何鴻燊博士醫療拓展基金會
Dr. Stanley Ho Medical Development Foundation

香港中文大學醫學院
Faculty of Medicine
The Chinese University of Hong Kong

Air Pollution and Heath

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Outline

- Why are we concerned with air pollution?
- What is the air quality today?
- What are the air pollutants of concern?
- How is our health being affected by air pollutants?
- The new Air Quality Health Index (AQHI)
- Cooking fumes and lung cancer among Chinese females
- How are we going to reduce the harmful effects of air pollution on our health?

Why are we concerned with air pollution?

Whoever wishes to investigate medicine properly should proceed thus: in the first place to consider the seasons of the year, and what effects each of them produces.

Then the winds, the hot and the cold, especially such as are common to all countries, and then such as are peculiar to each locality.

Why are we concerned with air pollution?

In the same manner, when one comes into a city to which he is a stranger, he should consider its situation, how it lies as to the winds and the rising of the sun; for its influence is not the same whether it lies to the north or the south, to the rising or to the setting sun.

One should consider most attentively the water which the inhabitants use, ….

Why are we concerned with air pollution?

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One should consider most attentively the water which the inhabitants use, ….

Hippocrates : 'On Airs, Waters and Places' 4 BC

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We Inhale a Huge Amount of Air Everyday

Table 3.1. Recommended Point Estimates for Long-Term Daily Breathing Rates

	3rd Trimester	0<2 years	2<9 years	2<16 years	16<30 years	16<70 years
	L/kg-day					
Mean	225	658	535	452	210	185
95th Percentile	361	1090	861	745	335	290
	m^3/day					
Mean	15.3	6.2	10.7	13.3	15.0	13.9
95th Percentile	23.4	11.2	16.4	22.6	23.5	22.9

OEHHA calculated mean and high end breathing rates for the third trimester assuming the dose to the fetus during the third trimester was the same as that to the mother.

The surface area of alveoli in an adult can reach the size of half a tennis court

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What is the air quality today?

地球物理暨氣象局
Direcção dos Serviços Meteorológicos e Geofísicos

空氣質量指數日報

2014-10-16(星期四) 錄得之空氣質量指數

監測站	澳門空氣質量指數	空氣質量	
路邊	119 污染物 : PM2.5	不良	
澳門高密度住宅區	106 污染物 : PM2.5	不良	
氹仔高密度住宅區	112 污染物 : O3	不良	
氹仔一般性	110 污染物 : PM2.5	不良	
路環一般性	----	----	----

