Prévention de l'impact de la pollution sur la santé à l'échelon du praticien

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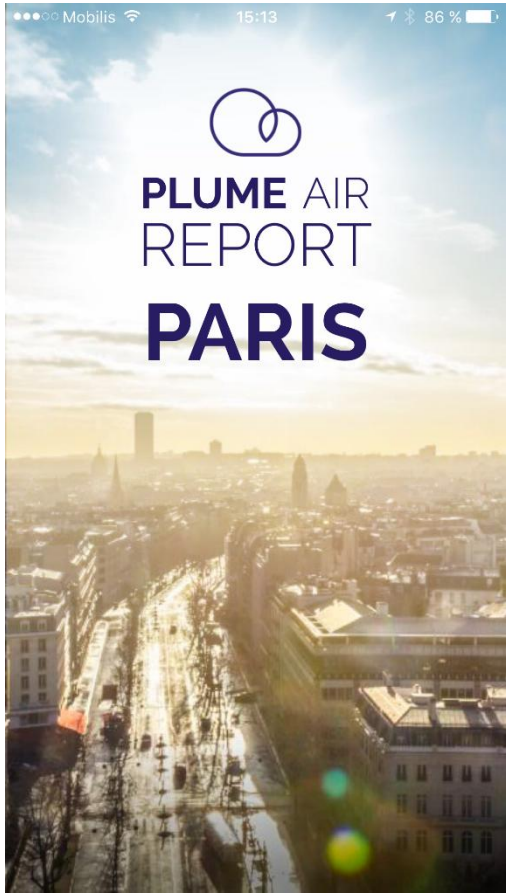
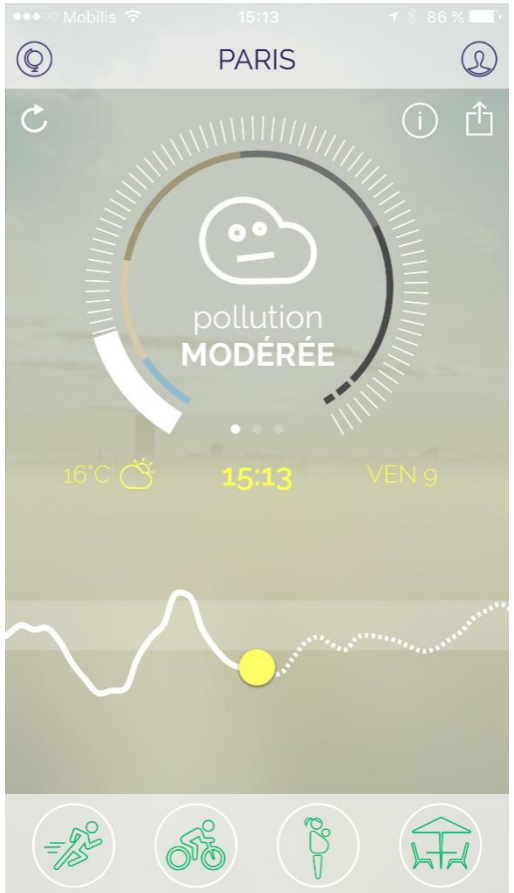
CENTRE HOSPITALIER INTERCOMMUNAL CRETEIL

