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Outdoor and indoor air pollution as risk factors for respiratory health

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Deputy-Director and Head of Department
Swiss Tropical and Public Health Institute Basel
& Professor of Public Health University Basel, Switzerland
State of evidence for respiratory health effects of «home outdoor» and «household» air pollution

<table>
<thead>
<tr>
<th>Outdoor</th>
<th>Indoor (biomass fuel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute effects in asthmatics</td>
<td>Important cause of lower respiratory</td>
</tr>
<tr>
<td>and others (also in children)</td>
<td>tract infections</td>
</tr>
<tr>
<td>Chronic bronchitis symptoms</td>
<td>Major cause of COPD in women (in low-</td>
</tr>
<tr>
<td>exacerbated by air pollution</td>
<td>income countries)</td>
</tr>
<tr>
<td>Near-road traffic related air</td>
<td>Many non-respiratory</td>
</tr>
<tr>
<td>pollution causes childhood</td>
<td>(including reproductive &amp; neonatal</td>
</tr>
<tr>
<td>asthma (possibly adult-onset</td>
<td>health, cardiovascular effects, burns,</td>
</tr>
<tr>
<td>asthma too?)</td>
<td>ocular disorders) well</td>
</tr>
<tr>
<td></td>
<td>established</td>
</tr>
<tr>
<td>Possibly etiologic role in</td>
<td></td>
</tr>
<tr>
<td>COPD</td>
<td></td>
</tr>
<tr>
<td>Major non-respiratory effects</td>
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</tbody>
</table>
Ambient particulate air pollution and acute lower respiratory infections: a systematic review and implications for estimating the global burden of disease

Sumi Mehta • Hwashin Shin • Rick Burnett • Tiffany North • Aaron J. Cohen

Health and Household Air Pollution from Solid Fuel Use: The Need for Improved Exposure Assessment

Clark et al, EHP 2013
Questions A7 & C9
Are there critical data gaps to be filled....?

Review of evidence on health aspects of air pollution – REVIHAAP Project

Scientific Advisory Committee:
Hugh Ross Anderson, Bert Brunekreef, Aaron Cohen, Klea Katsouyanni, Dan Krewski, Wolfgang Kreyling, Nino Künzli, Xavier Querol

1. Sources
2. Exposures
3. Susceptibilities
4. Action
5. Horizon 2020
Gap 1: SOURCES

Outdoor

Role of

- Road traffic
  - Exhaust
  - Break wear
  - Resuspension
- Type of engines / diesel
- Heating & wood burning

Indoor (biomass fuel)

- Types of stoves
- Contribution to ambient pollution

In Europe: main indoor pollution is tobacco smoke...
<table>
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</table>

Better tools to measure, monitor, and model personal exposure to source-specific air pollutants

(→ understand temporo-spatial patterns)
Unique example of efforts to standardize measurements, modelling, and exposure assignment: spatial distribution of ambient PM2.5 concentrations. 

Eeftens et al Atmos Env 2012

From ESCAPE Study

WHO Guideline Value
Elemental carbon \( \mu g/m^3 \) current levels still \(~10\) times higher than «acceptable cancer risk» (1:10’000)

«Soot» concentrations – a marker for transport related pollution – still not part of standard monitoring and modelling!

(Example: rural location in Switzerland) – 1970-2012

Need to standardize, measure, monitor, and model trends in source specific pollutants!

Current levels still \(~10\) times higher than «acceptable cancer risk» (1:10’000)
Lyon, France, June 12, 2012 -- After a week-long meeting of international experts, the International Agency for Research on Cancer (IARC), which is part of the World Health Organization (WHO), today classified diesel engine exhaust as carcinogenic to humans (Group 1), based on sufficient evidence that exposure is associated with an increased risk for lung cancer.
Near-road traffic-related air pollution exposure: Determined by proximity
Adjusted prevalence of chronic cough depends on residential distance from highway (Swiss survey based on ~1’800 adults, age 15-70)

ERS Lung White Book 2013

adapted from Hazenkamp et al, Env Health 2011
% of people living within 75m of roads with >10’000 vehicles per day!

Perez et al, - Eur Respir J –2013

Childhood asthma attributable to near-road pollution:

14% (CI: 3-25%) (city specific estimates: 7-23%)
Hierarchical oxidative stress response model for diesel and other air pollutant exposures
A. Nel, Science 2006
Gap 3: SUSCEPTIBILITIES...

