WORKING FOR A HEALTHY FUTURE

Health benefits of LAQM

Alison Searl

Director of Analytical Services

Outline

- Health effects of particles - which effects and components matter most?
- Health effects of NO_2?
- Nitric oxide: the forgotten pollutant
- Health impact of current exposure to air pollution in Edinburgh
- Are air pollution impacts evenly shared?
- Importance of air pollution versus other causes of ill-health
- Other health benefits of reducing emissions
- Benefits of LAQM?

Effects of particle exposure

- On high pollution days, raised PM levels associated with increased mortality, emergency health care demand, respiratory symptoms and cardiovascular effects
- Long term exposure correlated with increased mortality risk
- The American Cancer Society reported a 6% increase in long term mortality risk per 10 ugm^{-3} increment in $PM_{2.5}$ which has been widely used in effects quantification
- A recent Dutch study also found a 6% increase per 10 ugm^{-3} increment in $PM_{2.5}$
- A recent update of the ACS study reported an 12% increase in ischaemic heart deaths per 10 ugm^{-3}

Which particles matter?

- Adverse effects of air pollution most strongly associated with particles
- $PM_{2.5}$ strongly associated with cardiovascular illness and mortality
- $PM_{2.5-10}$ associated with respiratory illness
- Some experimental evidence indicating that PM_1 is relatively more harmful than $PM_{1-2.5}$ (eg impact on cardiovascular parameters)
- Substantial evidence linking traffic emissions to adverse effects

NO_2 – Why were air quality objectives set?

- In time series studies NO_2 correlates with daily mortality and with respiratory hospital admissions
- In studies of schoolchildren, personal exposure to NO_2 linked to day to day variability in respiratory function and respiratory symptoms
- Less consistent evidence linking respiratory function and respiratory symptoms to ambient NO_2 or NO_2 in indoor air
- Long term effects on lung function growth and respiratory symptoms in children correlated with NO_2 in some studies
- Better evidence linking children's respiratory health to traffic emissions

Is NO_2 the causal agent of observed effects?

- In outdoor air quality studies, NO_2 is a good marker of traffic emissions
- In indoor air quality studies, NO_2 is a good marker of use of a gas cooker
- In both cases NO_2 likely to be correlated with extremely fine PM
- NO_2 may also be correlated with substances such as aldehydes, other VOCs, PAHs

So does NO_2 matter?: high pollution days

- Volunteer experiments have found effects on airways responsiveness at concentrations marginally higher than during high pollution events
- Experiments do not include the full spectrum of susceptibility in the general population
- Reasonable to anticipate that exposure to NO_2 on high pollution days will cause adverse respiratory effects in a small number of people – and may enhance the response to PM

What about long term exposure to NO_2? Animal data

- In animal experiments long term exposure to NO_2 gave rise to emphysema like effects (188 ugm^{-3} with a daily two hour peak of 1880 ugm^{-3})
- – but no effects seen on continuous exposure to NO_2 at 940 ugm^{-3} for 12 months
- Reduced resistance to infection following repeated exposure to 940 ugm^{-3} (TWA = 117 ugm^{-3})
- Peak levels of exposure seem to be more important than long term low level exposure

What about long term exposure to NO_2? Human evidence

- No epidemiological evidence that exposure to NO_2 in ambient air associated with reduced life expectancy
- 40 ugm^{-3} objective based on meta-analysis of effects of gas cooking which gives rise to an increase of about 30 ugm^{-3} in indoor NO_2
- There is evidence that long term exposure to traffic pollution leads to increased mortality risks

Current view of importance of NO_2?

- Some consensus that effects attributed to NO_2 in outdoor air are due to some other component of traffic pollution
- Studies of indoor pollution generally find that emissions from gas combustion may have small adverse effects on children's respiratory health
- The WHO took the view that the reduction in traffic emissions required to achieve the NO_2 objectives would be beneficial regardless of the role of NO_2
- NOx emissions contribute to the formation of secondary particles

Nitric oxide: the forgotten pollutant?

