

From: geralyn mccarron

Sent: Wednesday, November 13, 2013 8:14 AM

To: Hanlon, Edward

Subject: EPA's Science Advisory Board's (SAB) Hydraulic Fracturing Research Advisory Panel
- submission

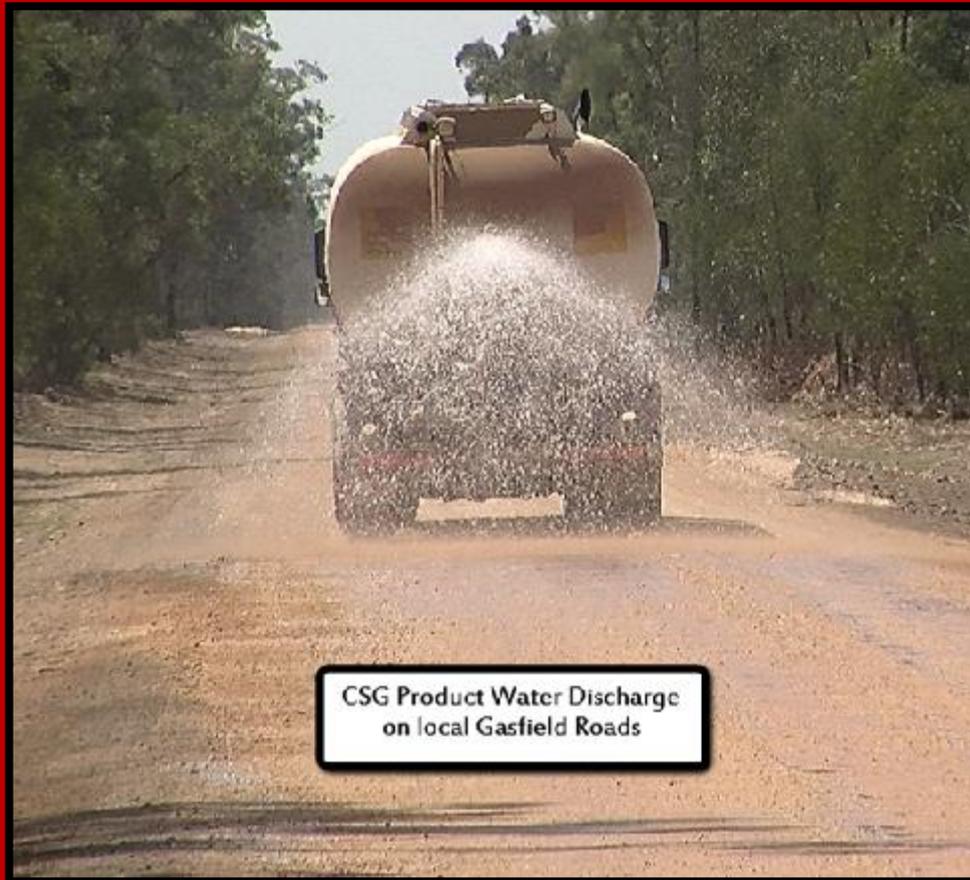
Dear Mr Hanlon,

I would like to make a submission to the EPA's Science Advisory Board's (SAB) Hydraulic Fracturing Research Advisory Panel. Please find two documents attached.

Yours sincerely,
Dr Geralyn McCarron

Symptomatology of a gas field

An independent health survey in the Tara rural residential estates and environs



CSG Product Water Discharge
on local Gasfield Roads

Photo courtesy local resident

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EXECUTIVE SUMMARY

This report documents an investigation during February and March 2013 by a concerned General Practitioner, in relation to health complaints by people living in close proximity to coal seam gas development in SW Queensland.

Thirty -five households in the Tara residential estates and the Kogan/Montrose region were surveyed in person and telephone interviews were conducted with three families who had left the area. Information was collected on 113 people from the 38 households. Of these, 17 were children 5 years of age or less, 31 were children aged between 6 and 18, and 65 were adults aged between 19 and 82. 58% of residents surveyed reported that their health was definitely adversely affected by CSG, whilst a further 19% were uncertain. The pattern reported was outside the scope of what would be expected for a small rural community. In all age groups there were reported increases in cough, chest tightness, rashes, difficulty sleeping, joint pains, muscle pains and spasms, nausea and vomiting. Approximately one third of the people over 6 years of age were reported to have spontaneous nose bleeds, and almost three quarters were reported to have skin irritation. Over half of children were reported to have eye irritation.

A range of symptoms were reported which can sometimes be related to neurotoxicity (damage to the nervous system), including severe fatigue, weakness, headaches, numbness and paraesthesia (abnormal sensations such as pins and needles, burning or tingling). Approximately a third of the all the 48 children to age 18 (15/48) were reported to experience paraesthesia. Almost all the 31 children aged 6-18 were reported to suffer from headaches and for over half of these the headaches were severe. Of people aged 6 years and over, severe fatigue and difficulty concentrating was reported for over half. Parents of a number of young children reported twitching or unusual movements, and clumsiness or unsteadiness.

This unfunded study is limited in terms of what can be concluded and does not claim to be without methodological problems. However what it does do is highlight the basis for serious concerns of the residents and the need for the Queensland government to fund a comprehensive epidemiological investigation of the problem.

No baseline air or water monitoring or baseline health studies were done prior to the Queensland Government permitting the widespread development of the CSG industry in close proximity to family homes. No ongoing health study or surveillance and no ongoing testing to monitor chronic exposure levels is in place. This is clearly unacceptable.

The rural residential estates near Tara are the most densely settled area in Australia to have seen intensive CSG development. Since 2008, the people of these estates have informed successive Queensland Governments of their health problems. Their reports of ill health have been trivialised and ignored. The recent report released by the Queensland Government following their investigation into the health impacts near Tara was so inadequate and flawed that it has done little to alleviate concerns.

The Queensland government undertook minimal non-systematic environmental sampling, and relied mainly on inadequate industry commissioned data. The investigation of patient symptoms was grossly underfunded and understaffed, with no medical staff actually visiting the site. Only 15 people were examined clinically. Positive findings of volatile chemicals were dismissed, despite the fact they are potentially capable of causing health impacts, especially over long periods of time.

The state government must take its responsibility for the health of these citizens seriously, and the federal government must develop federal legislation to protect public health from CSG impacts.

Recommendations are:

- 1) A fully funded comprehensive medical assessment of residents currently living in proximity to unconventional gas development should be carried out as a matter of urgency.
- 2) The planning and urgent implementation of fully funded, long term epidemiological studies is essential to track the health of people exposed to CSG over the next several decades. This must include workers in the industry as well as people who may already have left the area because of health concerns.
- 3) Health impact assessments must be an integral part of any and every unconventional gas development. No new permit should be issued without one, and health impact assessments should be carried out for every development already in place.
- 4) Comprehensive air and water monitoring (an open, ongoing and unlimited information loop) is essential. If we are looking at possible non beneficial human health impacts we need to look at all the gases and volatiles both natural and derived emitted via well drilling, gas and pipeline valves, leaking wellheads, flaring, and other processes involved in gas collection/purification/refining to export specifications. This monitoring is urgently required. It must be independent, unbiased, fully funded and available for public scrutiny preferably in real time and in electronic form.
- 5) Gas companies must be required to fully and openly disclose in a timely manner, all chemicals, and all quantities of chemicals, used or planned to be used for drilling, fracking, cleaning, dehydration, and other processes at every gas facility. All historical results they have of analyses of air, soil and water should be available for public scrutiny.
- 6) The federal government must develop legislation, a unified standard, to protect public health across Australia from the impacts of unconventional gas development and other extractive industries.
- 7) There must be open, fully informed, public debate on the future of the unconventional gas industry in Australia.

ACKNOWLEDGEMENTS

I would like to thank the residents of the Tara estates and surrounding areas for their trust and cooperation in completion of this survey which was, for very private people, at times intrusive and distressing. I sincerely hope this study will help to inform the wider community and highlight the basis of your serious concerns.

ABSTRACT

The unconventional gas industry has been allowed rapid, unprecedented expansion in Queensland within recent years with little regard to the public health consequences. The people of the remote rural residential estates on the Western Downs near Tara in Queensland are suffering from the side-effects of the industry. Despite their pleas over the past few years to successive Queensland Governments, as illustrated in the recently released Queensland Government health report into the effects of CSG in the Tara region, their reports of ill health have been trivialised or ignored.

Conversely this study found a pattern of symptoms which is extremely concerning. In particular a high percentage of the residents surveyed had symptoms which could relate to neurotoxicity. These included tingling, paraesthesiaⁱ, numbness, headaches, difficulty concentrating and extreme fatigue. Of particular concern was the high percentage of symptomatic children, with paraesthesia being reported in approximately a third (15/48) of children to age 18, and headaches being reported in more than 70% (36/48). These symptoms deserve further investigation, something which has not been done adequately to date. If these symptoms are caused by living within a gas field, there are serious implications not only for this community but for many more across Australia. If the health implications of the unconventional gas industry continue to be ignored and the industry is allowed to develop along its current path, the potential exists for serious and widespread harm to human health across Australia.

ⁱ Paraesthesia refers to a burning or prickling sensation that is usually felt in the hands, arms, legs, or feet, but can also occur in other parts of the body.

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INTRODUCTION

I am a general practitioner who has been living and working in suburban Brisbane for the past 25 years. As little as 18 months ago, I was oblivious to the concept of unconventional gas extraction. Having been made aware of impacts of CSG and Shale gas developments overseas, I took an increasing interest in what was happening in rural Queensland, and I became increasingly concerned. I began following the story of the CSG industry in the Tara area and visited the region on several occasions as part of a community initiative called "Bridging the Divide".ⁱⁱ This put into sharp focus the problems being experienced by people living within Queensland's gas fields and led to me undertaking this study.

BACKGROUND

Within the past few years the unconventional gas industry, particularly coal seam gas (CSG) has been permitted to develop with remarkable rapidity across rural Queensland. Little or no consideration has been given to how this will affect public health. No baseline health studies were done prior to the Queensland Government permitting the widespread development of this controversial industry in close proximity to family homes. No ongoing health study or surveillance is in place. No baseline air or water monitoring was done and no ongoing testing to monitor chronic exposure levels has taken place.

As reported in The Courier Mail on February 11th 2013, the approvals for the coal seam gas developments were controversial and were pushed through despite the public servants responsible for drafting the environmental response stating clearly that serious harm would ensue.¹

The following is just one of 26 objections made by Simone Marsh, the public servant in charge of drafting the environmental response from the Queensland's Government Coordinator-General, to the process of approving the Santos GLNG project:

"It is clear the project's activities will lead to wide-spread, serious environmental harm and material environmental harm, as defined by the Environmental Protection Act, both during and following the removal, transportation and processing of coal seam gas,"¹

The Courier Mail also reported that the EIS assessment team responsible for vetting the safety of these multibillion dollar projects were given a physically impossible task.

DERM director (EIS assessment) Stuart Cameron, May 4, 2010 responded to a request for draft conditions to be submitted in three days:

ⁱⁱ Bridging the Divide is a city-country communication and support network involving health and social justice issues.

"I have consistently been advised by DIP (Department of Infrastructure and Planning) the QGC was down the track and that DIP had not even started writing their report. We have had no warning for this sudden request for immediate provision of QGC conditions or any notice of a meeting tomorrow. In addition we have the APLNG comment on their EIS due today for which we were given less than four weeks to deal with 10,000 pages. Once again I am faced with a physically impossible request along with the other 80 EIS projects that are starting to slip."¹

People who owned their own home and land did not have protection in legislation or the right to prevent gas companies coming onto their property. Their only legal recourse was to negotiate compensation. Communities had no choice.

The circumstances surrounding the permitting of the coal seam gas developments have now been referred to the Crime and Misconduct Commission. The alleged inadequacies in the assessment process for CSG projects highlight the failure of state governments to put in place adequate protections for communities and the environment. No health impact assessment was undertaken for the CSG developments approved initially and no health impact assessment has been required for developments since.

TARA CASE STUDY

The rural residential estates outside Tara in Queensland's Western Downs are surrounded by the infrastructure of the coal seam gas industry and unconventional gas development. Since 2008, the people of these estates have been trying to draw the attention of successive Queensland Governments to their health problems.

It is approximately 70km from Chinchilla in the north to Tara in the south along the Chinchilla-Tara road. Major gas fields and infrastructure are located in the region between Chinchilla and Tara. They are under the control of Queensland Gas Company (QGC), British Gas, Origin and others. The Tara rural residential estates are located in the same area with most of the estates lying south of the immense Kenya gas field with its evaporation ponds, dehydration plants, compressor stations and associated infrastructure.

The Talinga gas field is to the North West, Ironbark to the West and Kenya East to the east. While hundreds of gas wells surround the residences, the Codie, Kate and Jake fields are actually situated within the Tara estates.



LAYOUT OF GAS FIELDS IN RELATION TO TARA RESIDENTIAL ESTATES
@Google 2013



GIANT KENYA HOLDING PONDS
@Google 2013



TALINGA GASFIELD, COMPRESSOR AND INFRASTRUCTURE
(NORTH OF RESIDENTIAL ESTATES)
@Google 2013

These major projects are often described as “development”ⁱⁱⁱ but their introduction has not brought better quality of life or additional services to the local people. The residents live on rural blocks ranging in size typically from 30 to 250 acres. They are surrounded by the infrastructure of the gas industry. There are no shops, petrol stations, schools or other basic facilities. The nearest doctor is in Tara which is an approximately 70km round trip. Residents habitually travel to medical facilities in Chinchilla, Dalby and Toowoomba where the regional base hospital is located.

Beyond the estates towards Kogan and Montrose, there has also been rapid CSG development on large acreage agricultural blocks.

In June 2012 the Queensland Government finally committed to investigate the growing health complaints of residents. On 21st March 2013 Queensland Health issued a report titled ‘Coal seam gas in the Tara region: summary risk assessment of health complaints and environmental monitoring data report.’²

Between June 2012 and March 2013, no doctor employed by the Queensland Government visited the residential estates to speak to the residents. The township of Tara was the closest that the Queensland Government doctors got to the source of the

ⁱⁱⁱ People who express concerns about the unconventional gas industry are often referred to as ‘anti-development’.

health complaints. Considering they were investigating the health impacts of living in a gas development it is somewhat surprising that no on-site visits were made.

In the nine months available to them, the Queensland Government Departments failed to establish a comprehensive, systematic long term testing regime to monitor potential chronic exposure to air or water borne toxins. Instead they commissioned QGC, the gas company at the heart of the residents' health complaints, to undertake testing, creating a clear conflict of interest. Sampling, which occurred as one off events at nine residences, was entirely inadequate in scope and duration. Importantly, what is missing are analyses of the gases produced in the localities concerned by flaring, well leakages and pipeline venting.

There is evidence of irregularities in the documentation accompanying the test samples. On the chain of custody for one site the start time was documented as 09:37 and finish time 07:30. In that particular case, the family left home shortly after the QGC representatives arrived. When the family returned at lunchtime, the QGC representatives had gone taking all their equipment with them. Sampling which is documented as lasting 22 hours could only have lasted for approximately 1-3 hours.

Apart from a limited number of passive samplers, in the 9 months of the investigation, the only other air testing employed was random 30-60 second Summa canisters. These tests were undertaken by the resident themselves.

People who believed they were impacted by CSG were told to phone a 13 HEALTH number or report to their local GP or hospital to fill in a questionnaire. No dedicated medical team was formed to undertake health assessments. One doctor from the Darling Downs Public Health unit was given the task of collating the information from the 13 HEALTH numbers and local doctors. This was in addition to their normal work load. No referral system was set up to assist the local doctors.^{iv}

On 11th and 12th October 2012, Dr Keith Adam, held a clinic in Tara as part of the promised Queensland Government investigation. The clinic was poorly advertised. A second clinic was promised but never took place. Dr Adam is from Medibank Health Solutions, a private healthcare company and is retained as a consultant by two large coal companies.³

By February 2013 no health report had been published, yet both the industry and politicians had repeatedly stated that Queensland Health had investigated and no health problem had been found. In a letter printed in The Sydney Morning Herald (19th January 2013), Rick Wilkinson, Chief Operating Officer Eastern Region, Australian Petroleum Production & Exploration Association Ltd (APPEA) claimed that Queensland Health had *"reported no pattern of illness consistent with effects from natural gas extraction."*⁴

^{iv} Shortly after announcing the health investigation, the Queensland Government sacked 14,000 public servants including many from Queensland Health.

Given the events and circumstances outlined above, I reluctantly concluded that the Government had no real commitment to investigate public health complaints related to CSG development. As a general practitioner, I was concerned about the potential long-term damage being done to the health of the people living in the residential estates. I decided to carry out my own study to clarify whether or not the implication that only a “handful” of people perceived health impacts was true, and then to document these perceived health impacts.

This paper does not claim to be a comprehensive health assessment of the people living within the Queensland gas fields. It is a health survey based on the voluntary work of one person in conjunction with the residents. In the nine months of their investigation the Queensland Government had the opportunity, the time and the resources to do what is necessary: to set up a detailed research study including comprehensive history taking, full clinical examination, testing and long term follow up. That still remains to be done. A comprehensive study would effectively investigate exposure and symptoms. It could compare the symptoms of those living near gas wells with those not exposed, or it could investigate the individual exposures of those who complain of illness with those who appear well. It would, as an added benefit, pick up and provide opportunity to treat cases of unrelated illness which have fallen through the gaps in the health system.

This study has significant limitations as there will be bias in the way the study participants have been selected and also in the fact that they are being asked to recall past events without independent verification. It is the opinion of the author that a study of this type could not be blinded. Nevertheless it has succeeded in obtaining data on a greater number of people than the official government investigation has done and has confirmed the extensive clustering of serious health complaints in this region. In addition, the significance of neurotoxic symptoms being reported with such frequency, especially in children, remains an issue of great concern, and should be fully investigated.

METHOD

On nine days between 24th February and 16th March 2013, I surveyed the health of people within 35 households in the Tara residential estates and the Kogan/Montrose regions of the Western Downs in Queensland. In addition to that I conducted telephone interviews with families from three households who had left the area because they believed their health had been adversely affected by CSG. One family moved 80km away but remained within 4413 post code, one family moved to postcode 4305 and one family moved interstate to post code 3380.

These locations were chosen to survey as residents from these areas had previously contacted the Gasfields Community Support Group with health concerns they related to CSG exposure.

In the majority of cases I documented the residents' responses; in a few cases the respondents preferred to complete the paperwork themselves. Parents provided current health data on their children with input from older children and parents provided comparison data on their children's health prior to CSG.

The survey was in two parts. Part [1](#) documented the environmental details of each household including perceived impact on animals. Part [2](#) was an individual questionnaire regarding the health of each person within each household. The first page was age specific.

For children aged up to 5 years this involved answering affirmatively if the parent was concerned about any of 25 health issues. There was a question whether the parent believed the child's health had been adversely affected by CSG with the options on answers being "yes", "no" and "uncertain". There were free form questions on perceived health impacts and their experience seeking medical help.

As no baseline health studies had been carried out prior to coal seam gas development, in lieu of baseline studies, for people aged 6 to 82, the first page of their health questionnaire was designed to compare how their health was perceived to be in the past two years^v whilst living in a gas development with their health in the two year period before they were exposed to the CSG industry. For before and after CSG, there were 30 questions, the answers to which were "never", "occasionally", "often" or "constantly".

^v Or for a lesser period if they had moved to the area within that two year timeframe

For the purpose of the questionnaire the definitions were as follows:

Definition	Details of definition
Never	Never.
Occasionally	That it has happened ever (within the 2 years ^v), a few times, sporadic.
Often	Recurring, regular, frequent.
Constantly	At least twice a week.

TABLE 1 QUESTIONNAIRE DEFINITIONS

There was a question on diagnoses made prior to CSG development and conditions diagnosed since CSG development. One question related to whether the respondents believed their health had been adversely affected by CSG and there were open format questions on health impacts and medical care.

With the assistance of the Gasfields Community Support Group,⁵ I visited some of the families who had previously stated that their health was impacted. In order to minimise bias, I endeavoured to visit and survey the near neighbours of impacted families. Of the 40 families I approached, only two declined to participate. Locked gates with “For Sale” signs proved to be more of an obstacle to participation. Families were willing to respond with the assurance of anonymity. Although identifying data such as names and addresses was collected, only postcode and/or survey number would be used in the pooled results.

FINDINGS

NUMBER SURVEYED

In total the health of 113 people from 38 households was documented.

There were 17 children between the ages of 0 and 5, 31 children between the ages of 6 and 18 and 65 adults between the ages of 19 and 82. This included just two people aged over 70 years. There were 56 males and 57 females.

ENVIRONMENTAL DATA

53 people lived within postcode 4421, 40 people lived within postcode 4413, 15 people lived within postcode 4406 and 3 people now lived in 4305 with two people in 3380.

Of the thirty eight households canvassed, 3 families lived in second dwellings on the acreage blocks so the environmental data was collected for 35 blocks

Of the 35 blocks 12 families had owned them for less than 5 years, 10 families for 6-9 years, 8 families from 10 to 19 years and 5 families for between 20 and 40 years.

The smallest residential block was 30 acres. 16 families lived on blocks of 30 or 40 acres. 8 families lived on blocks of between 50 and 100 acres. 7 families lived on blocks

of between 110 and 250 acres and 4 families outside the residential estates lived on blocks of between 640 and 8000 acres.

15 households used solar as their main source of power, while 15 had mains electricity and 5 used a generator as the primary source. 9 households had a generator as back up while 4 had solar as their secondary source of power.

24 households used gas for cooking while 11 used electric cookers or cooktops. 21 used a woodstove or wood heater.

3 households used bottled water for drinking and cooking. The rest used rainwater collected from the roof into tanks for drinking, cooking and washing dishes. 5 households used settled dam water treated with alum for washing clothes. 3 families habitually washed their clothes in town. 3 households used treated dam water for bathing, the rest used rainwater. Dam water and rainwater was used in various combinations for vegetable gardens and domestic animals and in one case for watering the lawn. Only one person swam in their dam. Four families used dam water to flush the toilet. Several families did not use their dam at all. Some believed it had been contaminated by run off from road spraying of CSG flow back.

There was a bore on three properties. None were currently used. One of these bores had sustained 145 head of cattle throughout Queensland's long drought. However, that bore is now flammable.

Flea and tick prevention was used by 13 households but otherwise pesticides and herbicides were used very sparingly around the home or garden; two households used pyrethrin ant sand; three occasionally used Roundup; one had treated for termites; one used Graslan in the paddocks. Several households were proudly organic.

Only one household had purchased new or refinished furniture or carpets.

For one family the nearest well was at a distance of 5km. For everyone else the infrastructure was much closer. One family had a major gas development site 20 metres from their property. For 6 families the nearest well was between 500 and 800 metres; for 6 families the nearest well at approximately one kilometre; for 5 families the nearest well was 1.5km; for 13 families the nearest well was 2-3km away; for 3 families the nearest gas well was approximately 4km away.

Many families were aware of multiple infrastructure including wells, compressors stations, pumping stations, vents, and open CSG waste disposal ponds in various directions from their homes which were operated by different companies including QGC, Origin and Linc Energy. Many families were unsure what infrastructure they were in proximity to. 18 families were aware of non-agricultural odours through their

property.^{vi} The intensity, frequency and duration were variable and depended on wind direction. Most people noticed the problems were worse when the wind was coming from the north. 11 families were aware of unusual cracking of the soil on their property and 8 families had seen bubbling in puddles on their property after the rain while one man, though not ever noticing a problem on his own property, had watched bubbling in cracks in the bitumen road which was covered in 6 inches of water at the time.

HEALTH DATA

Note that a complete set of the data is available in Appendix B.

Of the 113 people surveyed 66 or 58% were certain their health was being impacted by CSG. (Figure 2)

26 people (23%) felt sure that their health had not been impacted and 21 people (19%) were uncertain.

Of the 113 people there were 95 individuals in the age 6-82 age cohort who answered the 'before' questionnaire with 96 individuals answering the 'after'. The reason for this was that one child had to all extents and purposes always lived in the gas field so had no prior health history. For this reason the data for before and after has been in each case documented in separate pie charts.

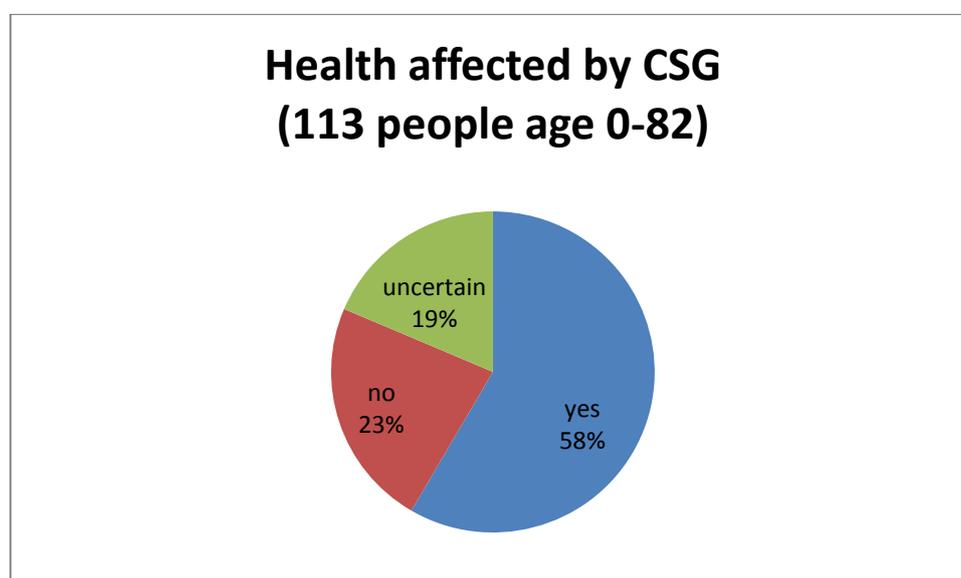


FIGURE 2 HEALTH AFFECTED BY CSG (113 PEOPLE AGE 0-82)

^{vi} In August 2011, Queensland Country Life reported Linc Energy offered to purchase air-conditioners for some of the surrounding farmers' houses so long as the landholders were willing to sign a confidentiality agreement and not tell anyone about the matter.

Visual representation of the data in this format is striking and shows major changes in perception of wellbeing for large percentages of the people surveyed. Of particular concern is the type of symptoms experienced as they are not symptoms one would expect due to aging alone over a 2-5 year time frame.

Skin irritation was a good example of the change in symptoms with 17% reporting skin irritation before CSG and 72% complaining of skin irritation after CSG. (Figures 3 and 4) People reported symptoms of discomfort, sensitivity, itch and inflammation of their skin which, particularly in adults, was often in the absence of a visible rash.

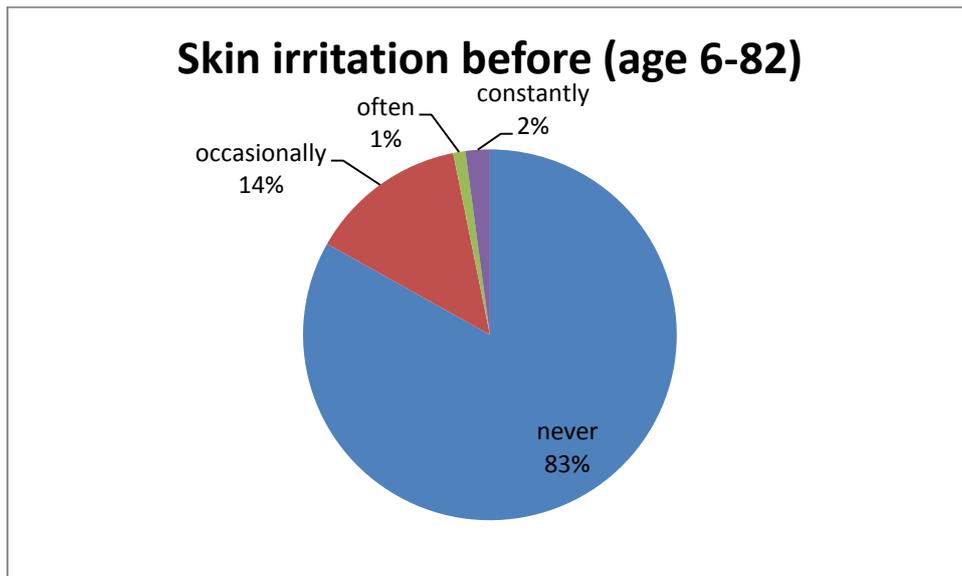


FIGURE 3 SKIN IRRITATION BEFORE CSG (AGE 6-82)

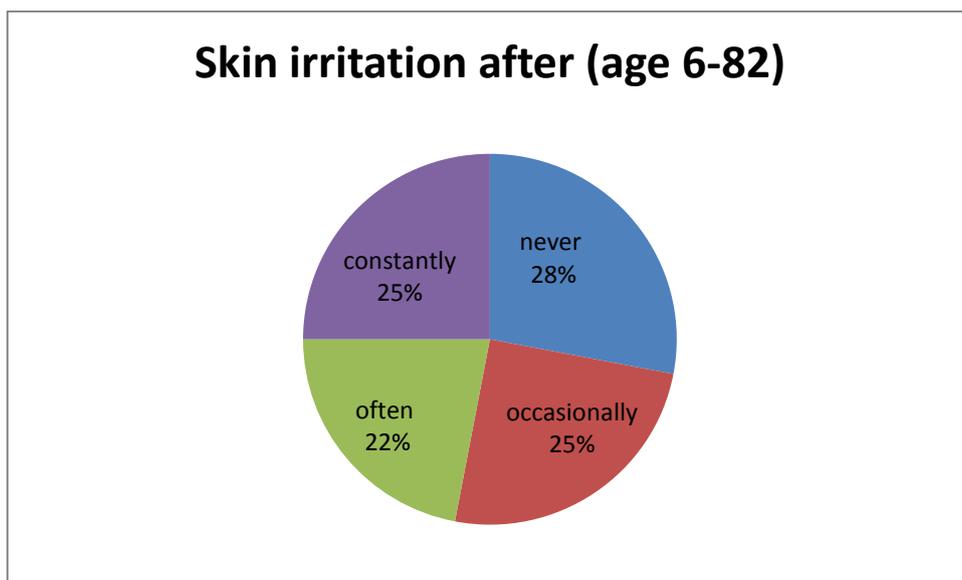


FIGURE 4 SKIN IRRITATION AFTER CSG (AGE 6-82)

Eye irritation was reported with similar frequency, with 7% reporting symptoms before and 60% after. (Figures 5 and 6)

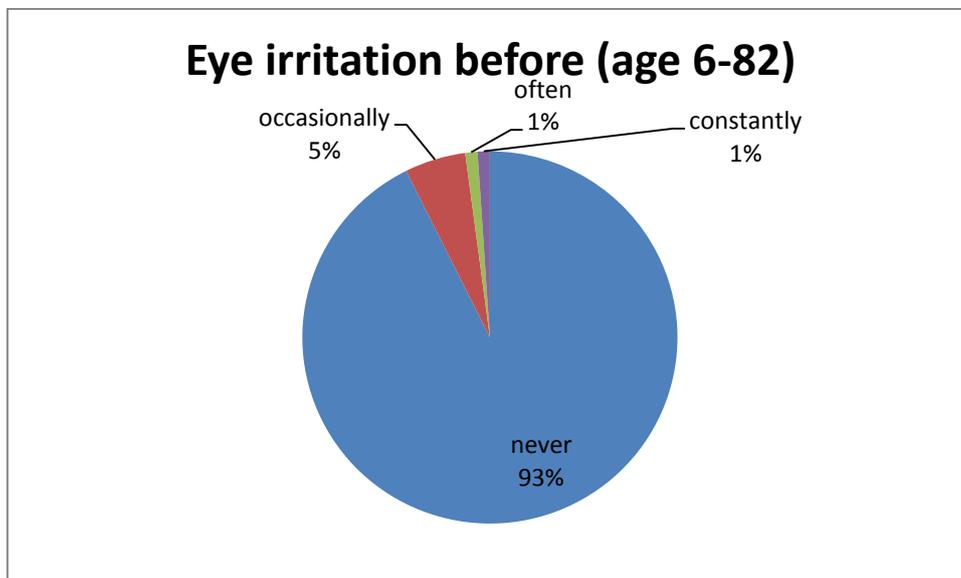


FIGURE 5 EYE IRRITATION BEFORE CSG (AGE 6-82)

