	+2.1 (-1.4 +5.6)
Auchan	+0.3 (-0.1 +0.8)	+1.0 (-0.2 +2.1)
Carrefour	+0.4 (+0.1 +0.8)	+1.4 (+0.3 +2.4)
Casino	+0.6 (+0.1 +1.2)	+2.0 (+0.5 +3.4)
Champion	+0.4 (-0.0 +0.8)	+1.3 (+0.2 +2.4)
Cora	+1.6 (+0.3 +2.8)	+3.4 (+0.2 +6.7)
Ed	+0.6 (+0.1 +1.1)	+2.3 (+0.9 +3.6)
Franprix	+0.4 (+0.0 +0.7)	+1.2 (+0.3 +2.2)
G20	+0.5 (-0.4 +1.4)	+1.3 (-1.1 +3.7)
Intermarché	+0.3 (-0.4 +1.0)	-0.1 (-1.9 +1.8)
Leader Price	+0.6 (+0.0 +1.2)	+1.5 (-0.0 +3.0)
Leclerc	+0.4 (-0.1 +0.8)	+1.2 (-0.0 +2.4)
Lidl	+1.2 (+0.4 +2.0)	+3.4 (+1.2 +5.6)
Simply market	+0.4 (-0.1 +0.9)	+1.2 (-0.2 +2.6)
Système U	+0.3 (-0.3 +1.0)	+2.1 (+0.3 +3.8)

Model adjusted for: age, sex, cohabitation, country of birth, mother's education, education, employment status, occupation, housing tenure, financial strain, neighborhood education, distance to the supermarket

	Δ IMC, kg/m ² (95% CI)	Δ waist circ., cm (95% CI)
Type of supermarket (vs. citymarket)		
Hypermarket	+0.4 (+0.0 +0.8)	+1.2 (+0.3 +2.2)
Small and large supermarket	+0.3 (+0.1 +0.6)	+1.2 (+0.4 +2.0)
Hard discount	+0.7 (+0.3 +1.1)	+2.1 (+1.1 +3.2)
Organic shop	-2.1 (-3.4 -0.9)	-6.2 (-9.4 -2.9)
Long distance to the supermarket	+0.4 (+0.1 +0.8)	+1.1 (+0.4 +1.8)
Education level of residential neighborhood (vs. high)		
Medium high	+0.1 (-0.2 +0.4)	+0.1 (-0.7 +0.8)
Medium low	+0.2 (-0.2 +0.5)	+0.1 (-0.8 +0.9)
Low	+0.8 (+0.4 +1.2)	+2.0 (+0.9 +3.0)
Education level of supermarket catchment area (vs. high)		
Medium high	+0.1 (-0.2 +0.5)	+0.6 (-0.2 +1.3)
Medium low	+0.1 (-0.3 +0.5)	+0.7 (-0.1 +1.6)
Low	+0.5 (+0.1 +1.0)	+1.0 (+0.0 +2.1)

Model adjusted for: age, sex, cohabitation, country of birth, mother's education, education, employment status, occupation, housing tenure, financial strain

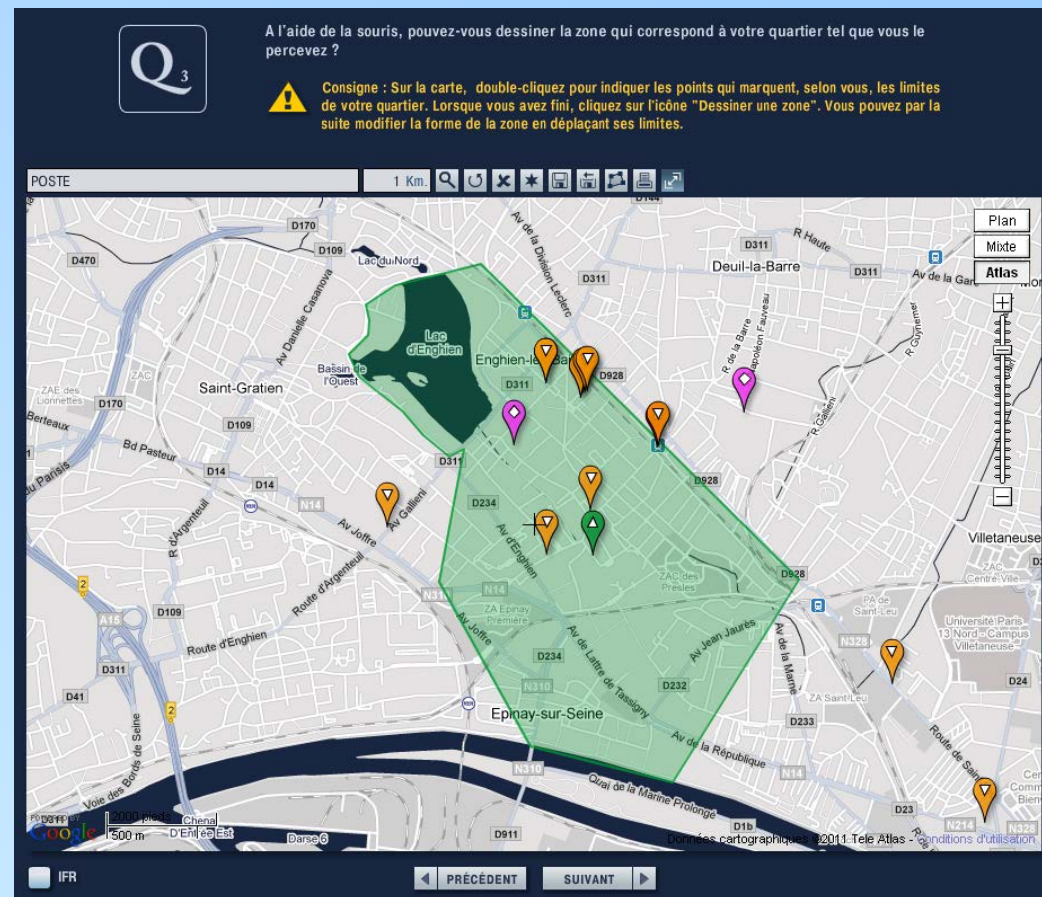
The excess BMI observed among people shopping in hard discounts increased with decreasing personal education (identical findings with waist circumference)



Model adjusted for: individual sociodemographic factors, education levels of residential neighborhood and supermarket catchment area, distance

SECOND RECORD STUDY WAVE

- Since February 1 2011: already **100** participants surveyed
- Evaluation of cardiovascular risk factors
- Geocoding of the network of usual destinations
- Assessment of the perceived delimitation of the neighborhood
- Selective migration
- Improved ecometric assessment of neighborhoods
- Questions on:
 - walking, physical activity
 - dietary habits
 - sedentary behavior
 - psycho-cognitive correlates of obesity
 - ...
- ...



Basile Chaix (Inserm), Yan Kestens (U Montreal)

FUNDING OF THE STUDY

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- IReSP
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