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dust impact on health in urban areas: an overview

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respiratory diseases

cardiovascular diseases

exposure to dust vs dust + pollutants in urban air

summary and recommendations
Tanaka and Chiba (2006)

Dust belt

12°N (Sahel) to 40°N (China)
Dust Emissions, Tg · y^{-1}

Longueville et al. (2010)
Air Quality Standards $\text{PM}_{10}$ and $\text{PM}_{2.5}$

health effects studies $\geq$ 1990s
Europe & North America
WHO (2013) review of evidences on health aspects of air pollution:

PM$_{10}$, PM$_{2.5}$
short & long term exposure
morbidity mortality
cardiovascular effects PM$_{2.5}$:
- physiological effects and biological mechanisms
- new health outcomes: atherosclerosis adverse birth outcomes respiratory diseases children

‘cities in the dust belt’

North Africa, Middle East, Asia,
PM$_{10}$, PM$_{2.5}$

health effects due to exposure to pollutants + dust mixing?

PM$_{x}$ composition
ultrafine fine coarse
0.001 µm 0.1 µm 2.5 µm 10 µm 70 µm

dp

EC OM SO$_4^{2-}$ NH$_4^{+}$ NO$_3^{-}$ sea salt

Izaña observatory (Tenerife):
dust$_{10}$, ~70% total dust
dust$_{2.5}$, ~20% total dust
dust$_{2.5}$, ~27% dust$_{10}$
Rodríguez et al. (2011)
people live in cities and breath a cocktail dust + pollutants
respiratory diseases

cardiovascular diseases

exposure to dust vs dust + pollutants in urban air

summary and recommendations
Desert Dust Exposure Is Associated with Increased Risk of Asthma Hospitalization in Children

Increasing cardiopulmonary emergency visits by long-range transported Asian dust storms in Taiwan

Chang-Chuan Chan a, *, Kai-Jen Chuang a, Wen-Jone Chen b, Wei-Tien Chang b

Atmospheric Environment 68 (2013) 256–264

Assessing exposure risk for dust storm events–associated lung function decrement in asthmatics and implications for control

Nan-Hung Hsieh, Chung-Min Liao *


Asian Dust Storm and pulmonary function of school children in Seoul

Yun-Chul Hong a, Xia-Chuan Pan b, Su-Young Kim c, Kwangsik Park d, Eun-Jung Park d, Xiaobin Jin b, Seung-Muk Yi e, Yoon-Hee Kim f, Choong-Hee Park g, Sanghwan Song g, Ho Kim f, *

Environment International 54 (2013) 35–44

Spatial vulnerability under extreme events: A case of Asian dust storm's effects on children's respiratory health

Hwa-Lung Yu a, Chiang-Hsing Yang b, Lung-Chang Chien c, *


A case-crossover analysis of Asian dust storms and mortality in the downwind areas using 14-year data in Taipei

Chang-Chuan Chan *, Huey-Ching Ng
Assessing exposure risk for dust storm events-associated lung function decrement in asthmatics and implications for control

Nan-Hung Hsieh, Chung-Min Liao

Australian Dust Storm: Impact on a Statewide Air Medical Retrieval Service


Asian Dust Storm and pulmonary function of school children in Seoul

Yun-Chul Hong, Xiaochuan Pan, Su-Young Kim, Kwangsik Park, Eun-Jung Park, Xiaobin Jin, Seung-Muk Yi, Yoon-Hee Kim, Choong-Hee Park, Sanghwan Song, Ho Kim

Asian sand dust enhances murine lung inflammation caused by Klebsiella pneumoniae

Miao He, Takamichi Ichinose, Seiichi Yoshida, Shoji Yamamoto, Ken-ichiro Inoue, Hirohisu Takano, Rie Yanagisawa, Masatake Nishikawa, Ikuko Mori, Guifan Sun, Takayuki Shibamoto
Hospital admissions for **asthma** and acute bronchitis in El Paso, Texas: Do age, sex, and insurance status modify the effects of dust and low wind events?   

Sara E. Grineski\textsuperscript{a,}\textsuperscript{*}, Joan G. Staniswalis\textsuperscript{b}, Priyangi Bulathsinhala\textsuperscript{b}, Yanlei Peng\textsuperscript{c}, Thomas E. Gill\textsuperscript{d}  

DOI 10.1007/s00484-005-0257-3

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**African dust clouds are associated with increased paediatric asthma accident and emergency admissions on the Caribbean island of Trinidad**


DOI 10.1007/s00484-009-0254-z

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**Reply to: African dust and asthma in the Caribbean—medical and statistical perspectives**