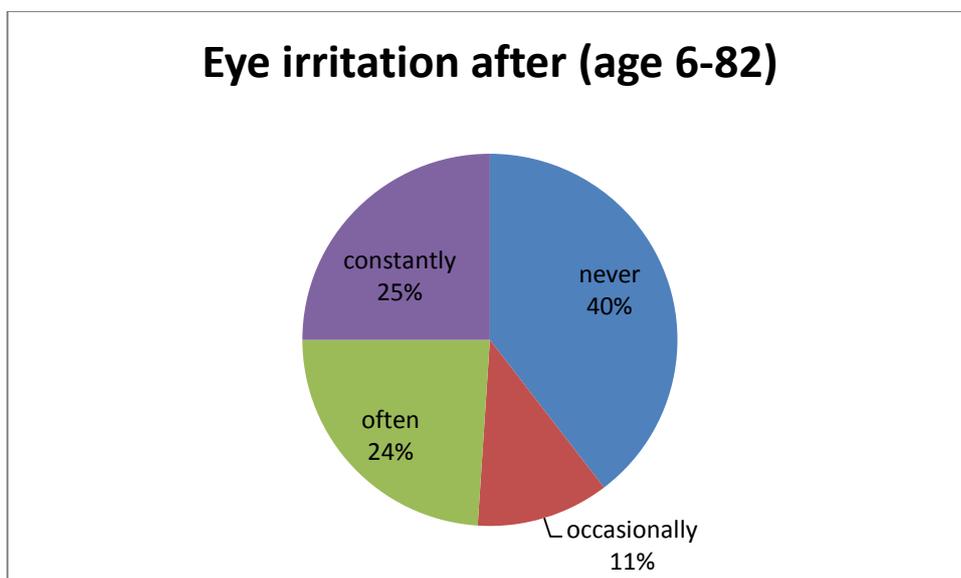


FIGURE 6 EYE IRRITATION AFTER CSG (AGE 6-82)

Likewise 7% reported trouble with spontaneous nose bleeds before CSG while 32% had spontaneous nose bleeds after. (Figures 7 and 8)

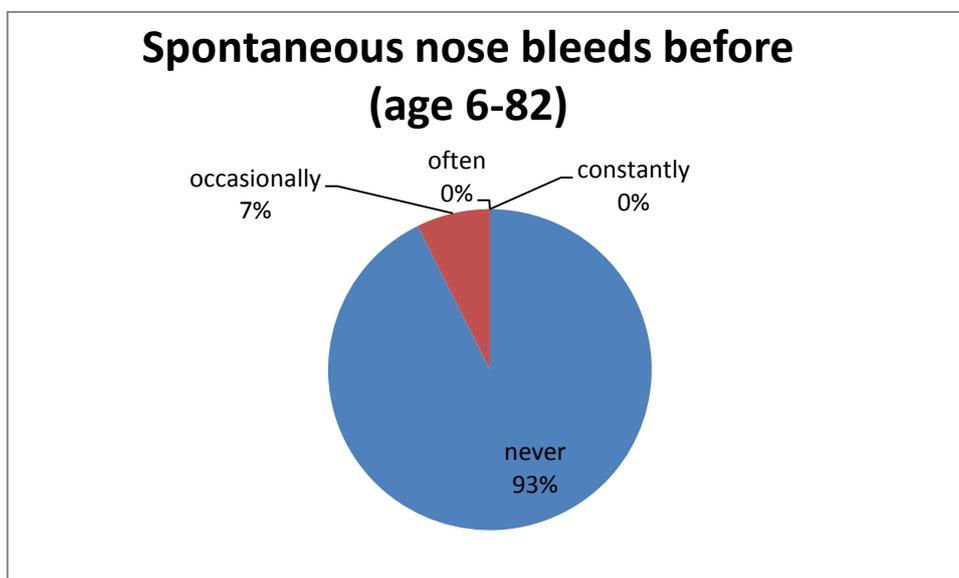


FIGURE 7 SPONTANEOUS NOSE BLEEDS BEFORE CSG (AGE 6-82)

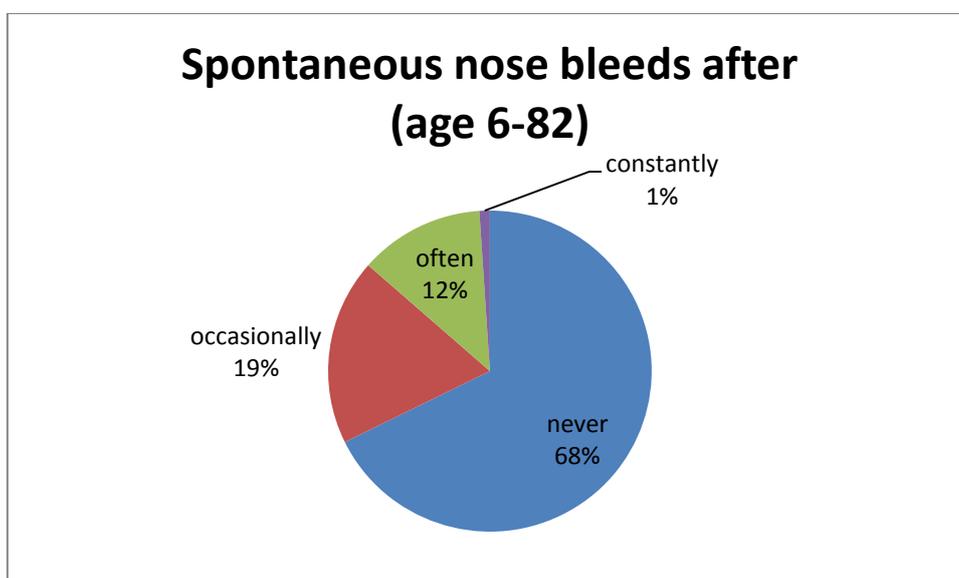


FIGURE 8 SPONTANEOUS NOSE BLEEDS AFTER CSG (AGE 6-82)

There was a marked increase in a range of symptoms which can be related to serious conditions such as neurotoxicity (damage to the nervous system), including weakness, severe fatigue, headaches, numbness and paraesthesia (abnormal sensations such as burning or tingling).

- 54% reported mild headaches prior to CSG while 87% had mild headaches after; (Appendix B)
- 23% reported having ever had a severe headache before CSG, while 55% had severe headaches after (38 % often or constantly); (Appendix B)
- 13% reported suffering from severe fatigue before while 64% suffered from severe fatigue after; (Appendix B)
- 7% reported suffering from weakness before while 51% were symptomatic after. (Figures 9 and 10)
- Depression and anxiety, difficulty concentrating and insomnia showed similar reported increases. (Appendix B)

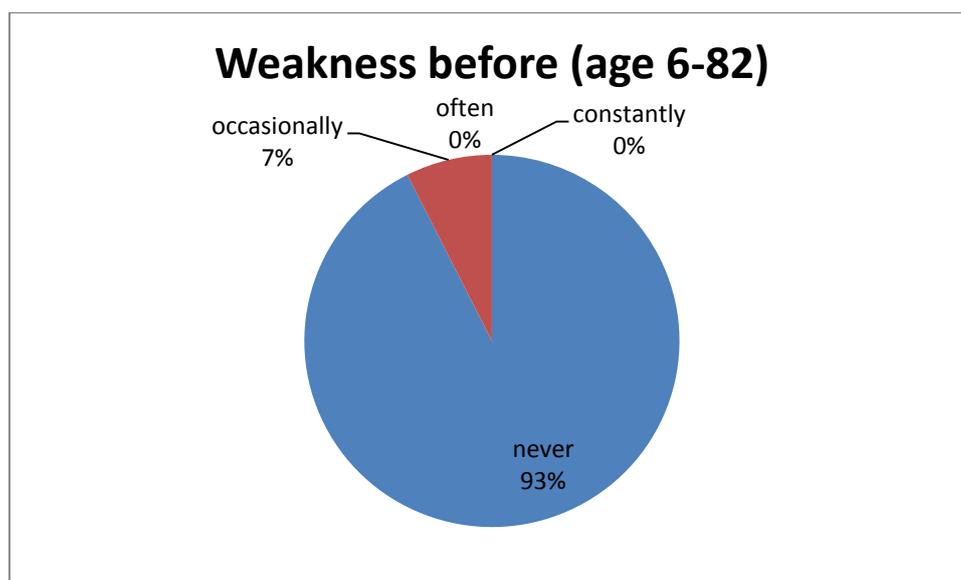


FIGURE 9 WEAKNESS BEFORE CSG (AGE 6-82)

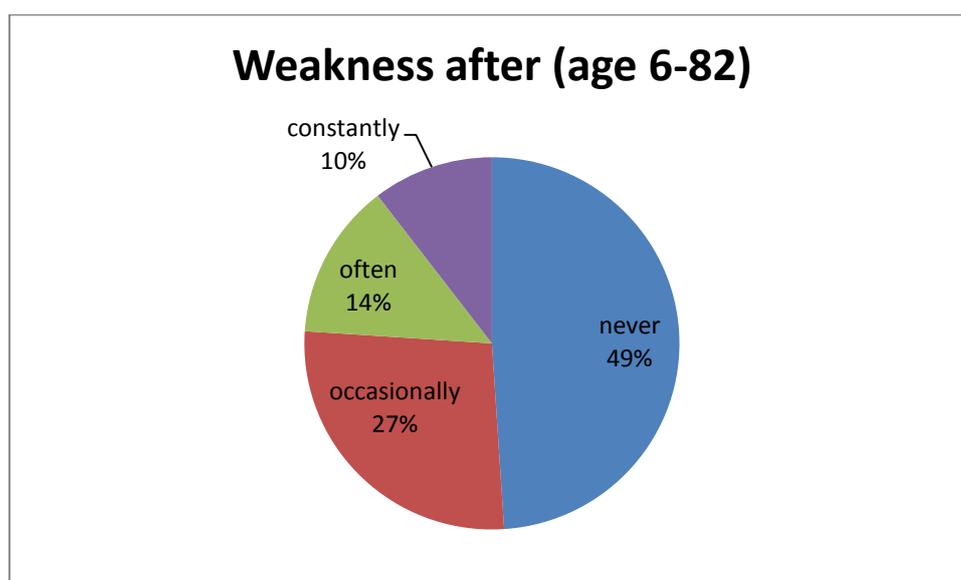


FIGURE 10 WEAKNESS AFTER CSG(AGE 6-82)

Reported symptoms of tingling, numbness, and pins and needles increased from 8% prior to CSG to 42% after. (Figures [11](#) and [12](#))

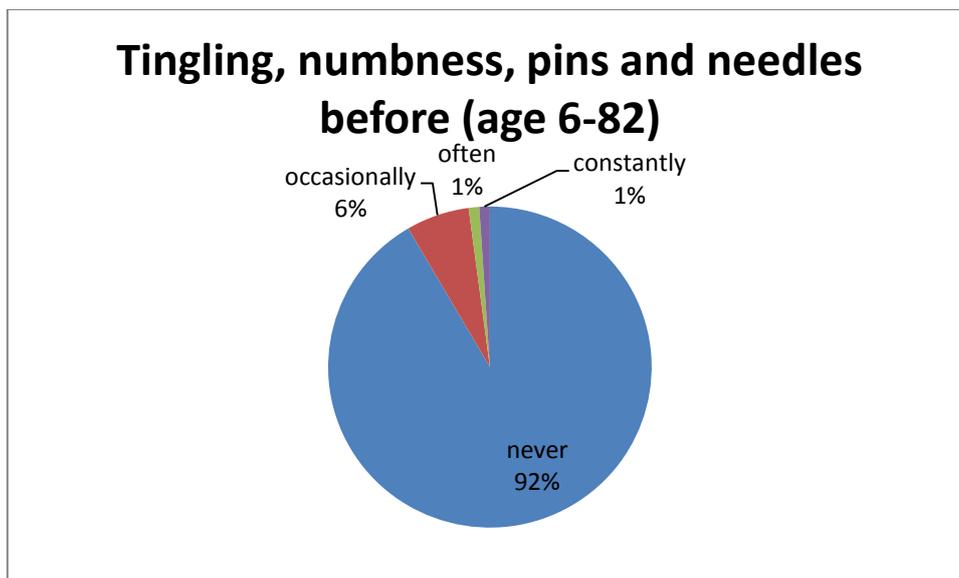


FIGURE 11 TINGLING, NUMBNESS, PINS AND NEEDLES BEFORE CSG (AGE 6-82)

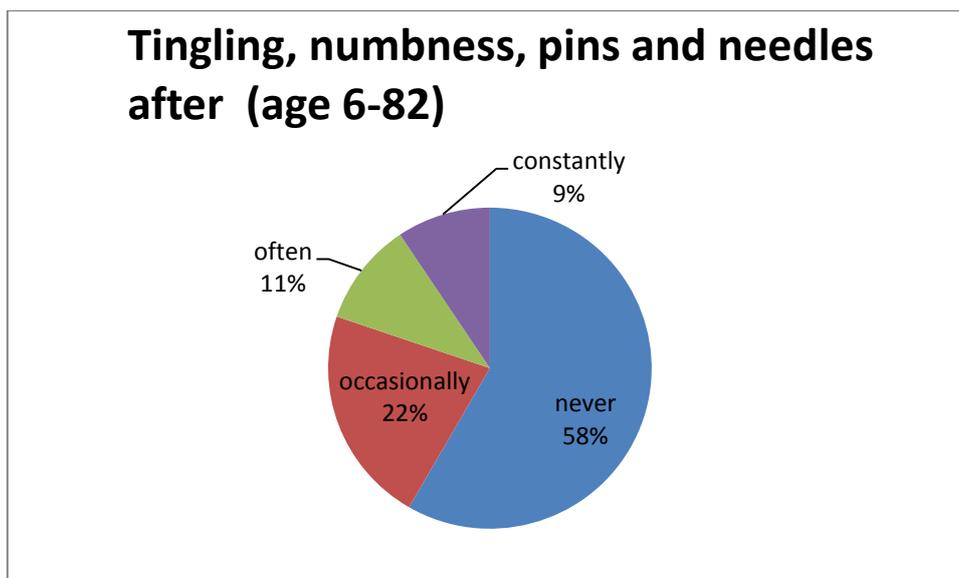


FIGURE 12 TINGLING, NUMBNESS, PINS AND NEEDLES AFTER CSG (AGE 6-82)

In order to determine if the symptoms were age related, the data was reanalysed for the age 6-18 age group. There were 31 children in this group (Appendix [B](#)). Since the results were similar for chest discomfort, chest tightness and difficulty breathing, only chest tightness was displayed in a pie chart. The results are striking.

After CSG

- 19 out of 31 children or 61% had spontaneous nose bleeds reported;

- 28 out of 31 children had mild headaches, 23% constantly;
- 17 out of 31 children had severe headaches, 4 of them or 13% constantly;
- 24 out of 31 children had skin irritation- 15 (almost 50%) often or constantly throughout the past two years;
- 10 out 31 children age 6-18(over 30%)experienced paraesthesia
- 8 out of 31 (26%) had severe chest pain;
- It was reported that children had increased rates of cough, chest tightness, difficulty sleeping, nausea, rashes, difficulty concentrating and muscle pains and spasms.

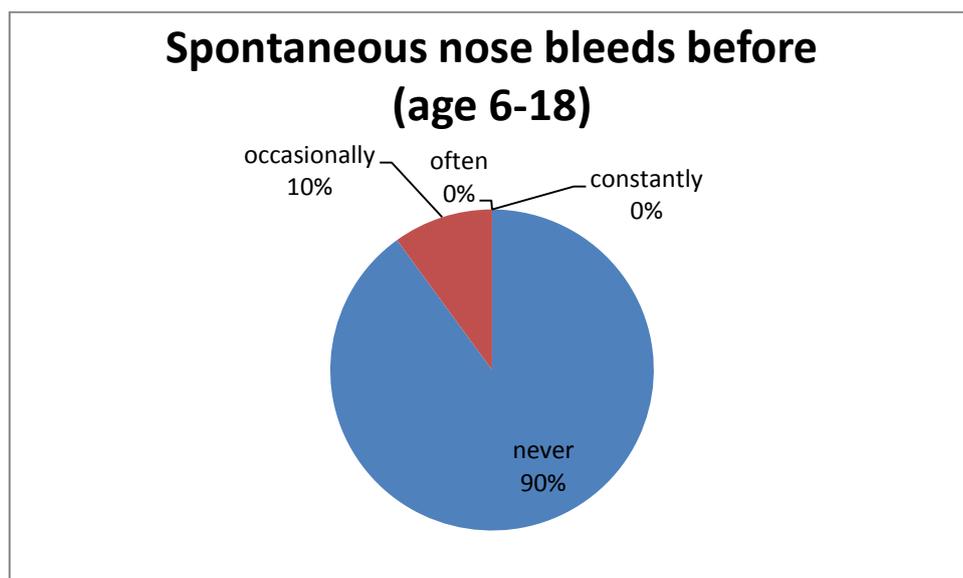


FIGURE 13 SPONTANEOUS NOSE BLEEDS BEFORE CSG (AGE 6-18)

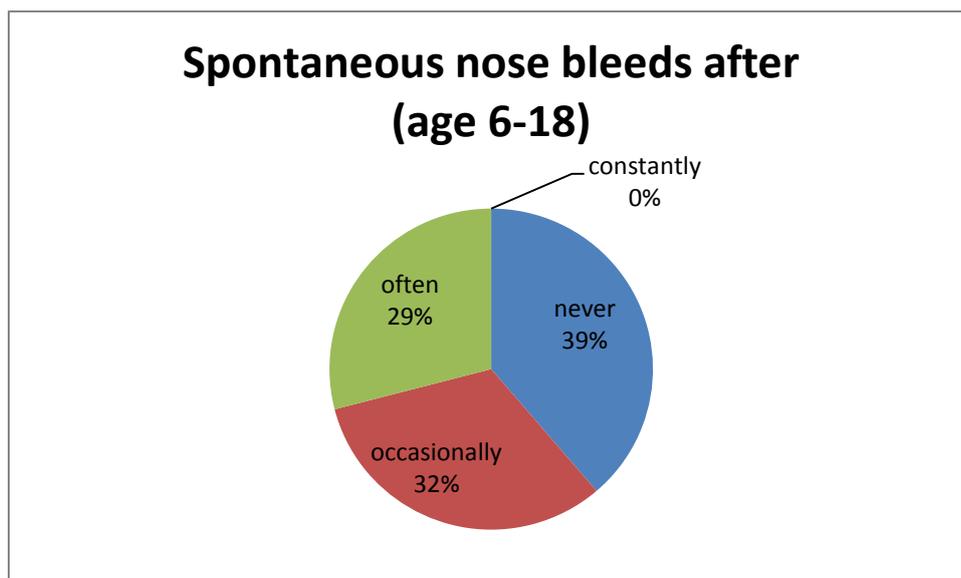


FIGURE 14 SPONTANEOUS NOSE BLEEDS AFTER CSG (AGE 6-18)

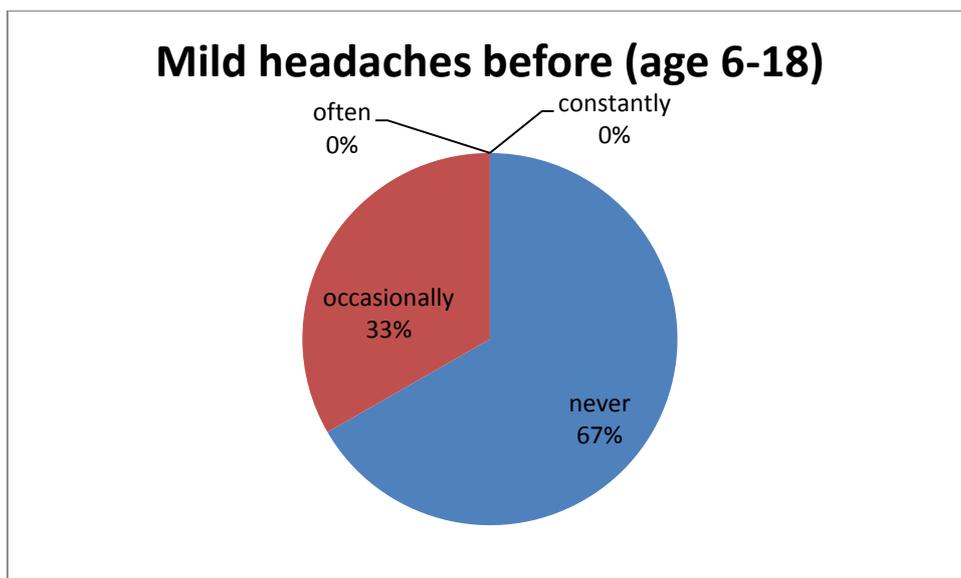


FIGURE 15 MILD HEADACHES BEFORE CSG (AGE 6-18)

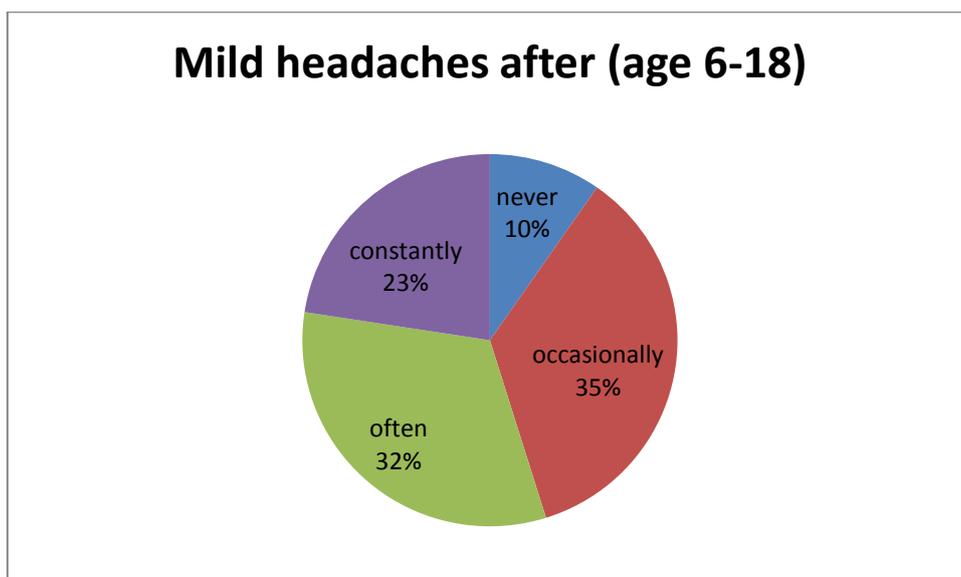


FIGURE 16 MILD HEADACHES AFTER CSG (AGE 6-18)

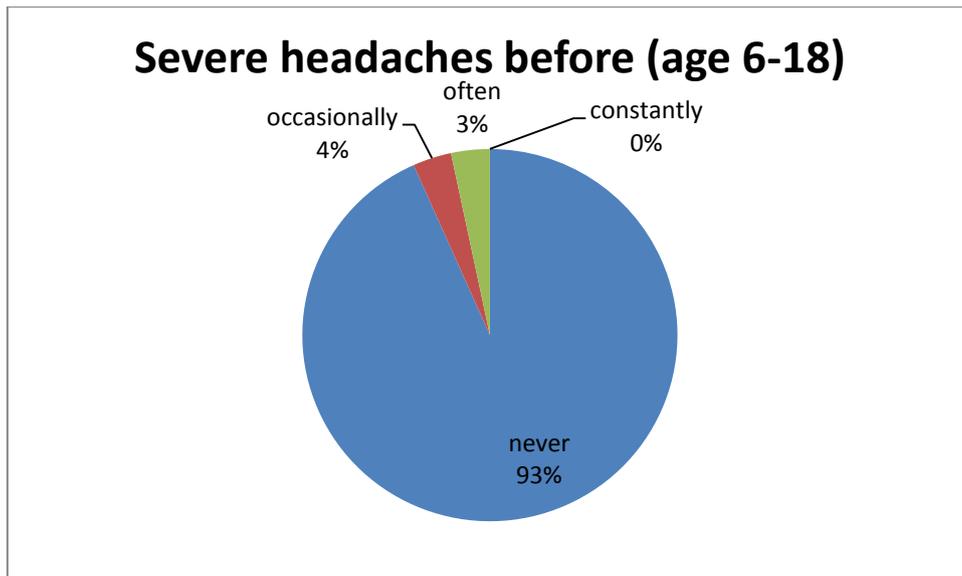


FIGURE 17 SEVERE HEADACHES BEFORE CSG (AGE 6-18)

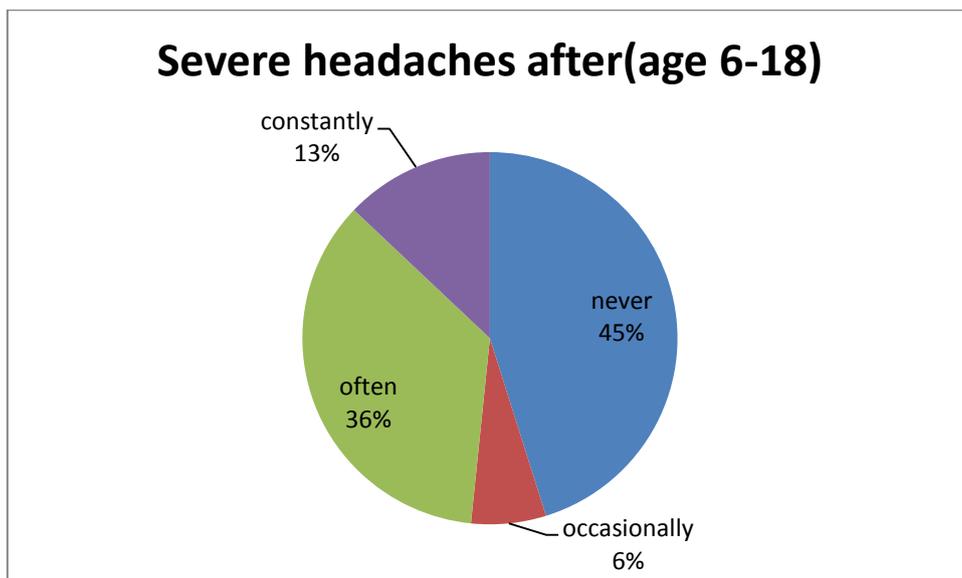


FIGURE 18 SEVERE HEADACHES AFTER CSG (AGE 6-18)

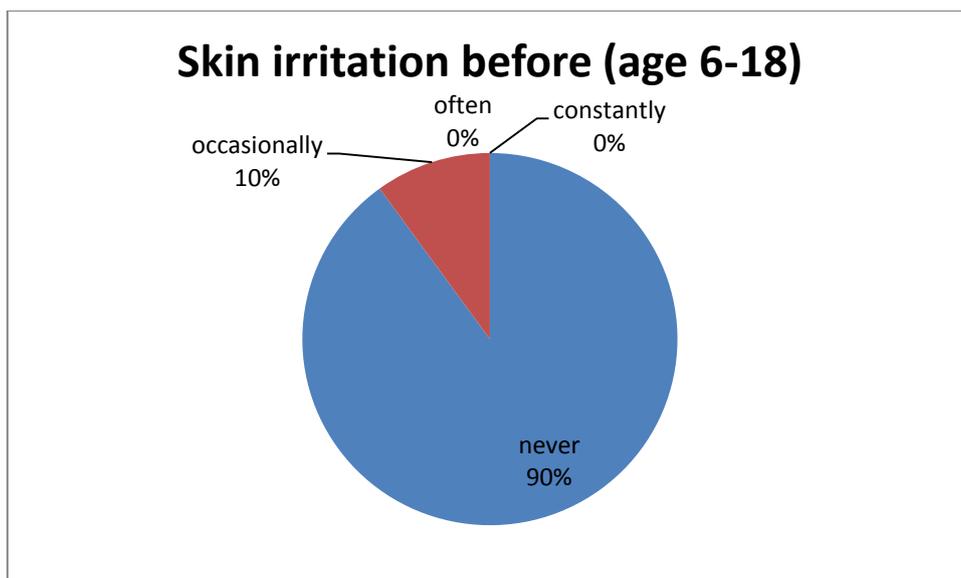


FIGURE 19 SKIN IRRITATION BEFORE CSG (AGE 6-18)

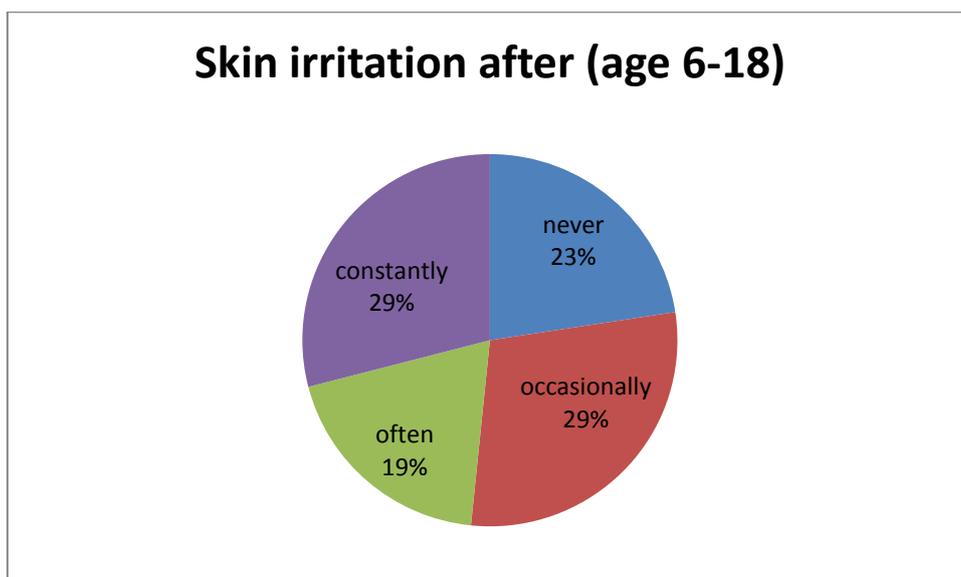


FIGURE 20 SKIN IRRITATION AFTER CSG (AGE 6-18)

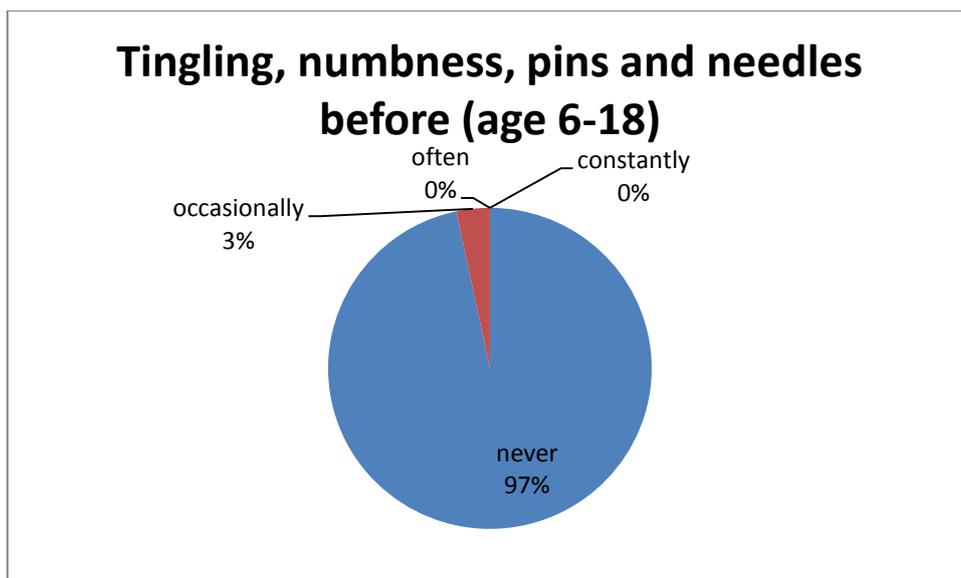


FIGURE 21 TINGLING, NUMBNESS, PINS AND NEEDLES BEFORE CSG (AGE 6-18)

