Ben Ewald

28-10-21

The Hon Mark Pearson MLC

Acting Committee chair

Portfolio Committee 7

Your ref: D21/53908

Thank you for the opportunity to respond to the criticisms of my health impact analysis work.

I would like to start by stating my credentials to undertake this work. As well as my clinical medical work I have completed a PhD in epidemiology, and taught epidemiology for the University of Newcastle for 19 years. I am the author of 49 scientific papers in the peer reviewed literature. My most recent publication was an example of air pollution health impact analysis (HIA), with co authors Prof Guy Marks, director of the Centre for Air Pollution energy and Health research (CAR) and Dr Luke Knibbs from the University of QLD. That paper is titled "Opportunity to reduce Paediatric asthma in NSW through nitrogen dioxide control"(1) and is published in the Australia and New Zealand Journal of Public Health 2021 http://dx.doi.org/10.1111/1753-6405.13111

Response to Malfroy:

The briefing note Mr Malfroy is responding to is, as you would expect, brief. It is less than one page of text plus a table, and is written to inform the local community of my best estimate of the asthma health burden due to power station nitrogen dioxide. It uses the same methods as the above HIA published in the ANZJPH but of course the journal article is much longer uses more technical language and is fully referenced as befits an academic journal.

On review of my briefing note I find that everything is correct, but I should clarify that in the table the second column, NO2 PPB is the power station contribution to ground level NO2, not total NO2. It should also make clear that this is the sum contribution from all 5 coal burning power stations in the state. The NO2 in Lake Macquarie is much more likely to have come from the two local power stations than to have blown in from Lithgow or Muswellbrook, but this is not quantified.

I feel that it is important to communicate health issues in a form the community can access. On the Central Coast there is a health problem, but neither the electricity companies or the EPA have ever communicated this to the local community so that task is left to NGOs like Doctors for the Environment Australia.

In Mr Malfroy's 11 page review of my one page briefing note he recalculates the asthma burden IF the ground level NO2 exposure due to power stations were only 0.2ppb, about one tenth the value in the results of the Exeter modelling I used. With this low value of NO2 he arrives at a health burden of 69 children having asthma due to power station nitrogen dioxide across the Lake Mac and Central Coast LGAs. The difference in asthma results is largely due to different air model results. Malfroy's calculatión is based on modelling reported in 2010 of pollution concentrations in 2004.

My exposure data comes from recent modelling conducted by Dr Andreas Anhauser and Dr Aidan Farrow at the University of Exeter. I am an epidemiologist not an air modeller, so I present their description of what they did:

Meteorology module. We use version 3 of the *The Air Pollution Model* (TAPM)[32] to calculate hourly meteorological conditions across a gridded model domain around the power stations. Although TAPM includes the ability to model pollutant dispersion, only its meteorology component is used. A more sophisticated chemistry-transport model is used to assess pollutant dispersion (see below). Around each of the power station groups TAPM is run on three nested domains with spatial resolutions of 30 km, 10 km and 5 km, respectively, getting finer towards the center . Boundary conditions for the meteorology simulation are derived from the GASP model data of the Australian Bureau of Meteorology.[33] In each simulation, the model is run for the whole year of 2018 with a 12 day spin-up period.

Chemistry-transport module. The atmospheric dispersion, chemical transformation and deposition of the power station emissions are modelled using version 7 of CALPUFF.[34] To isolate the impact of coal-burning power stations in this work, no boundary fluxes or emission sources other than the studied power stations are included in the model. No consideration is given to air pollution sources from other parts of the coal supply chain - such as mining, hauling, storage, coal ash disposal - or from other sources such as transport and industry. We include power station emissions of mercury (elemental, divalent and particle-bound), NO, NO_2, SO_2 and primary $PM_{2.5}$. Background concentrations of ozone (O_3), ammonia (NH_3) and hydrogen peroxide (H_2O_2) are included for use by the chemistry module. Chemical transformations of sulfur and nitrogen species are modelled using the ISORROPIA (gas-particle equilibrium NH_3, H_2SO_4, and HNO_3) and RIVAD (SO_2 to SO_4 and NO/NO_2 to HNO_3 and NO_3) chemistry modules within CALPUFF. The chemical reaction set requires background pollutant concentrations of ozone (O_3), ammonia (NH_3) and hydrogen peroxide (H_2O_2). These are obtained from Geos-Chem global benchmark simulations.[35] The model outputs an hourly time series of near-surface concentrations of the pollutants and the deposition of mercury at gridded receptor locations across the model domains.
CALPUFF is run for the whole year with static emission rates representing 100% utilisation of all of coal-burning power stations. Real world emissions from the power stations are time varying and power station capacity is in general not fully utilised (Table 1, see also Appendix A.1 for details). The resulting hourly ground-level pollutant concentration fields therefore represent a worst-case scenario. For the purposes of health impact assessment we only used annual average concentrations, which have been adjusted for real world utilization. Adjustment has been done with a scaling factor representing each station's load during 2018. This effectively spreads the station's annual emissions volume evenly through the year.