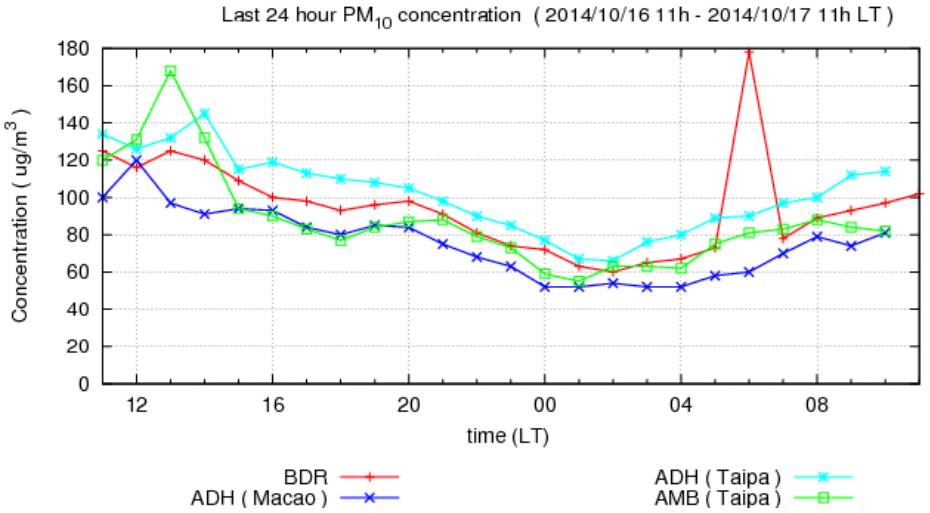
更新時間: 2014-10-16 16:57:51

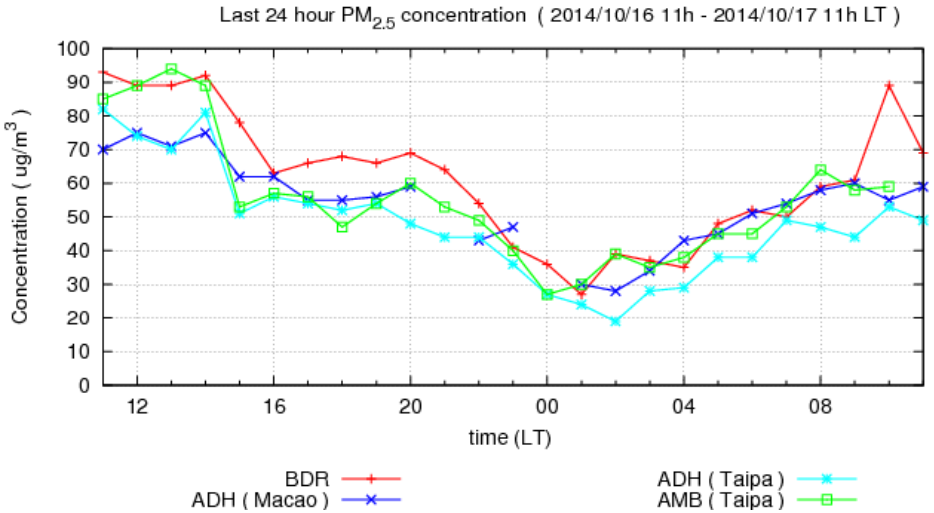
預測 2014-10-17(星期五) 之空氣質量指數

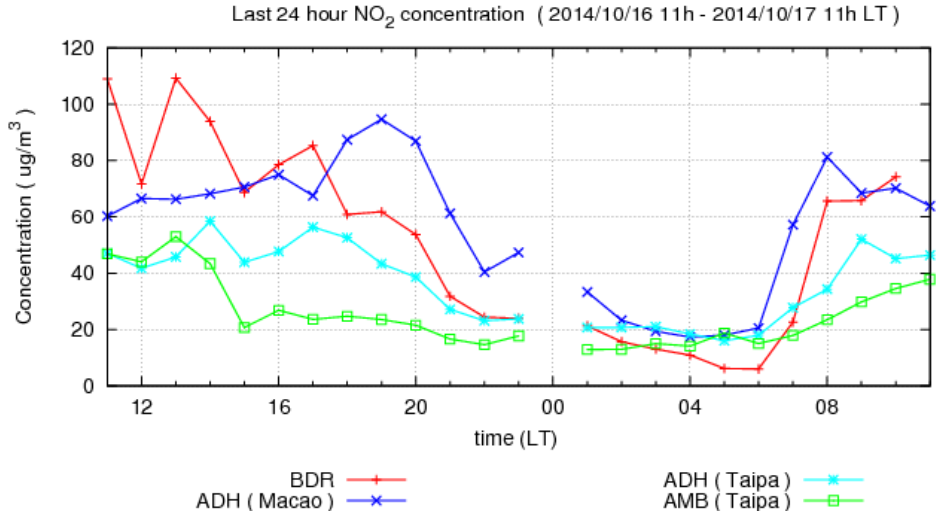
監測站	澳門空氣質量指數	空氣質量	
路邊	65 - 95	普通	
高密度住宅區	70 - 100	普通	
一般性	70 - 100	普通	

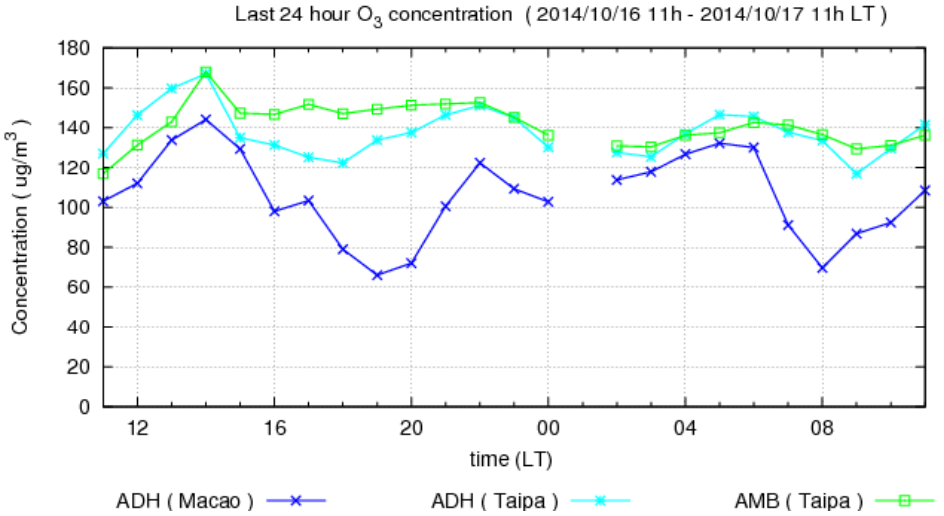
更新時間: 2014-10-17 06:44:27

http://www.smg.gov.mo/www/ccaa/iqa/daily/fe_iqa_index_latest.htm









http://www.smg.gov.mo/www/ccaa/hpolu/e_hpolu_conc.htm

Air Quality Index（AQI)
HK Air Pollution Index (API)[before 31/12/2013]