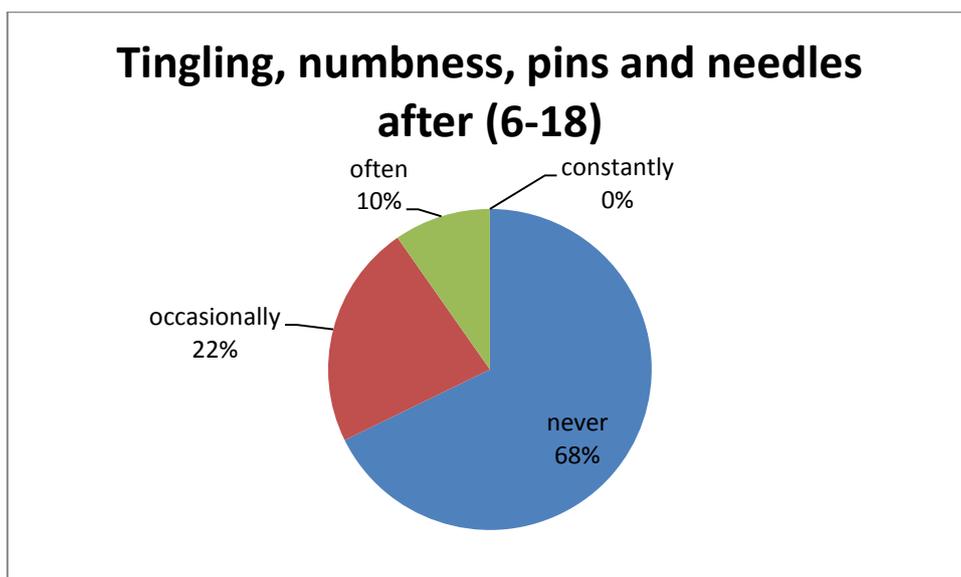


FIGURE 22 TINGLING, NUMBNESS, PINS AND NEEDLES AFTER CSG (AGE 6-18)

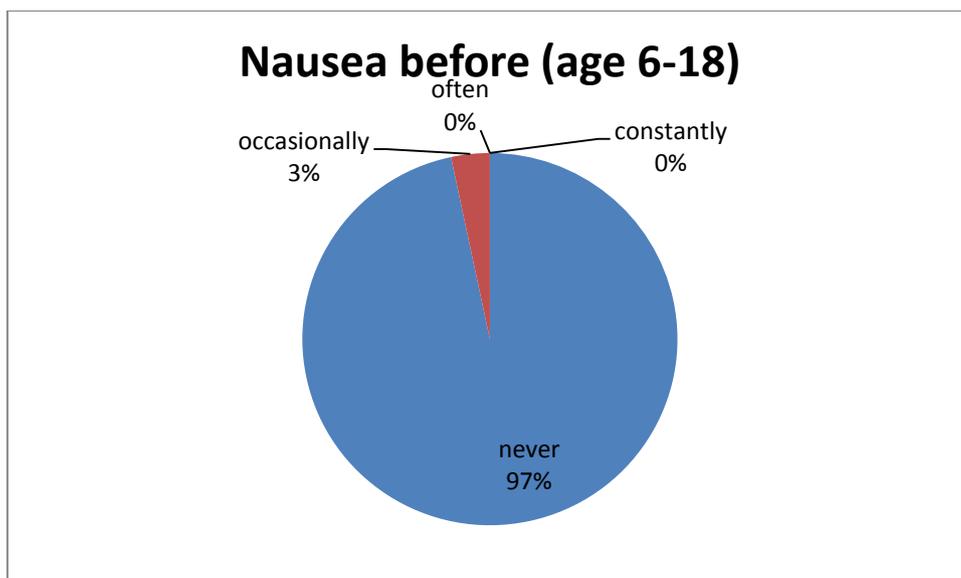


FIGURE 23 NAUSEA BEFORE CSG (AGE 6-18)

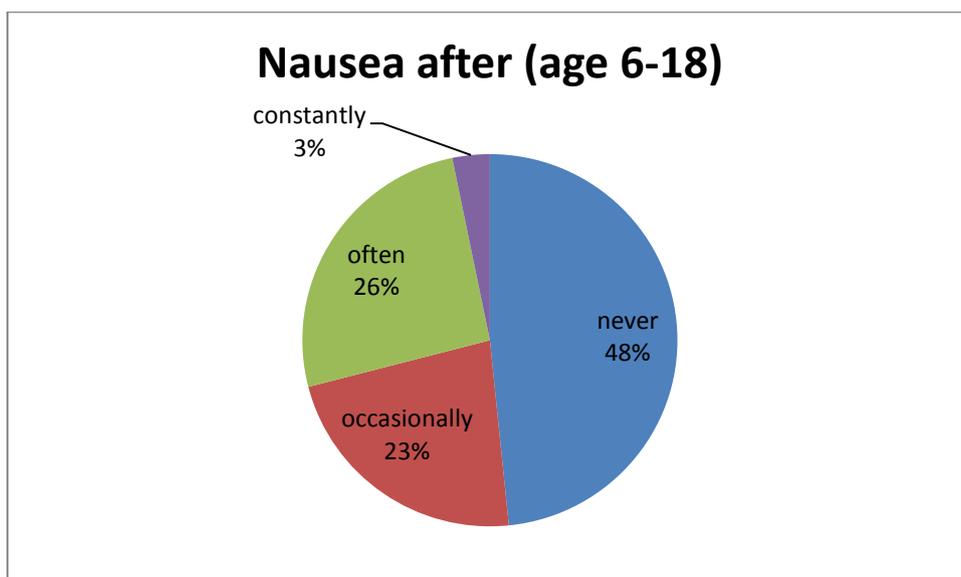


FIGURE 24 NAUSEA AFTER CSG (AGE 6-18)

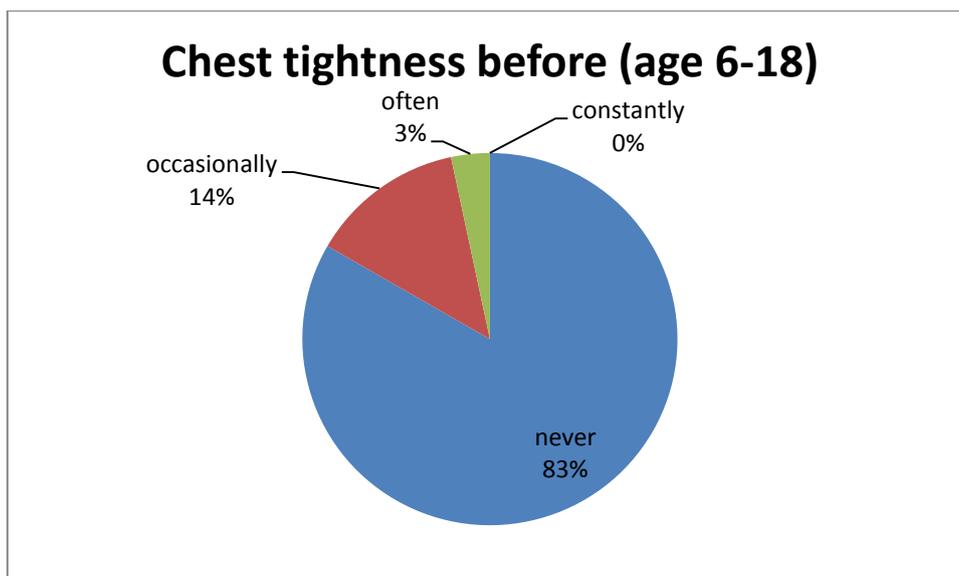


FIGURE 25 CHEST TIGHTNESS BEFORE CSG (AGE 6-18)

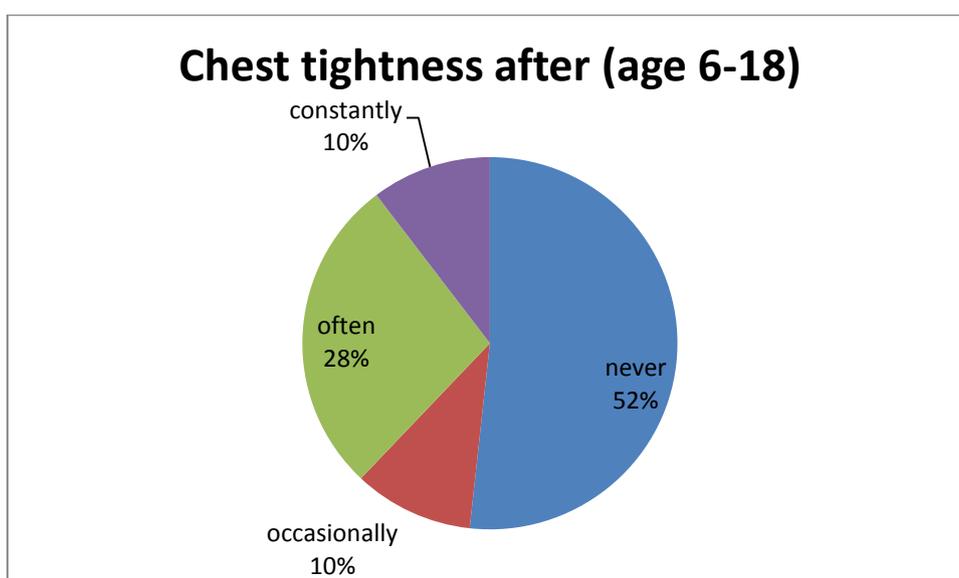


FIGURE 26 CHEST TIGHTNESS AFTER CSG (AGE 6-18)

PARENTAL CONCERNS

There were 17 children in the age group 0-5. Parental concerns for their children included rashes (11), eye irritation (11), and cough (5).

Significant concerns reported in this age group were:

- twitching and unusual movements (6);
- poor colour/blueness of mouth or limbs (6);
- blood from the nose (9);
- headaches (8);
- tingling/numbness/ pins and needles (5).

Of the 13 children who were walking, 5 were reported to have demonstrated unusual clumsiness or unsteadiness.

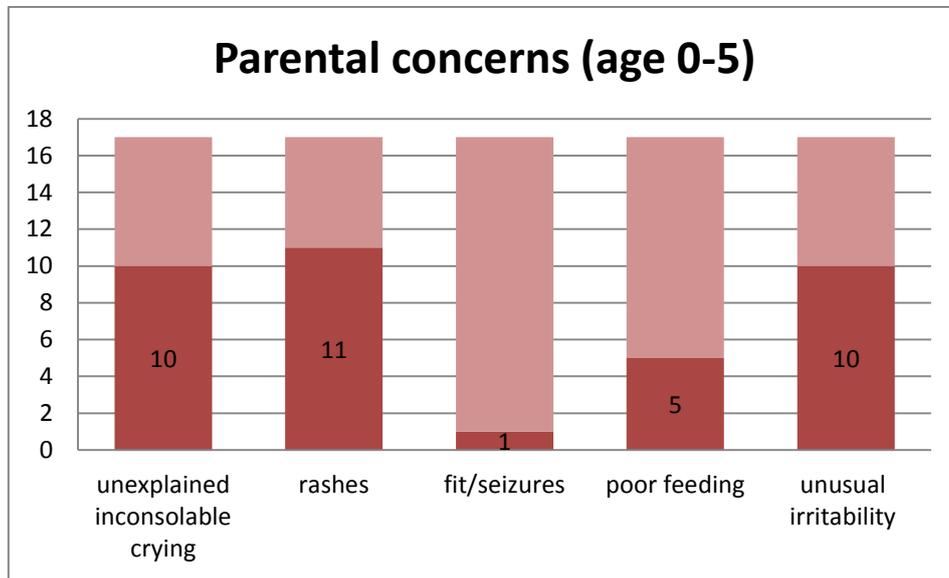


FIGURE 27 PARENTAL CONCERNS (AGE 0-5)

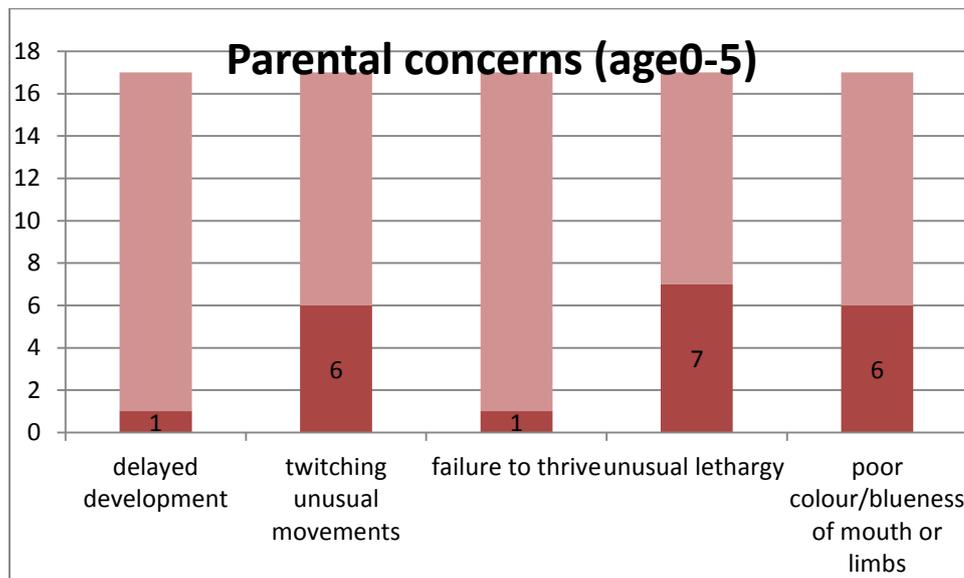


FIGURE 28 PARENTAL CONCERNS (AGE 0-5)

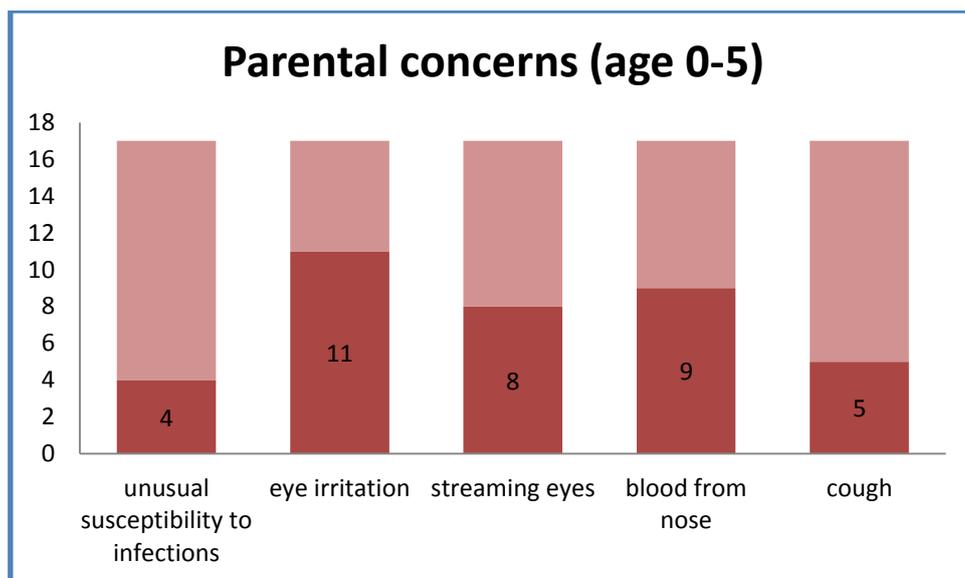


FIGURE 29 PARENTAL CONCERNS (AGE 0-5)

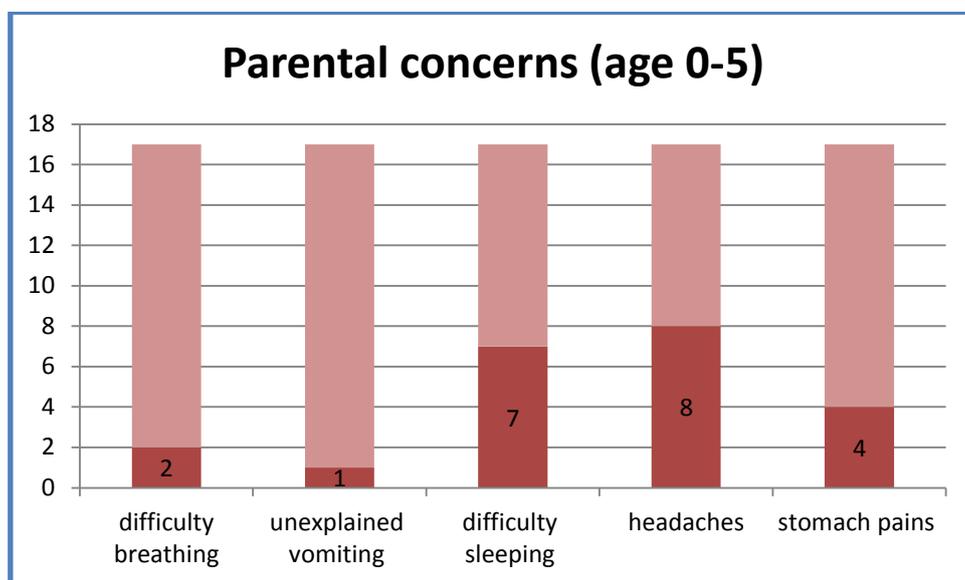


FIGURE 30 PARENTAL CONCERNS (AGE 0-5)

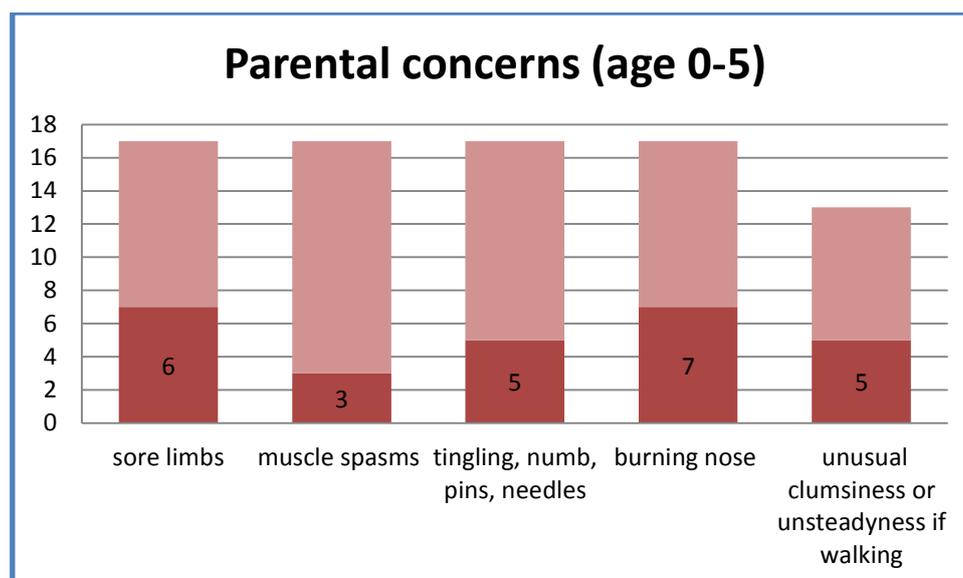


FIGURE 31 PARENTAL CONCERNS (AGE 0-5)

RESIDENTS' COMMENTS AND FEEDBACK

Residents' comments on health impacts were enlightening. Parents particularly noted their children coming in from playing outside with nose bleeds. Often they had linked increased frequency of these occurrences with wind direction and some had stopped their children playing outside at these times. Some adolescents had had daily nose bleeds for three months at a time. These rural children now deliberately avoided going outdoors when possible. Adults who had lived in the bush all their life now found their lives restricted to indoors.

Children were noted to be constantly rubbing their fingers. Children complained of ants in their hands and one infant reportedly screams and dips his fingers in water in the middle of the night. Children were reported to be waking at night in distress wanting their mums to rub their limbs. The only child who has been sent for evaluation by a paediatrician for this complaint was reportedly told she was attention seeking. Children were reported to be waking out of their sleep with headaches.

For adults and children alike, eye irritation and skin irritation, particularly when outside, were said to be constant background complaints, with severe exacerbations linked to odour events. So extreme was the discomfort for some people, they described that they felt they could rip their skin. Some said that after the odours came through, their skin felt like it had been washed by acid and their skin peeled in the shower.

Infants, children and adults alike suffered from headaches. Some had been so intense that they had been investigated with CT scans and lumbar puncture.

OTHER HEALTH AND WELL-BEING COMPLAINTS

Extreme fatigue, difficulty focusing and difficulty concentrating were new and debilitating symptoms for many residents. Symptoms were worse when odours came

through. Some people could identify distinct individual odours at different times, variously described as: "rotten eggs, sickly sweet, like pine tarsal, acetone, creosote, after burn from cigarette lighter." Many people noted the association between their symptoms, wind direction and the location of the CSG waste water/evaporation ponds. Some people commented on the link between road spraying and their symptoms.

Children and adults alike complained recurrently of a metallic taste which made them nauseous and anorexic. Undiagnosed cough, repeated diagnosis of 'flu', pneumonia, pleurisy and exacerbation of asthma were recurrent themes. Children were missing a lot of school. Sleep disturbance was endemic within the families surveyed. Many people related this directly to the noise associated with CSG activities: trucks moving, reversing, beeping, the noise and vibration from drilling, fracking and seismic testing. Some people were very clear that their sleep was disturbed by noise and vibration from the compressor station, at distances up to 15km away. Many other people's sleep was disturbed by the constant strain of living with, and dealing with, the impact of CSG on their daily lives. Many expressed helplessness and hopelessness in the face of their children's ill health and their inability to help and protect them. Some had the capacity to move away and did. Most found themselves trapped.

RESIDENTS' PERCEPTION OF HEALTH CARE

Residents who felt their health was not impacted in general had few comments on health care. A couple were happy with medical services in general. Several children were seen by paediatricians in Brisbane, and the families were happy with treatment there.

Residents who felt their health had been impacted had some disturbing comments on their experience of health care. Their experiences were based on presentations to different hospitals and medical practices in the local area including Chinchilla, Dalby, Tara and the Toowoomba base hospital. At one clinic a seriously ill, febrile infant was reportedly left unseen for 1½ hours while a stream of energy workers came and went. When eventually seen, this child was transferred as an emergency first to Toowoomba and then to Brisbane.

Residents reported being turned away from medical facilities without treatment with the triage nurse making the decision whether they would be seen by a doctor or not. People commented that after a one hour trip to see the doctor, and a four hour wait they were given a survey to fill in and turned away. For one family whose children presented with rashes and cough, the triage nurse made the unusual diagnosis of "flu" and turned them away without treatment.

A patient attended hospital with chest pains to be reportedly told by the nurse: "I'm not bringing the doctor in for this." At midnight, on the advice of the medical advisor on the 13 HEALTH line, a person with severe chest pain reportedly phoned triage at one of the larger hospitals and was told to take two panadol and go to bed.

People had the definite perception that if they questioned whether their symptoms were related to CSG they were treated differently and were shunned. A referral to the mental health service ended months later, without ever being seen, with a phone dismissal of the possibility of depression and the statement they were just frustrated with CSG.

When actually seen by the doctors the frequent impression gained was that they did not want to know. Comments included : *“just fobbed off”, “disappointing”, “unsatisfactory”, “not being taken seriously by health authorities”, “no idea why coughing”, “recurrent rashes, told dermatitis/allergy, asked about the effect of gas, told ‘just old age’”, “undiagnosed”, “treated poorly, didn’t help with anything, waited a long time for them to tell him to go home”, “given eye drops”, “given steroids”, “made him feel like a hypochondriac”, “told allergic reaction”, “given antidepressants”, “told didn’t know what it was”, “no tests”, “told all in head- worrying about nothing”, “constant flu” “chest pains unexplained”, “referred months ago-no appointment”, “doctor laughed at her when she said she had a metallic taste in her mouth”, “no diagnosis or explanation”, “demoralised by lack of treatment by Queensland health” and “bunch of idiots.”*

A paediatrician in Toowoomba told the parents that we *“are not here to discuss the gas.”* One doctor, whilst empathetic, said they couldn't get involved as they worked for Queensland Health saying *“got to stay out of this.”*

WORKERS SURVEYED

Of the 113 people surveyed, 4 worked in the CSG industry. Two of these were involved in infrastructure construction and although both had ongoing skin irritation, neither believed their health was impacted. One person, after 4 months employment in a CSG facility, began to develop severe symptoms in their hands and feet. After biopsy they were eventually diagnosed with neuropathy (nerve damage) and can no longer work. The fourth worker also has a symptomatic neuropathy which has been, without tests, diagnosed as carpal tunnel. They also suffer from severe fatigue, headaches and nausea.

DISCUSSION

This small survey is not a comprehensive epidemiological study. However it does refute the assertion that *“just a handful of people are complaining that their health is affected by CSG.”* Furthermore, the character and frequency of specific health complaints, particularly relating to potential neurotoxicity in both children and adults are concerning.

Almost all the 31 children aged 6-18 were reported to suffer from headaches to some degree, but in 17 of these children the headaches were severe and for four children constant (i.e. occurring at least twice a week). Approximately a third of the all the 48 children to age 18 (15/48) were reported to experience paraesthesia. Regardless of any potential recall bias of their pre-existing health status these numbers and the significance of these symptoms stand out as a matter of serious concern. Add to that

reports of spontaneous nose bleeds (31 out of 96 people age 6-82 (32%)) severe fatigue (61 out of 96 people (64%)), difficulty concentrating (59 out of 96 people (61%)), eye irritation 20 out of 31 children (64%) and skin irritation 69 out of 96 people (72%) and a pattern of ill health emerges which is undoubtedly abnormal in comparison to my suburban general practice. Parents of 6 of the 17 children, aged 5 and under, were concerned about twitching or unusual movements, and parents of 5 of the 13 children who were walking were concerned about their clumsiness or unsteadiness on their feet.

Considering that the rural residential estates near Tara is the most densely settled area in Australia to have seen intensive CSG development, the effect of any health impacts there should be taken seriously and investigated comprehensively.

LICENCES, HEALTH AND THE PRECAUTIONARY PRINCIPLE

Queensland continues to issue permits for rapid CSG expansion. Approximately 40,000 coal seam gas wells are planned across Queensland. In addition to that there are permits for shale gas and underground gasification. More than 80% of Queensland is under exploration licences. This could translate to a public health disaster.

The initial licences were issued in a cloud of controversy with compelling evidence that appropriate checks and balances to vet environmental safety were not undertaken. The consequences to public health were never part of the assessment at the time of issuing the initial licences. Health impacts are still not part of the assessment for the permits which have been issued since the initial licences. The precautionary principle was ignored: *"The precautionary principle asserts that the burden of proof for potentially harmful actions by industry or government rests on the assurance of safety and that when there are threats of serious damage, scientific uncertainty must be resolved in favor of prevention."* [6](#)

QUEENSLAND GOVERNMENT'S RESPONSE TO REPORTS OF ILL HEALTH

Shortly after the data for this report had been collected, the Queensland Government released the health report it had commissioned nine months earlier. Remarkably, the health minister Lawrence Springborg concluded that there was no evidence of health effects related to CSG.⁷

However the Queensland government report states:

"In summary the most that can be drawn from the DDPHU report is that it provides some limited clinical evidence that might associate an unknown proportion of some of the residents' symptoms to transient exposures to airborne contaminants arising from CSG activities."

As their report is based on minimal industry sampling and very limited clinical investigation this finding is important.

Following the publication of the Queensland Government's health report and Lawrence Springborg's assertion that CSG workers have had no health problems, a person

previously employed on CSG drilling rigs in a different area of Queensland was so disgusted that they contacted the Gasfields Support Group to relate their story. That data is not included in the numbers for this study. This worker's ill health included nosebleeds, spasms of the hands and extreme difficulty breathing, making it impossible to continue work. Their comment was: *"They wiped their hands of me."*

CRITIQUE OF THE QLD GOVERNMENT REPORT

The Queensland Government report appears to be an exercise in minimisation and misrepresentation. The report is based on three sources of clinical data:

- calls to a 13 HEALTH number
- presentation to doctors and hospitals in Tara, Chinchilla, Dalby and Miles and
- two clinics attended by their expert in October 2012.

FAILURE OF ADEQUATE HEALTH SYMPTOM SURVEILLANCE AND DATA COLLECTION

The report states: *"A range of information available to the Department of Health up to January 2013 was used for the assessment."* The decision then, to exclude all presentations to doctors and hospitals from 13th November 2012 onwards from the data is perplexing. It is apparent however, that if the November/December time frame had been included it would have been difficult for the author of the government report to state:

"It is worthwhile noting that the formal symptom reporting has occurred almost exclusively during the winter months (July) when the use of wood heaters and open fires could be expected to peak."

Feedback from the residents indicates that the time frame November through December coincided with a major peak in reports of illness amongst the residents and multiple emergency presentations. It was directly as a result of that peak in severe symptoms that the urine of a three year old child was tested. Testing revealed extremely high levels of hippuric acid, the major metabolite of toluene, in his urine. As soon as she was aware of the result, the mother of this child immediately contacted her local Queensland Health doctor with the contents of this report.

Toluene metabolites found at high levels in a child in a non-occupational context is worrying, taking into account the short half-life i.e. toluene is quickly metabolised. This should have prompted investigation by the health department as a matter of urgency. Toluene is a known neurotoxin, an irritant and a suspected reproductive toxin that can be absorbed via inhalation.⁸ It is known to be associated with coal seam gas⁹ and has been found repeatedly in air samples in the residential estates.

No action was taken by the health department.

MINIMISATION OF RESIDENTS' HEALTH CONCERNS

The Queensland Government report attempts to normalise the residents' health complaints by citing various studies:

"...54% of school children age for to 18 years were reported by themselves or their parents as currently having at least one of the following skin conditions, such as acne/pimples, eczema/ dermatitis, tinea/ringworm, and warts/papilloma."



RASH, ADOLESCENT
PHOTO COURTESY OF LOCAL RESIDENT

There can be no ambiguity; the children in this study were not complaining of pimples, warts, papillomas or fungal infections; they are complaining of rashes which improve or disappear when they are removed from the gas fields. The government's defined health expert reports he saw just one rash. He was unable to offer a diagnosis. One wonders why it was not referred for further investigation.



RASH ADULT AFTER ROAD SPRAYING
PHOTO COURTESY OF LOCAL RESIDENT



RASH CHILD
PHOTO COURTESY OF LOCAL RESIDENT

The image above left shows a rash which appeared on the leg of an adult visitor to the estate after road spraying. This was diagnosed as hives.

The report cites 34% of residents living beside a chemical waste site at Kingston in 1990 as complaining of eye irritation as though this were an acceptable benchmark against which the complaints of the people of Tara can be measured.

REPORT BY CONTRACTED MEDICAL CONSULTANT

The Queensland Government report states that Dr Keith Adam was commissioned by the Department of Health to provide an independent expert opinion on the health complaints of residents in the Tara area with particular regard for the potential for the complaints to be linked to CSG activities.

The report states:

“Dr Adams commented that his review of peer-reviewed literature in regard to occupational exposure to CSG did not identify evidence of unique or substantial harm to employees in the industry. This is highly relevant as potential exposure among workers in the industry itself could be expected to be significantly higher than in a community setting among residents located up to many kilometres from CSG sites.”

There is not a single reference in Dr Adam’s report to any study, peer reviewed or otherwise, confirming lack of harm to CSG workers.

With reference to his role as the independent expert opinion on the potential for the health complaints to be linked to CSG activities, there are some specific comments made by Dr Adam which caused me particular concern. Firstly:

“Once a well has been drilled it becomes the only conduit for gas and water to reach the surface. The two products are separated below ground, with water being transferred to centralised collection and treatment points, and the gas being piped to processing facilities where it is dried compressed and fed into commercial pipelines.”

These comments go to the heart of the underlying question: namely, is there a pathway, or are there pathways by which mixtures of volatile organic compounds (VOCs), heavy metals, radioactive materials and other chemicals associated with unconventional gas extraction can find their way on to the skin, up the noses, into the lungs and the blood stream of people who are living in close association with gas development? After all, if there were no possible pathway there could be no associated illness.

Not only is the well, after having been drilled, not the only conduit for gas to reach the surface, the Queensland Government itself recognised this and has documented the frequency of methane leaking from CSG wells in this very area. Of the 58 gas wells tested at the Queensland Gas Company (QGC) Kenya gas fields of Lauren, Codie and Kate in 2010, 26 wells (or 45%) were already leaking.¹⁰

In addition, gas migration from CSG wells is currently being investigated by scientists at Southern Cross University.¹¹ This research is in the public domain and indicates that gas migration from CSG wells is indeed occurring.

Of interest is their comment on one of the postulated mechanisms:

"We suspect that depressurisation (fracking, groundwater pumping) of the coal seams during gas extraction changes the soil structure (i.e., cracks, fissures) that enhance the release of greenhouse gases such as methane and carbon dioxide."

Regarding gas migration into water sources, there have been several reports in both the print and electronic media of gas bubbling up in the Condamine River. Currently the Queensland Government are carrying out an investigation¹² and stated in January 2013 following a preliminary report:

"While the results of this report don't provide definite evidence of the source or cause of the gas seeps, we are taking a long-term approach to find science-based answers to this phenomenon."