I note that CALPUFF is the specified modelling system listed in the NSW EPA 2016 publication Approved Methods for the Modelling and Assessment of Air Pollutants in NSW(2). The results of their modelling were expressed as a population weighted annual average for the boundaries of all LGAs in NSW. I regard Dr Farrow and Dr Anhauser as having a high degree of expertise and competence to do this work, and both modelling and computational methods have developed greatly since 2010. I regard the Exeter results to be a strong basis for health impact assessment, but would encourage the NSW government to commission their own independent modelling to fully answer questions of the health burden from all the air pollutants produced by coal fired electricity.

The evidence of Mr Everett (page 35-36 of transcript)

In response to questioning by Hon.Catherine Cusack, Mr Everett told the committee that the Australian Energy Council had commissioned a "peer review" of a previous Health Impact Assessment (HIA) of mine. I have a copy of that document, and to call it peer review is stretching the definition. Payment of a consultant by an industry looking to prevent reform does not constitute independent peer review.

The consultant report from EnRisk refers to the analysis I did for the report published by Environment Justice Australia in 2018 "The Health Effect of Fine Particle Pollution from Electricity Generation in NSW"(3)This piece of work is another HIA using similar methods to the ANZJPH paper. The power station contribution to fine particle pollution was based on the work of Dr David Cohen from ANSTO, some of which is published in the peer reviewed literature(4, 5), and other findings released by the NSW EPA as particle characterisation studies for both the Upper and Lower Hunter(6, 7). My analysis was published by Environment Justice Australia during a campaign to increase public awareness of air pollution from power stations. The peer reviewed scientific journals do not consider papers that have been previously published elsewhere, so that work was never subject to formal peer review. As an academic working on contentious issues one has to make a choice between peer reviewed journal publication or general media publication.

In summary, my analysis showed that secondary particle pollution from all the coal power stations in NSW causes an annual health burden of 279 (95%ci 190-367) deaths, 233 (95%ci 88-368) low birth weight babies, and 369 (95%ci 202-501) cases of incident diabetes. In each case the 95% confidence interval gives an estimate of the statistical precision of the concentration response function (CRF). There is considerable uncertainty in the estimates for the Central Coast, but that region accounts for only a small part of the total health burden. The largest part of the health burden is for Sydney, and that region had the highest certainty.

In the EnRisk review they checked all the calculations and could not find any errors. When they examined my table of results row by row, for each one they added the comment "values essentially the same". They then substituted lower values for the power station contribution to fine particle pollution derived from some very old modelling and found that the power stations were killing 98 people per year. (This value is the sum of the bottom row of their revised calculation in table 1 of the report). I note that the AEC failed to include this important number in their position statement.

The Enrisk report is full of errors such as:

Paragraph 2 at 6.1 confuses the notions of validity and causation. Causation has accepted criteria as identified by Doll and Hill that the author seems unaware of.

EnRisk completely confuse emissions and exposure. They quote CSIRO that 90% of PM2.5 in Australia is from natural sources. This includes the entire fire season in northern Australia which has nothing to do with exposure in the air people breathe in NSW. To make this statement is disingenuous and misleading, but is typical of their approach.

Evidence of Mr Flood (page 29 of transcript)

I understand Mr Flood has no expertise in health or epidemiology, but is disputing the associations of fine particle air pollution with low birth weight and incident diabetes. These are supported by systematic reviews and meta analysis of the world literature so I have high confidence in them.