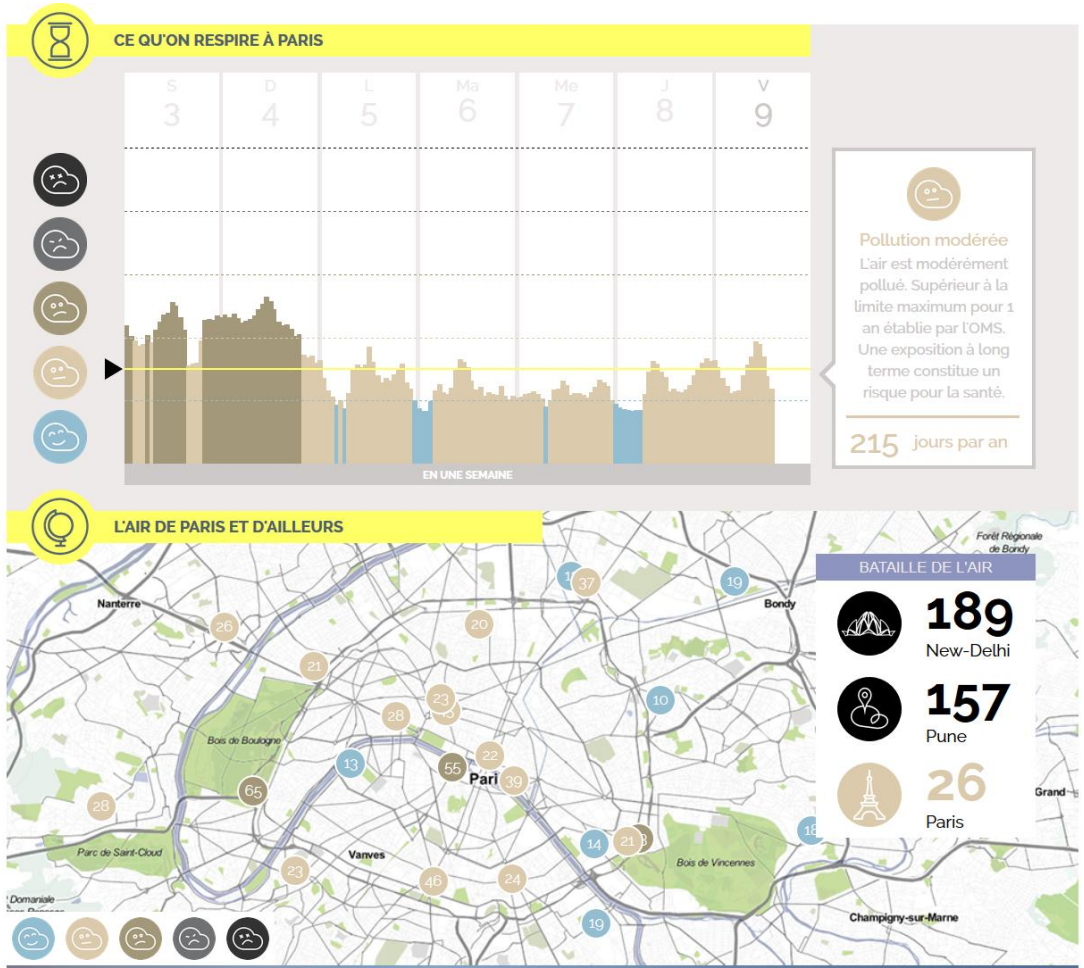
UPEC UNIVERSITÉ PARIS EST CRÉTEIL FACULTÉ DE MÉDECINE

Prévoir et s’informer

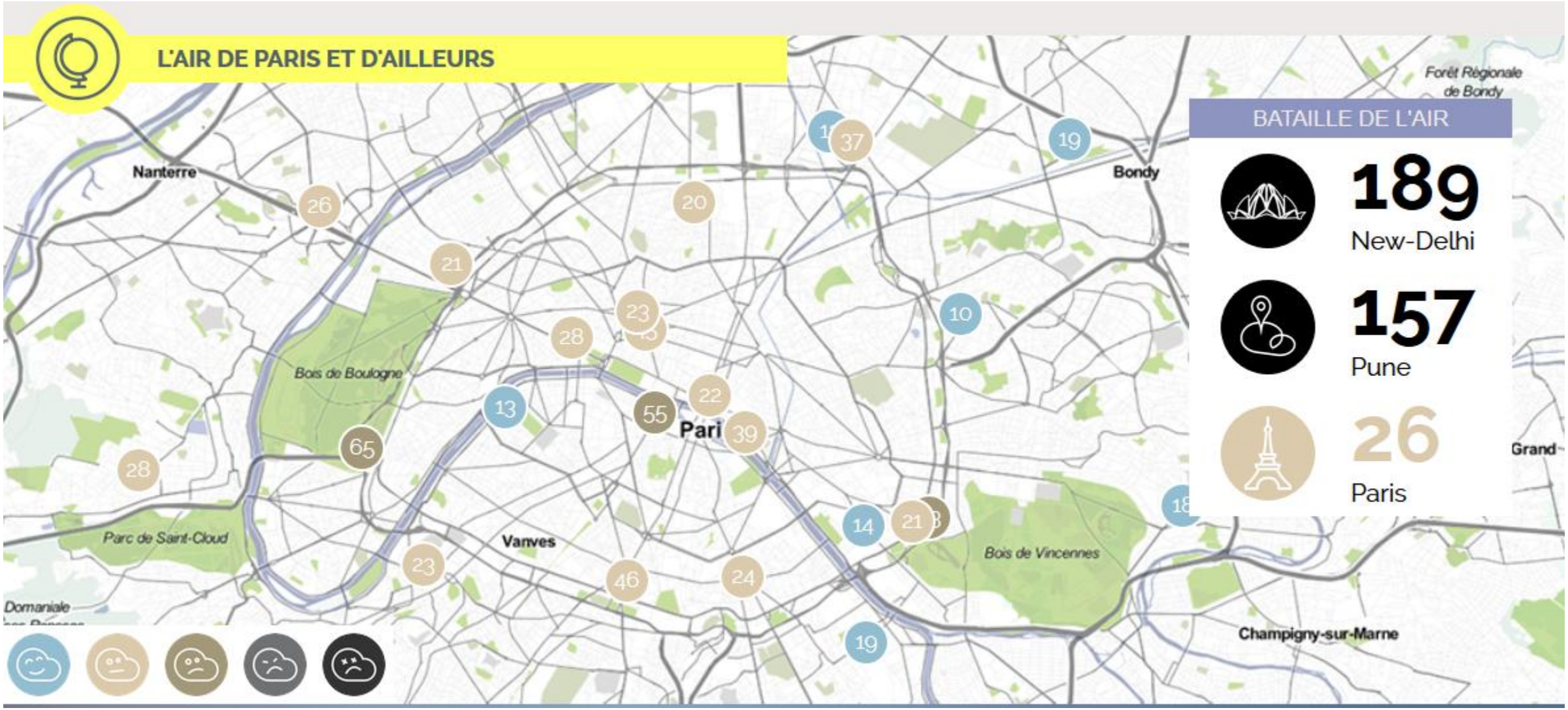
- Index ATMO
- Index PLUME avec prévision de l’évolution - https://air.plumelabs.com/Paris