... sorry, but we are NOT all equal...
Policies, prevention, advice & treatment need to protect ALL PEOPLE - also the most susceptible ones ... !

Some factors considered in some studies:
- Sex, age
- underlying diseases & phenotypes,
- smoking, diet & breast feeding,
- physical activity, BMI / obesity
- medication,
- genetic….

but lots of open questions to be tackled…
Lung function decline in OBESE did NOT profit from the improvements in air quality in Switzerland…!

Schikowski et al – Env Health Perspect 2013 (free online access) (SAPALDIA Study)
Lung function decline did not – or much less – profit from air quality improvements in Switzerland among some genotypes

Imboden et al – SAPALDIA Study
Env Health Perspect 2009

Did not profit from better air quality
In MICE: Inflammatory effects of Mexico City air pollution ...

**PM2.5 concentrations**

CTL: clean air

NW: 16 μg/m³

SW: 24 μg/m³

Villarreal-Calderon, Exp Toxicol Pathol 2010
In MICE: Inflammatory effects of Mexico City air pollution are reduced under supplementation with...
Flavonol-rich dark cocoa significantly decreases plasma endothelin-1 and improves cognition in urban children

Lilian Calderón-Garcidueñas¹,²*, Antonieta Mora-Tiscareño³, Maricela Franco-Lira², Janet V. Cross⁴, Randall Engle⁵, Mariana Aragón-Flores², Gilberto Gómez-Garza³, Valerie Jewells⁶, Lin Weili⁷, Humberto Medina-Cortina², Edelmira Solorio³, Chih-kai Chao¹, Hongtu Zhu⁸, Partha S. Mukherjee⁹, Lara Ferreira-Azevedo¹⁰, Ricardo Torres-Jardón¹¹ and Amedeo D’Angiulli¹²
Gap 4: ACTION

Outdoor

- Address and resolve reasons for inaction?
- Adopt and enforce air quality standards in line with WHO Guidelines
- Global view!

Indoor (biomass fuel)

- Strategies for women's empowerment
- Behavioural approaches
- Program evaluation
The Global Alliance for Clean Cookstoves calls for 100 million homes to adopt clean and efficient stoves and fuels by 2020....
... and where is the Global Alliance for Clean Air ??

Barcelona, Port
Call for Globalization of Clean Air Quality Standards

Example of PM$_{10}$:
Annual mean standards WHO-Guidelines: $20\mu g/ m^3$

<table>
<thead>
<tr>
<th>State of California</th>
<th>Several European countries, incl. Switzerland</th>
<th>EU (2008)</th>
<th>South Korea</th>
<th>Hong Kong</th>
<th>India (revised) and many other countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>$20 \mu g/ m^3$</td>
<td>$20 \mu g/ m^3$</td>
<td>$40 \mu g/ m^3$</td>
<td>$50 \mu g/ m^3$</td>
<td>$55 \mu g/ m^3$</td>
<td>$60 \mu g/ m^3$</td>
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Did you know that EU announced 2013 as the «Year of Air»... ?

Don’t Ask – don’t tell... !
Gain in Barcelona life expectancy if air
quality would comply with
WHO Guideline values (20µg PM$_{10}$/m$^3$)

+14 months

NOTE: Life expectancy increased ~3 months per year due to
ALL other health relevant changes in Barcelona!

Economic benefit of compliance with
WHO Guidelines: 1’600 € per person /yr.

Perez et al, Gac Sanit 2009
Gap 5: HORIZON2020 needs…

Driving forces of trends in health and disease

Distribution of «research funds for innovation»

POVERTY
ENVIRONMENT
SOCIO-ECONOMICS
LIFE-STYLE
DIET
DRUGS
-OMICS / Genetics

«Innovation» requires evidence-based allocation of funding
During the 20th century, the health and life expectancy ... improved dramatically. Since 1900, the average lifespan ... has lengthened by >30 years; 25 years of this gain are attributable to advances in public health.
GLOBAL RANKING OF RISK FACTORS
(out of >67 factors)

1. Dietary Risk
2. Air Pollution (ambient & household)
3. Blood pressure
4. Smoking
5. Alcohol
Disability Adjusted Life Years in Europe
Global Burden of Disease 2010

TOP-10 in Western, Central, and Eastern Europe
(with very similar ranking)

1. Diet
2. Smoking
3. Hypertension
4. Overweight
5. Physical inactivity
6. Fasting Glucose
7. Alcohol use
8. Cholesterol
9. Ambient & Household air pollution
10. Occupational risks
In 64 countries, air pollution is a Risk Factor...