To quote the recently released WHO Air Quality Standards 2021(8) page 11:

To date, strong evidence shows causal relationships between $PM_{2.5}$ air pollution exposure and all-cause mortality, as well as acute lower respiratory infections, chronic obstructive pulmonary disease (COPD), ischaemic heart disease (IHD), lung cancer and stroke (Cohen et al., 2017; WHO, 2018). A growing body of evidence also suggests causal relationships for type II diabetes and impacts on neonatal mortality from low birth weight and short gestation (GBD 2019 Risk Factors Collaborators, 2020).

Summary

There is a substantial health burden for people on the Central Coast from nitrogen dioxide and for people across the Greater Metropolitan Region from fine particle pollution due to burning coal for electricity. Various estimates of the scale of these health burdens have arrived at different numbers, but nothing that has been put forward to the committee undermines the fact that there is a health case to answer for continuing to pollute at current levels and that it is the duty of governments to protect their citizens through the precautionary principle.

I thank the committee for their interest in the health impacts of coal fired electricity, and how these might be minimised to protect public health.

Yours Sincerely

Dr Ben Ewald B.Med PhD

Attachments

ANZJPH HIA

Asthma briefing note

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Opportunity to reduce paediatric asthma in New South Wales through nitrogen dioxide control

Ben Ewald,[1] Luke Knibbs,[2] Guy Marks[3,4]

Abstract

Objective: The main sources of nitrogen dioxide (NO_2), road vehicles and electricity generation, are currently in a period of technological change. We assessed the number of cases of childhood asthma in New South Wales that could be avoided by lowering exposure to NO_2 by 25% from current levels.

Methods: Health impact assessment calculations for each of the 128 local government areas were based on the population of children aged 2 to 14, the prevalence of asthma derived from the 2017 NSW health survey, NO_2 exposure from a land-use regression model using satellite data, and risk estimates derived from two meta-analyses and one Australian study.

Results: A 25% reduction in NO_2 below current exposure would lead to between 2,597 and 12,286 fewer children with asthma in NSW. The wide range in these estimates reflects the variation in concentration-response functions used.

Conclusions: Even the lowest of these estimates would be a worthwhile reduction in this common childhood illness.

Implications for public health: A 25% reduction in NO_2 is ambitious, but it is achievable through improved vehicle exhaust standards, increasing electric vehicle numbers, and reform of the electricity sector. Current Australian ambient air quality standards for annual NO_2 should be revised downwards.

Key words: nitrogen dioxide, asthma, air pollution

Nitrogen dioxide (NO_2) is an irritant gas that has adverse respiratory effects, especially on children. NO_2 dissolves in the airway lining fluid, where the formation of nitration products and direct oxidative effects cause tissue inflammation.[1] Based on an extensive review, the US EPA Integrated Science Assessment concluded, in 2016, that "… evidence for asthma attacks supports a causal relationship between short-term NO_2 exposure and respiratory effects. Evidence for development of asthma supports a likely to be causal relationship between long-term NO_2 exposure and respiratory effects".[2] There is, however, uncertainty about the degree of asthma risk increase for a given exposure to NO_2.

Several meta-analyses have examined this question. Favarato et al. found 18 studies published before 2013 using a 12-month period prevalence definition for asthma and estimated that for each 4 ppb increase in annual average NO_2 concentration, there was a 4% (95%CI: 0–8%) increase in the prevalence of asthma in children.[3] Khreis et al. found 20 studies published before 2016 using a more inclusive definition of lifetime prevalence of doctor-diagnosed asthma but a stricter definition of exposure, and found that for each 4 ppb increase in NO_2 there was a 10% (95%CI: 4–14%) increase in asthma.[4] These international data were supported by a recently published cross-sectional survey of 2630 children aged 7–11 years living in 12 Australian cities. This study estimated that, for each 4 ppb increase in NO_2 concentration in the ambient environment, there was a 24% (95%CI: 8–43%) or 54% (95% CI: 26–87%) increase in the prevalence of current asthma, depending on the method for assessing NO_2 exposure.[5] Exposure to NO_2 also occurs indoors, however, these are the best estimates of the outdoor ambient exposure effects.