- Biologically active molecule
- Less soluble than NO_2 – reaches distal airways
- Balance between endogenous NO synthesis, tissue levels of NO and NO concentrations in exhaled air
- NO_2 gives rise to adverse respiratory effects at lower concentrations than NO
- NO has effects on blood vessels, the inflammatory process and cell function that are not observed on exposure to NO_2

Health impacts of current exposure to air pollution in Edinburgh: assumptions

	City	AQMAs
Concentrations PM_{10} ugm^{-3}	11.1	18
Concentrations $PM_{2.5}$ ugm^{-3}	6.9	11.6
Concentrations NO_2 ugm^{-3}	15.2	40
Population	448624	11892*
% Population under 16	15.3%	7.6%
% Population over 60	19.8%	13.3%

*including population within 50 m AQMA boundary data provided by Graeme Gainey, Edinburgh CC

Health impacts of current exposure to air pollution in Edinburgh

Annual impacts	City		AQMAs	
	Background rate	Air pollution	Background rate	Air pollution
Deaths brought forward	3038	25	81	1
Emergency respiratory and CV hospital admissions	9462	129	251	7
GP visits asthma/ LRS	29205	926	775	40
Days loss life expectancy	-	804935	-	35949

Individual Loss of life expectancy over 75 years:

City average 135 days, AQMA 227 days

Health impacts of current exposure to air pollution in Edinburgh

	City	AQMAs
Respiratory symptoms in asthmatics:		
Days per adult per year	1.86	3.02
Days per child per year	1.48	2.40
Total across population per year	9353	380
Restricted Activity Days:		
Days per adult per year	0.28	0.45
Total across population per year	105398	4945
Bronchitis – new cases per year	257	12