- **Sub-indices** of individual criteria air pollutants: 0 to 500
- Nitrogen dioxide (**NO_2**), sulphur dioxide (**SO_2**), ozone (**O_3**), carbon monoxide (**CO**), particulate matters (**PM_{10}**)
- A sub-index level of 100 corresponds to the short-term Hong Kong Air Quality Objectives (HKAQO) below which there is no adverse acute health effect to human while a level of 500 corresponds to significant harm to human health.
- API is subsequently calculated for each air quality monitoring station by taking the maximum of the sub-indices among all the parameters measured at that station to indicate the overall pollution level.

The API reveals five broad levels of air pollution and how they can affect you

Air Pollution Level	API Readings	Air Quality Status
Low	0-25	Air quality is well within acceptable standards, with no cause for concern.
Medium	26-50	Air quality is still within acceptable standards
High	51-100	Air quality is within the short term standard but is worse than the long term standard
Very High	101-200	Air quality is worse than both the short and long term standards
Severe	201-500	Air quality is significantly worse than both the short term and long term standards

- For high level of pollution, there is no immediate concern but long-term effects are possible with persistent exposure.
- Very high and severe pollution levels can mildly or significantly aggravate the symptoms to people with heart or reparatory illness. Healthy people may experience irritation to the eyes, wheezing, coughing and sore throats.

What are the air pollutants of concern?

- **Chemical hazards**
- **Biological hazards**
  - Bioaerosols
    - Infections [e.g. Legionnaire's Disease, TB, SARS]
    - Hypersensitivity/allergic reactions [hay fever, asthma]
- **Physical hazards**
  - Radioactive isotopes
    - Radon daughters [indoor]
    - Iodine 131 [Chernobyl]
    - Cesium 137 [Fukushima]