The prevalence of asthma among children in Australia is higher than in many other countries. Among children aged 2 to 14 years the 2017 prevalence of asthma was 12% in boys and 8% in girls.[6] Asthma has been estimated to be the largest contributor to disease burden in children aged 14 years and under[7] and is a common reason for presentation to general practice. The BEACH survey of general practice estimated that asthma accounts for 11.1% of all consultations.[8] Hence, we have a reason to focus on the prevention of asthma through population-level strategies.

Until 2015, NO_2 concentrations measured at urban background locations in Australian cities were trending down, however, since then the trend has flattened or even risen slightly. Given this adverse trend, the current review of the Australian Standard[9] and the importance of asthma in Australia, we believe it is timely to assess the potential impact of a reduction in NO_2 exposure that might be achieved by setting a lower National Environment Protection Measure standard for NO_2. The objective of this analysis was

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to measure the impact of an ambitious but achievable 25% reduction in the current annual average NO_2 on the prevalence of asthma in NSW children. Such reductions have been achieved elsewhere, for instance, annual average urban background NO_2 in the UK decreased by two-thirds between 1992 and 2018, albeit from a higher level than experienced in Australia.[10]

Methods

We performed a health impact assessment following the methods of Fann et al.[11] For each of the 128 local government areas (LGA) in NSW, we estimated the current prevalence of asthma and the current annual average NO_2 concentration. Applying concentration-response coefficients for NO_2 and asthma, we estimated the impact of a 25% reduction in annual average NO_2 concentration on prevalence. Finally, we summed the impacts across all LGAs to estimate the impact for all of NSW.

For each LGA, we retrieved the prevalence of asthma in children aged 2 to 14 years from the 2017 NSW Health Survey[12] and the population in this age range from the Australian Bureau of Statistics (ABS) Estimated Resident Population. We estimated annual average NO_2 concentrations for 2017 at all ABS mesh blocks (smallest census unit, 30–60 households) in each LGA using a validated satellite-based land-use regression model to give a population-weighted average NO_2 value for each LGA.[13] We assumed the NO_2 concentration applied to all residents of the LGA and applied the several risk estimates from the two meta-analyses and the Australian study mentioned above. Based on these risk estimates we calculated the number of prevalent cases of asthma that would be averted if the annual average NO_2 concentration in the LGA was 25% lower than the current concentration. We used the following formula:

$$P \times D \times \left(1 - \frac{1}{r^c}\right)$$

where

P is the population aged 2–14 years in each LGA

D is the prevalence of asthma among persons aged 2–14 years in each LGA

r is the relative risk of the concentration-response function per 4 ppb

C is the 25% reduction in NO_2 for each LGA (units ppb/4).

The estimated number of cases averted in each LGA was summed across NSW to estimate the total number of prevalent cases of asthma in children aged 2 to 14 years that would be averted with a 25% reduction in the annual average concentration of NO_2.

Results

Based on the NSW Health Survey, there were 162,040 (13% of 1.25 million) children aged 2 to 14 years in NSW who have a history of wheezing illness or used asthma medication in the past 12 months. The satellite LUR model estimated that the population-weighted annual mean (±SD) NO_2 concentration for NSW was 6.3 (±2.5) ppb.

Applying the risk estimate from the Favarato meta-analysis the number of cases of asthma in children aged 2 to 14 averted by a 25% reduction in the annual average concentration of NO_2 was 2,597 (95%CI: 0–4613). Using the risk estimate from the Khreis meta-analysis the result was 5,475 (95%CI: 2247–7530) and applying the risk estimate from the Australian cross-sectional study the result was that 12,286 (95%CI:4527–19,823) cases could be averted. This represents 1.6%, 3.4% and 7.6% of the total asthma burden, respectively. Using the Favarato risk estimate some of the small LGAs in the far west of the state had less than one averted case, while the large Canterbury-Bankstown LGA had 198 (Table 1).

Discussion

Lowering NO_2 exposure by 25% would lead to fewer children with prevalent asthma. It is a feature of the health impact assessment method that it relies on a concentration-response function derived from research conducted across a wide range of settings that give different risk estimates. We have based this analysis on three credible estimates of the risk, each with its own strengths and weaknesses. While there is a wide range between our three estimates, achieving even the smallest would be an important health gain.