A further point of concern is Dr Adam's claim that the gas and water are separated below ground. This claim bears little scrutiny. It is the intrinsic fact that there is water in the gas and gas in the water that causes so many technical problems for the industry as discussed by Peter Lather writing in Gas Today, November 2011:¹³

"Challenges unique to CSG gathering systems include dealing with significant volumes of CSG water and its associated treatment. The presence of large volumes of water creates problems in the gathering system design, as there is water in the gas and gas in the water, even after the process of separation. In order to combat this low point, drains need to be designed to siphon the water out of the gas, and high-point vents need to be designed to extract the gas from the water.", "Working out where to install vents and low-point drains can be a bit of a dark art. For example, a good location to place one of these low-point drains is at the lowest point of a pipeline, which is often in the middle of a creek or stream ..."

The Queensland Government also disagrees with Dr Adam. The Queensland Government website states:¹⁴

"When CSG comes to the surface, water in the gas is separated".

It is the fact that the methane must be separated not only from water but from its associated toxins and be "cleaned" before being shipped to markets overseas that provide many of the pathways for exposure of the local residents to volatile organic and other compounds. These processes include dehydration, compression and pumping, deliberate venting and flaring of wells and venting from high and low point valves scattered throughout the estates. Evaporation of volatile organic compounds from the giant CSG waste water ponds along with road spraying of CSG waste water provide yet more pathways for exposure.



PIPELINE VENT LOCATED INSIDE THE TARA RESIDENTIAL ESTATES
PHOTO COURTESY OF LOCAL RESIDENT

After confirming that benzene has in fact been found on testing in the residential estates, Dr Adam goes on to say:

“Benzene is not a normal constituent of coal seam gas, and so its source is uncertain.”

This statement is directly contradicted by the Queensland Government Department of Environment and Heritage Protection website:¹⁵ *“The BTEX^{vii} compounds are found naturally in crude oil, coal and gas deposits and therefore they can be naturally present at low concentrations in groundwater near these deposits.”*

In addition, The Sydney Morning Herald reported on August 28th 2011 that *“Benzene, toluene and xylene were discovered during routine tests of 14 bores used to monitor the company's [Arrow] coal seam gas (CSG) dams at the Tipton West and Daandine gas fields near Dalby.”*¹⁶ This was a year after Benzene had been outlawed as a fracking fluid in Queensland.

Dr Adam does note that the limits of detection by the analytical method used in the study were up to thirty-six times above the health standards they were being judged against. Incredibly he chooses to dismiss that as inconsequential stating that it does not invalidate the argument that 1,1,1,2-tetrachloromethane was not exceeded at the limit

^{vii} BTEX is an acronym that stands for benzene, toluene, ethylbenzene, and xylenes

Symptomatology of a gas field - An independent health survey in the Tara rural residential estates and environs

of detection. He says: *“Despite this criticism, the testing provides comfort that despite testing for a wide range of substances, the vast majority were not able to be detected.”*

It would seem small comfort when the limit of detection is 36 times above the safety level.



METHANE VENTING SIGN, KENYA GASFIELD, TARA REGION
PHOTO COURTESY OF LOCAL RESIDENT

Denial of a problem is rarely the best method of finding a solution to it.



PIPELINE VENT FLARE AND COMPRESSOR FLARE, TARA REGION
PHOTO COURTESY OF LOCAL RESIDENT

It is not the gas that is for the export market which poses a health hazard for the people of the residential estates. It is the mixture of chemicals which are rejected and contaminate the local atmosphere, the soil or water during the process of extraction,

cleaning and drying as well as those fugitive emissions which are inadvertently released which are of concern and warrant discussion. So too does the possible mobilisation of microbes in the coal seams.¹⁷

DEFICIENCIES IN THE ENVIRONMENTAL ASSESSMENT AND TESTING

The environmental air testing programme carried out by QGC, the gas company implicated in the health impacts, was extremely limited and inadequate in every aspect with only 13 air samples being collected. Despite this, many volatile organic compounds were detected. For 26 chemicals the detection level used was significantly higher than the health standard.

Although benzene, a known human carcinogen was detected at a level which demonstrably exceeded its reference criteria, its significance was dismissed. According to The World Health Organisation, because it is carcinogenic, no safe level of exposure to benzene can be recommended.¹⁸ The Ontario standard is 0.13 ppb while the Queensland air standard is 3 ppb, a level 23 times higher. Benzene was detected at Tara at 0.6 ppb. Four other samples reported benzene as <0.17ppb. Disturbingly the author of the Queensland Government report tried to dismiss the significance of this by saying that in suburban Springwood in Brisbane, air monitoring revealed the monthly maximum for benzene from Nov 2011 to October 2012 ranged from 0.9-1.3ppb. Far from this being an explanation or defence, it simply emphasises the poor level of air standards (in relation to world's best practice) which are acceptable to the Queensland government.

The airshed of urban Springwood is, by the Ontario standard, significantly contaminated and therefore associated with an increase in chronic health effects. Turning the airshed of a country area into one which is equally contaminated is not the appropriate solution.

The Queensland Government report recognises that *“the air monitoring programme had important limitations. The total limiting period was 9 days, the methodology resulted in limits of reporting for some analytes that were substantially higher than reference air quality criteria and the monitoring was not designed to identify short term peaks or troughs in air concentrations. It is considered a more strategic air quality monitoring programme could be implemented to provide more useful information....”*

An ad hoc limited odour sampling programme was initiated by the DEHP.

From a toxicological point of view odour does not necessarily correlate with an exposure of concern. However the summa canisters, of which a very limited number were available to the residents over this time period, were released in response to odour events. They detected a cocktail of toxic, irritant, volatile chemicals many of which individually or in combination were capable of causing irritation to the eyes, skin, nasal mucosa and respiratory tract along with systemic effects when absorbed. Carbon monoxide was not one of the chemicals tested following resident initiated sampling. Carbon monoxide is formed by incomplete combustion during flaring and is part of the

diesel emissions during drilling and fracking. It is slowly removed from the body, and episodic exposure causes neurotoxic symptoms particularly in children.

Summa canister	Passive
acetone, acrolein, chloromethane, dichlorofluoromethane, ethanol, hexane, methylene chloride, methyl ethyl ketone, propene, toluene, vinyl acetate	alpha-pinene, benzene, benzothiazole, cyclohexane, ethyl acetate, ethylbenzene, 2-ethyl-1-hexanol, heptane, hexane, heptadecane, hexadecane, 2-methylbutane, methylcyclohexane, 3-methylhexane, 3 methylpentane, naphthalene, pentane, phenol, tetradecane, tetrachlorethylene, 1,2,4-trimethylbenzene, toluene, xylene.

TABLE 2 CHEMICALS DETECTED DURING SAMPLING

Some phenols have been shown to have impacts on the endocrine system of living organisms.¹⁹ Endocrine disrupting chemicals can have impacts at very low levels.²⁰ Other chemicals used by the CSG industry are considered dangerous at concentrations near or below chemical detection limits. These include glutaraldehyde, brominated biocides (DBNPA, DBAN), propargyl alcohol, 2-butoxyethanol (2-BE) and heavy naphtha.²¹

Acrolein, an acute irritant to the eyes, nose, throat, lungs and skin, was reported at 0.5-0.6ppb in three samples. The Ontario 24 – hour criteria is 0.17ppb and the Texas annual criterion is 0.066 ppb. The report dismissed these findings saying it would be incorrect to attribute concern to these 30-60 second samples *‘as the exposure period decreases eg from 24 hours (or even annual) to just a few minutes, an acceptable exposure level increases.’* This logic is inexplicable since it presumes that the author knows how long the residents were exposed to acrolein. The exposure did not stop at the end of the 30-60 second grab sample. The report states that passive sampling over three weeks did not identify the presence of acrolein. Drilling, fracking, venting, flaring and road spraying occurred in varying locations and with varying frequency throughout the duration of the Queensland government investigation. One would expect certain chemicals to be associated with the timing of specific processes. The fact that one particular chemical was not detected in a particular 3 week period during the 9 months but was detected at high levels at other times, primarily by way of resident initiated tests, confirms the inadequacy of the testing programme.

For further information on acrolein, refer to the U.S. Department of Health And Human Services document ‘Toxicological profile for Acrolein’.²²

In summary the Queensland Government report appears to be at best a highly flawed inadequate investigation, unable to draw conclusions due to lack of appropriate data – at worst it could be interpreted as a cynical exercise to dismiss significant health concerns in the face of large financial profits.

EXPLORING THE EVIDENCE

The Queensland Health report did not undertake an extensive review of the evidence in relation to the health impacts of unconventional gas.

The underlying questions remain:

1. Are these health and well-being concerns legitimate?
2. Is there any independent supporting evidence to link these symptoms to unconventional gas exposure?

A search of the literature shows that there is a growing body of evidence documenting the adverse health impacts of unconventional gas development.

McKenzie et al (May 2012)²³

This study found that residents living $\leq \frac{1}{2}$ mile from wells are at greater risk for health effects from natural gas developments (both cancer and non-cancer) than residents living further away. Subchronic exposures to air pollutants during well completion activities presented the greatest potential for health effects.

Colburn et al (September 2011)²⁴

The technology to recover natural gas depends on undisclosed types and amounts of toxic chemicals..... More than 75% of the chemicals could affect the skin, eyes and other sensory organs, and the respiratory and gastrointestinal systems. Approximately 40% to 50% could affect the brain/nervous system, immune and cardiovascular systems, and the kidneys; 37% could affect the endocrine system; and 25% could cause cancer and mutations. These results indicate that many chemicals used during the fracturing and drilling stages of gas operations may have long term health effects that are not immediately expressed.

It should be noted that many of the chemicals used for drilling and hydraulic fracturing in Australia have not been assessed for their impacts on human health and the environment. Of the 23 identified as commonly used 'fracking' chemicals, only 2 had been assessed by the national regulator, National Industrial Chemicals Notification and Assessment Scheme (NICNAS) and neither was for their use in CSG.²⁵

Shale gas roulette (October 2012)²⁶ A study undertaken in Pennsylvania

25 most prevalent symptoms: fatigue (62%), nasal irritation (61%), throat irritation (60%), sinus problems (58%), eyes burning (53%), shortness of breath (52%), joint pain (52%), feeling weak and tired (52%), severe headaches (51%), sleep disturbance (51%), lumbar pain (49%), forgetfulness (48%), muscle aches and pains (44%), difficulty breathing (41%), sleep disorders (41%), frequent irritation (39%), weakness (39%), frequent nausea (39%), skin irritation (38%), skin rashes (37%); depression

(37%), memory problems (36%), severe anxiety (35%), tension (35%), and dizziness (34%)

“Contaminants that are associated with oil and gas development are present in air and water in areas where residents are experiencing health symptoms consistent with such exposures”, “Permitting widespread gas development without fully understanding impacts is risking public health”

Krzyzanowski (June 2012)²⁷

Northeast British Columbia has experienced increased rates of cancer and other illness due to contaminants and stressors associated with unconventional gas.

TEDX (November 2012)²⁸

Weekly air sampling for one year revealed that the number of non-methane hydrocarbons (NMHCs) and their concentrations were highest during the initial drilling phase. Methylene chloride, a toxic solvent not reported in products used in drilling or hydraulic fracturing, was detected 73% of the time; several times in high concentrations. Many of the NMHCs had multiple health effects, including 30 that affect the endocrine system, which is susceptible to chemical impacts at low concentrations, far less than government safety standards. Selected polycyclic aromatic hydrocarbons (PAHs) were at concentrations greater than those at which prenatally exposed children in urban studies had²⁹ lower development and IQ scores.

NIOSH (May 2012)³⁰

The American occupational health and safety organisation has highlighted the serious risks of cancer and chronic lung disease from silica (which is used in fracking and which the industry regularly innocuously refers to as “sand” There are risks of inhalation at every stage through quarrying, road transportation, and for workers on the well sites as well as residents nearby). Following on from their research they issued Silica sand Hazard Alert in April 2012.

American Academy of Pediatrics (December 2012)³¹

This document lists 12 chemicals used in fracking or found in the brine drawn out of the well which are of particular concern to the authors. They state *“most physicians will recognize that these are highly toxic substances”*

Below is an extract regarding 4 of the 12 chemicals.

ACETIC ANHYDRIDE- Severe irritation of eyes, upper respiratory mucous membranes and skin to very low concentrations. Permanent corneal scarring. Explosion related injuries

ETHYLENE GLYCOL- acute: neurotoxicity, cardiopulmonary effects, renal. Low dose effects, eyes, nose and throat.

TOLUENE- Noncancer acute effects: Neurotoxic, fatigue, drowsiness, headaches, nausea, unconsciousness. Noncancer chronic effects: CNS depression, ataxia, tremors, cerebral atrophy, impaired speech, hearing and vision, Inflammation and degeneration of nasal epithelium, pulmonary lesions. Maternal reproductive: increased spontaneous abortions. Developmental: neurotoxicant, attention deficit, cranio-facial and limb anomalies.

BENZENE- IARC Group 1 Carcinogen: Leukemia (acute myelogenous). Noncancer acute effects: Neurological: drowsiness, headaches, unconsciousness, convulsions. Skin, eyes and upper respiratory tract Irritation GI: Nausea, vomiting. Noncancer chronic effects: Blood dyscrasias, aplastic anemia, excessive bleeding, leukopenia Immunosuppression. Developmental: low birth weight, delayed bone formation.....

CONCLUSION

The unconventional gas industry has been allowed rapid, unfettered expansion in Queensland within recent years without taking into account the consequences to public health.

Experts in human health have been excluded from all decision making regarding CSG and other types of unconventional gas development in Australia despite this controversial industry being permitted and imposed in close proximity to human habitation. Studies documenting the serious health consequences have been already published overseas. It is essential that medical specialists relating to all aspects of human health, (paediatricians, oncologists, endocrinologists, neurologists, toxicologists, obstetricians and others) are urgently involved in decision making relating to the unconventional gas industry.

The population of the rural residential estates on the Western Downs near Tara is among the most densely settled cohort in Australia to have, so far, lived in close proximity to intensive unconventional gas development. Without any formal system in place to monitor the effect on human health of this industrial process, they have in effect become the sentinel population, the human equivalent of the canary in the coal mine.

This study shows a pattern of reported symptoms that is very concerning. In particular, a high percentage of the residents surveyed had symptoms of which could relate to neurotoxicity, including tingling, paraesthesia, numbness, headaches, difficulty concentrating and extreme fatigue. Of particular concern was the high percentage of symptomatic children, with paraesthesia being reported for almost a third of surveyed children to age 18, and headaches being reported for more than 70%. This is not a pattern of reported illness which is expected and should prompt an urgent and comprehensive response.

There are serious questions to be answered by the previous Queensland Government in relation to their due diligence in the process of permitting these gas developments. I believe there are also serious questions to be answered by the current Queensland Government in regard to their due diligence in investigating the harm that was reported to them by residents of the residential estates.

It is vitally important that the politicians of Australia, both state and federal, understand that they have a duty of care to the citizens of this nation. If the health implications of the unconventional gas industry continue to be ignored and the industry is allowed to develop along its current path, the potential exists for serious and widespread harm to human health across Australia.

RECOMMENDATIONS

1) A fully funded comprehensive medical assessment of residents currently living in proximity to unconventional gas development should be carried out as a matter of urgency. The residents of the rural residential estates and surrounding neighbourhoods on the Western Downs are an obvious first priority, but it should not be forgotten that throughout rural Queensland there are even more remote locations where isolated families have been living in close proximity to gas development.

2) Considering the toxins that residents could potentially have been exposed to, fully funded, long term epidemiological studies are necessary to track the health of people exposed to unconventional gas over the next several decades. These studies should be set up as a matter of urgency. It is important to include people who may already have left the area because of health concerns. The census of 9th august 2011 could provide data on residency at that point in time. The long term health of workers in the industry requires long term surveillance also. In this case baseline health studies are already available in the form of pre-employment medicals. For their own future reference, I would advise all workers to acquire a copy of their pre-employment medical under freedom of information.

The cause of human health impacts may not be simple, that is a single chemical culprit, but be the cumulative impact over time of several related or unrelated chemicals. It is the interactions of a mixture of chemicals both outside and inside the body which warrant investigation. If one compound prevents the breakdown or excretion of other compounds from the body then unforeseen toxicity can result. If solvents are part of the mix, then the blood brain barrier may be compromised, with serious and unpredictable consequences.^{viii}

3) Health impact assessments must be an integral part of any and every unconventional gas development. No new permit should be issued without one, and health impact assessments should be carried out for every development already in place.

^{viii} Dr John Polglase private email/Dr David Brown PSE

4) Comprehensive air and water monitoring (an open, ongoing and unlimited information loop) is essential. If we are looking at possible non beneficial human health impacts we need to look at all the gases and volatiles both natural and derived emitted via well drilling, gas and pipeline valves, leaking wellheads, flaring, and other processes involved in gas collection/purification/refining to export specifications. This monitoring is urgently required. It must be independent, unbiased, fully funded and available for public scrutiny preferably in real time and in electronic form.

5) Gas companies must be required to fully and openly disclose in a timely manner, all chemicals, and all quantities of chemicals, used or planned to be used for drilling, fracking, cleaning, dehydration, and other processes at every gas facility. All historical results they have of analyses of air, soil and water should be available for public scrutiny.

6) The federal government must develop legislation to protect public health in general but from the impacts of unconventional as development in particular. Public health legislation occurs at state level and it is important to have a unified standard and approach to public health across Australia.

7) Thought must be seriously given to what the future for the unconventional gas industry should be in Australia. Politicians must engage in public debate. Consideration of the health impacts of unconventional gas development should be added to the national debate on its future.

The questions which require answers are:

a) Is it simply enough to provide buffers around residential developments? If so how far should the buffer extend? It should be noted that New South Wales's proposed 2km buffer from a residential development of 1000 people or more would not have protected a single resident of the Tara estates.

b) If it is confirmed that the health of the residents of the Tara estates is impacted, should they be rehoused? If so where and at cost to whom?

c) What would the effect of loss or contamination of agricultural land and possible insecurity of food supply have on the future health of the population?

d) What would the effect of degrading or depleting the aquifers of the Great Artesian Basin and possible insecurity of fresh water supply have on the health of Australia?

e) If methane emissions accelerate global warming what impact will that have on our health?

If these questions are still unanswered should the activities of an industry which was imposed upon communities in Queensland in such controversial circumstances remain unchecked? Or is this the asbestos equivalent of the 21st century and no matter how unpalatable and how unprofitable, difficult decisions need to be made.

APPENDIX A – QUESTIONNAIRES

Name

survey no

Water supply

	Drinkin g	cookin g	Washin g dishes	Washin g clothes	Bathin g	Vegetabl e garden	Domesti c animals	othe r
Town								
Trucked								
Bottled								
Rainwater tanks								
Dam								
Bore								
River/cree k								
other								

Water storage, type of tanks

How is water treated before use?

Home environment

Air conditioner	Air purifier	Central heating(gas) (oil)	Gas stove
Electric stove	Fireplace	Wood stove	humidifier

Have you recently acquired new furniture, carpet or refinished furniture?

Yes, no

Are pesticides or herbicides (bug or weed killers; flea and tick sprays, collars powders or shampoos) used in your home or garden, or on pets?

Yes, no

To your knowledge, when did CSG activity start?

Closest infrastructure	distance /quantity	Direction
Wells		
Ponds		
High point valves		
Low point valves		
Compressor stations		
Dehydration plants		
Pipelines		
other		

Name

Survey no

Usual wind directions

Relative to your home, which companies have gas infrastructure and in which direction?

On or near your property are you aware of the following And if so since when?

Odours	Unusual cracking of soil	Bubbling in puddles	Bubbling of river/ creek

Do you have domestic animals/birds on the property?

Cattle	sheep	goats	Pigs	chickens	ducks	Dogs	cats	Pet birds	other

Have you noticed any unusual illness amongst the livestock?

Birds – loss of feathers, unexpected death

Dogs- rashes, change in temperament/ apparent pain / unexpected death/

Have you noticed any change in health or numbers of native animals, birds or frogs?

If so what and since when?

Part 2- Individual questionnaire for each person within each household

Past history questionnaire

Name

survey no

Health prior to CSG development

DIAGNOSIS	Yes	No
asthma		
allergies		
eczema		
COPD		
Heart attack		
stroke		
Peripheral neuropathy		
Carpal tunnel		
Diabetes		
Epilepsy		
Other neurological problem		
Skin cancer		
Other cancer		
Congenital heart disease		

Conditions diagnosed since CSG development

Name

Survey

no

Do you believe your health has been adversely affected by CSG?

yes no

uncertain

If yes, explain how you feel your health is impacted. Describe symptoms. Relate specific incidents / frequency and duration of exposures / frequency and duration of symptoms/ time frame of symptoms related to weather events and known specific gas

field activities. Describe odours- if there are different odours do you notice any difference in symptoms?

If medical attention sought: where, from whom and how frequently?

What was the outcome?

If medical attention not sought, reasons why not

Child age 6-adult questionnaire

Name.

Survey number

Age

male female

smoker non-smoker

date

	In the two years prior to CSG development how often did you suffer from;				Since CSG development(in the past 1-2 years) how often have you suffered from;			
	Never	Occasionall y	often	Constantl y	Never	Occasionall y	often	Constantl y
Eye								
Streaming eyes								
Nasal burning								
Blood from nose on wiping								
Spontaneous nose bleeds								
Mild headaches								
Severe headaches								
Cough								
Chest discomfort								
Chest tightness								
Difficulty breathing								
Severe chest pain								
Irregular heartbeat								
Skin irritation								
Rashes								
dizziness								
Severe fatigue								
Difficulty concentrating								
Difficulty sleeping								
Depression/ anxiety								
weakness								
forgetfulness								
nausea								
vomiting								
Stomach pains								
Muscle pains/ spasms								
Tingling /numbness hands / feet/ head								

seizures								
Collapse								
Sore joints								

Never:- never. Occasionally :- has happened ever (in the time frame), few times, sporadic. Often:- recurring, regular, frequent. Constantly :- at least twice per week.

Age 0-5 questionnaire

Infants / Children

Name survey number

Age male female date

History by mother / father /

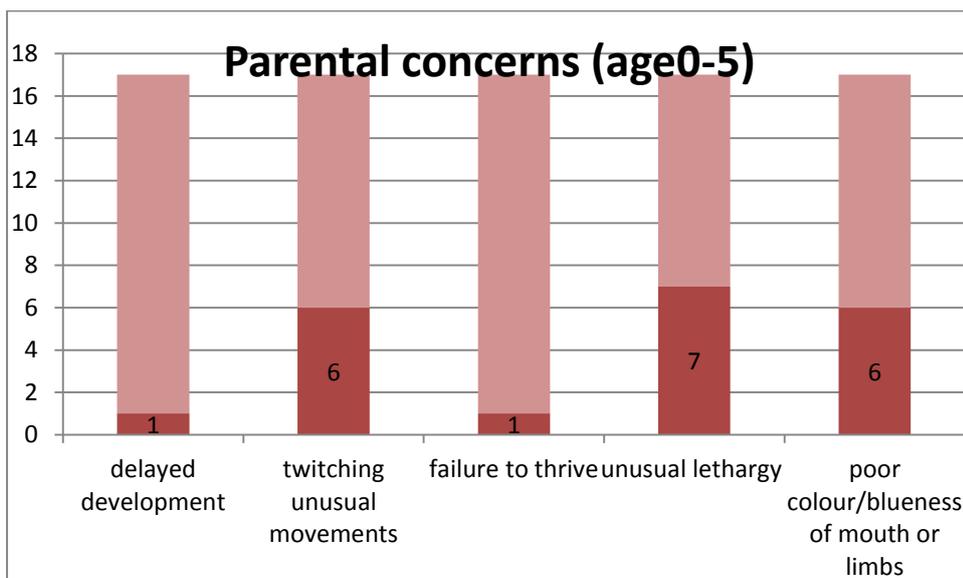
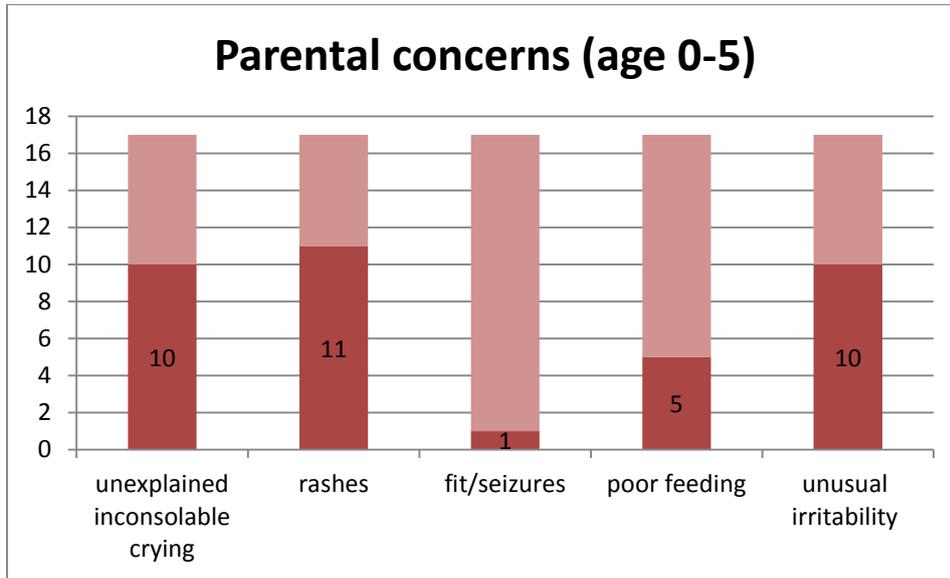
Have you noticed or been concerned by any of the following:

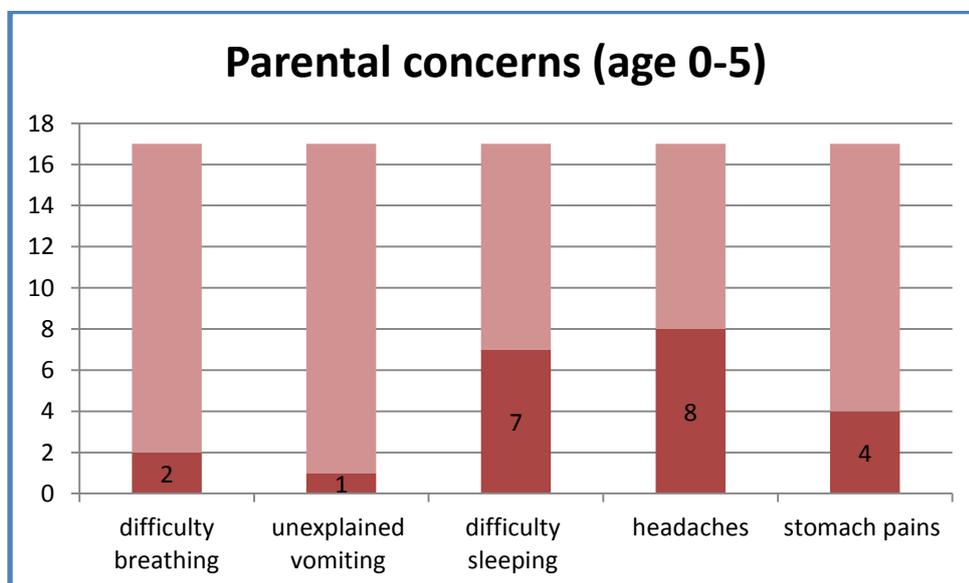
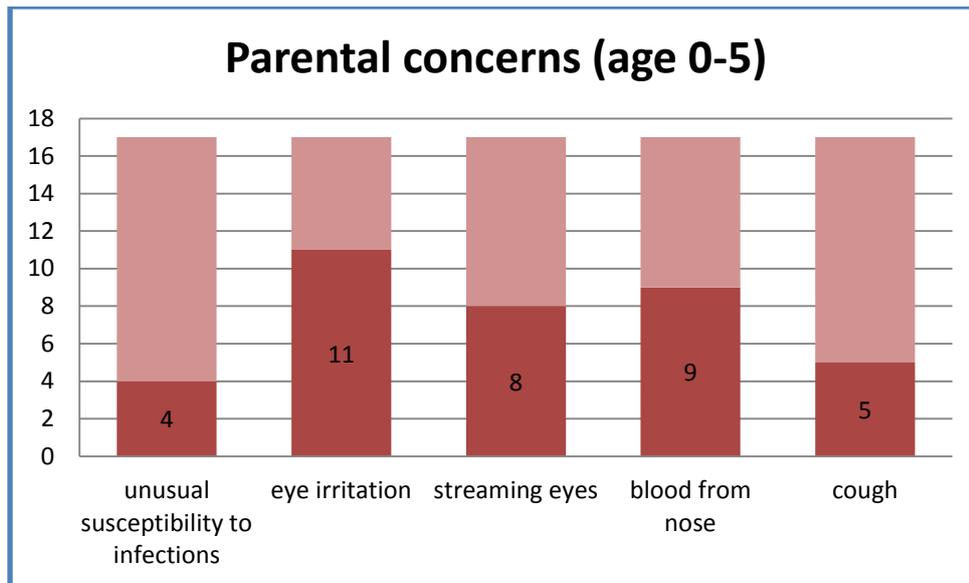
Unexplained inconsolable crying	Rashes	Fits /seizures	Poor feeding
Unusual irritability	Delayed development	Twitching /unusual movements	Failure to thrive
Unusual lethargy	Poor colour /blueness around mouth or limbs	If walking, unusual clumsiness unsteadiness or falls	Unusual susceptibility to infections
Eye irritation	Streaming eyes	Blood from nose	
Cough	Difficulty breathing	Unexplained vomiting	Difficulty sleeping
Headaches	Stomach pains	Sore limbs	Muscle spasms
Tingling hands feet head	Burning nose		