Joseph M. Prospero - Edmund Blades - Raana Naidu - Marc C. Lavoie  

DOI 10.1007/s00484-009-0254-z
Environmental Health

A 10-year time-series analysis of respiratory and cardiovascular morbidity in Nicosia, Cyprus: the effect of short-term changes in air pollution and dust storms
Nicos Middleton*, Panayiotis Yiallouroς†, Savvas Kleanthous§, Ourania Kolokotroni¶, Joel Schwartz∥, Douglas W Dockery¶, Phil Demokritou* and Petros Koutrakis

Acute effects of air pollution on pediatric asthma exacerbation: Evidence of association and effect modification

The impact of desert dust exposures on hospitalizations due to exacerbation of chronic obstructive pulmonary disease
Alina Vodonos, Michael Friger, Itzhak Katra, Lone Avnon, Helena Krasnov, Petros Koutrakis, Joel Schwartz, Orly Lior, Victor Novack
During and a few days after dust events:
- increase in hospitalizations due to respiratory diseases (exacerbation)
- pediatric asthma
- COPD: Chronic Obstructive Pulmonary Diseases
- reduced lung functions

Bennion et al. (2007): 1y UZB
* Chang et al. (2008): 7y TW
Cowie et al. (2010): 1 event NZ
Holyoak et al. (2010): 1 event AUS
Hong et al. (2010): 1 month CH & SK
Kanati et al. (2010)
Hsieh and Liao (2013): 9 years TW

Gyan et al. (2005): 1 year TRINIDAD
respiratory diseases

cardiovascular diseases

exposure to dust vs dust + pollutants in urban air

summary and recommendations
Coarse Particles From Saharan Dust and Daily Mortality

Laura Perez, Aurelio Tobias, Xavier Querol, Nino Künzli, Jorge Pey, Andrés Alastuey, Mar Viana, Natalia Valero, Manuel González-Cabrero, and Jordi Sunyer

Saharan dust, particulate matter and cause-specific mortality: A case–crossover study in Barcelona (Spain)

Laura Perez, Aurelio Tobías, Xavier Querol, Jorge Pey, Andrés Alastuey, Julio Díaz, Jordi Sunyer

Role of Saharan dust in the relationship between particulate matter and short-term daily mortality among the elderly in Madrid (Spain)

E. Jiménez, C. Linares, D. Martínez, J. Díaz

Saharan dust and association between particulate matter and case-specific mortality: a case–crossover analysis in Madrid (Spain)

Julio Díaz, Aurelio Tobias and Cristina Linares

Short-term effects of particulate matter on total mortality during Saharan dust outbreaks: A case-crossover analysis in Madrid (Spain)

Aurelio Tobías, Laura Pérez, Julio Díaz, Cristina Linares, Jorge Pey, Andrés Alastruey, Xavier Querol
Saharan dust and daily mortality in Emilia-Romagna (Italy).
Regional Center for Environment and Health, ARPA Emilia-Romagna, Via Begerelli 13, 41121 Modena, Italy. szauli@arpa.omr.it

Environmental Health Perspectives • VOLUME 119 • NUMBER 10 • October 2011

Saharan Dust and Associations between Particulate Matter and Daily Mortality in Rome, Italy

Sandra Mallone,1 Massimo Stafoggia,2 Annunziata Faustini,2 Gian Paolo Gobbi,3 Achille Marconi,4 and Francesco Forastiere2

Research
A 10-year time-series analysis of respiratory and cardiovascular morbidity in Nicosia, Cyprus: the effect of short-term changes in air pollution and dust storms
Nicos Middleton*1,2, Panayiotis Yiiallouros2, Savvas Kleanthous3, Ourania Kolokotroni2, Joel Schwartz1, Douglas W Dockery1, Phil Demokritou1,2 and Petros Koutrakis1

Science of the Total Environment 409 (2011) 2049-2054

Does the presence of desert dust modify the effect of PM_{10} on mortality in Athens, Greece?

Evangelia Samoli a,*, Evgenia Kougea a, Pavlos Kassomenos b, Antonis Analitis a, Klea Katsouyanni a


Health effects from Sahara dust episodes in Europe: Literature review and research gaps

A. Karanasiou a,*, N. Moreno a, T. Moreno a, M. Viana a, F. de Leeuw b, X. Querol a
Asian dust and daily all-cause or cause-specific mortality in western Japan

Saori Kashima,¹ Takashi Yorifuji,² Toshihide Tsuda,² Akira Eboshida¹

Effect of Asian Dust Storms on Mortality in Korea during 2001-2009

Hyewon Lee¹, Ho Kim¹, Youn-Hee Lim², Seungmuk Yi¹

...there more studies
Mortality & cardiovascular diseases

Increase (↑)

Barcelona
↑ 10 µg/m³ of PM$_{10-2.5}$
↑ mortality by:
8.4% Saharan dust days
1.4% non-Saharan dust days

Madrid
↑ 10 µg/m³ of PM$_{10-2.5}$
↑ mortality by:
2.8% in Saharan dust days
0.6% non-dust days