The Southern California Children's Health Study followed three cohorts of children between 1993 and 2014, during which time average NO_2 decreased from 24 ppb to 18 ppb.[14] A modelled 20% decrease in NO_2 beyond the decline that actually occurred was predicted to decreased asthma incidence by a further 19.6%. This is a higher proportion than we have predicted for NSW, but not unexpected as California has a higher baseline level of NO_2 exposure.

A recently published global study based on the Khreis meta-analysis showed that, for Sydney, approximately 13% of asthma incidence could be attributed to total NO_2 exposure, congruent with our estimate of 3.4% from one-quarter of current exposure.[15] A strength of our analysis is the statewide scope and the use of geographically specific values for NO_2 exposure and asthma prevalence.

Reductions in NO_2 exposure could be pursued through more stringent national ambient air quality standards, and low or zero emissions vehicles as a population-level approach to reduce asthma in NSW. One positive development is the serious attention being paid to the construction of Metro rail lines in both Sydney and Melbourne that will make train transport the quick, easy and cheap option. Reducing the number of car trips improves both air quality and safety.

Opportunities to achieve health gains through the current review of Australia's air quality standards have been further discussed in a companion paper.[16]

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Table 1: Population numbers, asthma prevalence, modelled NO2 exposure and the results of health impact calculations for the number of asthma cases potentially averted by a 25% reduction in annual NO_2 exposure for selected Local Government Areas of NSW.

Local Government Area	Population of children aged 2 to 14 years	Prevalence of asthma(%)	Annual average NO_2 concentration (ppb)	Number of cases of asthma averted by a 25% reduction in NO_2*
Canterbury-Bankstown	63,492	13.4	8.6	198
Northern Beaches	45,560	15.6	7.0	135
Liverpool	41,648	13.4	7.5	113
Penrith	36,900	18.5	5.7	105
Fairfield	34,501	13.4	8.4	105
Central Coast	54,952	12.1	5.4	97
Lake Macquarie	32,844	17.2	5.9	90
Inner West	24,961	11.7	10.7	84
Newcastle	23,561	17.2	7.6	84
Hornsby	25,481	15.6	6.4	69
Blacktown	68,289	5.1	6.9	65
Campbelltown	30,343	13.4	5.8	63
Sutherland Shire	37,670	9.3	6.6	62
Ku-Ring-Gai	22,376	15.6	6.5	62
Wollongong	33,286	11.5	5.6	59
Ryde	16,925	15.6	8.1	58
Bayside	22,610	9.3	10.1	57
Sydney	12,275	11.7	14.0	54
Willoughby	12,998	15.6	9.2	50
Cumberland	38,962	5.1	9.0	48
Parramatta	36,400	5.1	9.3	47
Georges River	22,135	9.3	8.3	46
Randwick	18,884	9.3	9.6	46
Maitland	15,248	17.2	5.2	37
North Sydney	7,462	15.6	11.2	35
Canada Bay	12,644	11.7	8.6	34
Camden	16,703	13.4	4.8	29
Wagga Wagga	11,492	24.6	3.6	28
The Hills Shire	30,938	5.1	6.1	26
Lane Cove	5,937	15.6	10.4	26
Waverley	9,596	9.3	10.7	26
Blue Mountains	12,877	18.5	3.9	25
Albury	8,607	24.6	4.3	25
Port Stephens	11,467	17.2	4.6	25
Hawkesbury	11,672	18.5	4.1	24
Cessnock	10,270	17.2	4.8	23
Woollahra	7,856	9.3	10.6	21
Remaining 91 LGAs with less than 20 cases averted	322,590			414

Note:

** based on meta-analysis estimate that relative risk of asthma is 1.04 per 4 ppb increase in NO_2*

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Power station NO_2 emissions and paediatric asthma in Central Coast, Hunter Valley and Sydney Local Government Areas

Briefing note by Dr Ben Ewald*, January 2021

Asthma is a common paediatric illness that has many causes, one of which is nitrogen dioxide (NO_2), a pollutant that comes from power stations and road vehicles.

Across the Greater Metropolitan Region (GMR), 46% of NO_2 comes from power stations, 15% from road vehicles, with the road pollution being released closer to where many people live.