Common Chemical Pollutants

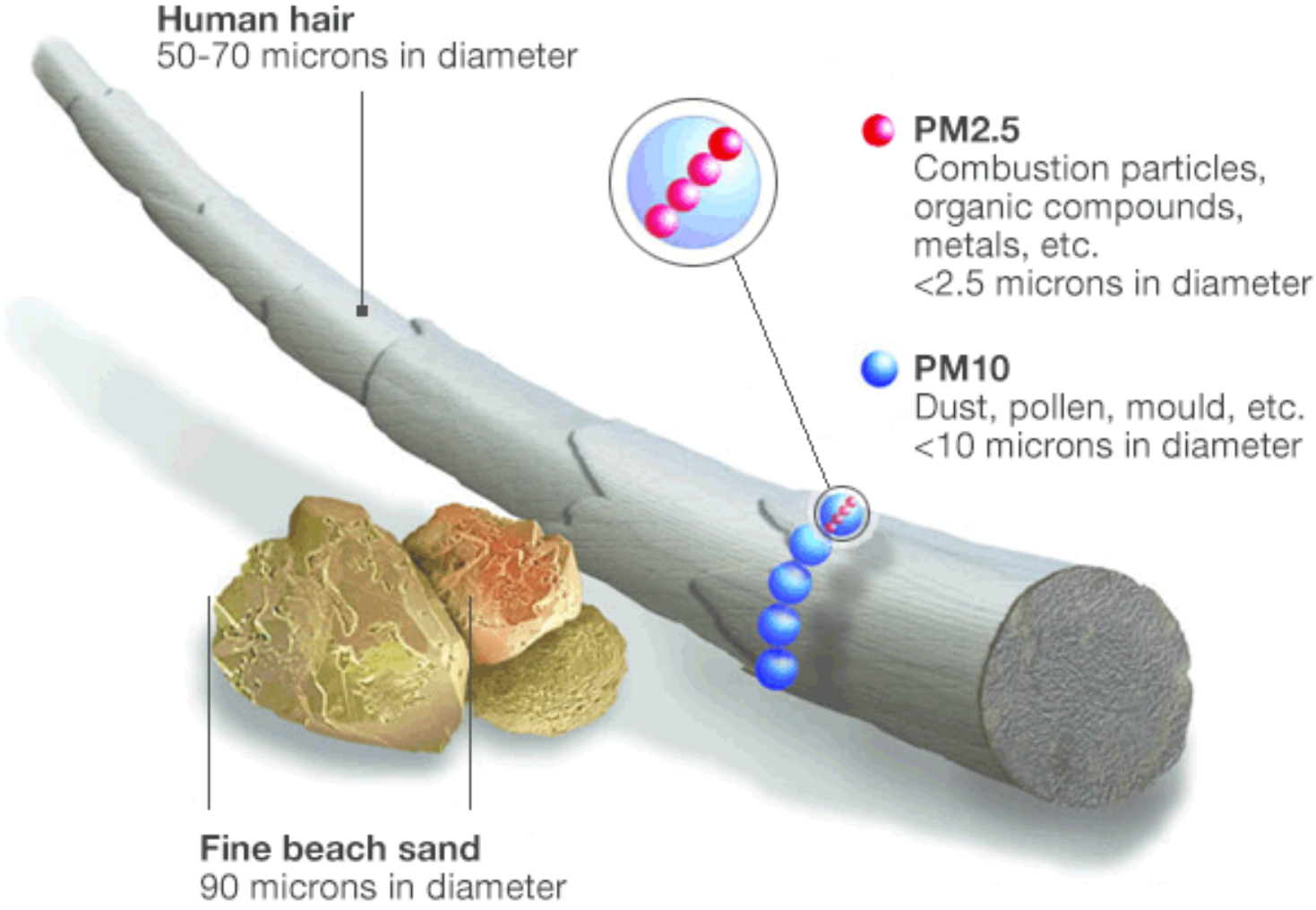
Major (criteria) pollutants

- Nitrogen oxides [NO_x – NO, NO_2]
- Sulfur dioxide [SO_2]
- Photochemical oxidants (e.G. Ozone [O_3])
- Carbon monoxide [CO]
- Suspended particles [RSP/PM_{10}, $PM_{2.5}$ ...UFP]

Common Chemical Pollutants

Other chemical pollutants

- Volatile organic compounds (VOCs)
- Polyaromatic hydrocarbons (PAHs)
- Polychlorinated biphenyls (PCBs) and dioxins
- Metals
- Asbestos



Source: US EPA

How is our health being affected by air pollutants?

- Short term effects
  - Mortality [*the straw that broke the camel's back*]
  - Emergency hospital admissions
  - General practitioner consultations
- Long term effects
  - Cancers
  - Cardiovascular diseases
  - Respiratory diseases
  - Others
- Ambient air pollution
- Indoor air pollution –home, school, workplace

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Developing the Air Quality Health Index

Air Quality Health Index (AQHI)

- A risk-based, multi-pollutant air quality health index replacing the Air Pollution Index (API)
- Based on excess risks estimated from local time series analyses of emergency hospital admissions for respiratory and cardiovascular diseases
- Assumption of additive joint effects
- 3-hourly moving averages for pollutant levels to give more timely estimation of health effects

Developing a risk-based air quality health index

Tze Wai Wong [a,*], Wilson Wai San Tam [a], Ignatius Tak Sun Yu [a], Alexis Kai Hon Lau [b], Sik Wing Pang [c], Andromeda H.S. Wong [a]

Atmospheric Environment 76 (2013) 52–58

Table 1
Relative risk of hospital admissions for cardiovascular and respiratory diseases per 10 μg m^{-3} increase in air pollutant concentrations.

RR (95% CI) per 10 μg m^{-3} increase in air pollutant concentration (single pollutant model)				
Emergency hospital admissions	NO_2	O_3	PM_{10}	SO_2
Cardiovascular and respiratory (all ages)	1.0045[d] (1.0044–1.0046) (lag day 0)	1.0051[d] (1.0050–1.0052) (lag day 1)	1.0028[d] (1.0027–1.0029) (lag day 0)	1.0014[b] (1.0013–1.0015) (lag day 0)
Cardiovascular and respiratory (≥65 years)[a]	1.0051[d] (1.0039–1.0063) (lag day 0)	1.0057[d] (1.0045–1.0069) (lag day 1)	1.0033[d] (1.0028–1.0044) (lag day 0)	1.0017[b] (1.0003–1.0030) (lag day 0)
Cardiovascular and respiratory (<5 years)	1.0034[c] (1.0032–1.0037) (lag day 2)	1.0074[d] (1.0072–1.0077) (lag day 0)	1.0025[b] (1.0003–1.0048) (lag day 2)	1.0019 (NS) (0.9991–1.0046) (lag day 1)

[a]The ≥65 years age group constituted about 80% of all respiratory and cardiovascular admissions; [b]$p < 0.05$, [c]$p < 0.001$, [d]$p < 0.0001$; NS = not significant at $p = 0.05$.

