



WORKING FOR A HEALTHY FUTURE

# Health effects of air pollution in AQMAs: HIA case study in Edinburgh

Alison Searl

*Institute of Occupational Medicine*

Margaret Douglas, Martin Higgins

*NHS Lothian*

Janet Brown, Graham Gainey, Ben Wilson

*City of Edinburgh Council*



# Outline

- Health effects of air pollution - which components matter?
  - Particles
  - Nitrogen dioxide
- Sources of air pollution in Edinburgh
- 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
- Benefits of reducing emissions
- Conclusions



# 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  $10 \text{ ug m}^{-3}$  increment in  $\text{PM}_{2.5}$  which has been widely used in effects quantification
  - A recent Dutch study also found a 6% increase per  $10 \text{ ug m}^{-3}$  increment in  $\text{PM}_{2.5}$
  - A recent update of the ACS study reported an 12% increase in ischaemic heart deaths per  $10 \text{ ug m}^{-3}$
- $\text{PM}_{2.5}$  strongly associated with cardiovascular illness and mortality
- $\text{PM}_{2.5-10}$  associated with respiratory illness

# Effects of nitrogen dioxide

- Epidemiological studies have linked  $\text{NO}_2$  to adverse effects on children's respiratory health and also impacts on daily mortality and hospital admissions—but observed effects may be due to concurrent PM exposure
- Better evidence linking children's respiratory health to traffic emissions
- Effects on airways responsiveness in volunteers at concentrations marginally higher than during high pollution events
- Exposure to  $\text{NO}_2$  on high pollution days may cause adverse respiratory effects in a small number of people – and may enhance the response to PM



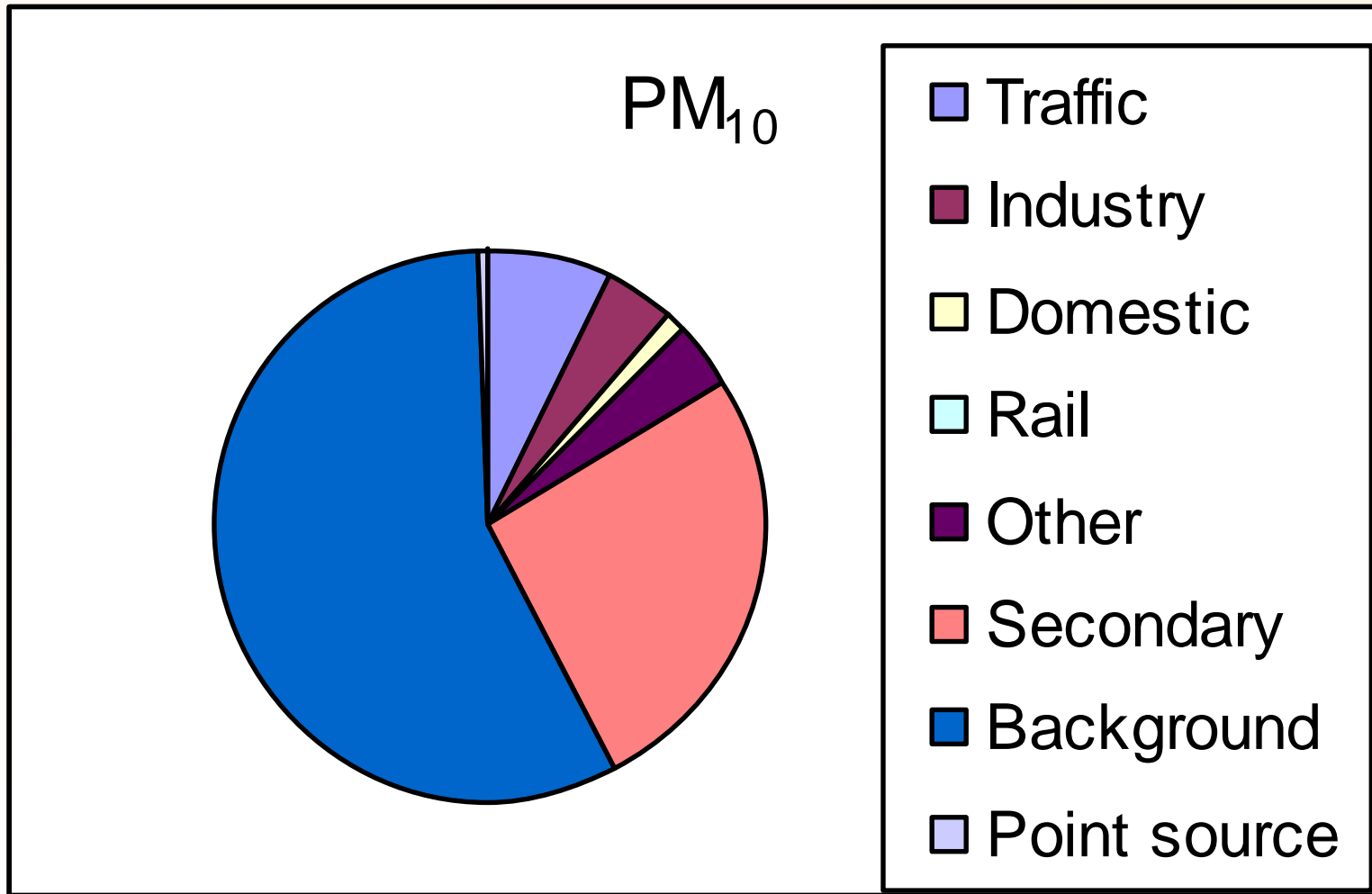
# What about long term exposure to NO<sub>2</sub>?