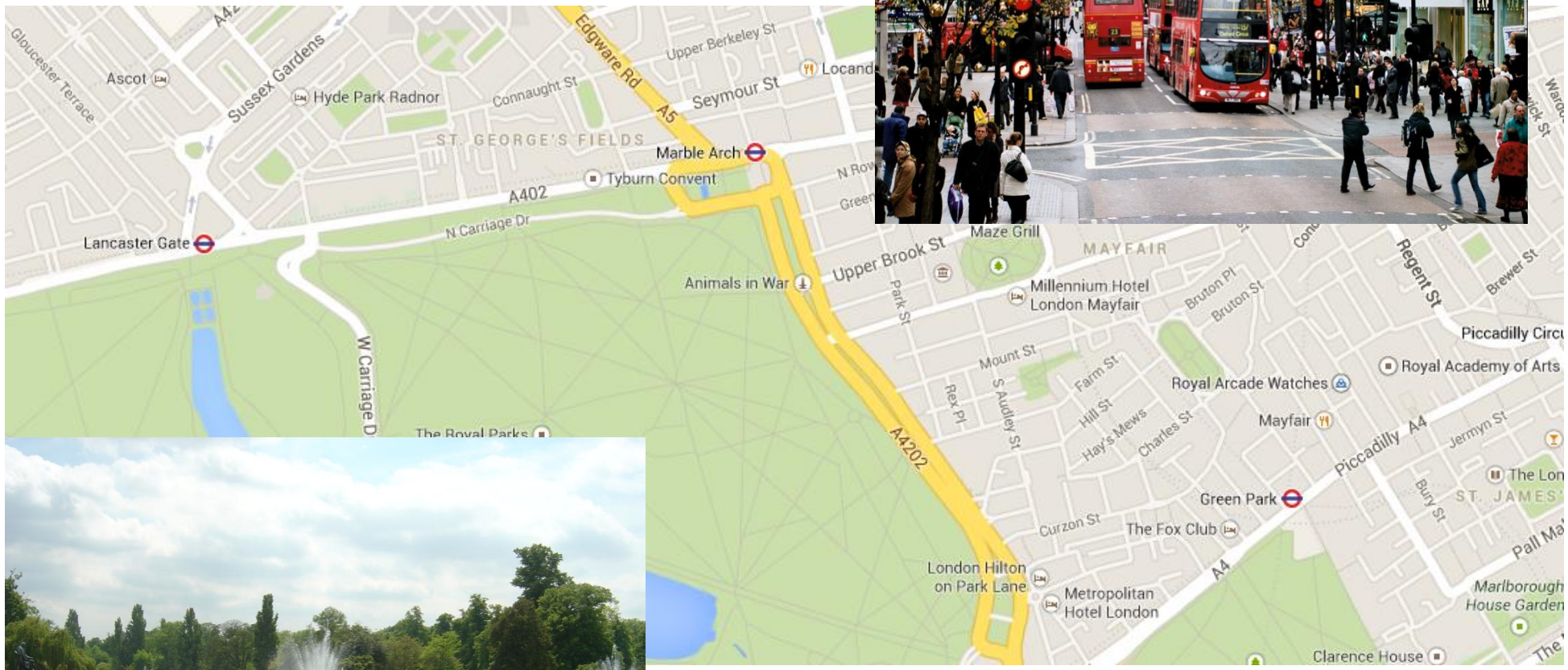
Limiter les expositions en évitant les lieux pollués



Expérience londonienne

- Comparaison des effets respiratoires d'une sortie de 2 heures à Oxford Street (section réservée bus et taxis) vs Hyde Park (interdit aux voitures) à 3 semaines d'intervalle
- 2 groupes d'asthmatiques légers(31) et modérés (29)
  - Mesure de la pollution
  - Mesure des effets respiratoires

McCreanor, J., et al., *Respiratory Effects of Exposure to Diesel Traffic in Persons with Asthma.* N Engl J Med, 2007. **357**(23): p. 2348-2358.


Gloucester Terrace
A42
Sussex Gardens
Ascot
Hyde Park Radnor
Edgware Rd
A5
Upper Berkeley St
Connaught St
Seymour St
ST. GEORGE'S FIELDS
Marble Arch
Tyburn Convent
A402
N Carriage Dr
Lancaster Gate
W Carriage D
The Royal Parks
Animals in War
Maze Grill
MAYFAIR
Upper Brook St
Park St
Millennium Hotel
London Mayfair
Bruton Pl
Bruton St
Regent St
Brewer St
Piccadilly Circu
Mount St
Rex Pl
S Audley St
Farm St
Hill St
Hay's Mews
Charles St
Royal Arcade Watches
Royal Academy of Arts
Mayfair
Piccadilly
A4
Jermyn St
A4202
Green Park
Curzon St
The Fox Club
Bury St
ST. JAMES'
Pall Ma
London Hilton
on Park Lane
Metropolitan
Hotel London
Marlborough
House Garden
Clarence House

Variable	Oxford Street	Hyde Park	P Value
Exposure			
Nitrogen dioxide in previous week ($\mu g/m^3$)			0.90
Median	23.5	22.3	
Range	1.46–135	0.49–61.6	
Temperature (°C)			0.04
Median	10.8	9.1	
Range	4–17.1	2.5–17.2	
Relative humidity (%)			0.03
Median	66	76	
Range	41.9–93.2	43.2–93.3	
$PM_{2.5}$ ($\mu g/m^3$)			<0.001
Median	28.3	11.9	
Range	13.9–76.1	3–55.9	
Ultrafine particles (thousands/cm^3)			<0.001
Median	63.7	18.3	
Range	39.5–92.4	10.3–37.1	
Elemental carbon ($\mu g/m^3$)			<0.001
Median	7.5	1.3	
Range	3.9–16	0.4–6.7	
Nitrogen dioxide ($\mu g/m^3$)			<0.001
Median	142	21.7	
Range	10.7–289	2.4–146	
PM_{10} ($\mu g/m^3$)†			0.03
Median	125	72	
Range	62–161	60–100	
Baseline lung function			
FEV_1	93.8±11.0	92.2±11.4	0.44
FVC	103.5±12.4	102.8±11.8	0.76
$FEF_{25–75}$	65.6±16.8	63.4±18.6	0.51