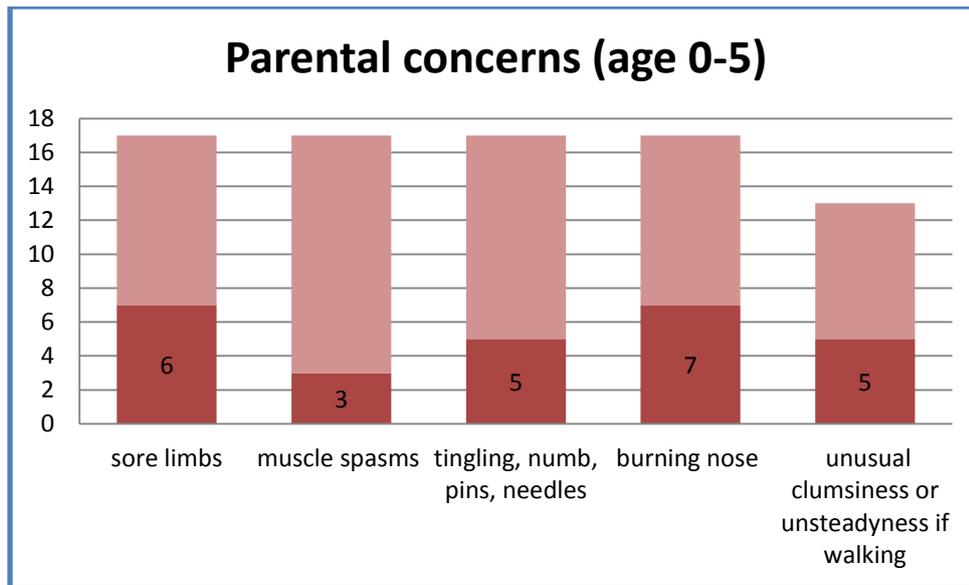
APPENDIX B – DATA CHARTS

Parental Concerns age 0-5

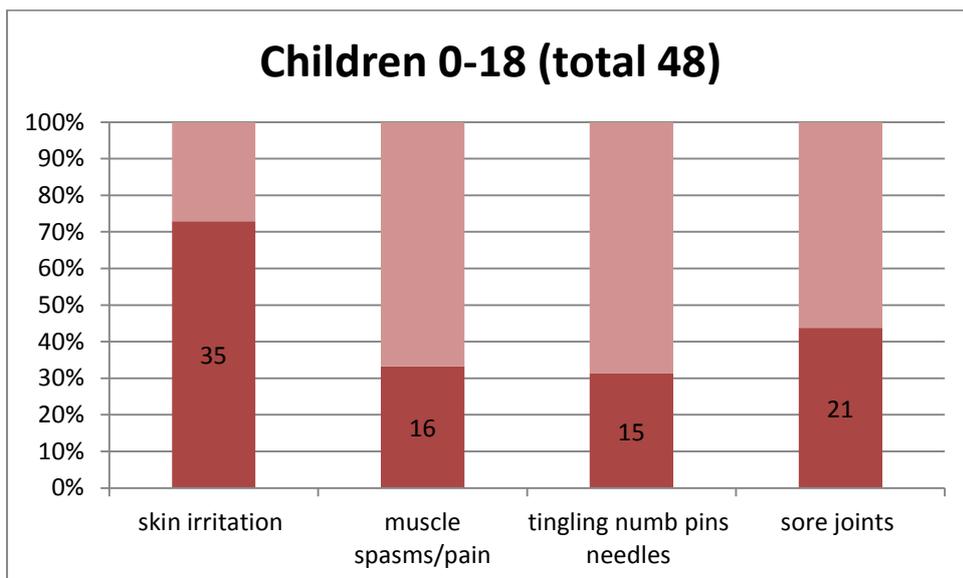
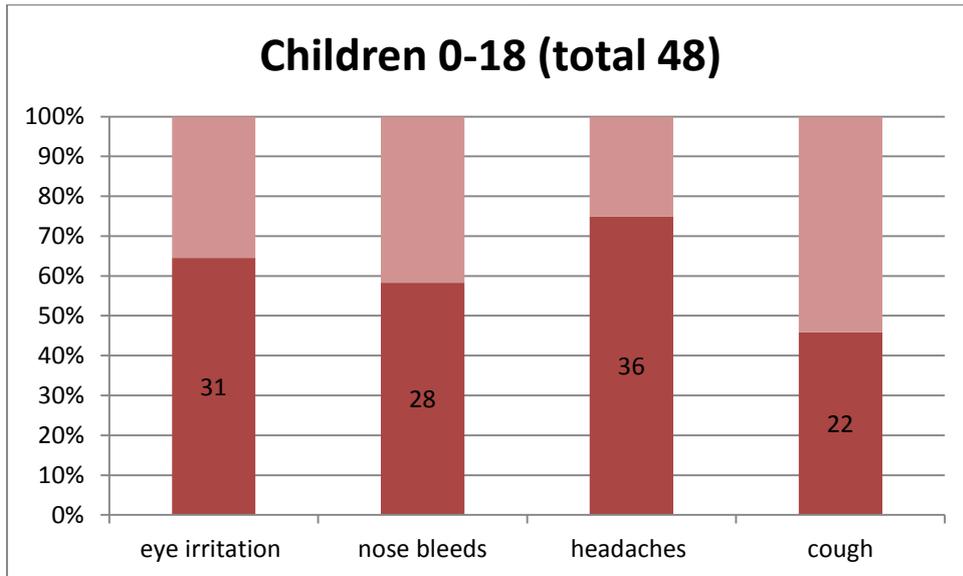
Bar Charts



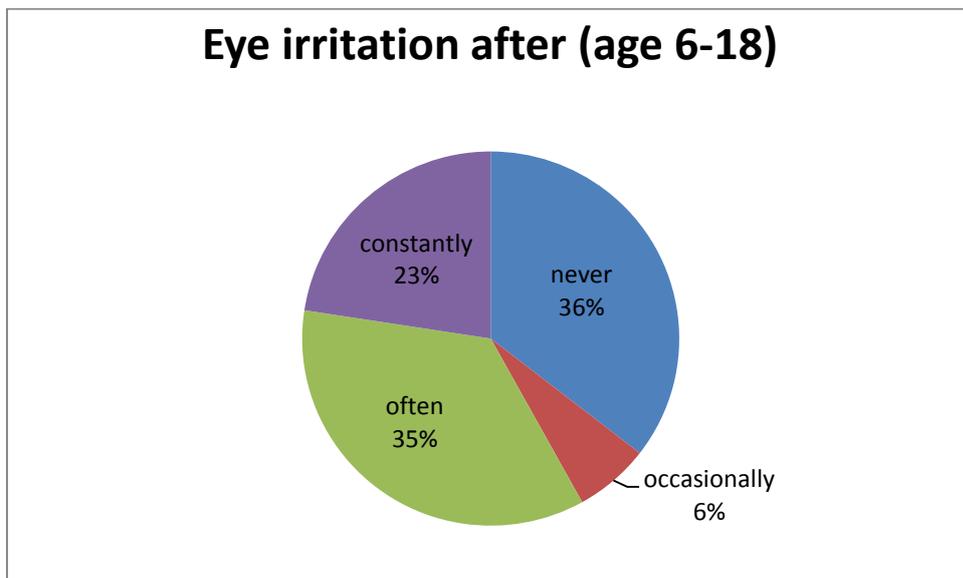
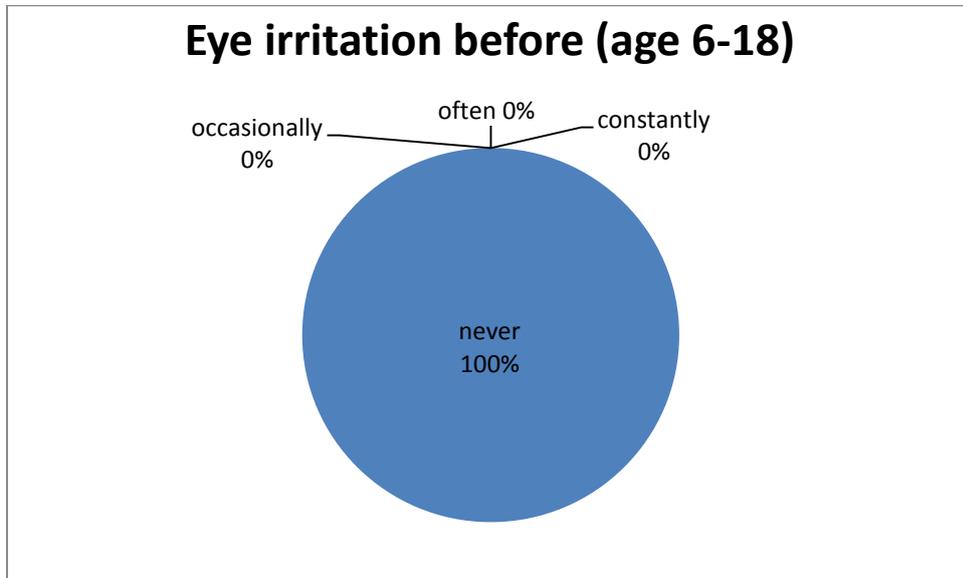




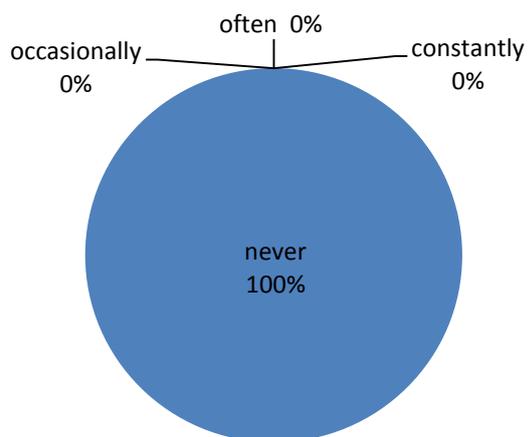
Children age 0-18, Percentage symptomatic - Bar Charts



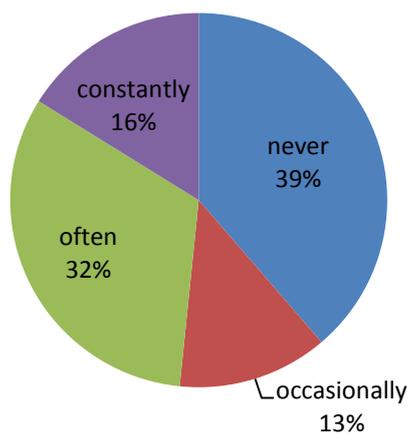
Age 6-18 Symptoms reported before and after Coal Seam Gas exposure - Pie Charts



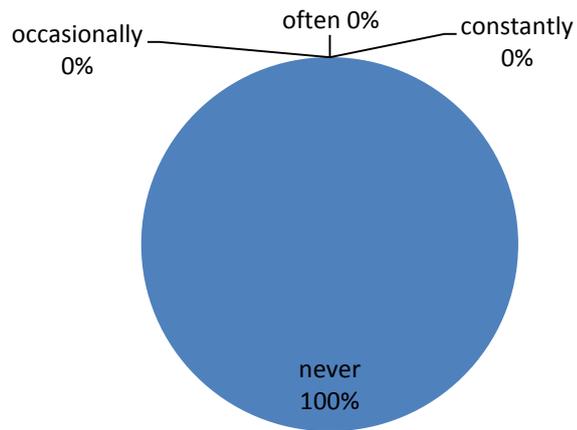
Streaming eyes before (age 6-18)



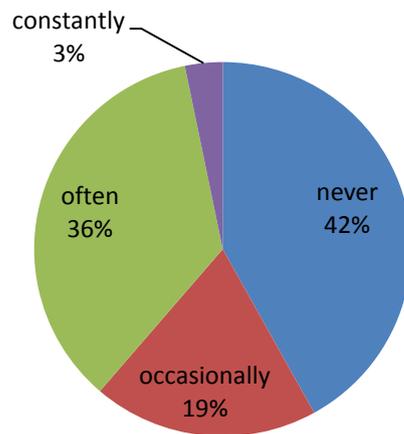
Streaming eyes after (age 6-18)



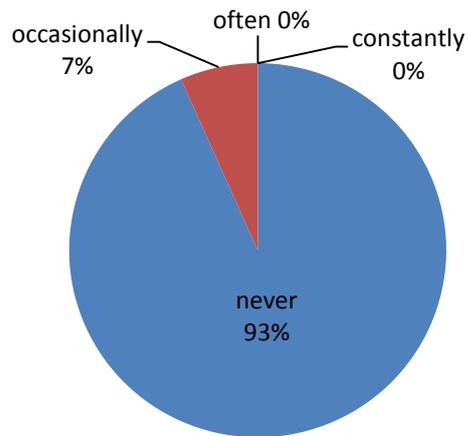
Nasal burning before (age 6-18)



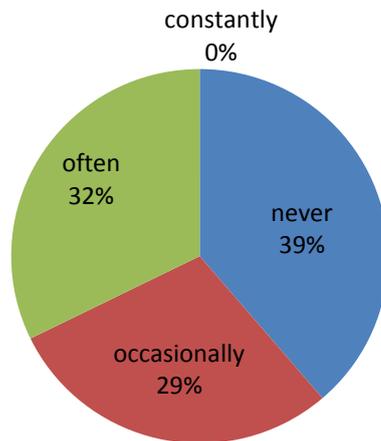
Nasal burning after (age 6-18)



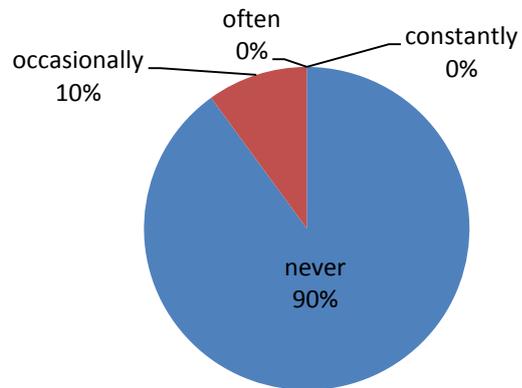
Blood nose on wiping before (6-18)



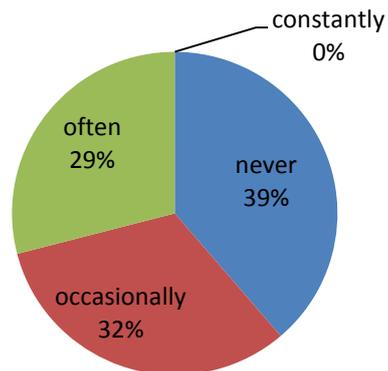
Blood nose on wiping after (age 6-18)



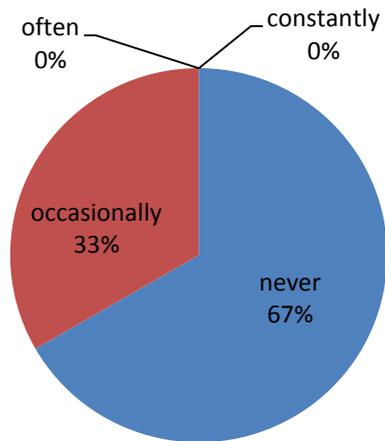
Spontaneous nose bleeds before (age 6-18)



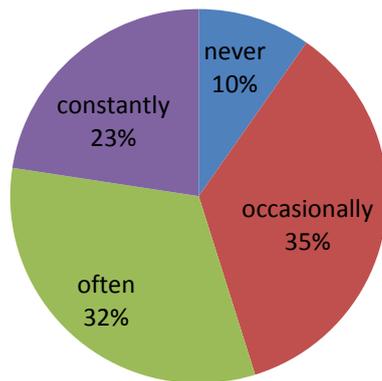
Spontaneous nose bleeds after (age 6-18)



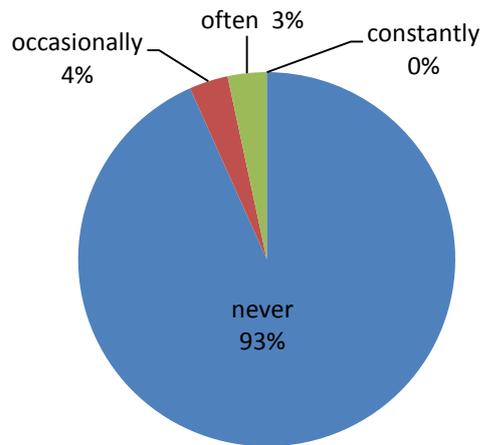
Mild headaches before (age 6-18)



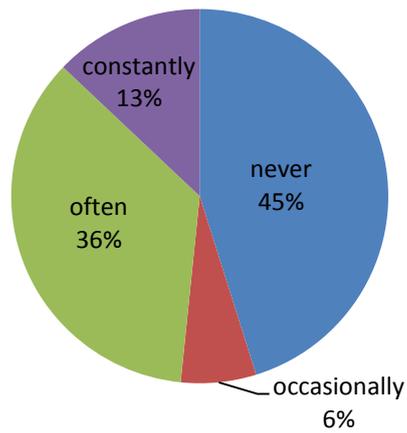
Mild headaches after (age 6-18)



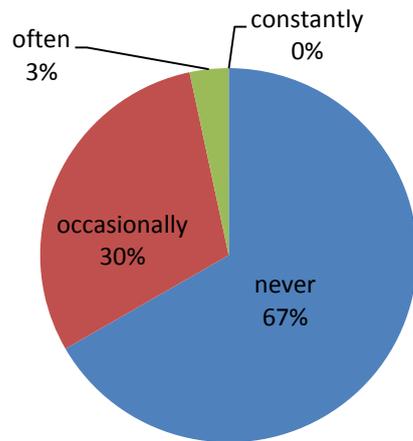
Severe headaches before (age 6-18)



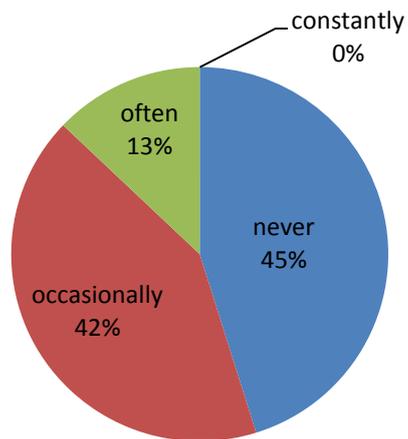
Severe headaches after (age 6-18)

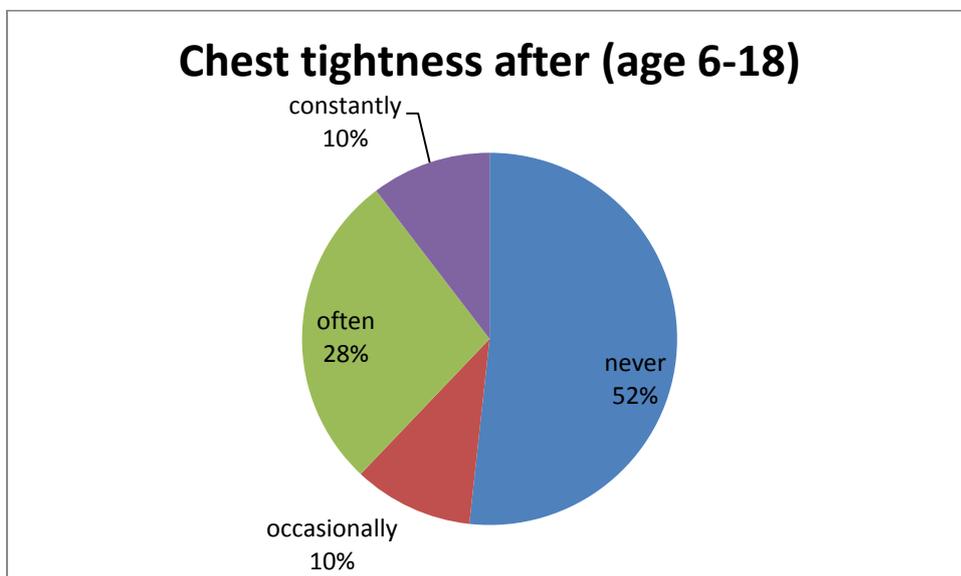
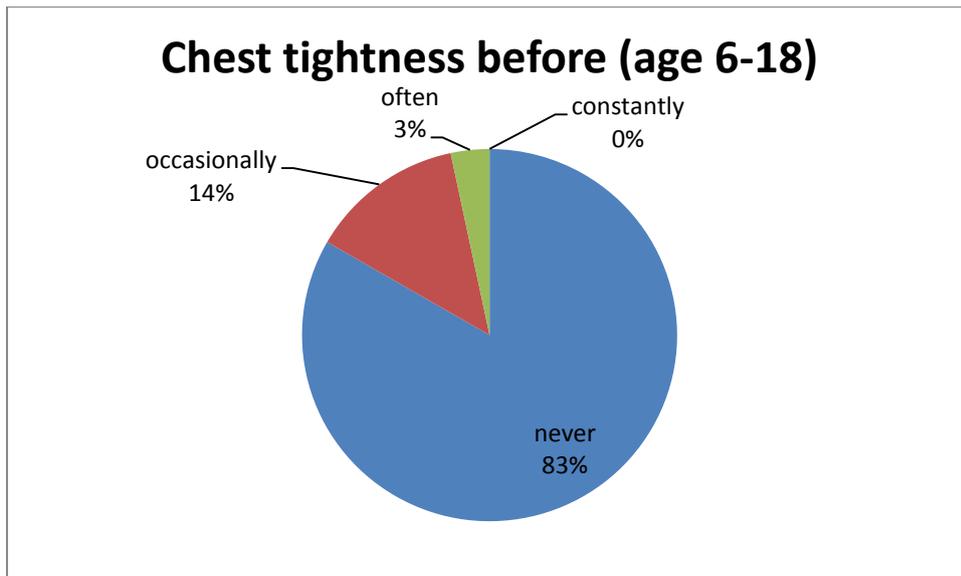


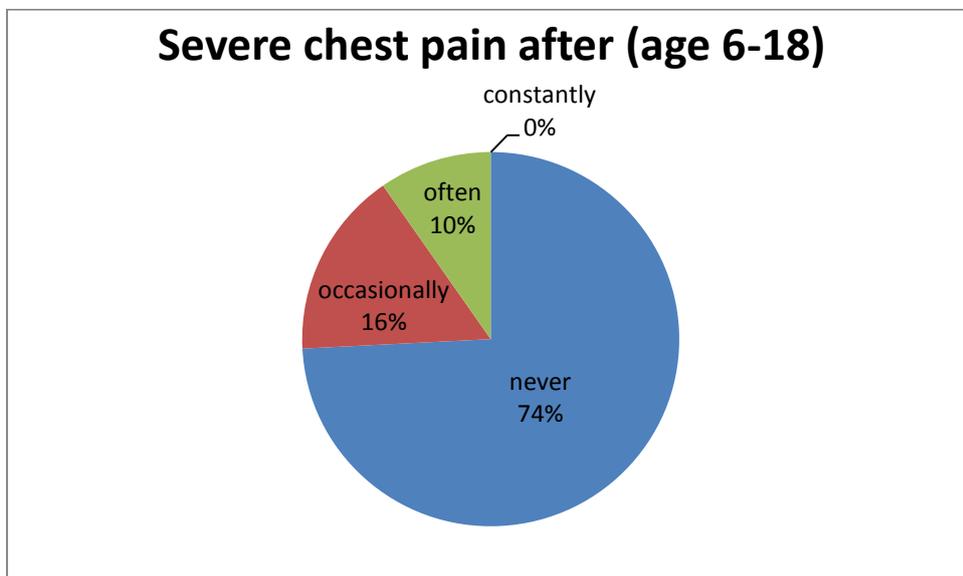
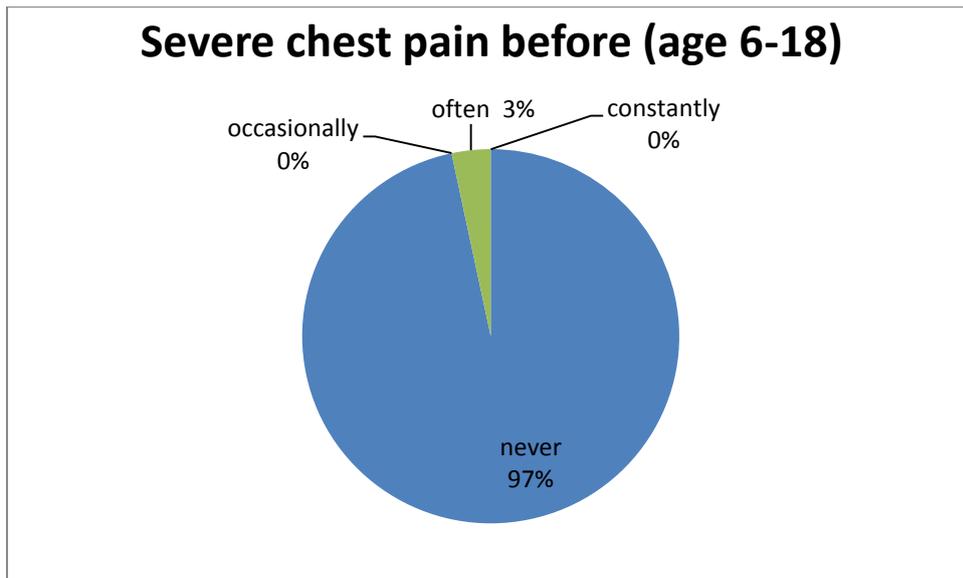
Cough before (age 6-18)



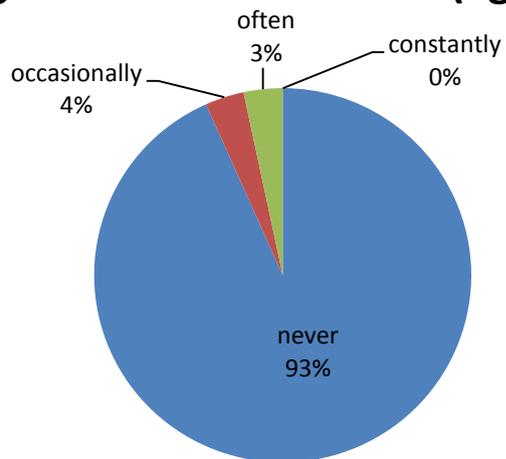
Cough after (age 6-18)



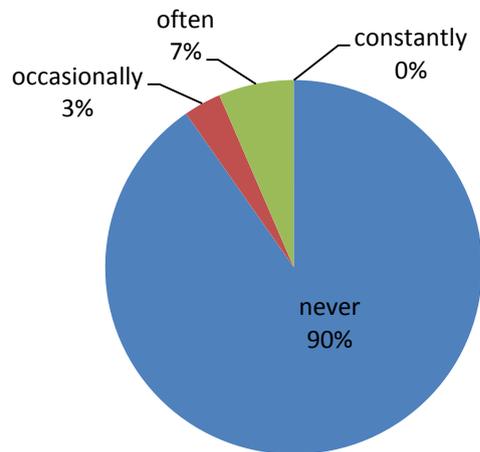




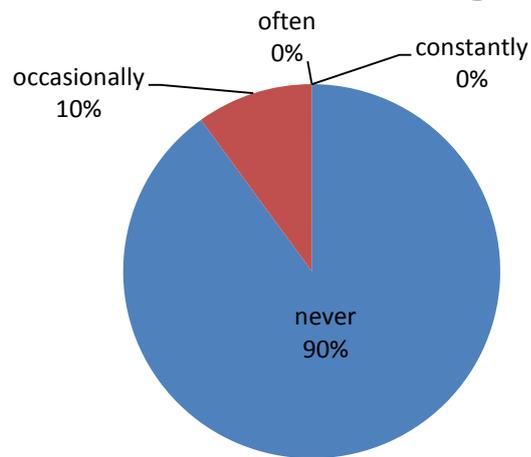
Irregular heartbeat before (age 6-18)



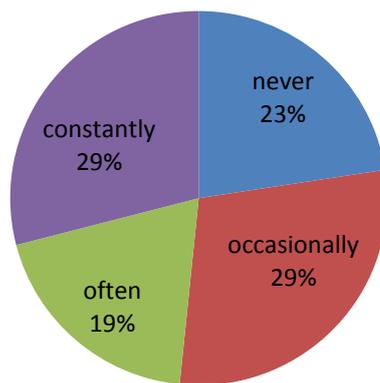
Irregular heart beat after (age 6-18)

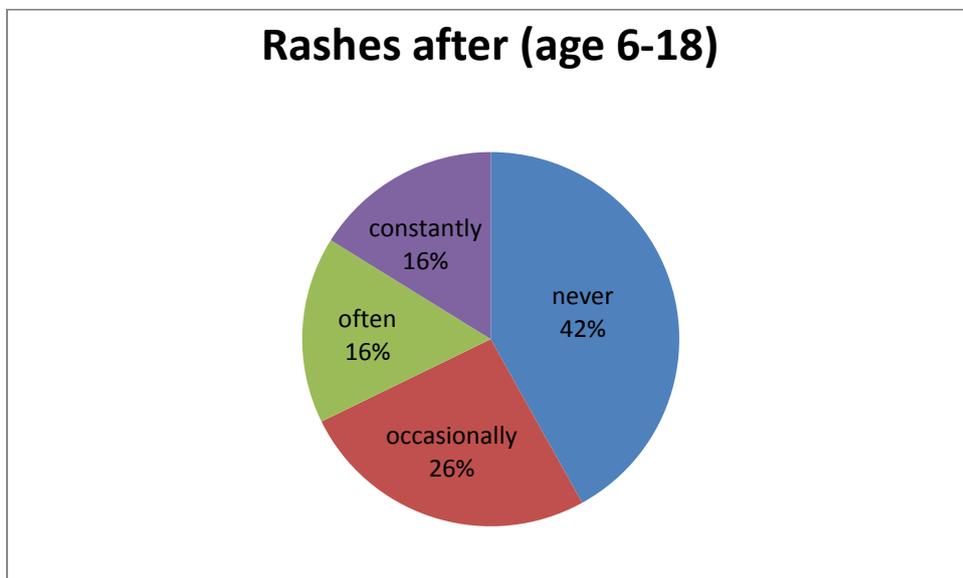
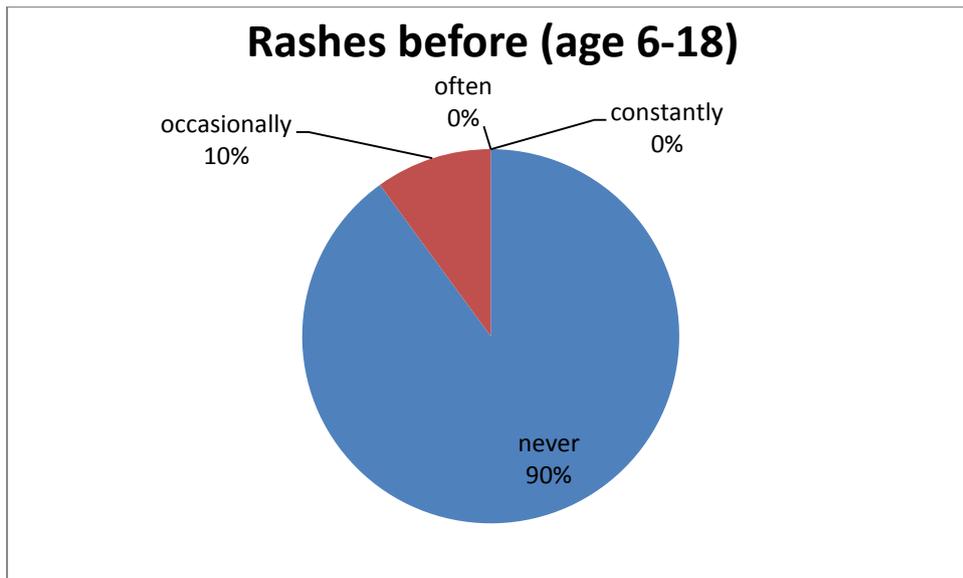


Skin irritation before (age 6-18)

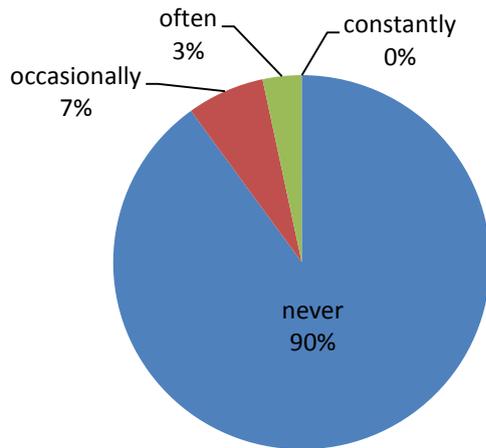


Skin irritation after (age 6-18)

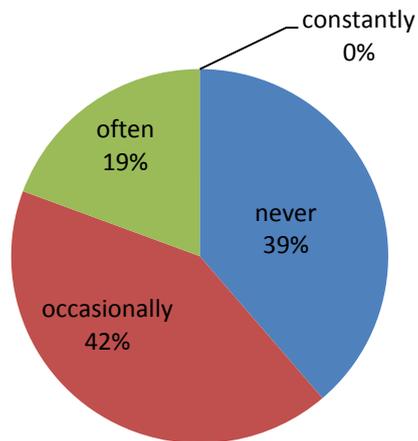




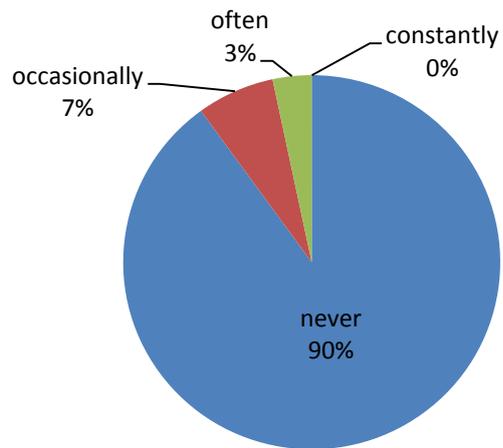
Dizziness before (age 6-18)



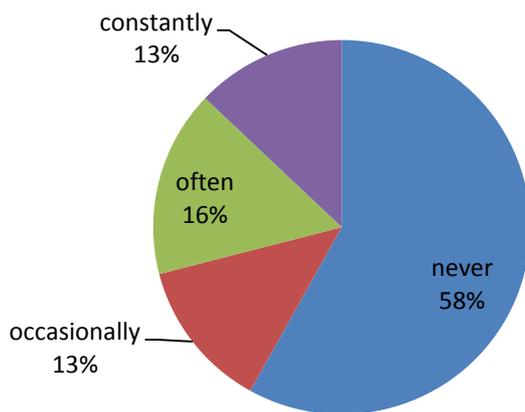
Dizziness after (age 6-18)



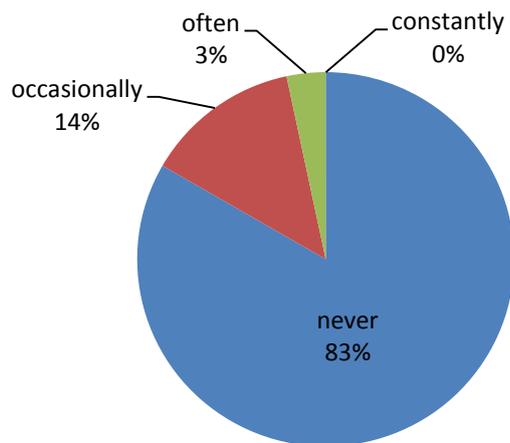
Severe fatigue before (age 6-18)