- In animal experiments long term exposure to NO<sub>2</sub>
  - gave rise to emphysema like effects and reduced resistance to infection (TWA >100 ug<sub>m</sub><sup>-3</sup>)
  - Peak levels of exposure more important than long term low level exposure
- No epidemiological evidence that exposure to NO<sub>2</sub> in ambient air associated with reduced life expectancy
- 40 ug<sub>m</sub><sup>-3</sup> objective based on meta-analysis of effects of gas cooking which gives rise to an increase of about 30 ug<sub>m</sub><sup>-3</sup> in indoor NO<sub>2</sub>
- There is evidence that long term exposure to traffic pollution leads to increased mortality risks

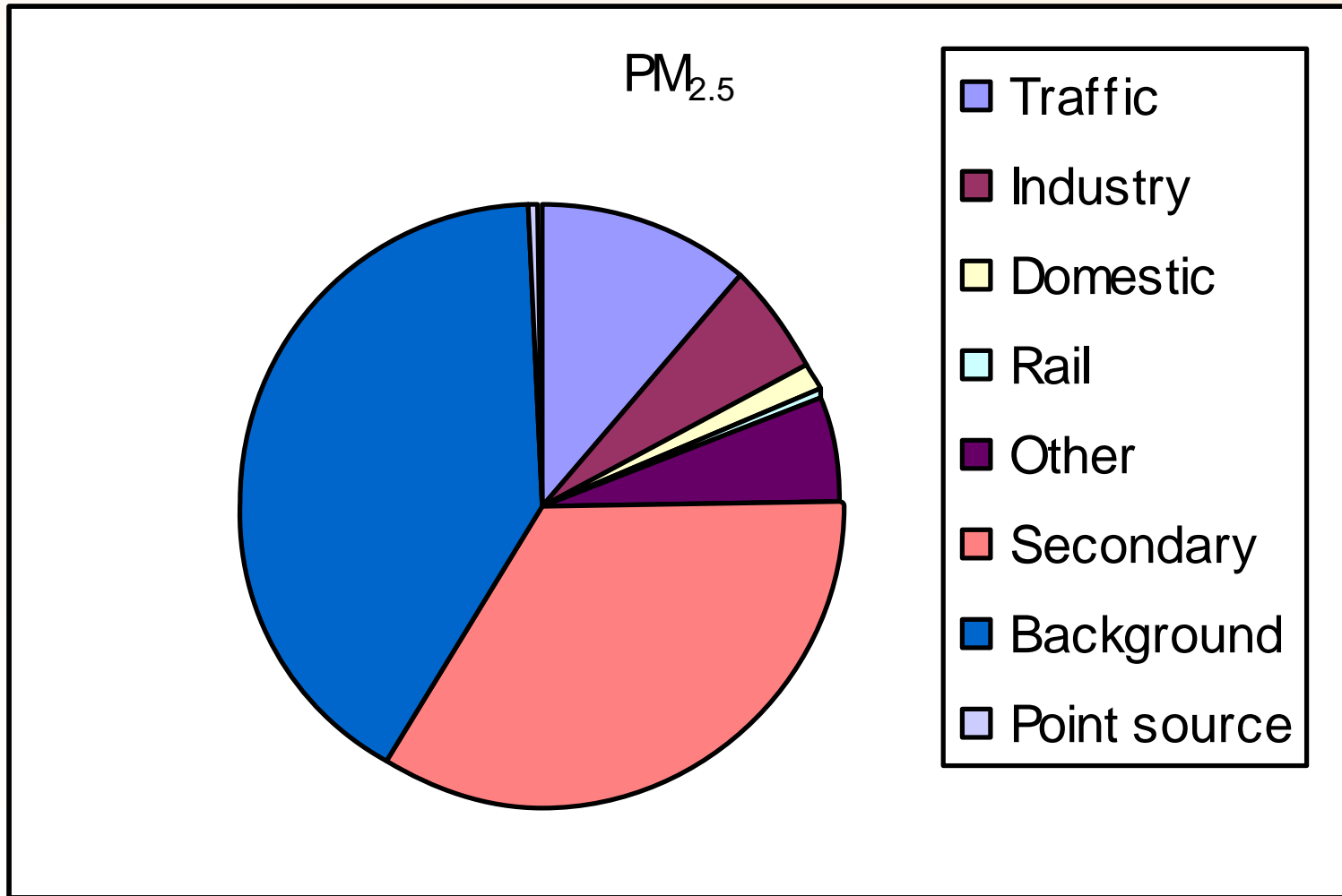




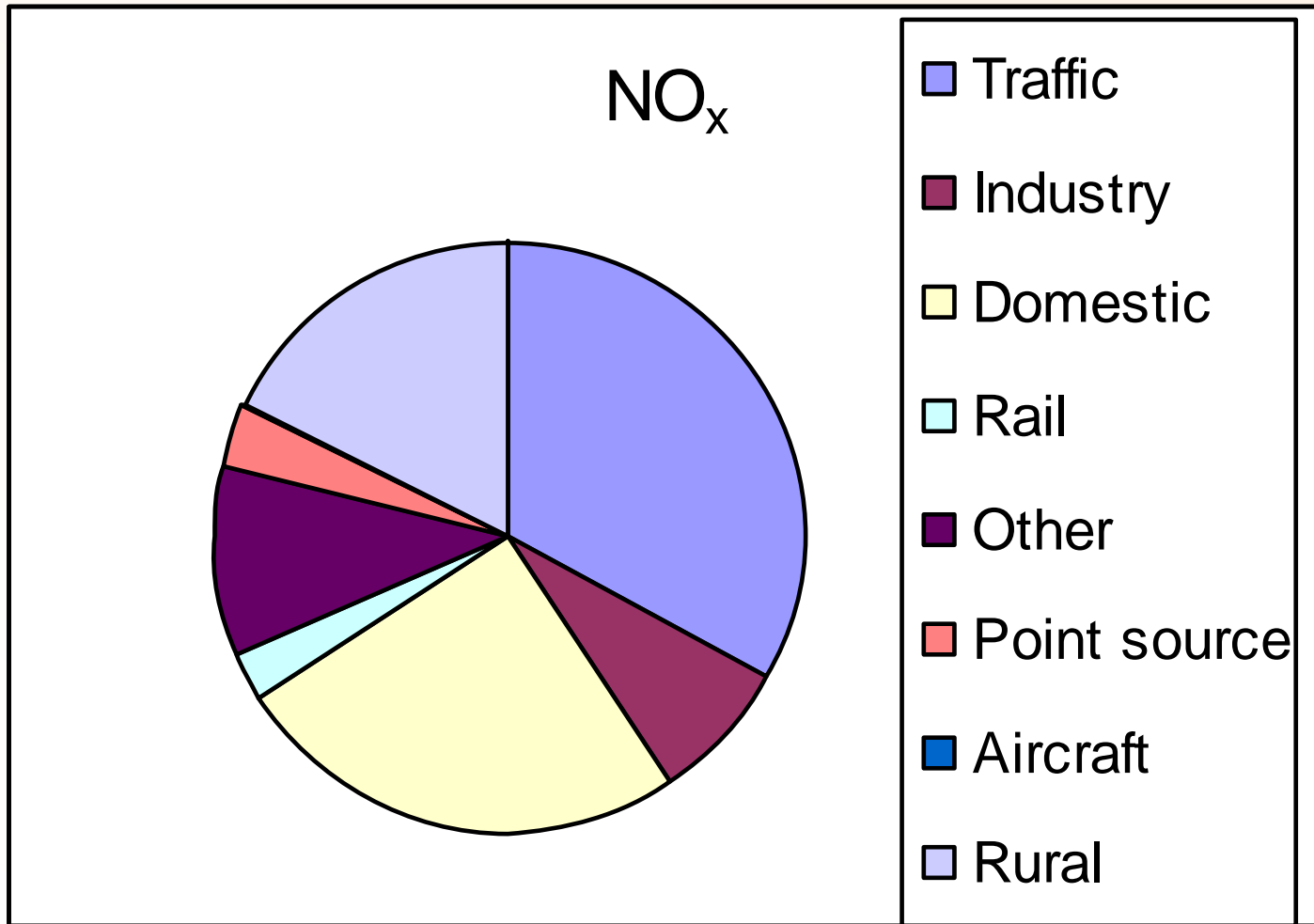
# Pollution sources: PM<sub>10</sub>



# Pollution sources: PM<sub>2.5</sub>



# Pollution sources: NO<sub>x</sub>





# Calculation of impacts of air pollution

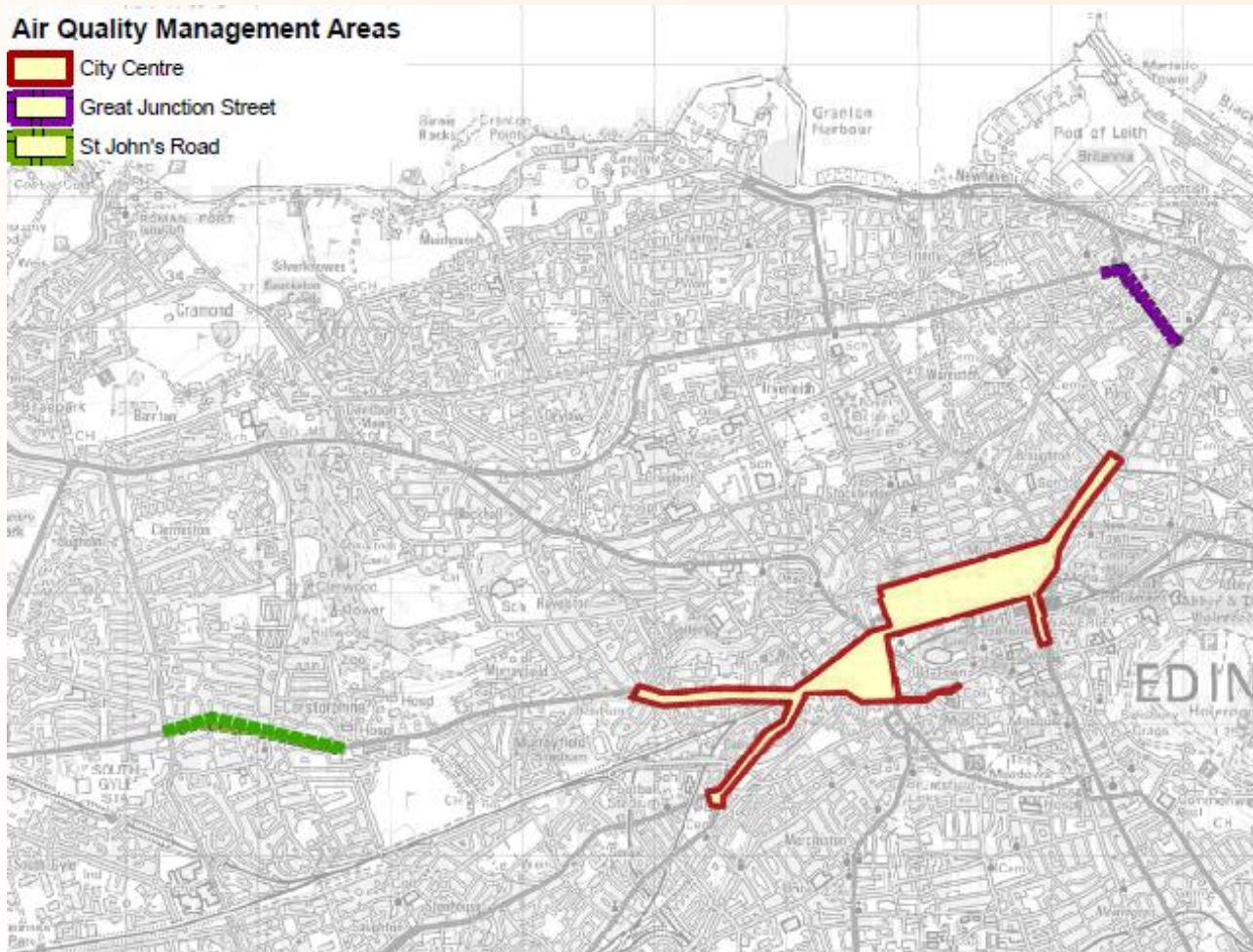
- City wide population mean concentrations estimated from netcen maps, factored for population density
- Concentrations in AQMAs estimated as  $18 \text{ ug m}^{-3}$  for  $\text{PM}_{10}$  and  $40 \text{ ug m}^{-3}$  for  $\text{NO}_2$  (AQ objectives);  $\text{PM}_{2.5}$  estimated in proportion to  $\text{PM}_{10}$
- Effects (cases/days per year exposure) estimated from concentration-response information used to underpin National Air Quality Strategy
- Concentration-response information for additional health endpoints from 2003 study of impacts of air pollution in Central Scotland