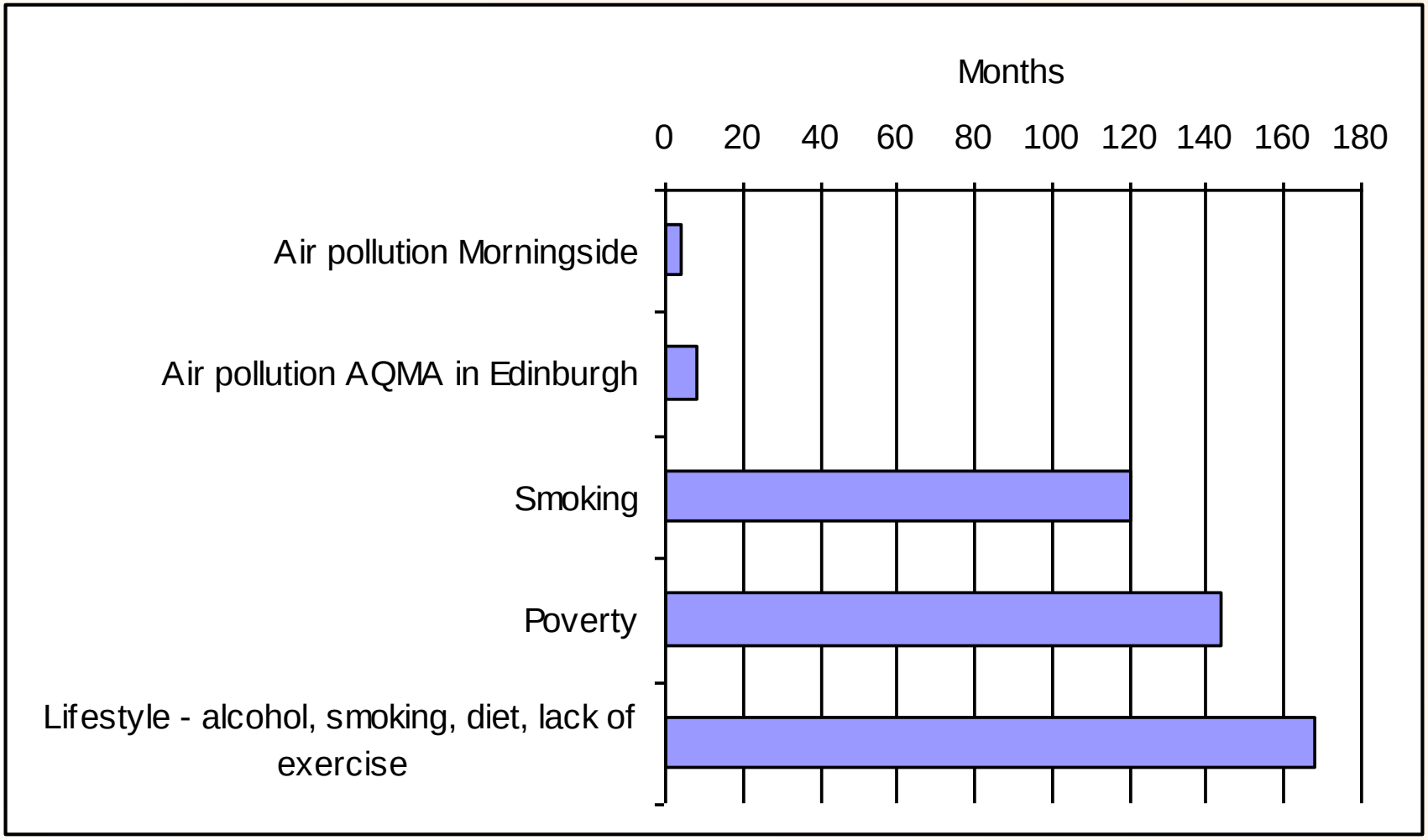
Distribution of effects

	Percent within AQMAs
Population	2.6%
Days lost per year across population	4.4%
Number of deaths brought forward	4.4%
Emergency hospital admissions	5.2%
GP visits asthma/LRS	4.4%

Are air pollution impacts evenly shared?

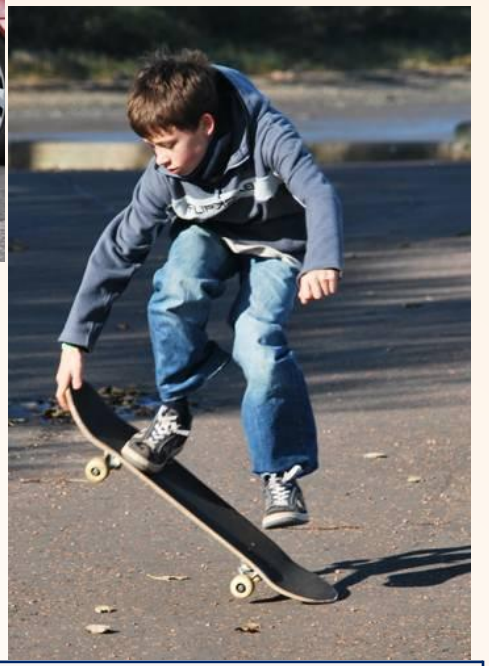
- Differences in exposure – 4 months loss of life expectancy in Morningside versus 5.5 in Comely Bank
- Effects on daily mortality and health care demand increase with age and deprivation
- Impacts of age and deprivation partly due to higher baseline rates and differences in exposure
- Increased vulnerability associated with age and deprivation beyond that attributable to baseline health and exposure
- ACS study - some evidence of increased risks associated with lower educational status
- How many months of loss of life expectancy due to airborne PM in Glasgow's East End?

Public health importance of air pollution



Other health benefits of reducing emissions

- Reducing car use could
  - Revitalise local communities – increased social contact, improved welfare
  - Increase exercise – improved cardiovascular health
  - Reduce noise exposure
  - Promote different life choices
- Improved liveability of neighbourhoods – improved mental well being



Benefits of LAQM?

- Reduce peak exposures to NO_2 and SO_2 that may trigger respiratory symptoms
- Reduce peak exposures to PM - reduce health care demand, symptoms (24 hour std not a “no effects level”)
- Substantial benefits in reducing population mean exposure to airborne particles – gain in life expectancy
- No obvious benefit in reducing NO_2 independently of reducing exposure to PM
- Reducing dependency on cars could bring other health benefits unrelated to air pollution

Thank you for listening