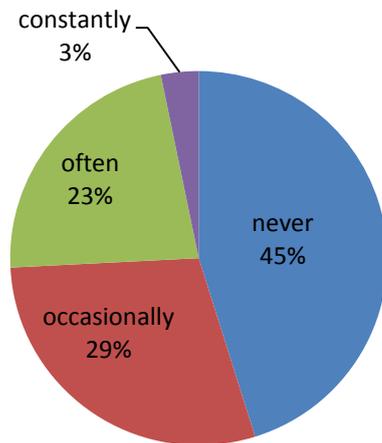
Severe fatigue after (age 6-18)



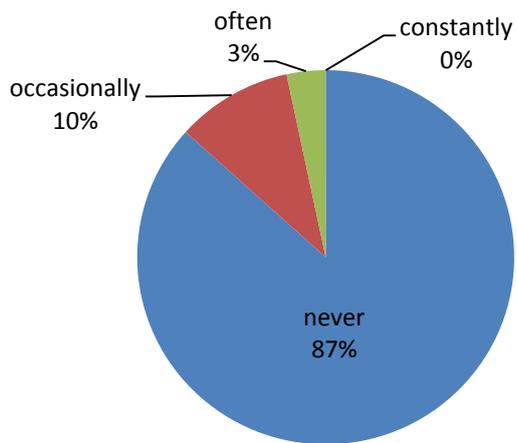
Difficulty concentrating before (6-18)



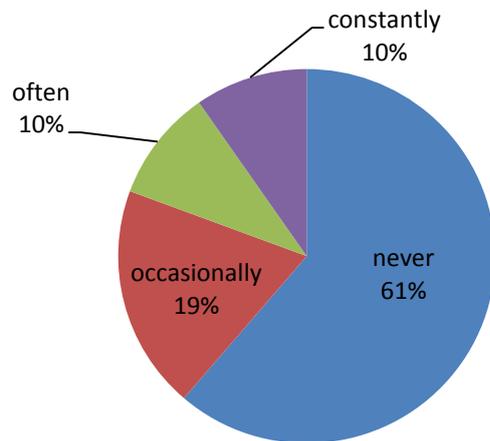
Difficulty concentrating after (6-18)



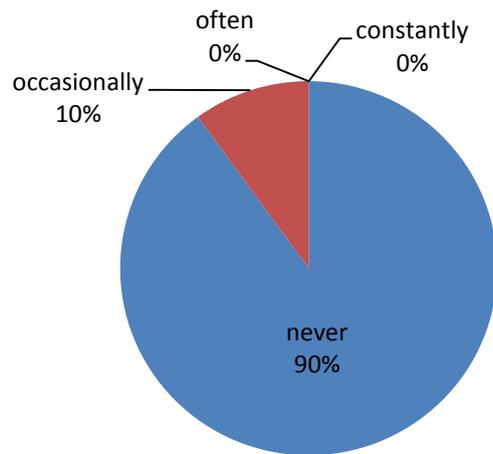
Difficulty sleeping before (age 6-18)



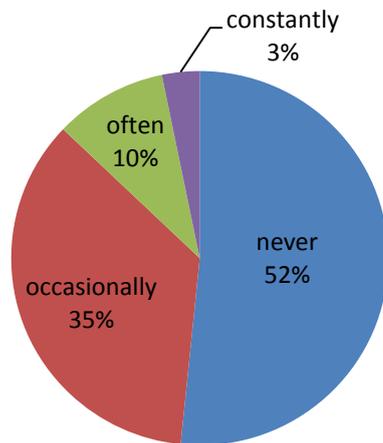
Difficulty sleeping after (age 6-18)



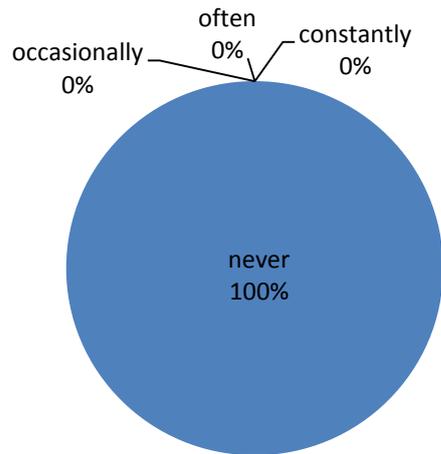
Depression/anxiety before (age 6-18)



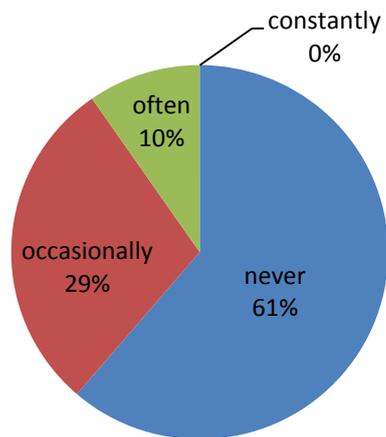
Depression/anxiety after (age 6-18)



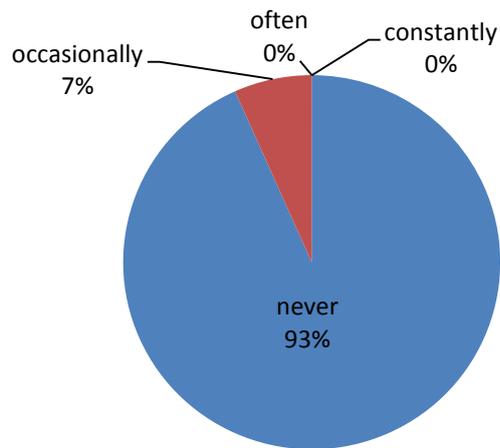
Weakness before (age 6-18)



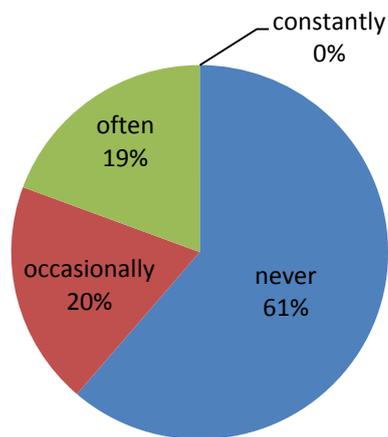
Weakness after (age 6-18)



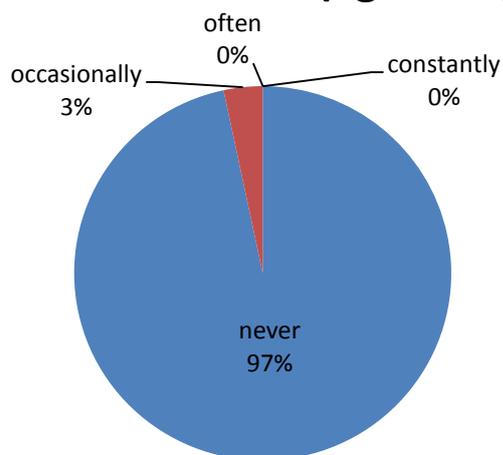
Forgetfulness before (age 6-18)



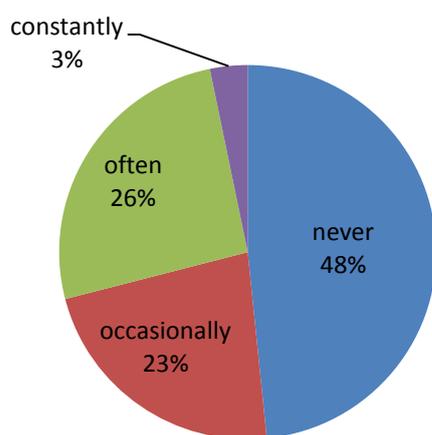
Forgetfulness after (age 6-18)



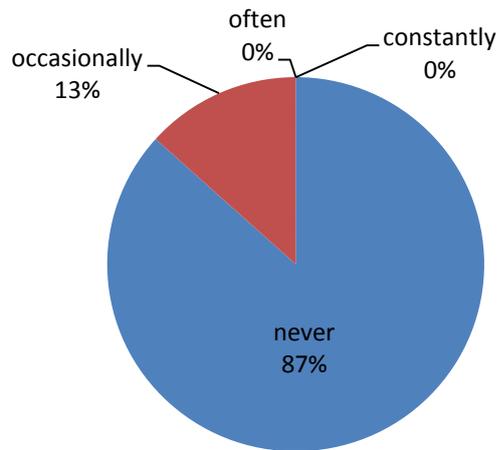
Nausea before (age 6-18)



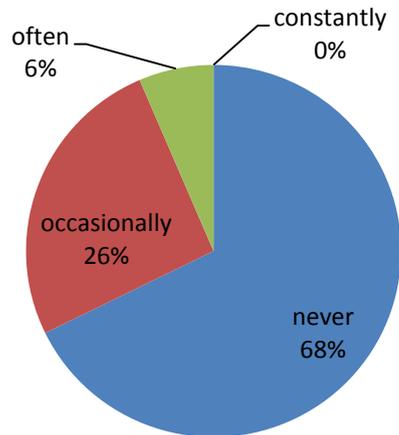
Nausea after (age 6-18)



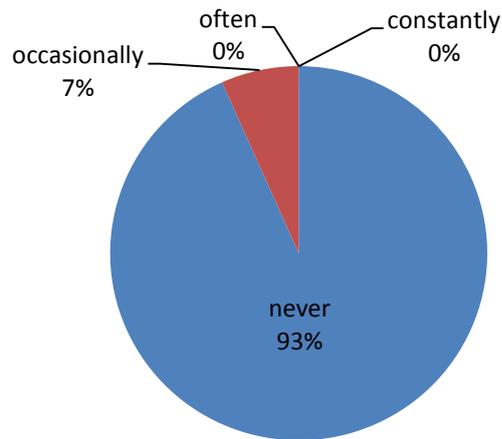
Vomiting before (age 6-18)



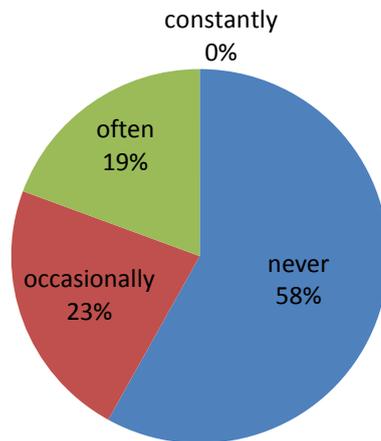
Vomiting after (age 6-18)

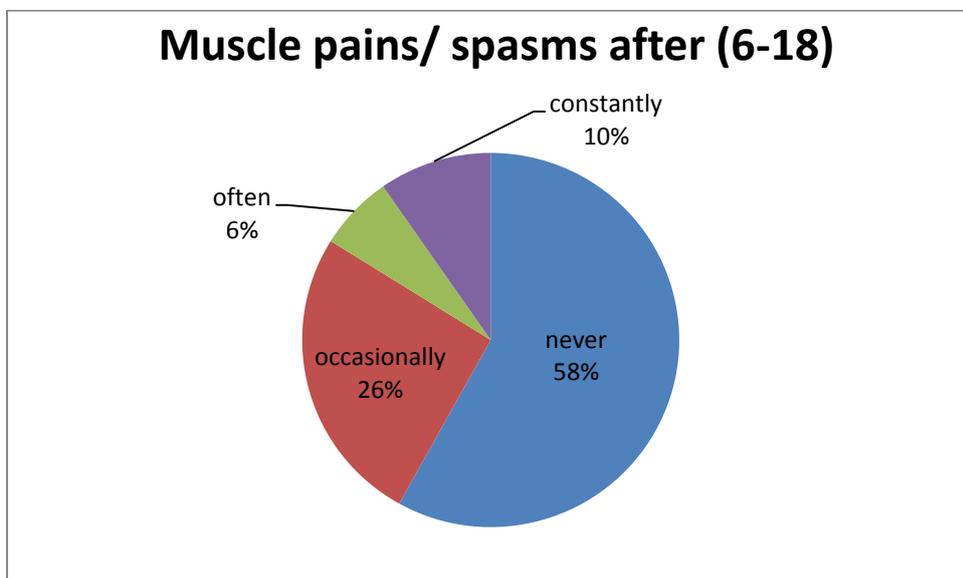
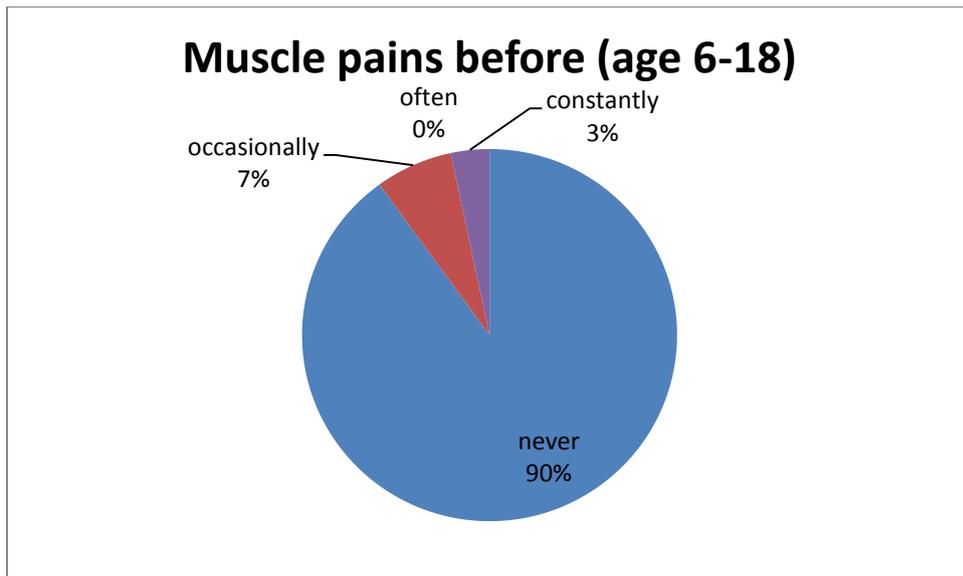


Stomach pains before (age 6-18)

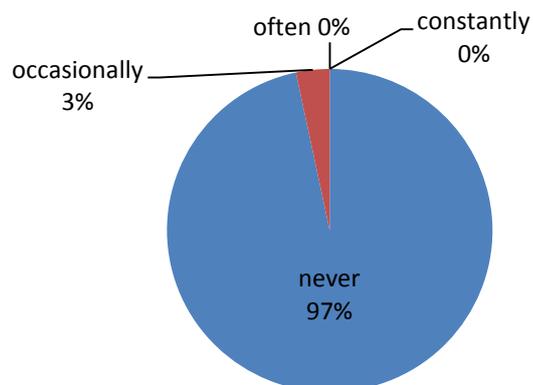


Stomach pains after (age 6-18)

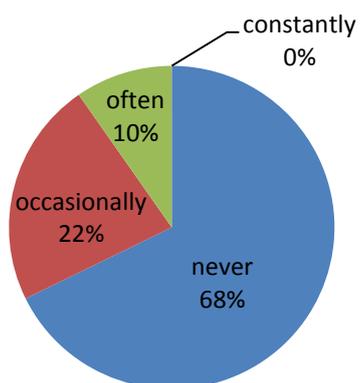




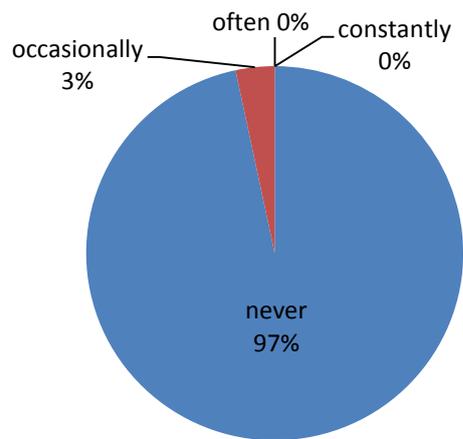
Tingling numbness pins and needles before (age 6-18)



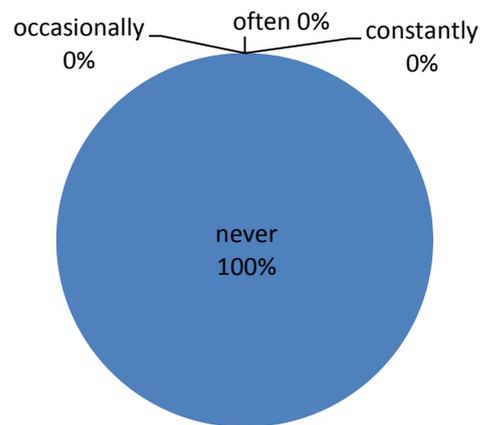
Tingling numbness pins and needles after (age 6-18)



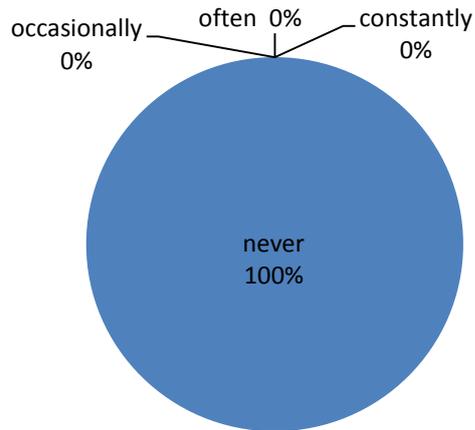
Seizures before (age 6-18)



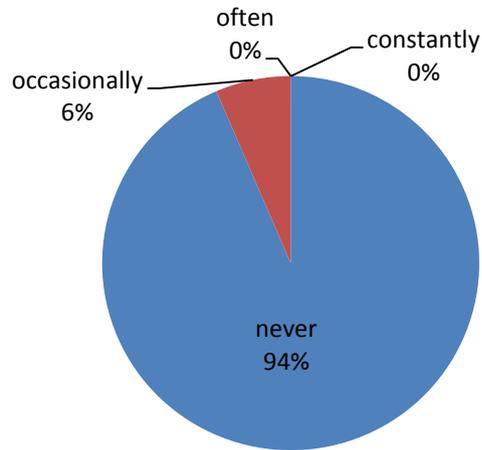
Seizures after (age 6-18)



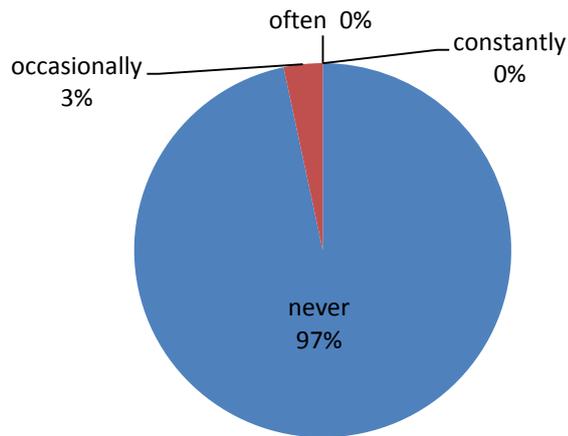
Collapse before (age 6-18)



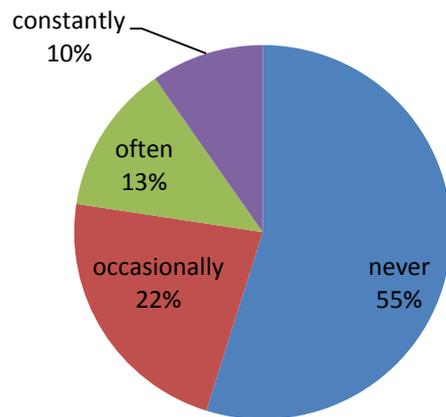
Collapse after (age 6-18)



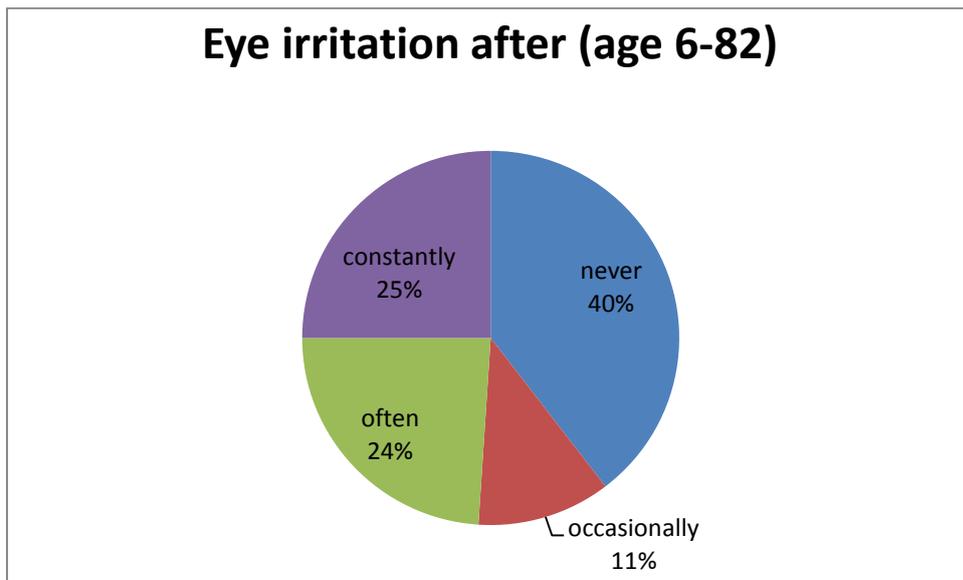
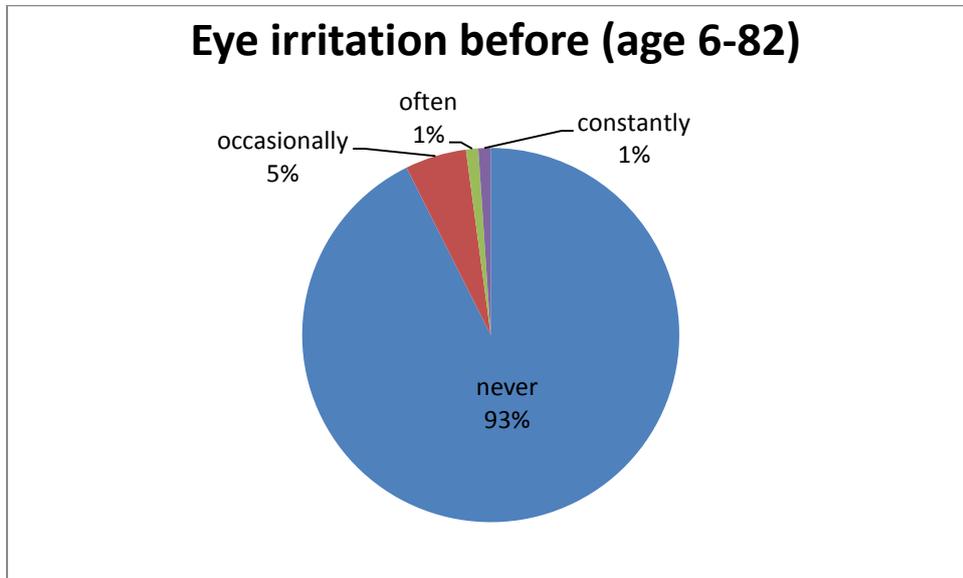
Sore joints before (age 6-18)



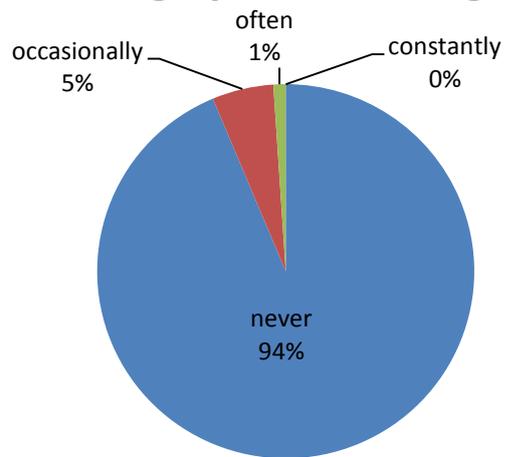
Sore joints after (age 6-18)



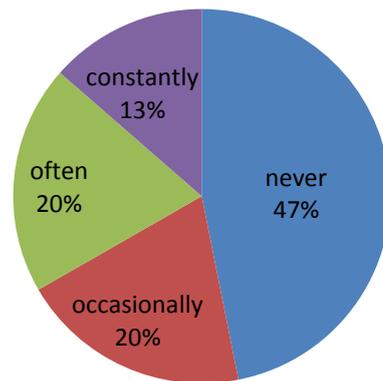
Age 6-82 Symptoms reported before and after Coal Seam Gas development - Pie Charts



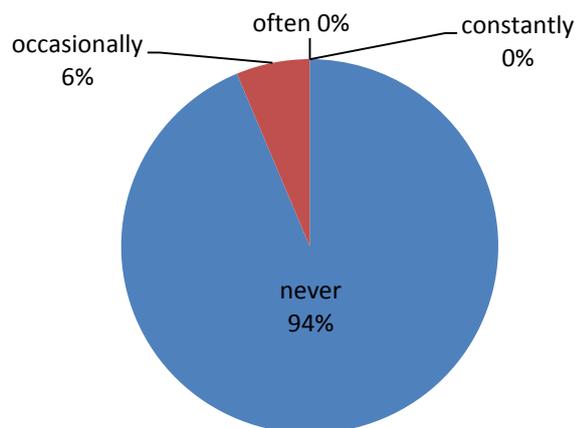
Streaming eyes before (age 6-82)



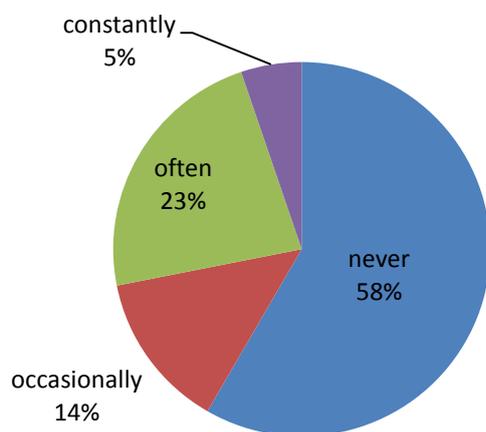
Streaming eyes after (age 6-82)



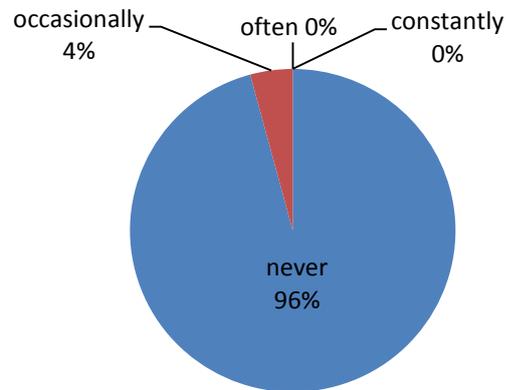
Nasal burning before (age 6-82)



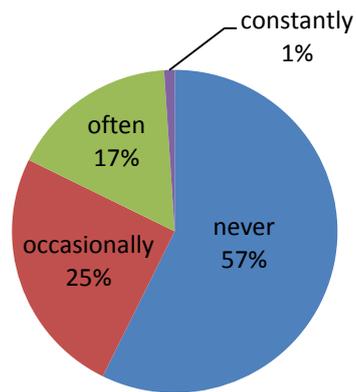
Nasal burning after (age 6-82)



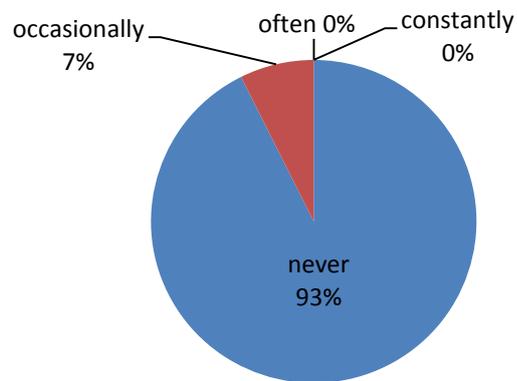
Blood nose on wiping before (age 6-82)



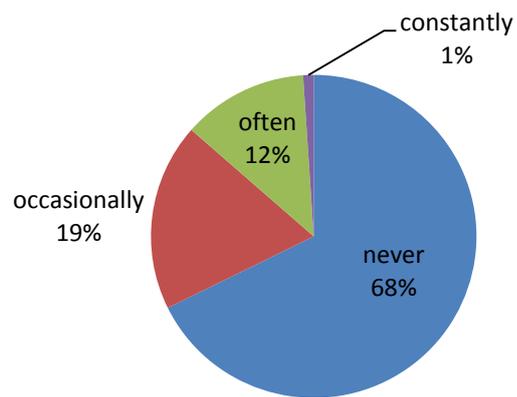
Blood nose on wiping after (age 6-82)



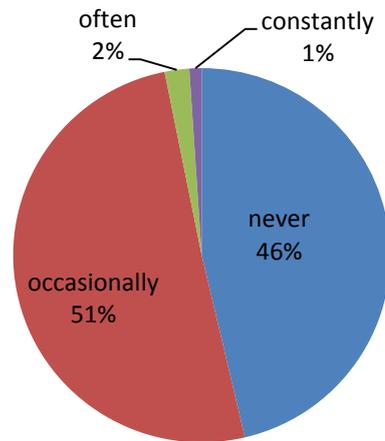
Spontaneous nose bleeds before (age 6-82)



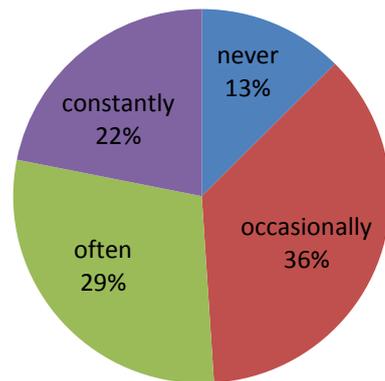
Spontaneous nose bleeds after age (6-82)



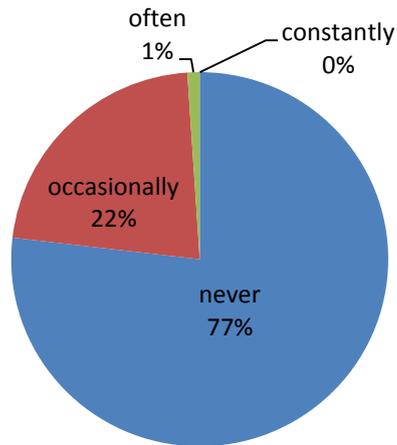
Mild headaches before (age 6-82)



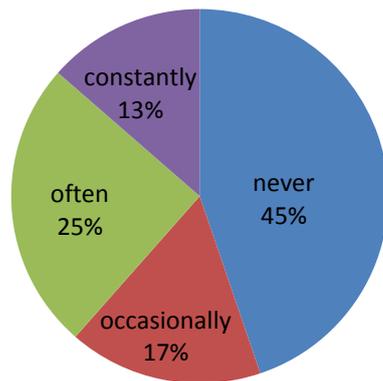
Mild headaches after (age 6-82)



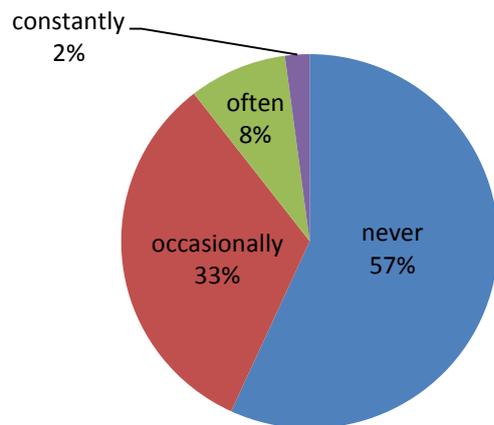
Severe headaches before (age 6-82)



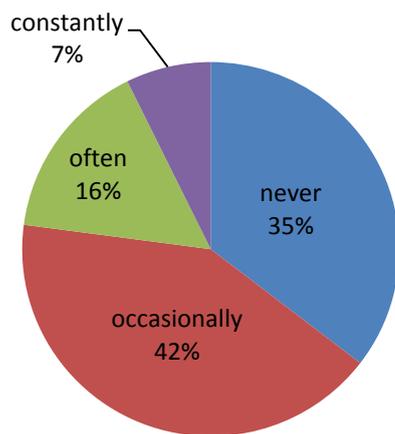
Severe headaches after (age 6-82)