<table>
<thead>
<tr>
<th>Nr. 1</th>
<th>Nr. 2</th>
<th>Nr. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan, Bangladesh, Benin, Butan, Cambodia, Cameroon, Comoros, Congo, Eq. Guinea, Gambia, Ghana, Guinea, India, Laos, Malawi, Mauretania, Mozambique, Myanmar, Nepal, North Korea, Pakistan, Ruwanda, Tanzania, Zimbabwe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1990 to 2005: air quality got WORSE in those countries with highest pollution!

(from the air pollution exposure research team for the 2010 GBD – Brauer et al 2012)
Globalize «Clean air policies» for better health

http://www.youtube.com/watch?v=JNHhGVeD050
HORIZON 2020 needs to foster relevance-based transdisciplinary health research, thus, giving balanced weight and funds to:

POVERTY
ENVIRONMENT
SOCIO-ECONOMICS
LIFE-STYLE & CULTURE
DIET
DRUGS
BIO «-OMICS»
HORIZON2020 must promote large-scale research beyond bio-omics!

To understand, prevent & treat respiratory diseases
IN A PERSONALIZED APPROACH we need cutting-edge research combining ALL «–omics»:

- BIO-OMICS AND.....
- PHEN-OMICS
- DISEASE-OMICS
- ENVIR- OMICS
- EXPOS-OMICS
- SOCI-OMICS
- DIET-OMICS
- LIFE-STYLE-OMICS

Heavily under-funded, under-«respected»
Funded mostly as «annex» to the «real (bio)–omics science»
Consequences of under-funded areas:

...underfunded PHENOMICS:

«Did your doctor ever tell you that you have asthma»

...underfunded ENVIROIMICS

«living within 50 meters of a busy road»

...underfunded SOCIOMICS

«How many years of formal education do you have?»
HORIZON2020 must foster large-scale population-based research, integrating ALL «omics»

- BIO-OMICS → Bio-banks
- PHEN-OMICS → Pheno-banks
- DISEASE-OMICS → Disease-registries
- ENVIRO-OMICS → Enviro-banks
- EXPOS-OMICS → Expo-banks
- SOCI-OMICS → Socio-eco-banks
- DIET-OMICS → Diet-banks
- LIFE-STYLE-OMICS → Life-style-banks

Publicly-funded research with data banks under control of (publicly controlled) research community
La medicina personalizada es la administración de una terapia para cada paciente concreto a la vista de su individualidad química y genética. …

• Private companies own DNA of millions…!
• No other objective pheno-enviro data
• No public control over data use
• Highly selected populations
• Sooner or later… another «Snowden» story ➔ jeopardizing population-based research
CONCLUSION : Gaps to fill in air pollution & health

1. Beyond respiratory health...
2. Complementary atmospheric science, epidemiological, controlled human exposure and toxicological studies needed, equally integrating all “omics” domains as defined above
3. Focus on sources and on research into susceptibility factors and modifiers of effects
4. Foster large-scale population based research integrating air pollution, other environmental factors and ALL determinants of health and disease
5. Beyond Europe – foster research to promote expertise and policy dialog and action in those countries with the largest burden of air pollution related health problems
>1800 participants from 70 countries & 5 continents

>40% about air pollution

... HOWEVER: still very unequally distributed:

Countries with > 20 participants per 1 Million inhabitants
Switzerland, Sweden, Finland, Cyprus, Denmark, Belgium, Israel, Iceland, Norway, Taiwan, Netherlands, Estonia, New Zealand

Countries with < 1 participant per 1 Million inhabitants
Brazil, Ivory coast, Poland, Zambia, Kenya, Malaysia, Ukraine, Morocco, Russian Federation, Ghana, Saudi Arabia, Sudan, China, Turkey, Pakistan, India, Iran, Egypt, Nigeria, Vietnam, Philippines

Thank You - Nino.Kuenzli@unibas.ch