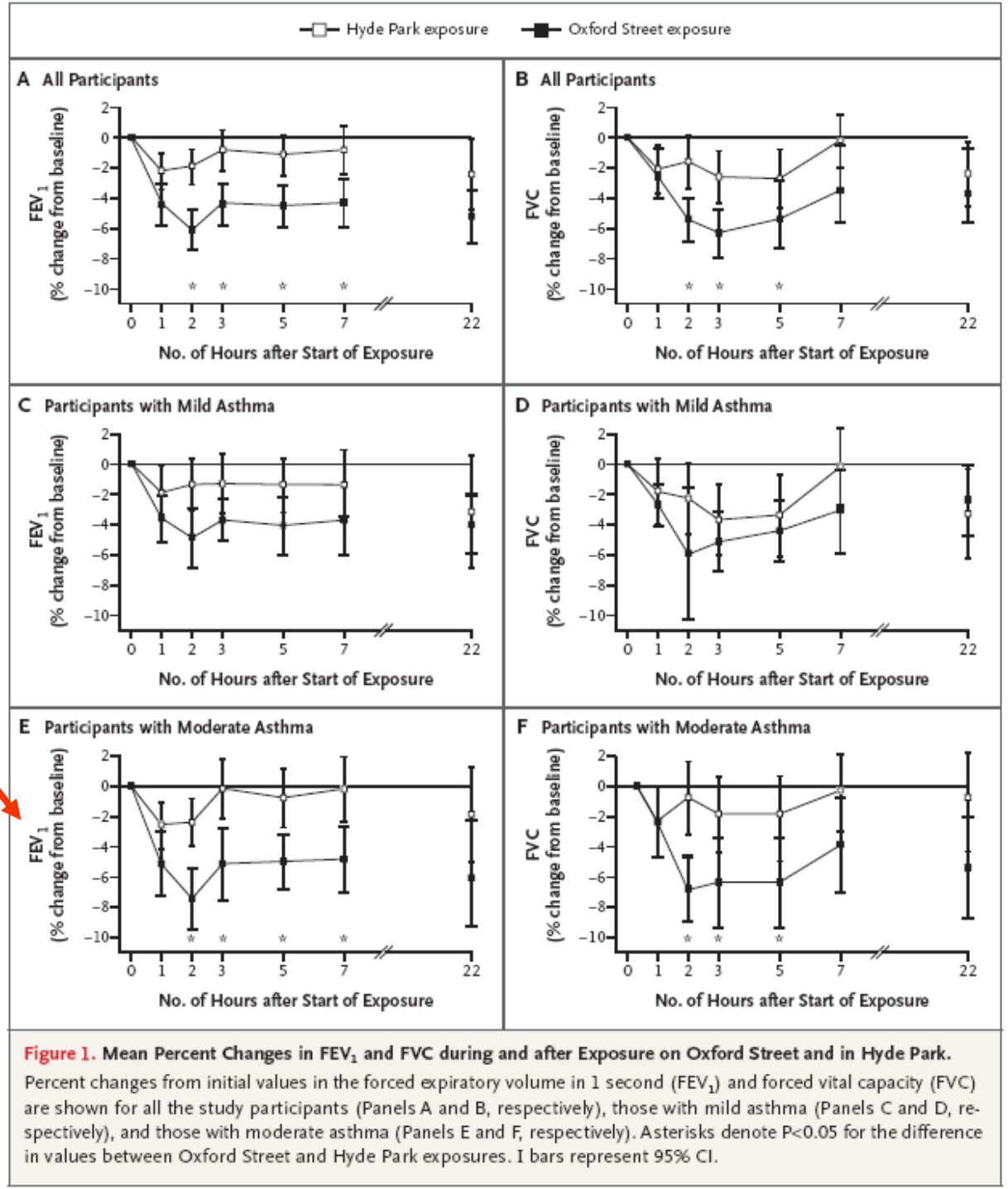


Figure 1. Mean Percent Changes in FEV_1 and FVC during and after Exposure on Oxford Street and in Hyde Park.

Percent changes from initial values in the forced expiratory volume in 1 second (FEV_1) and forced vital capacity (FVC) are shown for all the study participants (Panels A and B, respectively), those with mild asthma (Panels C and D, respectively), and those with moderate asthma (Panels E and F, respectively). Asterisks denote $P<0.05$ for the difference in values between Oxford Street and Hyde Park exposures. I bars represent 95% CI.

Effets fonctionnels
Effets inflammatoires

Limiter l’exposition en limitant les efforts

- Notamment dans les lieux pollués
- Eviter la fin de journée
- La bicyclette, le jogging exposent davantage

Tableau I.
Taux d’inhalation selon le mode de transport (litre/minutes).

	Voiture	Vélo	Marche	Transports en commun
Hommes	12,1	28,8	18,4	13,0
Femmes	9,6	22,8	14,6	10,3

Source : *Irmes*[20]

Prise correcte des traitements

- A visée respiratoire
  - Asthme
  - BPCO
- A visée cardiologique

Notamment dans les populations à risque

Voire majoration des traitements

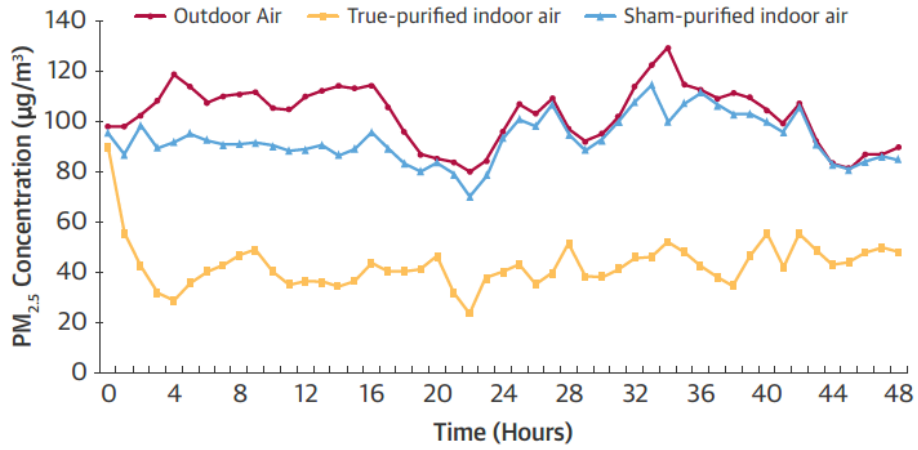
Purificateurs d'air HEPA ?