Developing a risk-based air quality health index

Tze Wai Wong [a,*], Wilson Wai San Tam [a], Ignatius Tak Sun Yu [a], Alexis Kai Hon Lau [b], Sik Wing Pang [c], Andromeda H.S. Wong [a]

Table 2
Distribution of percentage excess risk (%ER) of hospital admissions for cardiovascular and respiratory diseases by health risk category and AQHI band.

Recommended health risk category	AQHI band	%ER	No. of days	Frequency (%)
Low	1	0–1.88	0	0.0
	2	>1.88–3.76	36	2.0
	3	>3.76–5.64	333	18.2
Moderate	4	>5.64–7.52	277	15.2
	5	>7.52–9.41	339	18.6
	6	>9.41–11.29	306	16.8
High	7	>11.29–12.91	194	10.6
Very high	8	>12.91–15.07	172	9.4
	9	>15.07–17.22	93	5.1
	10	>17.22–19.37	27	1.5
Serious	10+	>19.37	49	2.7
Total			1826	100.00

Air Quality Health Index (AQHI)

- 11 bands (Band 1-10 and 10+) grouped into 5 categories (Low, Moderate, High, Very High, Serious)
- Health warning messages
- In use since 30 December 2013

EPD: http://www.aqhi.gov.hk/

HKUST-CUHK: http://envf.ust.hk/dataview/aqhi

健康風險級別	提示標籤	空氣質素健康指數	易受空氣污染影響的人士		戶外工作僱員*	一般市民
			心臟病或呼吸系統疾病患者#	兒童及長者		
低		1	建議可如常活動。	建議可如常活動。	建議可如常活動。	建議可如常活動。
		2				
		3				
中		4	建議一般可如常活動，但個別出現症狀的人士應**考慮減少**戶外體力消耗。	建議可如常活動。	建議可如常活動。	建議可如常活動。
		5				
		6				
高		7	心臟病或呼吸系統疾病患者應**減少**戶外體力消耗，以及**減少**在戶外逗留的時間，特別在交通繁忙地方。 這類人士在參與體育活動前應諮詢醫生意見，在體能活動期間應多作歇息。	兒童及長者應**減少**戶外體力消耗，以及**減少**在戶外逗留的時間，特別在交通繁忙地方。	建議可如常活動。	建議可如常活動。
甚高		8	心臟病或呼吸系統疾病患者應**盡量減少**戶外體力消耗，以及**盡量減少**在戶外逗留的時間，特別在交通繁忙地方。	兒童及長者應**盡量減少**戶外體力消耗，以及**盡量減少**在戶外逗留的時間，特別在交通繁忙地方。	從事重體力勞動的戶外工作僱員的僱主應評估戶外工作的風險，並採取適當的預防措施保障僱員的健康，例如**減少**戶外體力消耗，以及**減少**在戶外逗留的時間，特別在交通繁忙地方。	一般市民應**減少**戶外體力消耗，以及**減少**在戶外逗留的時間，特別在交通繁忙地方。
		9				
		10				
嚴重		10+	心臟病或呼吸系統疾病患者應**避免**戶外體力消耗，以及**避免**在戶外逗留，特別在交通繁忙地方。	兒童及長者應**避免**戶外體力消耗，以及**避免**在戶外逗留，特別在交通繁忙地方。	所有戶外工作僱員的僱主應評估戶外工作的風險，並採取適當的預防措施保障僱員的健康，例如**減少**戶外體力消耗，以及**減少**在戶外逗留的時間，特別在交通繁忙地方。	一般市民應**盡量減少**戶外體力消耗，以及**盡量減少**在戶外逗留的時間，特別在交通繁忙地方。

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Cooking Fumes and Female Lung Cancer

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Research Article

Dose-Response Relationship between Cooking Fumes Exposures and Lung Cancer among Chinese Nonsmoking Women

Ignatius T.S. Yu,[1] Yuk-lan Chiu,[1] Joseph S.K. Au,[2] Tze-wai Wong,[1] and Jin-ling Tang[1]

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Cancer Res 2006; 66: (9). May 1, 2006

Table 3. ORs for lung cancer related to total cooking dish-years after adjusting for potential confounding factors