Rome
↑ 10.8 µg/m³ PM$_{2.5-10}$
↑ cardiovascular mortality:
9.73% Saharan dust days
0.86% no dust days

Emilia Romagna
↑ respiratory mortality for elderly people (≥75y) during Saharan dust events with respect to no dust events.
22% in the whole year
34% in summer

no modification of dust events on the concentration-response relationship between PM$_{10}$ and daily deaths

-25000 deaths
Pérez et al. (2008)
Pérez et al. (2012)

cardiovascular mortality:
- associated with PM$_{2.5-10}$
- not associated with PM$_{2.5}$

respiratory & cardiovascular mortality is associated with:
- PM$_{10}$ Saharan dust days,
- PM$_{2.5}$ non-Saharan dust days,
Jiménez et al. (2010)
Jiménez et al. (2012)
Tobias et al. (2011a)

4 years
Mallone et al. (2011)
Sajani et al. (2011)
Mortality & cardiovascular diseases

Asian dust did not modify the response of mortality to PM.

10 µg/m³ PM₃ increase:
- 0.6% heart disease
- 0.8% ischemia hearth diseases
- 2.1% arrhythmia

Kashima et al. (2012): 5y
1.4 million targeting people

47 cities (Japan) > 65y

Athens
- Association between PM₁₀ and mortality is higher during no - Saharan dust days

Traffic related particles have more toxic effects than Saharan dust.

Cyprus
- Compared to no dust events, hospitalizations during Saharan dust events were:
  - 4.8% higher for all-causes
  - 10.4% higher for cardiovascular diseases

Taipei (Taiwan)
- Asian dust increased cardiovascular effects when PM₁₀ > 90 µg/m³ compared to pre-dust conditions, observed increases in hospital visits:
  - 35% for ischemic heart diseases
  - 20% for cerebrovascular diseases
  - 67% for cardiovascular diseases

- Chang et al. (2008): 7y
- Chang and Ng (2011): 14y

bulk PM₁₀
- 10 years
- Middleton et al. (2008)

bulk PM₁₀
- 6 years
- Samoli et al. (2011)
Mortality & cardiovascular:
During dust events in urban areas:
short term exposure

\[ \text{PM}_{10}, \text{PM}_{2.5-10} \quad \rightarrow \quad \text{association with cardiovascular mortality} \]
\[ \text{PM}_{2.5} \quad \rightarrow \quad \text{no association with mortality} \]

response of mortality to increases in \( \text{PM}_{10} \) and/or \( \text{PM}_{2.5-10} \) during dust changes city to city

- What is the origin of the relationship between dust and cardiovascular mortality?
  (disease, mechanism)
respiratory diseases

cardiovascular diseases

**exposure to dust vs dust + pollutants in urban air**

Summary and recommendations
Some considerations:

1. Levels of local urban & industrial pollutants may be higher during dust-days than during none-dust-days

2. Exposure to dust+pollutants may be worse than simple exposure to dust
PMx = pollutants + dust

there is more pollution when there is dust due to:

- Adverse meteorological conditions for dispersion of pollutants during dust events (observed in Mediterranean and Atlantic cities)
- Reaction of local urban/industrial pollutants with dust, resulting in dust coating by pollutants (sulphate, nitrate, etc.)

Heterogeneous reactions between dust and pollutants

\[
\begin{align*}
\text{HNO}_3 + \text{CaCO}_3 \text{ [dust]} & \rightarrow \text{CaNO}_3 + \ldots \\
\text{H}_2\text{SO}_4 + \text{CaCO}_3 \text{ [dust]} & \rightarrow \text{CaSO}_4 + \ldots
\end{align*}
\]

coating of fine and coarse dust particles by pollutants reactivity of the surface of dust particles
people live in cities and breath a cocktail dust + pollutants

Some considerations:
1. Levels of local urban & industrial pollutants may be higher during dust-days than during none-dust-days
2. Exposure to dust+pollutants may be worse than simple exposure to dust

2 example studies
a 7y study:

In Taiwan, an increase in children respiratory clinic visits is observed just after Asian dust events. However, the relative increase is higher in urban than in rural areas.

*Yu et al. (2013). Environ. Int (54), 35-44.*

Does the presence of pollutants increase the sensitivity to dust exposure?

Then, emissions of urban and industrial pollutants should be reduced during dust days.
Desert Dust Outbreaks in Southern Europe: Contribution to Daily PM$_{10}$ Concentrations and Short-Term Associations with Mortality and Hospital Admissions

**Results:** On average, 15% of days were impacted by desert dust at ground level (desert PM$_{10}$ > 0 μg/m$^3$). Most episodes occurred in spring-summer, with increasing gradient of both frequency and intensity North-South and West-East of the Mediterranean basin. We found significant associations of both PM$_{10}$ concentrations with mortality. Increases of 10-μg/m$^3$ in non-desert and desert PM$_{10}$ (lag 0-1 days) were associated with increases in natural mortality of 0.55% (95% CI: 0.24, 0.87%) and 0.65% (95% CI: 0.24, 1.06%), respectively. Similar associations were estimated for cardio-respiratory mortality and hospital admissions.