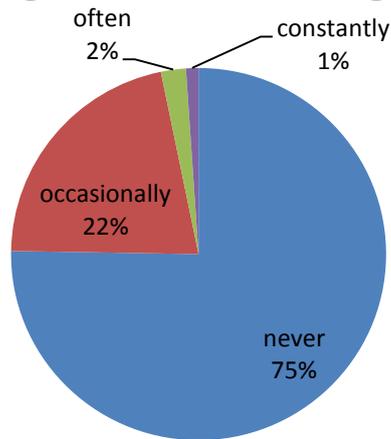
Cough before (age 6-82)



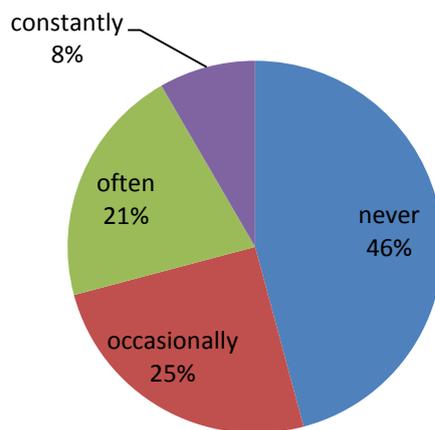
Cough after (age 6-82)



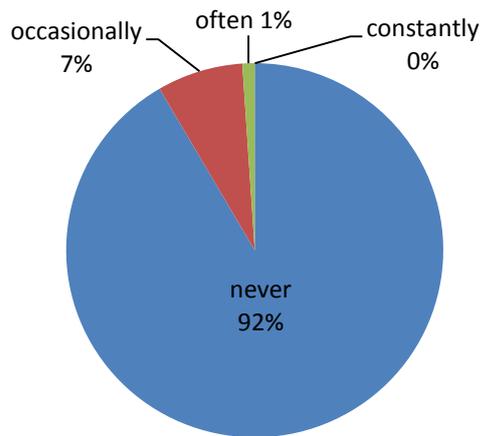
Chest tightness before (age 6-82)



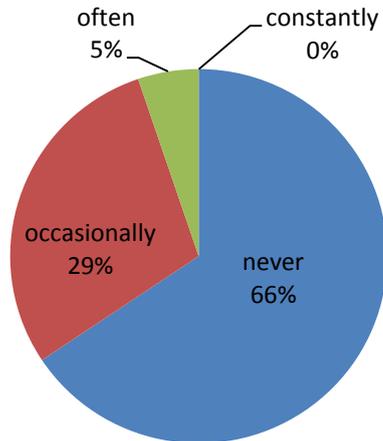
Chest tightness after (age 6-82)



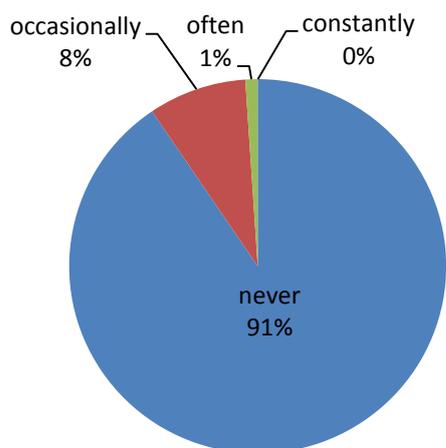
Severe chest pain before (age 6-82)



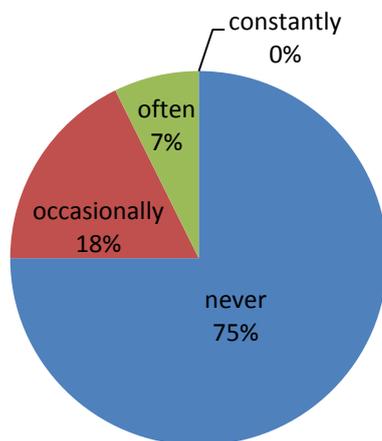
Severe chest pain after (age 6-82)



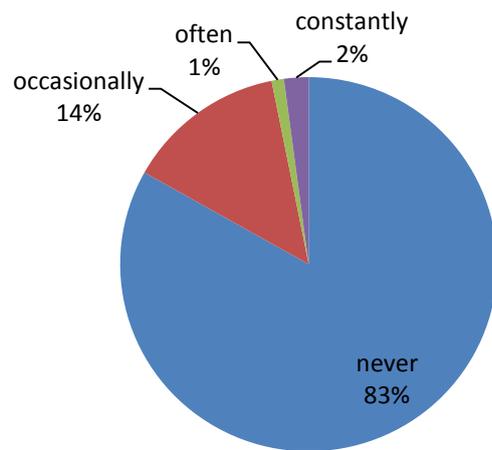
Irregular heart beat before (age 6-82)



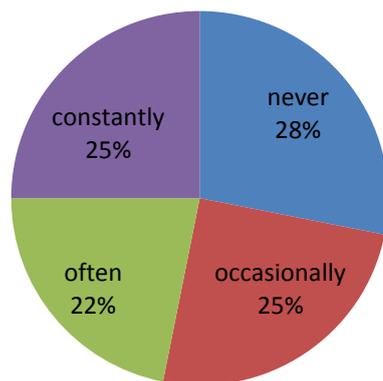
Irregular heart beat after (age 6-82)

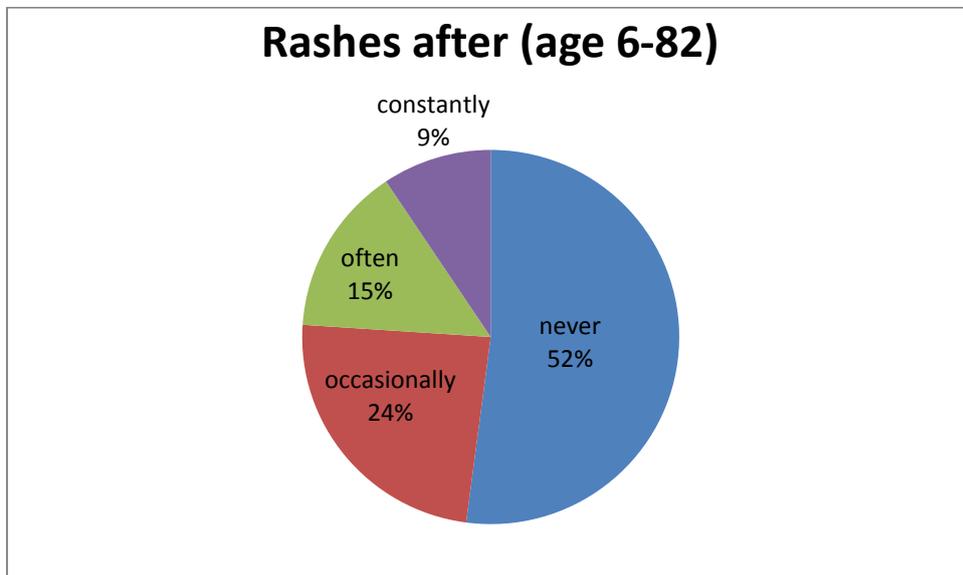
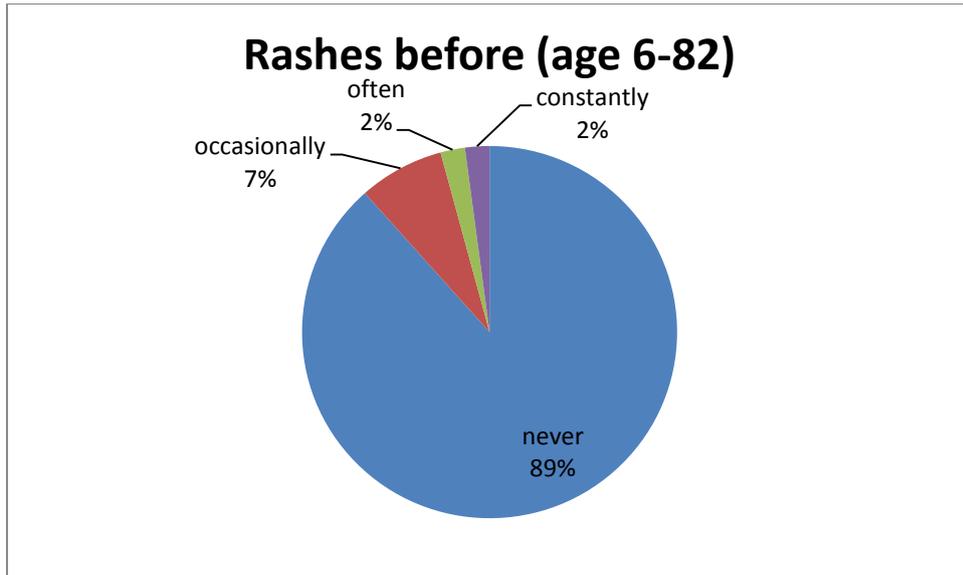


Skin irritation before (age 6-82)

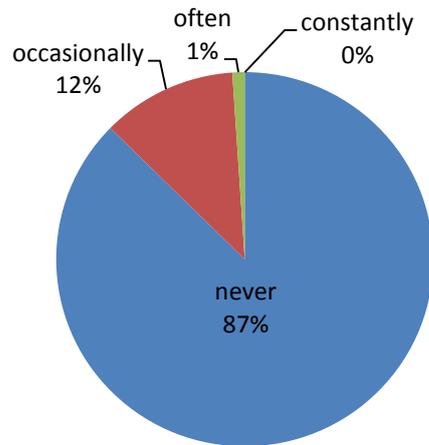


Skin irritation after (age 6-82)

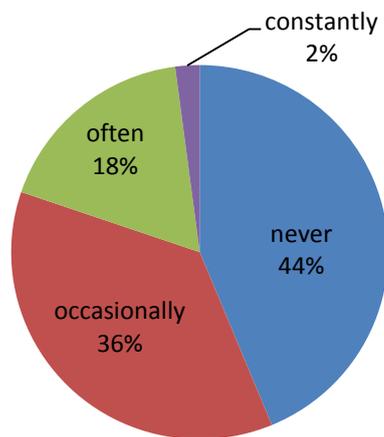




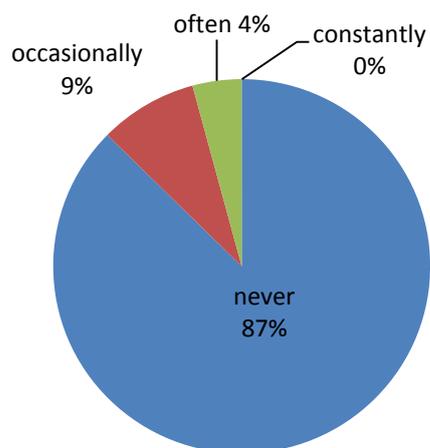
Dizziness before (age 6-82)



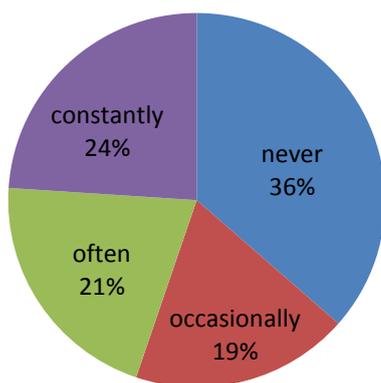
Dizziness after (age 6-82)



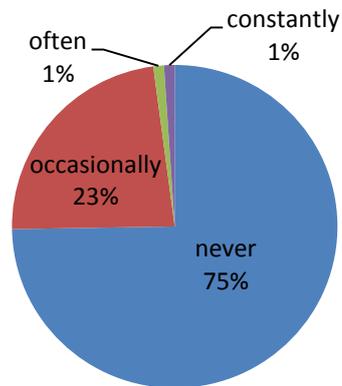
Severe fatigue before (age 6-82)



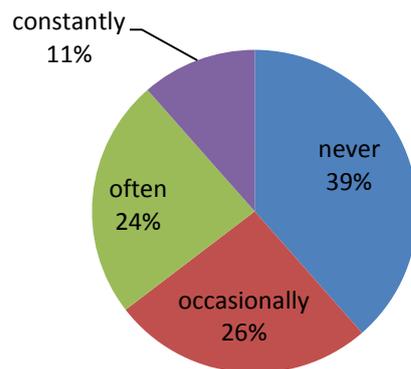
Severe fatigue after (age 6-82)



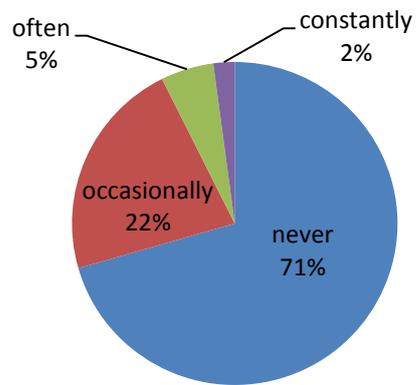
Difficulty concentrating before (age 6-82)



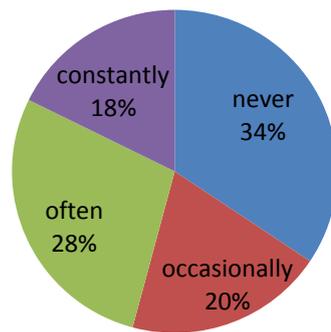
Difficulty concentrating after (age 6-82)



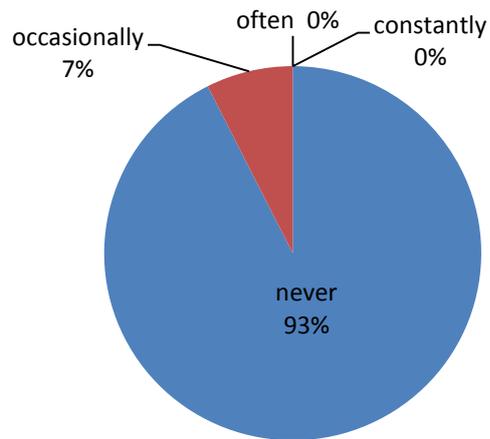
Difficulty sleeping before (age 6-82)



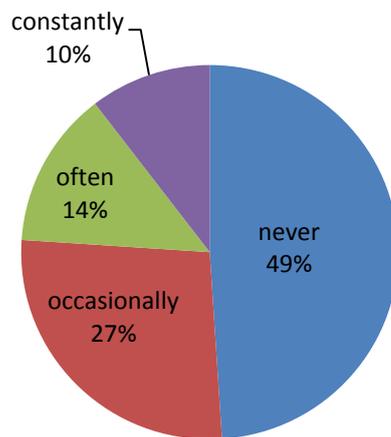
Difficulty sleeping after (age 6-82)



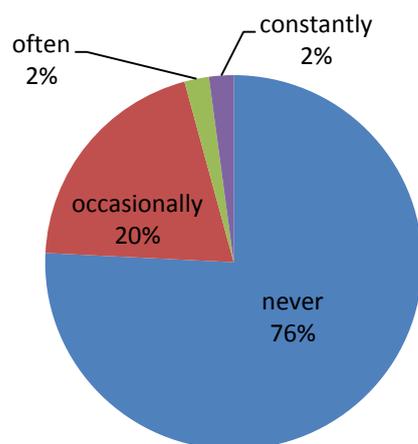
Weakness before (age 6-82)



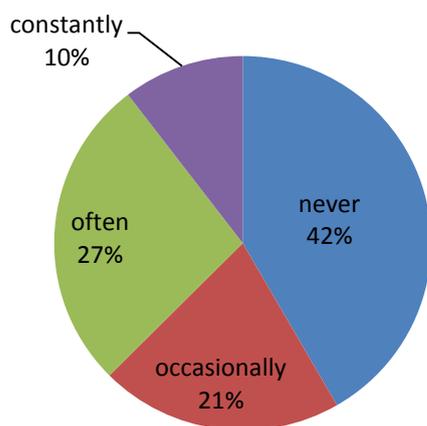
Weakness after (age 6-82)

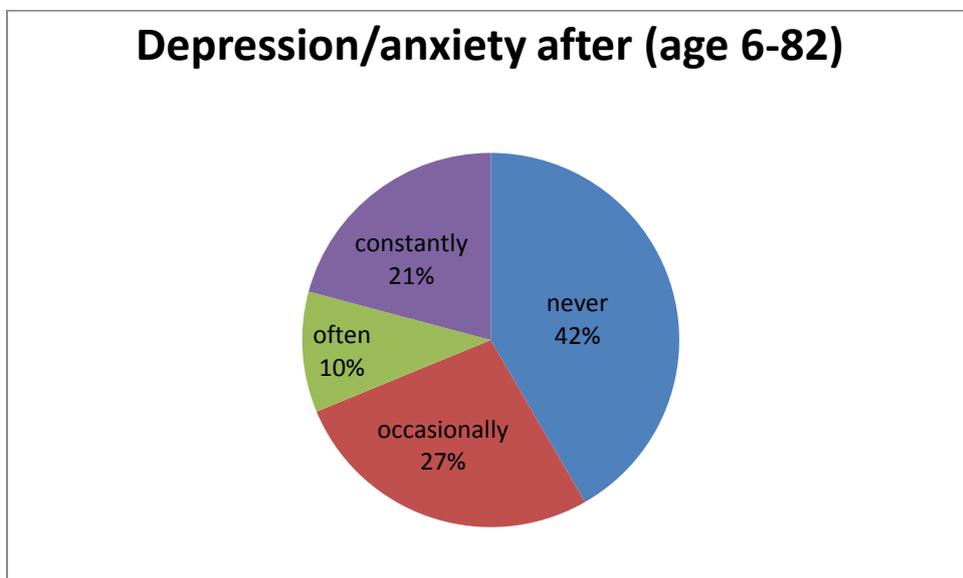
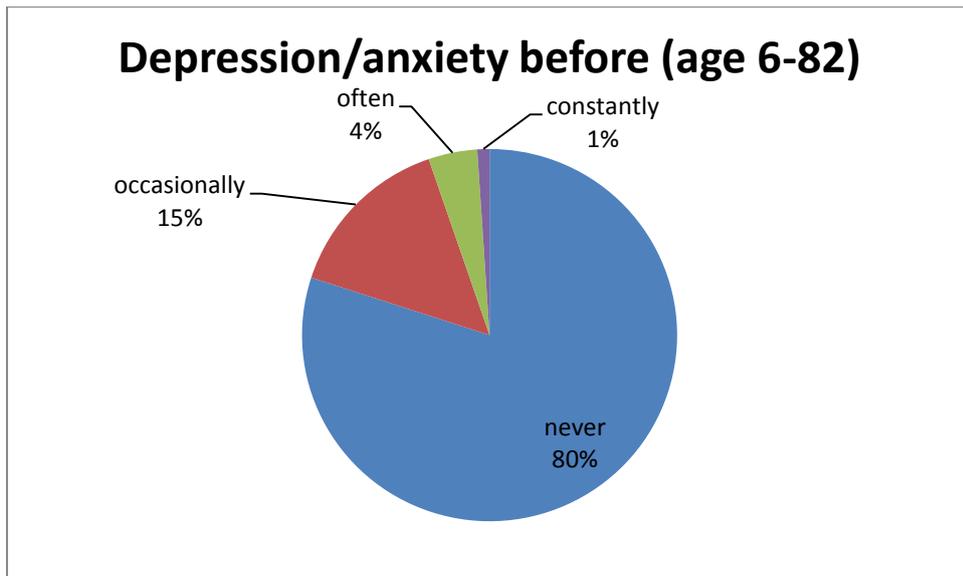


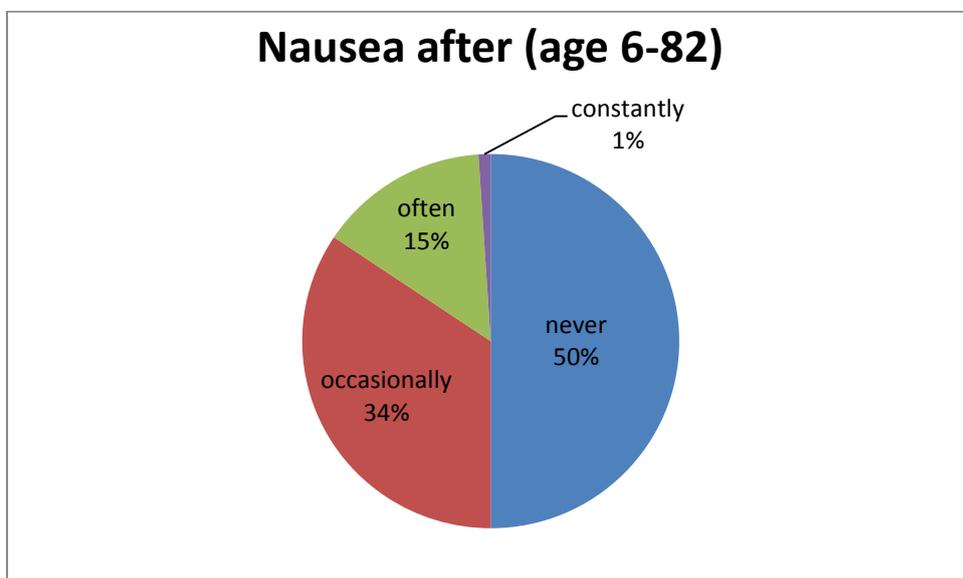
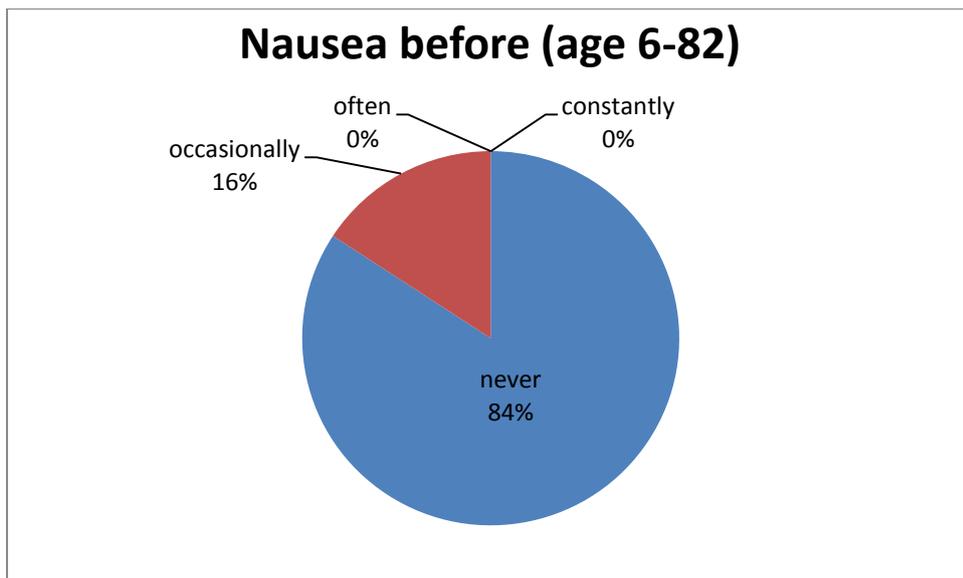
Forgetfulness before (age 6-82)



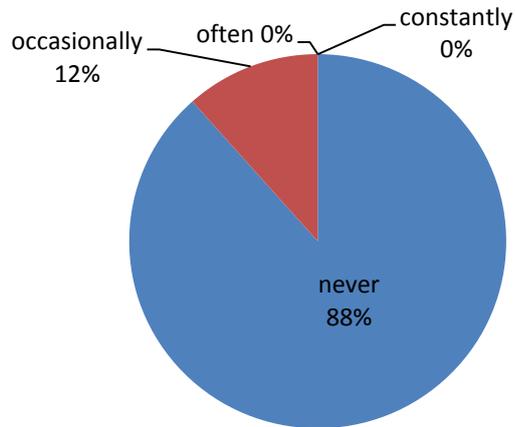
Forgetfulness after (age 6-82)



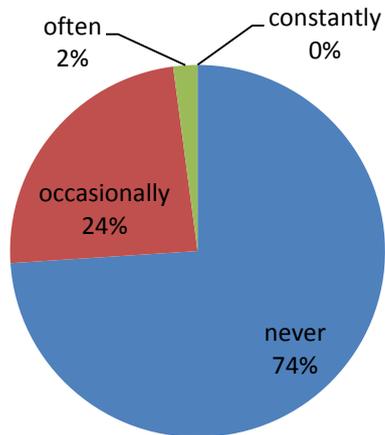




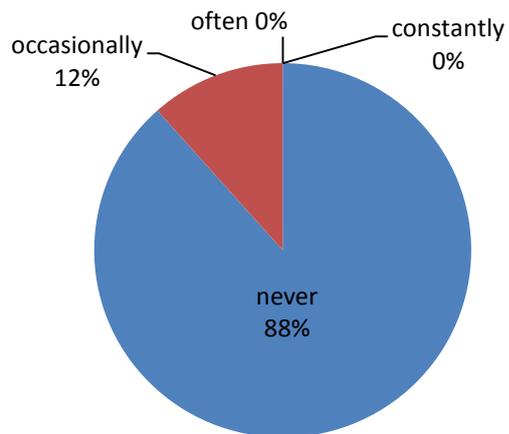
Vomiting before (age 6-82)



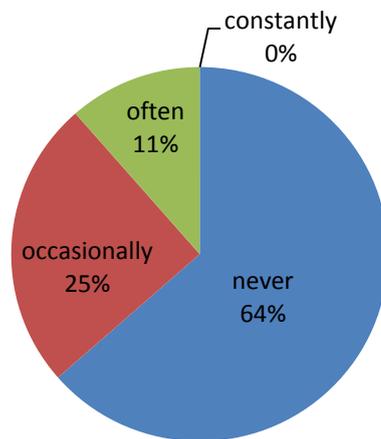
Vomiting after (age 6-82)



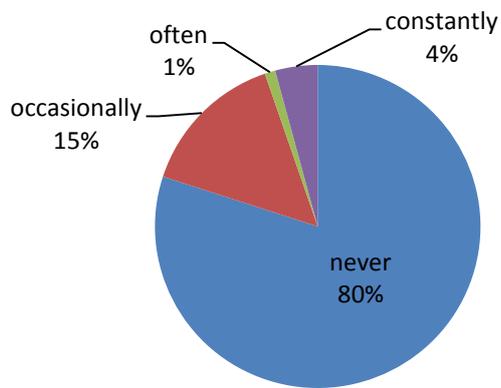
Stomach pains before (age 6-82)



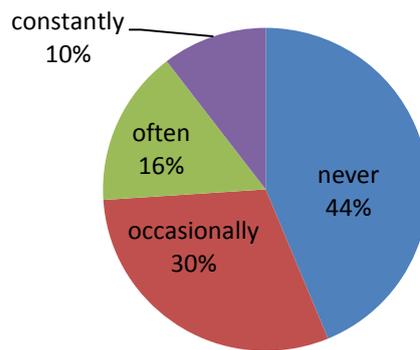
Stomach pains after (age 6-82)



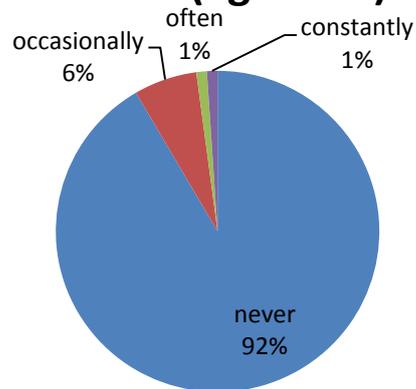
Muscle pains/spasms before (age 6-82)



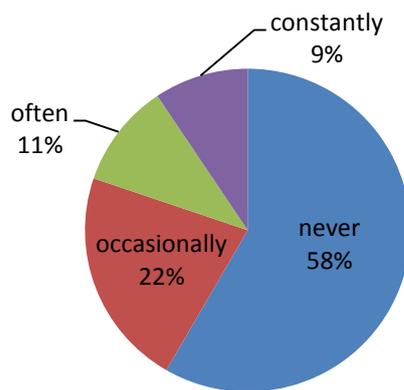
Muscle pains/spasms after (age 6-82)



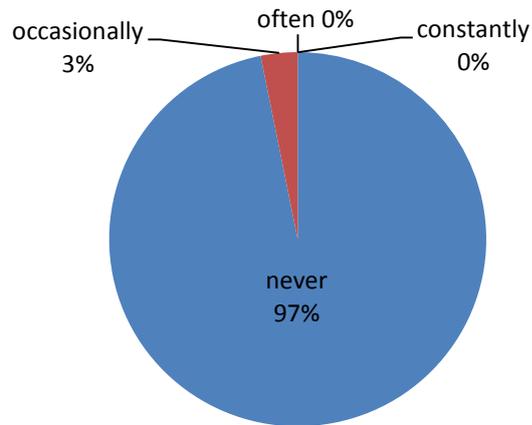
Tingling, numbness, pins and needles before (age 6-82)



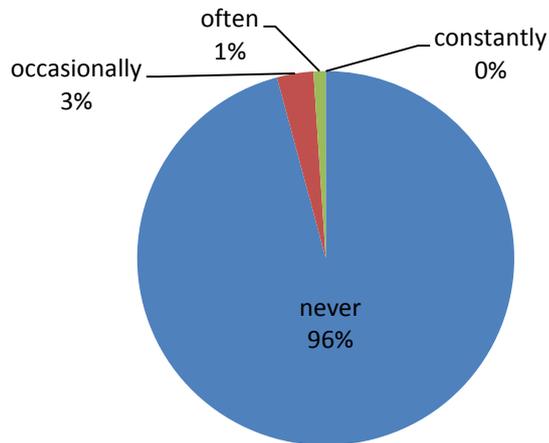
Tingling, numbness, pins and needles- after (age 6-82)



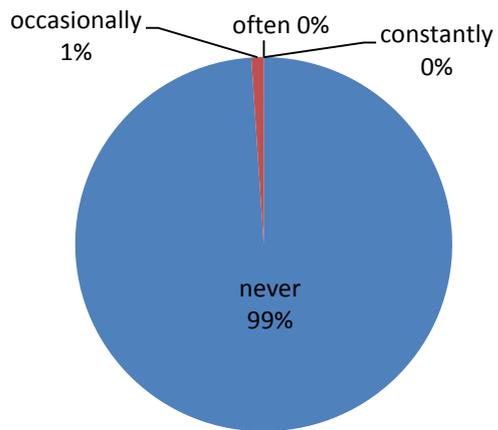
Seizures before (age 6-82)



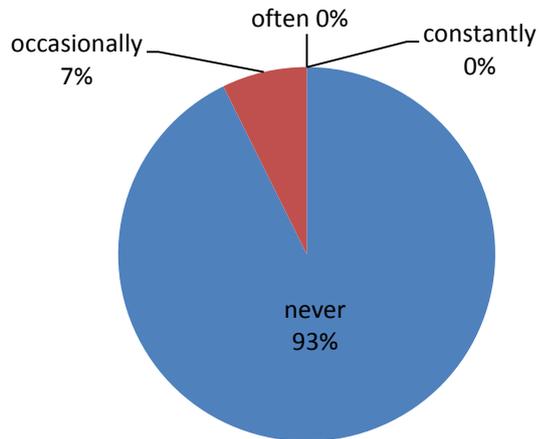
Seizures after (age 6-82)