Total dish-years	Adjusted OR (95% CI)			
	Model 1	Model 2	Model 3	Model 4
≤50	1	1	1	1
51-100	1.31 (0.81-2.11)	1.43 (0.87-2.34)	1.23 (0.73-2.07)	1.31 (0.73-2.33)
101-150	2.80 (1.52-5.18)	2.65 (1.42-4.97)	2.89 (1.47-5.70)	4.12 (1.90-8.94)
151-200	3.09 (1.41-6.79)	3.10 (1.37-7)	3.63 (1.57-8.40)	4.68 (1.80-12.18)
>200	8.09 (2.57-25.45)	10.02 (3.21-31.26)	20.66 (5.26-81.11)	34 (7.16-161.39)

NOTE: Model 1: adjusting for *age*, education, employment status, previous lung diseases, and *history of lung cancer in first-degree relatives*; Model 2: adjusting for age, radon exposure index, ETS exposure, kerosene use, firewood use, incense burning, and mosquito coil use; Model 3: adjusting for *age*, intakes of *dark green vegetables, yellow orange vegetables, meat*, citrus fruit, salted fish, pickled vegetables and *multivitamin*, and *coffee* and tea drinking; Model 4: adjusting for all the above potential confounding factors with statistical significance for *history of lung cancer in first-degree relatives, dark green vegetables, yellow orange vegetables, meat, multivitamin*, and *coffee* (italicized variables were significant at 0.05 level in the respective models).

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The roles of smoking and cooking emissions in lung cancer risk among Chinese women in Hong Kong

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Received 17 March 2008; revised 4 October 2008; accepted 8 October 2008

Table 3. Effects of exposure to cooking emissions on lung cancer in smokers and nonsmokers

Total dish-years	Nonsmokers (n = 505)[a]		Smokers (n = 96)[b]	
	Case/ control	OR (95% CI)[c]	Case/ control	OR (95% CI)
≤50	66/125	1.0	21/9	6.29 (2.46, 16.09)
51–100	65/104	1.18 (0.73, 1.92)	18/8	4.72 (1.75, 12.69)
101–150	38/38	2.73 (1.45, 5.11)	8/7	1.69 (0.52, 5.50)
>150	39/24	4.16 (2.06, 8.41)	13/6	5.19 (1.64, 16.40)

[a]Five missing data in cases and one in controls.
[b]Six missing data in cases.
[c]ORs were adjusted for employment, age, education, yellow/orange vegetables, multivitamin, radon index, and family history of any cancer, (and pack-year in smokers).
OR, odds ratio; CI, confidence interval.

Table 4. ORs (95% CI) for cell types of lung cancer in relation to cooking emission exposure and smoking[a]

	Adenocarcinoma versus control (n = 174 versus 322)	Nonadenocarcinoma[b] versus control (n = 43 versus 322)
Smoking[c]		
Never smoking	1.0	1.0
Ever smoking	1.86 (0.98, 3.50)	14.13 (5.32, 37.51)
Pack-year[c]		
Never smoking	1.0	1.0
<25	1.39 (0.61, 3.13)	8.36 (2.53, 27.62)
≥25	2.59 (1.00, 6.69)	23.62 (6.58, 84.78)
Total dish-years[d]		
≤50	1.0	1.0
51–100	0.98 (0.58, 1.63)	1.47 (0.53, 4.06)
101–150	1.91 (1.00, 3.65)	2.81 (0.77, 10.30)
>150	3.23 (1.61, 6.47)	3.98 (0.92, 17.27)

[a]Total dish-years, smoking, and pack-years were estimated in separate models, with exclusion of unspecified types (n = 62).
[b]Nonadenocarcinoma includes small cell, squamous cell and large cell.
[c]Adjustment for total dish-years (as continuous variable), employment, age, education, yellow/orange vegetables, multivitamin, radon index, and family history of any cancer.
[d]Adjustment for smoking status, employment, age, education, yellow/orange vegetables, multivitamin, radon index, and family history of any cancer.