# Location of AQMAs in Edinburgh

## Air Quality Management Areas

-  City Centre
-  Great Junction Street
-  St John's Road



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

	City	AQMAs
Concentrations PM <sub>10</sub> ugm <sup>-3</sup>	11.1	18
Concentrations PM <sub>2.5</sub> ugm <sup>-3</sup>	6.9	11.6
Concentrations NO <sub>2</sub> ugm <sup>-3</sup>	15.2	40
Population	471650	9363*
% Population under 16	15.3%	8.7%
% Population over 60	19.8%	13.1%

\*including population within 25 m AQMA boundary

# Health impacts of current exposure to air pollution in Edinburgh

Annual impacts	City		AQMA	
	Background rate	Air pollution	Background rate	Air pollution
Deaths brought forward	3194	27	63	1
Emergency respiratory and CV hospital admissions	9368	88	198	3
GP visits asthma/ LRS	20605	974	609	31
Days loss life expectancy	-	846249	-	28304

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	9833	302
Restricted Activity Days:		
Days per adult per year	0.28	0.45
Total across population per year	11808	3893
Bronchitis – new cases per year	257	10



# Estimated contribution of traffic emissions to air pollution impacts

Air pollution impacts	City-wide	AQMAs
Loss of life expectancy	11.5%	40.7%
Emergency hospital admissions	16.2%	49.3%
GP consultations, increased symptoms in people with asthma	7.2%	38.4%

# Distribution of effects

	Percent within AQMAs
Population	2.0%
Days lost per year across population	3.3%
Number of deaths brought forward	3.7%
Emergency hospital admissions	3.4%
GP visits asthma/LRS	3.2%