- Shanghai
- 35 sujets sains – étudiants – non fumeurs
- 10 dortoirs – 2 groupes de 5
- 2 WE (48h) à 2 semaines d'intervalle
- Randomisation en cross-over
- Purificateur d'air « FAP04, 3M Filtrete » avec ou sans filtre

Chen R, Zhao A, Chen H, Zhao Z, Cai J, Wang C, et al. Cardiopulmonary benefits of reducing indoor particles of outdoor origin: a randomized, double-blind crossover trial of air purifiers. J Am Coll Cardiol. 2 juin 2015;65(21):2279-87.

Purificateurs d'air HEP

FIGURE 1 Time-Varying $PM_{2.5}$ Concentration in Outdoor Air, Sham-Purified Indoor Air, and True-Purified Indoor Air



The hourly concentrations in sham-purified air and true-purified air are the arithmetic averages of measurements in all dormitory rooms for a group. The hourly concentrations in outdoor air were measured on the rooftop of 1 dormitory building. $PM_{2.5}$ = particulate matter <2.5 µm in aerodynamic diameter.

CENTRAL ILLUSTRATION Air Purifiers and Cardiopulmonary Benefits: Percent Change in $PM_{2.5}$ and Associated Cardiopulmonary Health Indicators Comparing the True-Purified Air Scenario to the Sham-Purified Air Scenario

Chen, R. et al. J Am Coll Cardiol. 2015; 65(21):2279-87.

Different colors represent different indicators of exposure and health: **green** = $PM_{2.5}$; **salmon** = blood inflammation; **gray** = blood coagulation; **blue** = vasoconstriction; **purple** = lung function; **yellow** = blood pressure; and **orange** = respiratory inflammation. ACE = angiotensin-converting enzyme; CD40L = CD40 ligand; CRP = C-reactive protein; FeNO = fractional exhaled nitric oxide; FEV_1 = forced expiratory volume in 1 s; FVC = forced vital capacity; MCP = monocyte chemoattractant protein; PAI = plasminogen activator inhibitor; PEF = peak expiratory flow; $PM_{2.5}$ = particulate matter <2.5 µm in aerodynamic diameter; TNF = tumor necrosis factor; t-PA = tissue plasminogen activator.

Chen R, Zhao A, Chen H, Zhao Z, Cai J, Wang C, et al. Cardiopulmonary benefits of reducing indoor particles of outdoor origin: a randomized, double-blind crossover trial of air purifiers. J Am Coll Cardiol. 2 juin 2015;65(21):2279-87.

Rôle de la climatisation ? à la maison

Table 1
Summary statistics for HRV indices, blood markers, and indoor air pollution levels and indoor climate conditions at 24-hour average before collecting blood samples and measuring heart rate variability among 300 study participants.

	First two visits (windows open) N = 600	Next two visits (windows closed) N = 600	Last two visits (air conditioners on) N = 600	ANOVA	
				p-Value	Scheffe's test
PM_{10}, $\mu g/m^3$					
Mean ± SD	41.0 ± 20.2	29.5 ± 14.0	20.4 ± 11.3	<0.05	1st/2nd; 1st/3rd; 2nd/3rd
IQR	26.7	20.1	14.2		
Range	7.8–99.4	7.2–85.2	6.5–75.3		
$PM_{2.5}$, $\mu g/m^3$					
Mean ± SD	25.5 ± 11.6	24.8 ± 10.4	14.3 ± 5.2	<0.05	1st/3rd; 2nd/3rd
IQR	15.8	15.4	8.9		
Range	9.5–80.5	8.4–72.0	5.5–42.0		
Total VOCs, ppb					
Mean ± SD	77.2 ± 27.3	68.6 ± 23.1	52.3 ± 20.4	<0.05	1st/3rd; 2nd/3rd
IQR	48.6	43.2	32.9		
Range	12.1–180.5	10.0–115.3	10.0–89.5		

Lin L-Y, Chuang H-C, Liu I-J, Chen H-W, Chuang K-J. Reducing indoor air pollution by air conditioning is associated with improvements in cardiovascular health among the general population. Sci Total Environ. 1 oct 2013;463-464:176-81.

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	First two visits (windows open) N = 600	Next two visits (windows closed) N = 600	Last two visits (air conditioners on) N = 600	ANOVA	
				p-Value	Scheffe's test
Log10 SDNN, msec					
Mean ± SD	1.48 ± 0.23	1.91 ± 0.19	1.96 ± 0.18	<0.05	1st/2nd; 1st/3rd
Range	0.69–2.09	0.78–2.55	0.82–2.66		
Log10 r-MSSD, msec					
Mean ± SD	0.98 ± 0.28	1.38 ± 0.22	1.41 ± 0.24	<0.05	1st/2nd; 1st/3rd
Range	0.40–1.82	0.42–1.96	0.46–2.10		
hs-CRP, mg/dl					
Mean ± SD	0.17 ± 0.05	0.14 ± 0.04	0.13 ± 0.01	0.12	-
Range	0.05–0.56	0.02–0.15	0.02–0.18		
8-OhdG, ng/ml					
Mean ± SD	2.8 ± 0.3	1.7 ± 0.3	0.8 ± 0.2	<0.05	1st/2nd; 1st/3rd; 2nd/3rd
Range	0.9–4.3	0.3–1.3	0.2–1.3		