Table 4 Population-attributable fraction[a] of lung cancer associated with risk factors

Risk factors	Population-attributable fraction (95% CI)[b]	
	All subjects	Nonsmoking subjects
Total dish-years[c]	26.5 (12.4, 36.4)	34.9 (22.3, 43.5)
Smoking	15.8 (7.2, 26.9)	–
Residential radon	22.5 (3.5, 36.1)	21.6 (0, 36.4)
Low vegetable intake	29.9 (8.8, 44.2)	30.7 (8.6, 45.2)
Family cancer history	15.8 (6.4, 27.1)	16.0 (5.8, 28.3)

[a] Adjusted for age, years of education, occupations, and intake of total fruit. In addition, total dish-years, smoking, family cancer history, radon index, and vegetables were adjusted each other. The least exposed (total dish-years, residential radon, low vegetable intake) and no exposed (smoking, family cancer history) were reference groups

[b] 95% confidence interval

[c] One dish-year means cooking one stir-fried dish daily for a year

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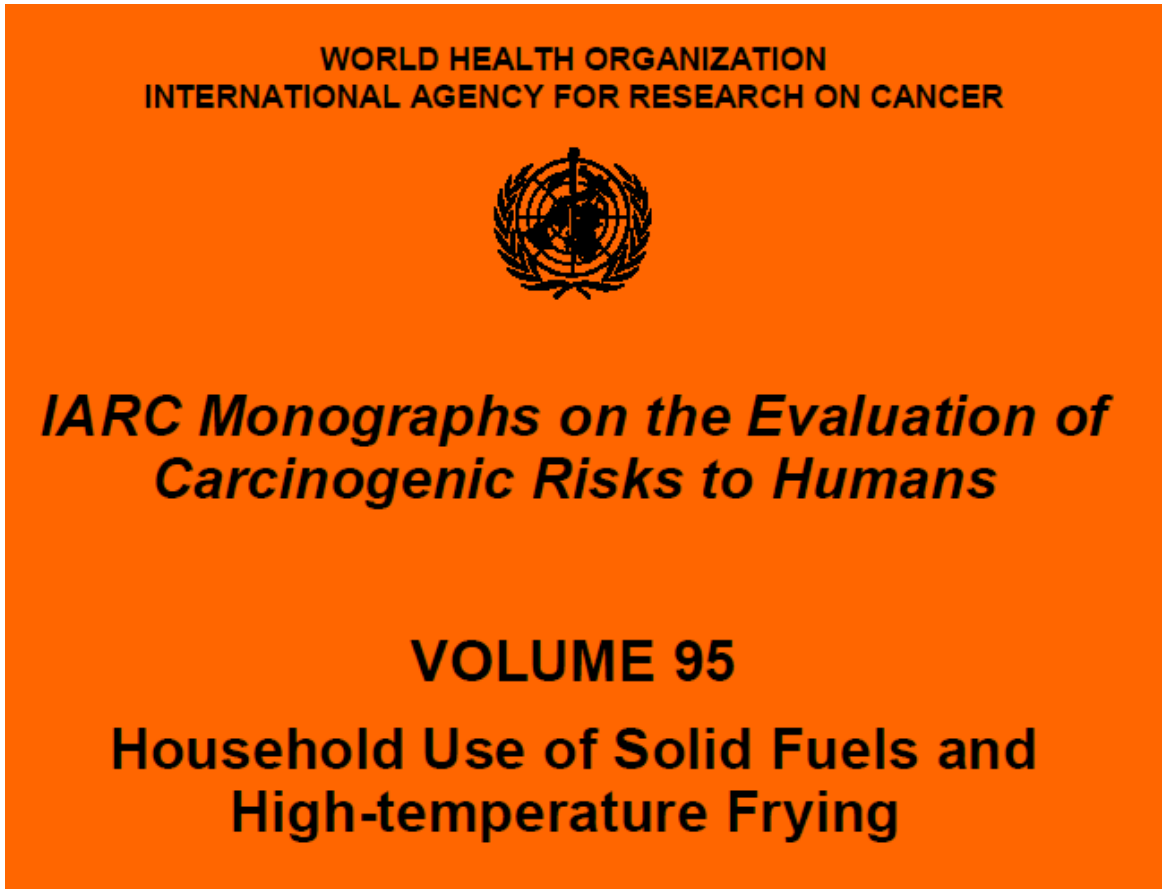
Carcinogenicity of household solid fuel combustion and of high-temperature frying

Kurt Straif, Robert Baan, Yann Grosse, Béatrice Secretan, Fatiha El Ghissassi, Vincent Cogliano, on behalf of the WHO International Agency for Research on Cancer Monograph Working Group

http://oncology.thelancet.com **Vol 7 December 2006**

In October, 2006, 19 scientists from eight countries met at the International Agency for Research on Cancer (IARC) in Lyon, France, to assess the carcinogenicity of household solid fuel combustion (coal and biomass) and of **high-temperature frying**....

On the basis of limited evidence in humans and sufficient evidence in experimental animals, the Working Group concluded that emissions from high-temperature frying are "probably carcinogenic to humans (Group 2A)".