Modellers at the University of Exeter in the United Kingdom used CALPUFF, an advanced, integrated modelling system for the simulation of atmospheric pollution dispersion, to estimate the proportion of ground-level NO_2 that originated from NSW coal-fired power stations (CFPS) across Local Government Areas. CALPUFF is the NSW Environmental Protection Authority's approved method for modelling and assessing air pollutants.

Publicly available health and population data was used to determine the number of children in Local Government Areas on the Central Coast and in Sydney and the Hunter Valley who have asthma, and the proportion that is attributable to NO_2 emitted by CFPSs (see Table 1 below).

Analysis found 6% of asthmatic children in Lake Macquarie LGA suffered the condition due to power station NO_2 emissions, while the figure was 5% for the Central Coast, Cessnock and Muswellbrook.

Emissions of NO_2 from NSW CFPSs could be significantly reduced using existing technologies, such as scrubbers, and by applying stricter air pollution standards.

All countries in North America, Europe or North Asia require power stations to have scrubbers that remove noxious gases from the chimney before they escape into the atmosphere. The NO2 emissions standards for CFPSs in other countries are significantly more stringent than those that apply in NSW. While the NSW power stations comply with their licences, the emissions standards contained within those licences are decades old and do not reflect world's best practice.

For example, Vales Point power station in NSW is allowed 1500 mg/m3 NO_2 whereas the standard for existing plants in Europe is 150 mg/m3 and 57 mg/m3 in Japan.

Table. *Ground-level NO_2 concentrations (PPB) in Sydney, Central Coast and Hunter Valley Local Government Areas. Number of children aged 2-14 with asthma attributable to CFPS NO2 emissions. The percentage of all asthma cases that is attributable to CFPS NO_2 emissions. [1] [2]*

LGA	NO_2 PPB	Cases	95% ci Lower	95%ci Upper	% of all cases
Lake Macquarie	2.50	320.7	132.3	439.5	6
Central Coast	2.21	334.5	137.7	459.1	5
Cessnock	2.21	88.8	36.6	121.9	5
Muswellbrook	2.07	26.7	11.0	36.7	5
Maitland	1.81	108.6	44.6	149.4	4
Newcastle	1.62	150.2	61.6	206.6	4

*Dr Benjamin Ewald is Conjoint Senior Lecturer, School of Medicine and Public Health, University of Newcastle, and a member of Doctors for the Environment Australia.

Singleton	1.55	27.0	11.1	37.1	4
Hornsby	1.18	107.6	44.0	148.4	3
Upper Hunter	1.03	10.9	4.5	15.0	2
Northern Beaches	1.02	166.5	68.0	229.8	2
The Hills Shire	0.93	34.1	13.9	47.0	2
Port Stephens	0.92	42.1	17.2	58.1	2
Ku-ring-gai	0.90	72.5	29.6	100.0	2
Willoughby	0.82	38.4	15.7	53.1	2
Edward River	0.82	6.8	2.8	9.3	2
Mosman	0.78	13.1	5.3	18.1	2
Hawkesbury	0.76	38.0	15.5	52.5	2
Ryde	0.76	46.3	18.9	63.9	2
North Sydney	0.76	20.4	8.3	28.1	2
Woollahra	0.74	12.5	5.1	17.2	2
Lane Cove	0.74	15.8	6.4	21.8	2
Waverley	0.72	14.9	6.1	20.6	2
Blacktown	0.71	57.1	23.3	78.9	2
Parramatta	0.70	30.0	12.2	41.4	2
Sydney	0.69	23.0	9.4	31.8	2
Hunters Hill	0.69	6.1	2.5	8.5	2
Randwick	0.67	27.2	11.1	37.6	2

Notes

[1] The definition for asthma is 12-month period prevalence, i.e., children who have been wheezy or required asthma medications in the last 12 months.

[2] Asthma prevalence was derived from the NSW health survey, and population data from the Australian Bureau of Statistics.

[3] The risk estimate is from a meta analysis published by Khreis, H., et. al, 2017. Exposure to traffic-related air pollution and risk of development of childhood asthma: A systematic review and meta-analysis, Environment International Volume 100, March 2017, Pages 1-31

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