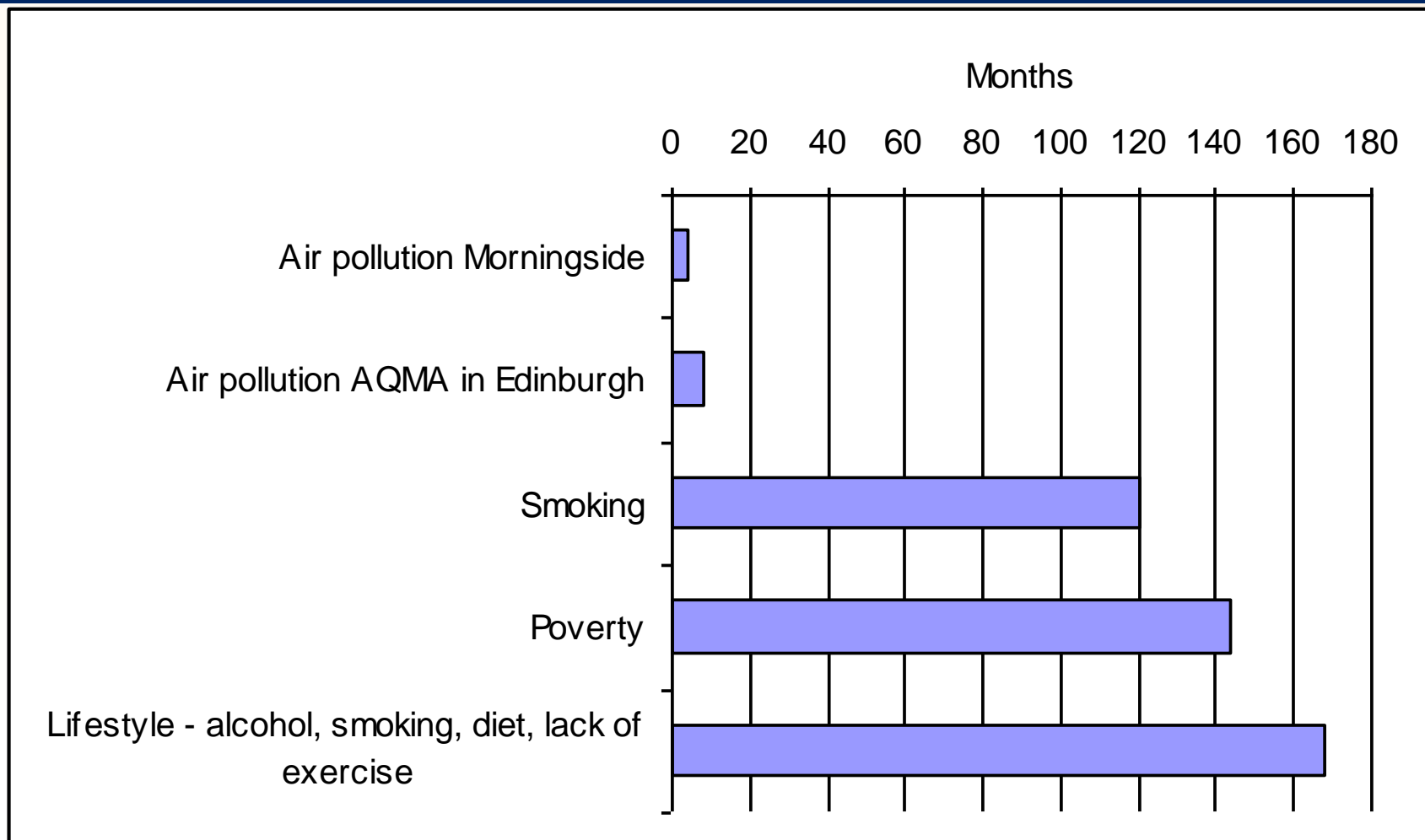




# Are air pollution impacts evenly shared?

- 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 Craigmiller versus Morningside?

# Public health importance of air pollution: Loss of life expectancy for individuals



# Benefits of reducing exposure to PM<sub>10</sub> and to NO<sub>2</sub> by 1 ug m<sup>-3</sup>

Annual impacts	Impacts of current air pollution		Benefit of 1 ug m <sup>-3</sup> reduction	
	City	AQMAS	City	AQMAS
Deaths brought forward	27	1	-2	-
Emergency respiratory and CV hospital admissions	88	3	-11	-
GP visits asthma/ LRS	974	31	-88	-2
Days loss life expectancy	846249	28304	-122912	-1572

Increase in individual life expectancy over 75 years: 20 days

# Benefits of reducing exposure to PM<sub>10</sub> and to NO<sub>2</sub> by 1 ug m<sup>-3</sup>

	City	AQMAs
Reduction in respiratory symptoms in asthmatics:		
Days per adult per year	0.17	0.17
Days per child per year	0.13	0.13
Total across population per year	886	17
Reduction in restricted Activity Days:		
Days per adult per year	0.03	0.03
Total across population per year	1064	216
Bronchitis – reduction in new cases per year	23	1

# Benefits of reducing exposure to traffic pollution by 10%

Annual impacts	Impacts of current air pollution		Benefit of 10% reduction in traffic pollution	
	City	AQMAS	City	AQMAS
Deaths brought forward	27	1	-	-
Emergency respiratory and CV hospital admissions	88	3	-2	-
GP visits asthma/ LRS	974	31	-7	-1
Days lost life expectancy	846249	28304	-9732	-932

Increase in individual life expectancy over 75 years: city wide - 2 days; AQMAS – 9 days

# Benefits of reducing exposure to traffic pollution by 10%

	City	AQMAs
Reduction in respiratory symptoms in asthmatics:		
Days per adult per year	0.01	0.11
Days per child per year	0.01	0.09
Total across population per year	71	9
Reduction in restricted Activity Days:		
Days per adult per year	<0.01	0.02
Total across population per year	1274	125
Bronchitis – reduction in new cases per year	2	<1

# 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
  - Reduced accident risk
- Improved liveability of neighbourhoods – improved mental well being





# Conclusions

- Air pollution in Edinburgh may be associated with about 100 emergency hospital admissions and 1000 extra GP consultations each year
- At current exposure levels, the individual Loss of life expectancy over 75 years is:
  - 135 days city average
  - 227 days AQMAs
- Substantial benefits in reducing population mean exposure to airborne particles – gain in life expectancy
- Little benefit in reducing NO<sub>2</sub> independently of reducing exposure to PM
- Reducing dependency on cars could bring other health benefits unrelated to air pollution



# Thank you for listening