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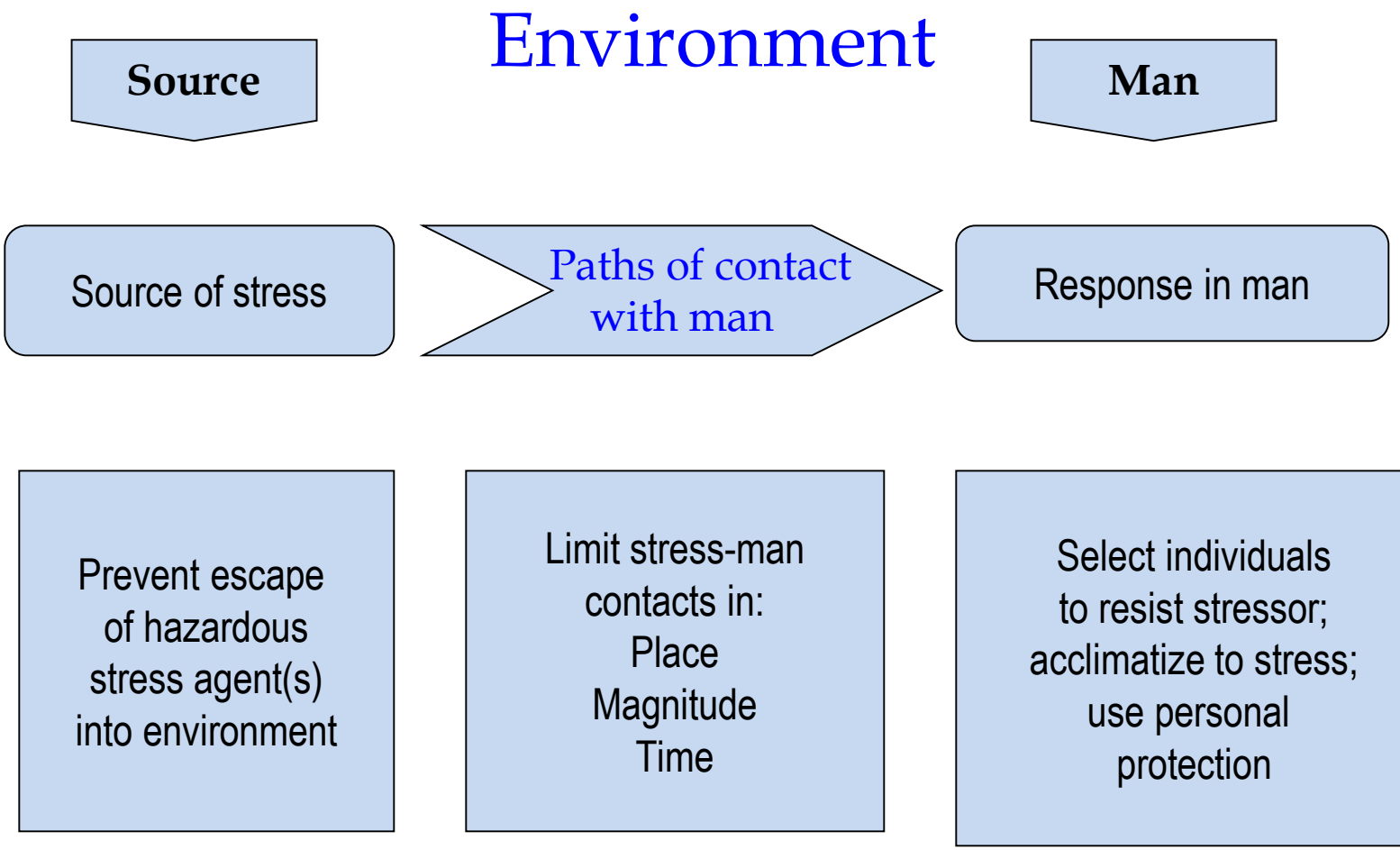
How are we going to reduce the harmful effects of air pollution on our health?

Health protection through correction of harmful stress-strain relationship between man and environment



Hierarchy of Prevention

1. *Remove the hazards at source*

2. *Reduce the contacts between the hazards and the individuals*

3. *Protection for the individuals*

Source Control

- Reduce unnecessary use of energy
- Alternative/renewable energy
- Improve energy efficiency
- Improve quality of fuels
- Control exhaust from cars
- Control emissions from factories
- Control emissions from power plants

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There are more we can do for indoor environments


Hope you have enough food for thought …
Thank you for your kind attention!