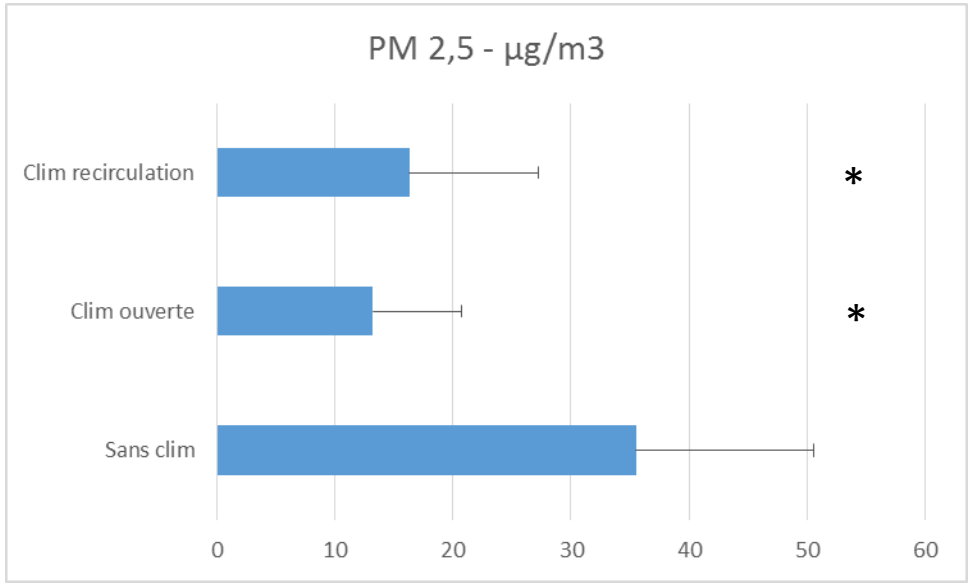
Lin L-Y, Chuang H-C, Liu I-J, Chen H-W, Chuang K-J. Reducing indoor air pollution by air conditioning is associated with improvements in cardiovascular health among the general population. Sci Total Environ. 1 oct 2013;463-464:176-81.

Rôle de la climatisation ? en voiture…

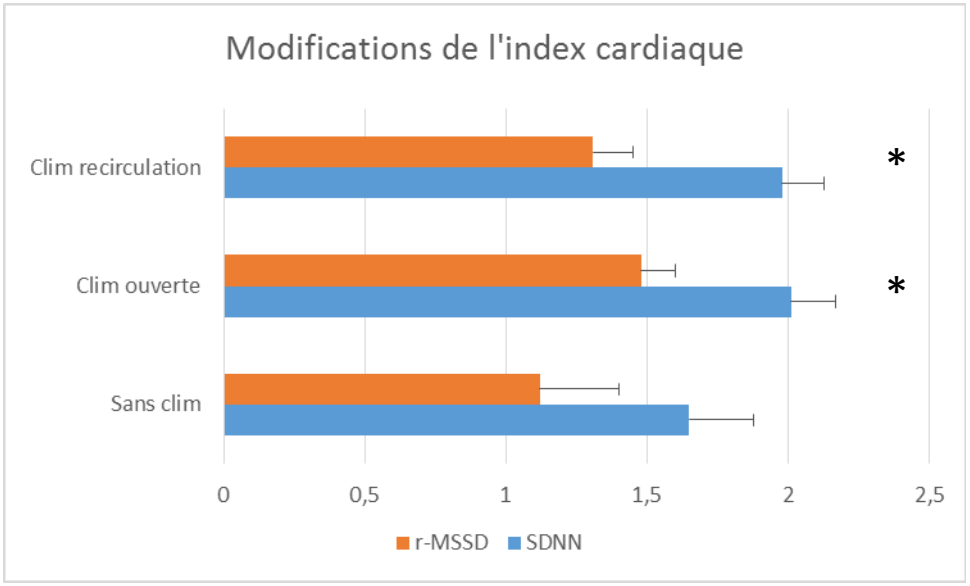
- 60 sujets en bonne santé entre 20 et 50 ans
- 3 mesures de 2 heures (Nov, Dec, Janv) dans la région de Taipei
- 3 conditions :
  - Fenêtres ouvertes sans climatisation
  - Climatisation ouverte
  - Climatisation avec recirculation d'air

Mesure continue de l'ECG, des PM 2,5, du bruit et de l'humidité

Calcul des index de variabilité du rythme cardiaque



* p < 0,05



Chuang H-C, Lin L-Y, Hsu Y-W, Ma C-M, Chuang K-J. In-car particles and cardiovascular health: an air conditioning-based intervention study. Sci Total Environ. 1 mai 2013;452-453:309-13.

Porter un masque ?

- Pas d'effet sur les gaz
- Peu d'effet sur les particules

- Pas d'étude sur les manifestations respiratoires et une étude sur les conséquences cardiologiques en milieu fortement pollué (Pékin) chez des sujets souffrant d'insuffisance coronarienne après une marche de 2 heures avec ou sans masque

Langrish JP, Li X, Wang S, Lee MMY, Barnes GD, Miller MR, et al. Reducing personal exposure to particulate air pollution improves cardiovascular health in patients with coronary heart disease. Environ Health Perspect. mars 2012;120(3):367-72.

Porter un masque ?