**Conclusions:** PM$_{10}$ originated from desert was positively associated with mortality and hospitalizations in Southern Europe. Policy measures should aim at reducing population exposure to anthropogenic airborne particles even in areas with large contribution from desert dust advections.
respiratory diseases

cardiovascular diseases

exposure to dust vs dust + pollutants in urban air

Summary and recommendations
Health effects

1. health effects in the context of air quality

   Europe, North America and Asia ➔ PM\(_{10}\) and PM\(_{2.5}\) = pollutants

   dust belt (North Africa, Middle East, West Asia to Asia)

   ➔ PM\(_{10}\) and PM\(_{2.5}\) = dust + pollutants

2. Respiratory diseases. Short time effects

   - increase in hospitalizations due to respiratory diseases (exacerbation)
   - paediatric asthma
   - COPD: Chronic Obstructive Pulmonary Diseases
   - reduced lung functions

3. Heart diseases observed in urban areas of European-Mediterranean and Asia.

   - increase in hospitalizations due to cardiovascular diseases
     PM\(_{10}\) and PM\(_{2.5-10}\): association with cardiovascular mortality

   - response of mortality to increases in PM\(_{10}\) and/or PM\(_{2.5-10}\) during dust changes city to city

   - mechanisms by which dust exposure increase cardiovascular mortality is still unknown.
     More Research is needed ➔ countries of the dust belt plays a key role
The number of scientific papers on the impact of dust on air quality from 1999 to 2009 has been reviewed by Longueville et al. (2010). The paper focuses on desert dust originating from different regions:

1) **49% Asian dust**
   - China, Taiwan, Southern Korea, Gobi desert

2) **39% North African dust**
   - 37% Europe
   - 23% Spain
   - 1% North African countries

- **9% North America**
- **2% Middle East**
- **1% Latin America**
- **1% Oceania**


What do we know about effects of desert dust on air quality and human health in West Africa compared to other regions?

Florence De Longueville, Yvon-Carmen Hountondji, Sabine Henry, Pierre Ozer
Dust Emissions, Tg · y⁻¹

12°N (Sahel) to 40°N (China)
European part of the Mediterranean: pollutants + dust (20 - 30 μg/m³)
Asia: pollutants + dust (80 - 100 μg/m³)
North Africa + Middle East + West Asia: pollutants + dust (100 - 1000 μg/m³)

Dust concentrations are much higher in North Africa, Middle East and Western Asian cities

- Implication to health effects, differentiated with respect to Europe
- More research and measurements needed in the dust belt
What we know about the impact of air pollutants and anthropogenic - PM
Comparison to dust

7 million premature deaths annually linked to air pollution

Outdoor air pollution-caused deaths – breakdown by disease:
- 40% – ischaemic heart disease;
- 40% – stroke;
- 11% – chronic obstructive pulmonary disease (COPD);
- 6% - lung cancer; and
- 3% – acute lower respiratory infections in children.

Indoor air pollution-caused deaths – breakdown by disease:
- 34% - stroke;
- 26% – ischaemic heart disease;
- 22% - COPD;
- 12% - acute lower respiratory infections in children; and
- 6% - lung cancer.
What we know about the impact of air pollutants and anthropogenic - PM
Comparison to dust

1. Studies focused on understanding the mechanisms by which PM-pollution cause hearth diseases:
What we know about the impact of air pollutants and anthropogenic - PM
Comparison to dust

2. Studies focused on identifying the profile of people that may suffer a cardiovascular disease in the short term exposure due to air pollution:

Med Clin (Barc). 2013;141(12):529–532
Impact of air pollution on inflammation, oxidative stress and 1-year prognosis in patients hospitalized for acute coronary syndrome: Design of the AIRACOS study
Alberto Dominguez-Rodriguez a,b,c, Sergio Rodríguez d, Pedro Abreu-Gonzalez c,e y Pablo Avanzas f

International Journal of Cardiology 188 (2015) 47–49
Black carbon exposure, oxidative stress markers and major adverse cardiovascular events in patients with acute coronary syndromes
Alberto Dominguez-Rodriguez a,b,*, Sergio Rodríguez c, Pedro Abreu-Gonzalez d, Pablo Avanzas e, Ruben A. Juarez-Prera a

Patients that had suffered an cardiovascular event, and were then exposed to high levels of black carbon, suffered an new event in the next 30 days and presented high levels of Serum malondialdehyde -a bio marker indicative of oxidative stress-

This research is needed for dust in the the dust belt cities
thank you