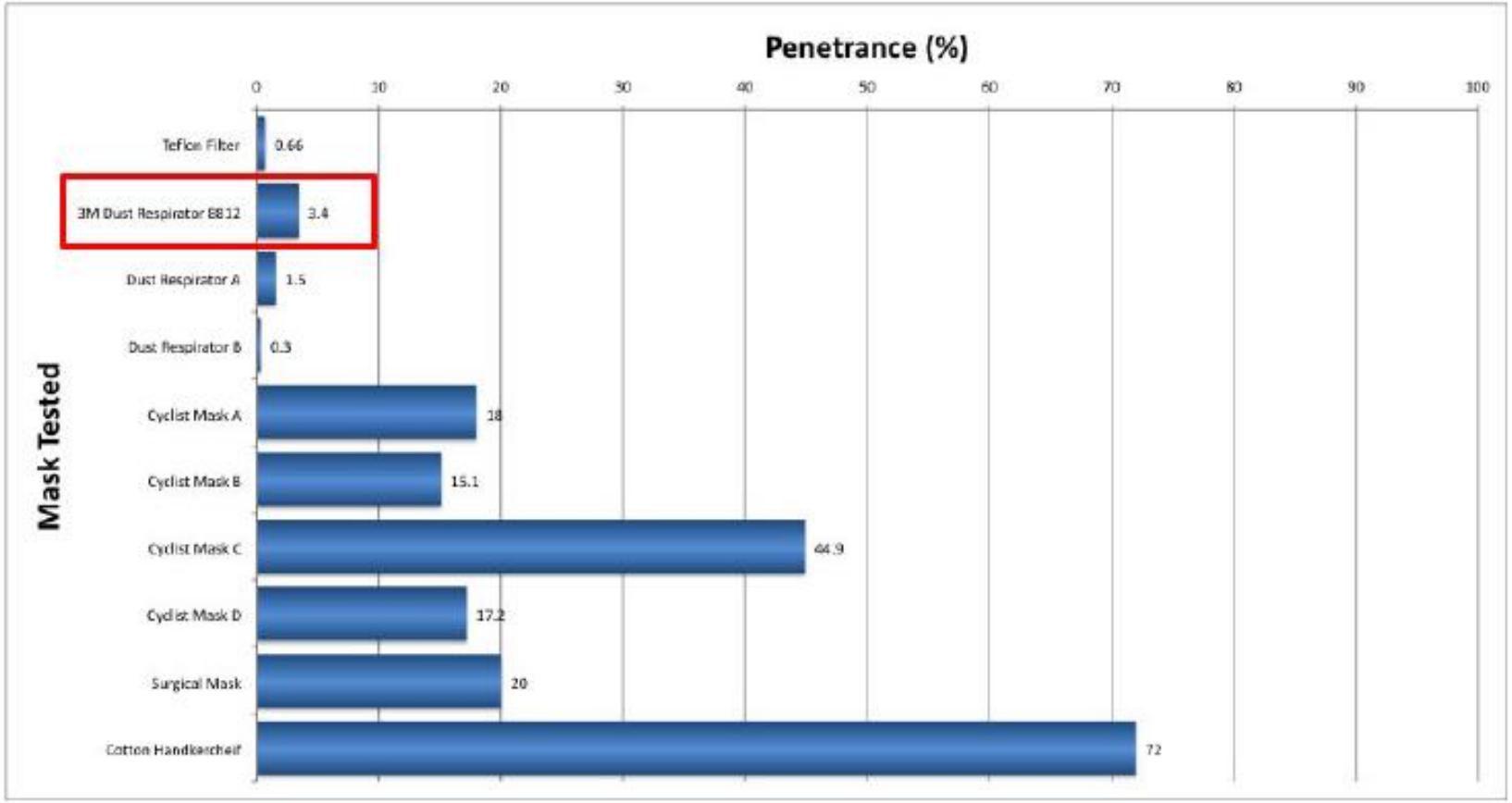


Figure 2
Penetrance of commercially available filters: 3 M Dust Respirator 8812, Dust Respirators A and B, Cyclist Masks A to D. The Teflon filter is an industry standard filter for aerosol studies included as a control. Cotton handkerchiefs and surgical masks are often seen worn in public areas in parts of Asia.

Langrish JP, Mills NL, Chan JK, Leseman DL, Aitken RJ, Fokkens PH, et al. Beneficial cardiovascular effects of reducing exposure to particulate air pollution with a simple facemask. Part Fibre Toxicol. 2009;6:8.

Effet sur les symptômes

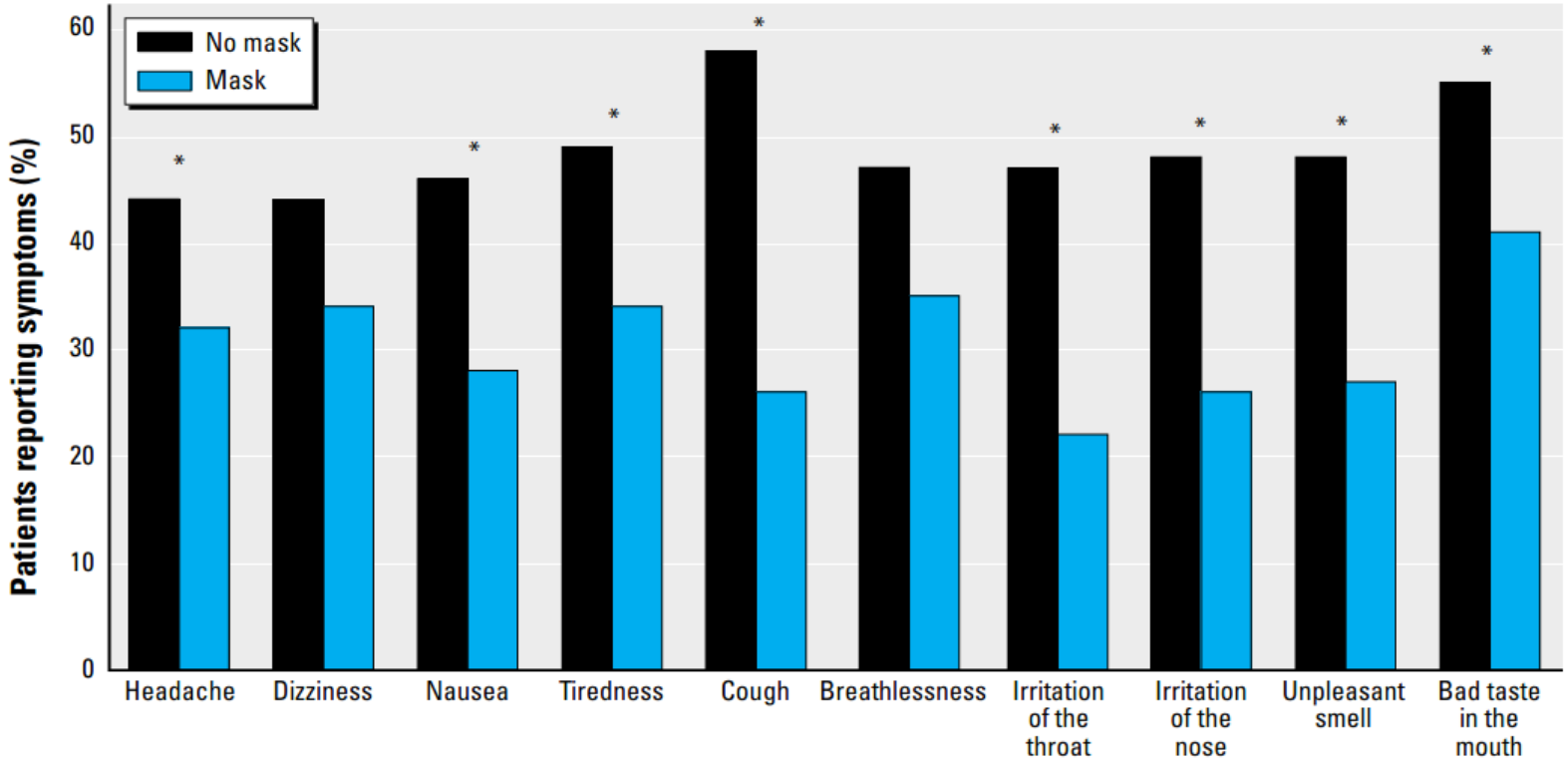


Figure 1. Self-reported symptoms of well-being in the presence or absence of the face mask.
*$p < 0.05$.

Langrish JP, Li X, Wang S, Lee MMY, Barnes GD, Miller MR, et al. Reducing personal exposure to particulate air pollution improves cardiovascular health in patients with coronary heart disease. Environ Health Perspect. mars 2012;120(3):367-72.

Table 3. Ambulatory blood pressure, heart rate variability during the 2-hr city center walk and the 24-hr study period, and myocardial ischemia measured as ischemic burden, in each individual territory and as a composite according to face mask use.

	Walk		24 hr	
Parameter	Mask	No mask	Mask	No mask
Systolic blood pressure (mmHg)	126.9 ± 15.9	128.1 ± 16.5	121.2 ± 11.9	120.8 ± 12.4
Diastolic blood pressure (mmHg)	78.0 ± 9.3	79.5 ± 8.6	73.8 ± 7.2	74.0 ± 7.3
Mean arterial pressure (mmHg)	93.3 ± 9.7*	95.7 ± 10.0	89.8 ± 7.5	90.0 ± 7.9
Heart rate (bpm)	81.5 ± 8.7	81.5 ± 10.1	77.6 ± 11.3	76.7 ± 11.1
LF power ($msec^2$)	133 (68–97)	136 (52–227)	81 (40–172)	93 (46–208)
HF power ($msec^2$)	54 (27–108)*	40 (20–69)	27 (11–77)	31 (11–68)
LFn (msec)	58.4 (45.6–69.1)*	62.9 (51.1–75.5)	67.2 (55.5–78.0)	71.1 (59.4–81.1)
HFn (msec)	23.5 (18.0–32.4)*	20.5 (13.5–27.9)	21.4 (15.0–31.6)	20.9 (12.7–30.1)
HF:LF ratio	0.418 (0.258–0.712)	0.328 (0.207–0.573)	0.301 (0.190–0.554)	0.306 (0.161–0.492)
pNN50 (%)	1.2 (0.2–2.8)	0.7 (0.0–2.3)	0.5 (0.0–3.1)	0.6 (0.0–2.6)
RMSSD (msec)	16.7 (13.2–22.5)*	14.8 (10.9–19.6)	15.5 (11.0–22.6)	14.4 (10.3–20.3)
SDNN (msec)	59.8 (46.4–79.1)	60.1 (41.0–79.3)	45.6 (30.8–70.4)	48.2 (30.0–66.3)
Ischemic burden (mV-sec)				
Inferior (II) territory	–66 (–118 to –26)	–52 (–149 to –21)	–641 (–767 to –504)	–615 (–820 to –473)
Anterior (V2) territory	–66 (–142 to –16)	–50 (–124 to –13)	–597 (–859 to –435)	–632 (–905 to –489)
Lateral (V5) territory	–37 (–104 to –8)	–43 (–85 to –18)	–604 (–811 to –429)	–586 (–790 to –412)
Sum (II + V2 + V5)	–189 (–382 to –90)	–188 (–340 to –112)	–1,930 (–2,306 to –1,541)	–1,934 (–2,391 to –1,575)

Abbreviations: LFn, low frequency–normalized; pNN50, percentage of successive RR intervals that differ by > 50 msec; SDNN, standard deviation of RR intervals. Data are mean ± SD, or median (interquartile range). LFn and HFn are normalized units to account for variation in the total power and very low-frequency components. LF and SDNN reflect mainly sympathetic nervous stimulation; HF, pNN50, and RMSSD reflect parasympathetic tone.

*$p < 0.05$ from Wilcoxon matched pairs signed rank test or Student's paired *t*-tests as appropriate, mask versus no mask.

Langrish JP, Li X, Wang S, Lee MMY, Barnes GD, Miller MR, et al. Reducing personal exposure to particulate air pollution improves cardiovascular health in patients with coronary heart disease. Environ Health Perspect. mars 2012;120(3):367-72.

Connaitre son profil personnel d’exposition

- Au travail
- Dans la rue
- A la maison

et adapter son comportement et son traitement selon les nuisances auxquelles on peut s’attendre…

= intérêt de capteurs individuels (en cours de développement)

Conclusion

- S’informer
- Eviter les zones polluées
- Prendre correctement son traitement
- Pas de réponse univoque sur :
  - Épurateur d’air
  - Climatisation
  - Masque