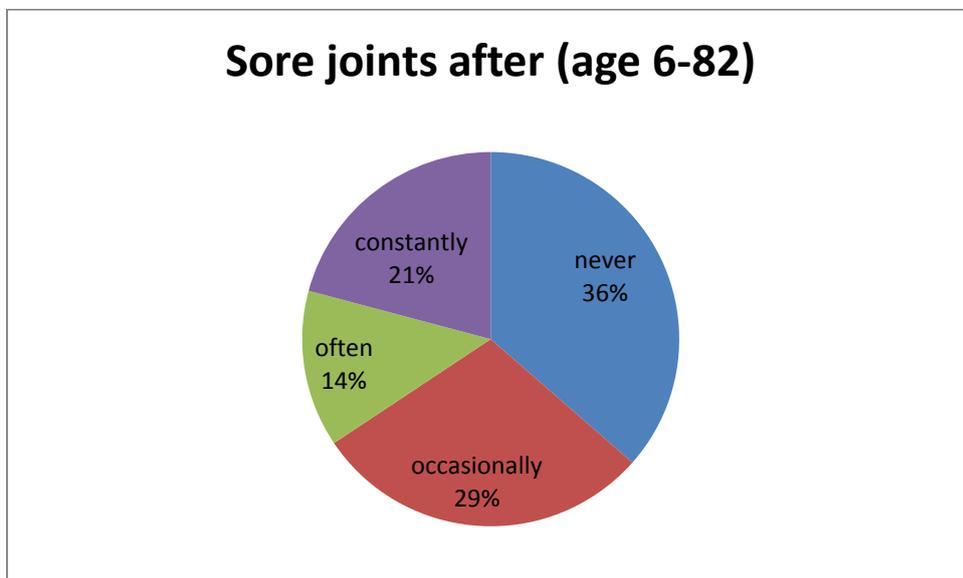
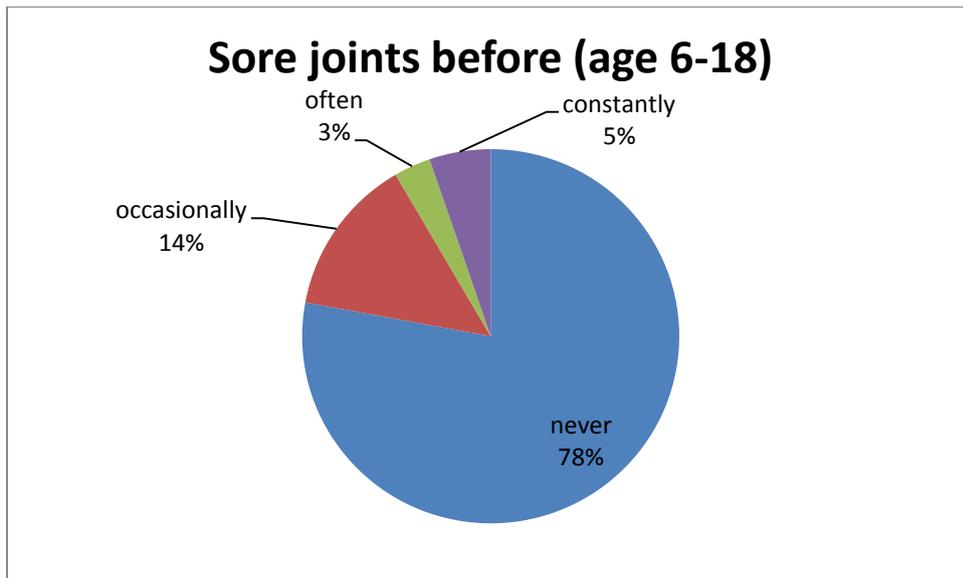


Collapse before (age 6-82)

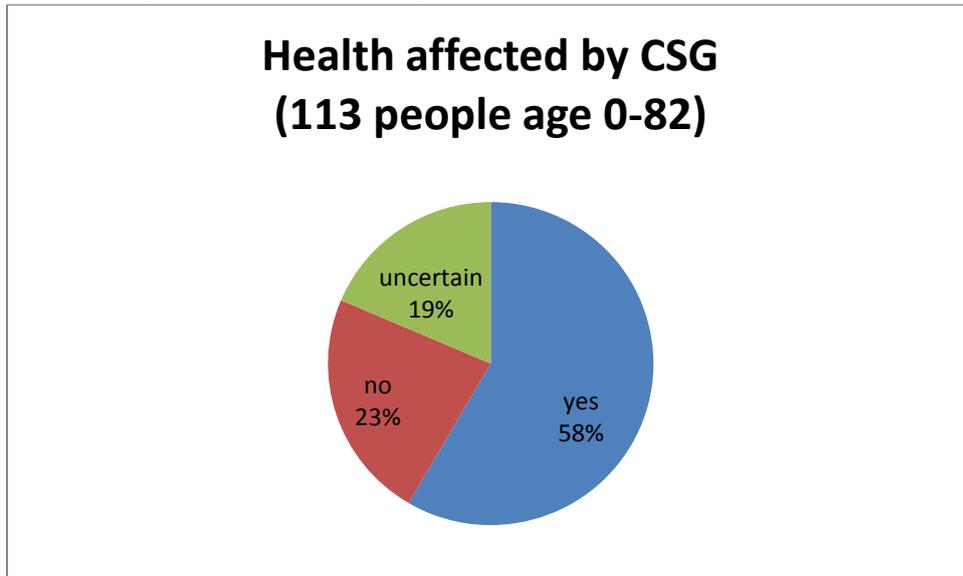


Collapse after (age 6-82)

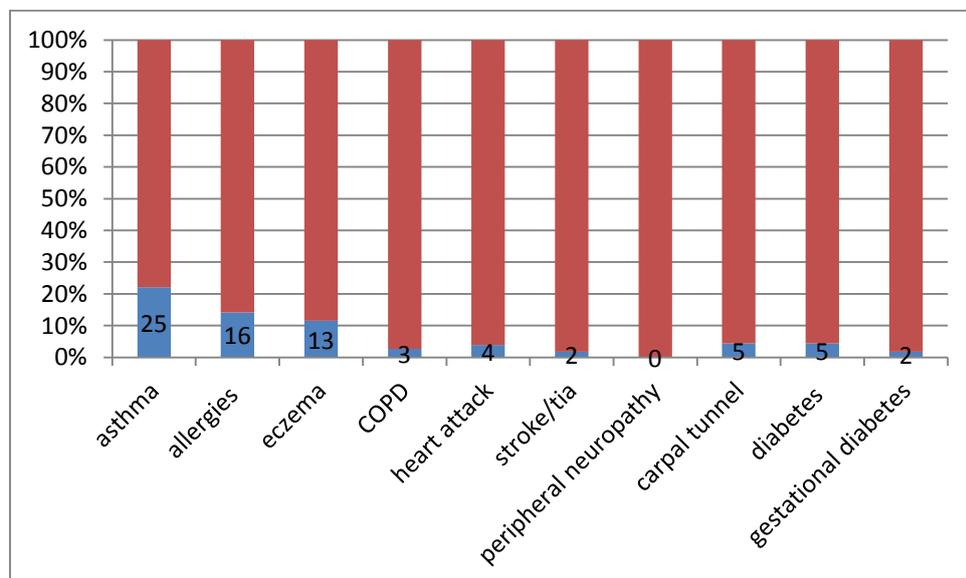
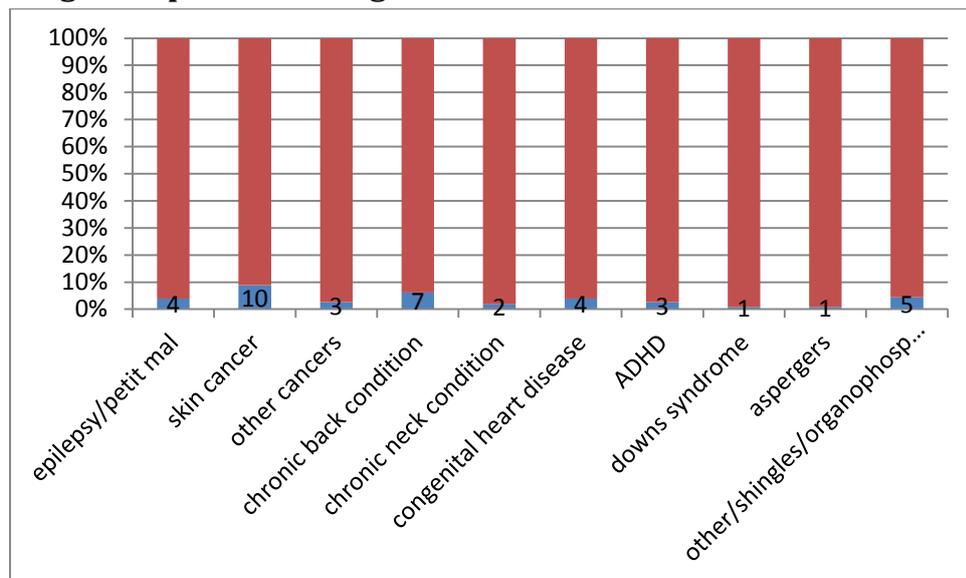




Percentage Total Affected age 0-82 - Pie Chart



Diagnoses prior to CSG age 0-82



Diagnoses after CSG

- Unexplained marker for ovarian cancer
- Asthma
- Attention seeking
- Chronic cough (undiagnosed)
- Depression/anxiety
- Asthma
- Hypertension
- Petit mal
- Anxiety/reflux /asthma/ chest infection
- Scabies (unresponsive to treatment)

COPD/ thyroid lump/helicobacter/ diverticulosis/ dermatitis

Low/normal calcium

Constant "flu"

Eczema

Cerebral haemorrhage/secondary hydrocephalus

Anxiety/depression

Pneumonia 6 times since Oct 2012/ abnormal PSA

Skin cancers/ heart issues

Pulmonary emboli post cholecystectomy/ sleep apnoea

Suicidal

Prolapsed disc

Depression/anxiety

Allergies(told environmental)

Pleurisy ?viral

Hashimotos/gastritis/diverticulosis /hypertension

COPD/ Barrett's oesophagus

Arthritis

Ectropian

Skin cancer

Recurrent chest infections/hypertension

Carpal tunnel

Peripheral neuropathy/ renal impairment

Ross River

Depression/anxiety

APPENDIX C – PERCEIVED IMPACTS ON ANIMALS/ BIRDS

Feathers falling off birds and chickens. Skin irritation in dogs, bald patches.

No frogs for 3 years until 2012/2013 season.

Frogs back after the rains.

Horse keeps getting sores on its legs. Less birds- redwings. Used to be heaps. Not here for years.

At one points budgies and chickens died. Turkeys died. No sign of disease. Well one day – dead the next. Parent budgies and babies all dead inside breeding box in the morning. Birds dead outside. 3 chickens died at point of lay. 20 week old turkeys died.

Didn't notice less birds. Goannas disappeared in the last few months-kept finding dead goannas. Cane toads were brought in with the pipes. Puts fresh water and food out for the birds.

Haven't noticed anything

Dog died 10 months after arriving in Tara-heart attack, gums white. Died overnight. Healthy cat- age 8 years, suddenly sick. Persian cat, developed kidney problems, died.

Haven't noticed any problems

More cane toads. Less small birds- no redcaps, robins, wrens. Plants aren't flowering as used to.

Haven't noticed anything

Haven't noticed anything

Increased road kill- emus, echidnas, goannas, snakes, blue tongue lizards, kangaroos, wallabies

No unusual illness

Within a 6 month period dog lost fur, couldn't walk properly, stopped eating and two placid family dogs (raised from pups) -overnight became vicious, had to be put down.

Native animals disappeared especially frogs. Some back in last few weeks in the rains.

Haven't noticed anything

Dogs vomiting after being near surface water

No unusual illness. puts out fresh water for wildlife

Used to be a lot of wallabies, none recently- very scarce. Birds ok mainly king parrot, rosella, redwing, galah, less snakes, frogs ok

Haven't noticed anything

Rarely see native animals. Previously lots of emus, kangaroos, parrots, galahs

More roos- moved away from traffic nearer wells.

Lots of frogs

Dog bites skin until he has no fur. Other dog that doesn't go outside is ok. Used to be a lot of parrots, red parrots, king parrots, now don't see them

Dogs- rashes after swimming in the dam. No birds, kangaroos or wallabies will drink from the dam now- they used to. Puts out rainwater for the wild animals.

Unexpected death of two kangaroos hand raised from birth. Gives kangaroos and wildlife tank water.

Ample wildlife

Used to be lots of birds and kangaroos- not now. Less green and red/black frogs.

Haven't noticed anything

Nothing unexpected

Dogs rashes, birds loss of feathers.

Hasn't seen a snake in the past seven years. No goannas- previously plentiful. Uses to be lots of birds, now infrequently. Has lots of native trees, no birds even when they are in flower.

Hasn't noticed anything

Cane toads came in with the pipeline, large influx of large adult cane toads. (? Came in with machinery and pipes) rarely see snakes now. Less kangaroos- ?because of road kill

Puppies lost their fur. Loss of frogs for 18 months during drilling. Coming back – finding dead frogs now.

-
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CSG and Your Health:

Understand the Risks, Protect Your Family



Self-help Risk Management Tools:

A Report on the Health Impacts of CSG and Shale Gas Mining & CSG Health Checklists

Dr Wayne Somerville B.A.(Hons.), M.Clin.Psych., D.Psy. Clinical Psychologist

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CSG and Your Health: Understand the Risks, Protect Your Family

A Report on the Health Impacts of CSG and Shale Seam Gas Mining

Dr Wayne Somerville B.A.(Hons.), M.Clin.Psych., D.Psy. Clinical Psychologist

“Despite the rapid expansion of CSG developments, the health impacts have not been adequately researched, and effective regulations that protect public health are not in place. There is a lack of information on the chemicals used and wastes produced, insufficient data on cumulative health impacts, and a lack of comprehensive environmental monitoring and health impact assessments. In circumstances where there is insufficient evidence to ensure safety, the AMA recommends that the precautionary principle should apply. This is essential given the threat of serious and irreversible harms to human health.”

Dr Steve Hambleton, President of the Australian Medical Association, May 2013¹

Introduction

Gas mining has traditionally used a limited number of wells in unpopulated areas to extract gas from naturally formed underground reservoirs. In contrast, “unconventional” mining for gas from coal seams, shale, and tight sands can involve thousands of wells spread across populated areas, and the horizontal drilling, fracturing, and depressurising of gas-bearing strata.² All forms of unconventional gas mining share a common technology and involve the use and liberation of similar dangerous substances.

Mining for Coal Seam Gas (CSG) and other forms of unconventional gas is an unprecedented threat to our community. Australians have never before faced the prospect of living and raising children amidst heavily industrialised gas fields - in landscapes dominated by gas wells, pipes, flares, busy roads, wastewater ponds, and pumping and compression stations. Entire communities are being exposed to a myriad of psychological and social stresses, and a witch’s brew of air, water, and soil contaminants.

The fundamental problem with unconventional gas mining is the unmanageable creation of dangerous pollution during production. Liquefied Natural Gas (LNG) burns cleaner than coal, but this benefit is only achieved by polluting air, water and soil and by compromising the health of communities where the gas is mined and processed.

Professor Mary O’Kane³, the NSW Chief Scientist and Engineer, concluded that “considerable work and research still needs to be conducted by researchers, government and industry to determine the potential risks to health from activities related to CSG extraction”. Nonetheless, we already know much about the potential for unconventional gas mining to harm human health, and specific threats are identified and understood.

Protecting Public Health - The Role of Baseline Data

Any industry that exposes people to potentially harmful products or processes has an obligation to assess and manage risks to health. Legal responsibilities for duty of care and due diligence require “duty holders” to actively seek out evidence of possible threats, and to think beyond known dangers to consider all risks, “not only those for which regulations and codes of practice exist”.⁴

When assessing health risks, a proposed development is not entitled to the presumption of innocence accorded a defendant in a criminal prosecution. The development can not be assumed to be safe (i.e., “innocent”) until it is proved to be harmful (i.e., “guilty”) “beyond a reasonable doubt”.

For instance, new medications are not approved for public use until they have been rigorously tested in controlled studies that look for harmful effects by comparing data taken before and after use of the medication. The “burden of proof” is on the pharmaceutical company, which has to demonstrate that the medication is safe before it can be sold to the public.

Corporations that seek to profit from operating heavily industrialised gas fields in populated areas should be responsible for establishing the safety of their operations. Citizens should not need to prove that gas mining is dangerous.

Baseline health assessments are essential to establish the safety of gas mining operations. Scientific methodology for determining the safety of a product or process requires well designed research that compares data on human health and the presence of potentially harmful substances in water, air, and soil, obtained both before (i.e., the “baseline”) and after development takes place.

Will governments and industry protect community health?

“There is no credible evidence that CSG operations have a negative impact on humans and livestock. CSG operations have operated safely in Australia for over 16 years and following extensive reviews have the support of Australian, Queensland and NSW governments.”
Metgasco CSG Mining Company, 2012⁵

◆
“That information (from anti-CSG activists) has gone into the mainstream to such an extent that there is a perception and a view that this is a risky, dangerous, unhealthy industry, which is in fact the furthest from the truth.”
AGL has been operating a project in Camden for over 13 years, “where there has been no health impacts, no water contamination taking place, no fugitive emissions of any magnitude have been detected, so therefore the perception they’ve built up is far from reality, but the perception has driven public sentiment and in turn public policy”.

Michael Moraza, AGL Upstream Gas Group General Manager, 2013.⁶

The proper assessment and management of risks to human health requires more than CSG companies deciding what constitutes “credible” evidence and simply declaring that their mining operations are in all ways safe.

If CSG companies confidently “know” that their operations are safe, there is a greatly reduced likelihood that they will discharge their duty to the community to properly monitor, investigate, and prevent or mediate health risks associated with operating gas fields in populated areas.

AGL’s failure to monitor air emissions at their Camden CSG operation illustrates how vital health risk assessment processes can fail.

In March 2013 the Environment Protection Authority (EPA) fined AGL for not maintaining its emissions monitoring equipment.⁷ In the August 2013 “Undertaking to the Environment Protection Authority”⁸ signed by AGL Director Michael Moraza, the EPA expressed “concern” that in 2007 AGL’s emissions monitoring equipment began to break down, and by 2009 all their monitoring equipment had stopped operating. Monitoring for the single pollutant nitrous oxide only recommenced in July 2012.

AGL provided false information to the EPA in Annual Returns from 2006 to 2011, and its publicly available 2007 to 2011 Annual Environmental Performance Reports included the “false and misleading” statement that, “Full results of the continuous emissions monitoring for the reporting period are kept on file”. “AGL advised that the non-reporting was due to oversight combined with a lack of understanding by AGL staff regarding the significance of the equipment breakdown”.⁹

What evidence could underpin AGL Manager Mr Moraza’s claim that there has been “no health impacts, no water contamination taking place, no fugitive emissions of any magnitude” at their Camden gas field? In this case, the absence of evidence of harm does not mean that there is no harm, only that there is no data. Further, AGL’s permitted annual air emissions of 103,000 kg of nitrogen oxides¹⁰ do appear to have some “magnitude”, especially given that their CSG emissions include significant amounts of other unmonitored substances.

It is not clear why gas mining companies and regulatory authorities have not obtained the pre-drilling baseline health and environmental data essential for proving the safety of this industry. Only a few politicians have called for proper assessment of health risks prior to approval of unconventional gas mining. Even if the possibility of great harm was small, those promoting gas mining would have a responsibility to properly assess and manage risks to public health. But in this case, evidence to support the claim that gas mining is safe is entirely lacking, while abundant scientific research indicates a high level risk of potentially catastrophic health impacts from operating gas fields in populated areas.

Reports of people being harmed have been dismissed on the perverse grounds that a lack of baseline data makes it impossible to “prove” that their health deteriorated after CSG drilling began. Such arguments demonstrate a disregard for principles of risk assessment and duty of care, and reverse the “burden of proof” that should apply when assessing risks to human health.

If we do not heed the warning that “those who cannot remember the past are condemned to repeat it”, unconventional gas mining could become the 21st Century’s version of last century’s asbestos and tobacco health tragedies, only much worse.

By the 1930s, scientists had linked asbestos to cancer, but in Australia asbestos was not banned until 2003. In the late 1970s, court documents proved that industry executives had known all along that asbestos was dangerous, but had concealed this information as they promoted their business. The 1964 US Surgeon General’s Report found that cigarette smoking was the cause of lung and laryngeal cancer, but until court cases in the late 1990s, the tobacco industry lied about the known health impacts of smoking, and claimed that nicotine was not addictive and that there was no “proven” link between cancer and smoking.

The asbestos and tobacco industries thrived while executives denied the known health risks of their products and public regulators did little. Profits harvested over decades were never discounted to reflect the true costs in suffering, illness and death borne by the community.

Nowadays, like asbestos and tobacco in the past, unconventional gas mining is promoted in the absence of proper risk assessment. As before, regulatory authorities appear unwilling or unable to effectively protect public health.

What can we do to protect the health of our communities?

Many people have called for assessment of the health risks from operating gas fields in populated areas, but this is not a straightforward process. Epidemiological studies can take years to complete, and the current threat to health is serious and urgent. Baseline data has to be collected prior to drilling and for many areas that time has passed. Communities are already exposed to dangerous pollutants. In the Northern Rivers, the safety of the existing 60 or so CSG wells cannot be assumed, and no one knows whether people have been exposed to levels of pollution sufficient to cause illness.

In the current circumstances, responsibility for protecting community health falls on individuals. A self-help process of risk assessment and management could make a difference.

A good understanding of how gas mining pollutants can affect health is essential. A potential danger that is not recognised cannot be avoided or mitigated. If you do not know that the fibro you are breaking up contains asbestos, you will have no idea that you are being injured. If you develop lung cancer years later you will have no idea why this has happened to you. People need to understand the risks and how they could be harmed.

Medical professionals need information about CSG health impacts so they can properly diagnose and treat affected patients. Gas field pollutants can cause severe permanent injuries, and for all affected people, but especially for children, it is essential that exposure to harm ends as soon as possible. Unlike asbestos and tobacco-related illnesses, some symptoms of gas poisoning develop quickly, and effective treatment is possible if symptoms are promptly and accurately diagnosed.

This report and the questionnaires are self-help risk management tools which could help people better protect their families from the health impacts of unconventional gas mining.

- The Report on the Health Impacts of CSG and Shale Gas Mining reviews what is known about the dangerous substances and processes, potential pathways to contamination, and health impacts associated with unconventional gas mining.
- The Symptoms List presents symptoms that researchers have associated with exposure to gas field pollutants. If repeated over time, the list can provide either ongoing reassurance of a clean bill of health, or alternatively assist early recognition of a change in health status.
- The Exposure to Gas Mining Questionnaire records information about possible sources of contamination.
- The CSG Concerns Questionnaire records ratings of emotional distress from various dimensions of the CSG experience.
- The Depression Anxiety Stress Scale (DASS-21) - If repeated over time, responses to this questionnaire could help a person to better recognise changes in symptoms of anxiety or depression.

The Report and the associated questionnaires are educational materials only, and are not any form of medical assessment or treatment or legal advice. In all cases, you should discuss any concerns that you have about your mental or physical health with your family doctor. No guarantee is given or implied that the report or the questionnaires carry any legal weight, and you should seek professional legal advice for any questions you have regarding gas mining, personal injury, the law, or other legal issue.

The Report on the Health Impacts of CSG and Shale Gas Mining and associated questionnaires are provided free of charge in the interests of community health. You can copy and distribute these documents provided that they are reproduced in full, without alteration and with all citations and references, and no fee is charged. Copies of these materials and many of the referenced publications are available for free download by clicking the links in the attached “Selected References on Gas Mining Health Impacts” on page 41 of this document.



Risks to worker and public health from unconventional gas mining can arise from political and industrial processes that cause emotional distress and/or create air, water, soil, light, and noise pollution.

Mental Health Impacts of the “CSG Experience”

The rapid transformation of rural communities into industrialised gas fields introduces complex social, psychological and environmental stresses that can undermine health.

The CSG experience is not necessarily stressful in itself - people who profit from gas mining often consider it a good thing. People who feel threatened by, or who suffer losses or injuries as a result of gas mining are most at risk of developing symptoms of emotional distress.

A sense of threat can trigger the “fight or flight” response - a natural coping mechanism which helps us survive dangerous situations. Anxiety signals the presence of danger, and adrenaline and anger prepare us to fight off, or escape from, the threat. If these responses lead to action that successfully removes the danger, then stress will ease. But if the threat cannot be removed, stress reactions can become chronic and result in symptoms such as sleep disturbance, anxiety and depression.

Potentially Distressing Features of the CSG Experience include:

- Loss of control over access to one’s property
- Loss of the right to quiet enjoyment of home and property
- Diminished quality of lifestyle

Every rural landowner subject to a Petroleum Exploration License faces the prospect of unconventional gas companies being legally empowered to forcibly enter their properties, build roads, set up camps, drill multiple wells, dig dams to hold contaminated water, and establish noisy, brightly lit up well sites that run 24 hours a day for years.

- Noise¹¹ and light pollution
- Disturbed sleep cycles

Grief, emotional shock, and a sense of loss, complicated by disturbed sleep due to noise and light pollution from lighting, traffic, compressors, and reverse osmosis plants, can lead to debilitating symptoms of psychopathology.¹²

During sleep, the brain and body repeatedly cycle through stages of dreaming to deep sleep. Deep sleep repairs the body, and dreaming works to resolve emotional issues and consolidate memories. Noise and light pollution disrupt dreaming and deep sleep, impede natural healing and restorative processes, and can trigger anxiety and depressive illnesses.

- Loss of land value
- Lack of adequate compensation
- Compromised livelihood from loss of productive agricultural land

For many farming families, their land is their life's work. For most people, their home is their major asset and legacy for their children. For affected people, the loss of property value and damage to their land feels like a personal injury. The decline in land values can be resented as an unfair transfer of wealth from families to mining companies.

- Denial of an economic "level playing field"
- Politicians' lack of respect, and even contempt for citizens' concerns
- Damage to privately owned assets and small businesses

Respect for Government and the rule of law can be undermined when principles of "a fair go" for all and an economic "level playing field" are seen to be abandoned in favour of powerful mining companies. The perceived violation of individual rights and lack of regard for small businesses can foster unhealthy beliefs that political and legal processes are unfair and that politicians cannot be trusted to protect the community's interests.¹³

- Sense of violation of "Mother Earth"
- Grief over loss of "Nature's gifts of beauty rich and rare"
- Powerlessness to protect one's natural environment
- Negotiating with companies from an inferior position

For some Australians the degradation and pollution of the land can foster a sense of disempowerment and pessimism.¹⁴ Australian psychiatrist Glenn Albrecht (2005)¹⁵ coined the term "Solastalgia" - a loss of solace - to describe the distress that people who are connected to the land feel when their environment is damaged. Affected people can develop unhealthy beliefs that the world is malevolent and uncontrollable.

- Community impacts from rising rents and large numbers of transient workers
- Increased sexual assaults, illicit drugs, and prostitution
- Intimidation by young male mining workers
- The trauma of ill-health

Dubbed the "Boomtown Effect" in the US, for some communities the rapid changes in population, intensive industrialisation, and economic effects due to gas mining result in social ills that can undermine health. There are reports of CSG industrialisation in some Queensland communities leading to: increased rates of crime, drug and alcohol abuse, sexually-transmitted infections, and domestic violence; inadequate supply and quality of housing; increased cost of living; increased community dissatisfaction; increased mental health and social services case loads; and increased hospital admissions.^{16,17}

In their submission to the NSW Parliamentary CSG Inquiry, the Doctors for the Environment group noted that, “The CSG process can divide previously close-knit rural communities, increasing tension and disharmony, impact on local economies, and threaten other industries. The final common pathway for effects from these impacts may be poorer mental health, with increases in depression and anxiety.”¹⁸

Emotional distress triggered by the CSG experience can undermine health, but exposure to dangerous chemicals and industrial processes can result in serious physical injuries.

Physical Health Impacts of Unconventional Gas Mining

“The fundamental public health issue is the potential for water contamination by chemicals which could seriously affect human health decades after exposure. Health impacts may arise from the use of fracking chemicals or from the release of hydrocarbons and other contaminants from the coal seams.”¹⁹

Professor David Shearman, Emeritus Professor of Medicine, University of Adelaide

Three conditions need to be satisfied for an industrial process to be considered a serious threat to human health. The industry must use dangerous substances. There have to be environmental pathways which potentially bring people into contact with these substances. And it has to be possible for people to be exposed to pollutants in doses sufficient to cause illness. There is abundant evidence that operating CSG gas fields in populated areas satisfies these three criteria.

This report reviews what is known about:

- The identity and health impacts of potentially harmful substances used in gas mining and naturally present in coal and shale gas seams,
- The environmental pathways that make it possible for humans to come in contact with these substances, and
- Cases of illness reasonably attributed to contact with these dangerous substances.

Dangerous Substances

Coal seam and shale seam gases are predominantly methane, but can also contain: other gases such as carbon dioxide, carbon monoxide, and nitrogen; hydrocarbons, including ethane, propane, butane, benzene, toluene, and xylenes; other volatile organic compounds (VOCs), such as carbon disulfide, hexane, cyclohexane, ethylbenzene; toxic non methane hydrocarbons (NMHC); and various particulates.²⁰

Coal and shale seams also naturally contain: various salts; heavy metals such as lead, arsenic, mercury; barium, boron, and sulphate; and radioactive materials, including radium 226, radium 228, thorium, strontium, uranium and radon.²¹

In addition to dangerous substances naturally present in coal and shale seams, unconventional gas mining also involves the use and production of significant quantities of industrial chemicals, as well as dust, particulates, and diesel emissions.

Industrial Chemicals

Gas mining companies argue that only a small percentage of drilling and fracking fluids consists of chemicals, but the volume of fluids used creates a considerable chemical load.

The scale of chemical use in a developed gas mining operation was illustrated by a US House of Representatives Committee finding that over a four year period, 14 companies used more than 2,500 hydraulic fracturing products containing 750 chemicals and other components, to make up (excluding water added at the well site) 780 million gallons of hydraulic fracturing products.²²

In Australia, in some cases, large quantities of chemical additives are used both at the drilling stage and during hydraulic fracturing. A risk assessment provided to the Queensland Department of Environment and Resource Management (DERM) listed approximately 18,500 kilograms of chemical additive used per well with up to 40% (7,500kg) not recovered.²³

In Australia, there is no national requirement for public disclosure of all chemicals used in CSG operations, and there is no publicly available comprehensive list of fracking chemicals. The following information regarding the types of chemicals used in unconventional gas mining was compiled from research by the National Toxics Network.^{24,25,26}

In Australia, drilling fluid can include:

- Viscosifiers (e.g., bentonite, polyacrylamide)
- Weighting agents (e.g., barium sulphate)
- Bactericides/biocides (e.g., glutaraldehyde)
- Corrosion inhibitors (e.g., zinc carbonate, sodium polyacrylate)
- Defoamers (e.g., glycol blends, light aromatic and aliphatic oil, naptha)
- Emulsifiers and deemulsifiers
- Lubricants (e.g., chlorinated paraffins)
- Scale inhibitors (e.g., anionic polyacrylamide, acrylamide copolymer)
- Polymer stabilisers (e.g., Sodium sulfite)
- Breakers (e.g., diammonium peroxydisulphate, hemicellulase enzyme)
- Salts (e.g., potassium chloride, sodium chloride, calcium chloride)

Hydraulic fracturing fluids usually include:

- Gelling agents (e.g., guar gum, diesel, alkanes/alkenes)
- Gel stabilisers (e.g., sodium thiosulphate)
- Gel breakers (e.g., Ammonium persulfate, sodium persulfate)
- Friction reducers (e.g., polyacrylamide, mixtures of methanol, ethylene glycol)
- Surfactants (e.g., isopropanol, 2-Butoxyethanol /2-BE)
- Biocides (e.g., glutaraldehyde, Tetrakis hydroxymethyl phosphonium sulfate/THPS, 2-Bromo-2-nitro-1,3-propanediol (Bronopol), 2,2-Dibromo-3-nitrilopropionamide)
- Clay stabilisers (e.g., tetramethyl ammonium chloride)
- Buffer fluids and cross-linking agents.

Fracking may also use:

- Corrosion inhibitors (e.g., formamide, methanol, naphthalene, naptha, nonyl phenols, acetaldehyde)
- Scale inhibitors (e.g., ethylene glycols)
- Iron control agents (e.g., citric acid, thioglycolic acid)
- pH adjusting agents (sodium or potassium carbonate)
- Diluted acid to dissolve minerals (e.g., hydrochloric acid, muriatic acid)

Dust, Particulates and Diesel Emissions

Dust and particulates are created and mobilised by vehicle and construction activity. Dust is especially hazardous when it contains coal seam and mining chemicals from the spraying of dirt roads with waste water, proppants (i.e., sand/silica and chemicals injected into coal and shale seams to keep fissures open), and diesel fumes and exhaust.

Crystalline silica is a common mineral found in sand, clay and stone. Respirable crystalline silica is the portion of silica that is small enough if inhaled to enter the gas-exchange regions of the lungs. The handling of huge quantities of sand during fracking generates dust containing respirable crystalline silica.

Diesel emissions from vehicles, drills, pumps, compressors, generators, and other equipment are created during all phases of the unconventional gas mining process - from exploration through production, processing and transportation. Diesel fumes and exhaust contain: a mix of fine particles; gases such as carbon monoxide; sulfur oxides and nitrogen oxides; and volatile organic compounds including benzene, toluene, ethylbenzene and xylene.

Unconventional gas mining uses a significant volume of diesel for transport. The New York City Department of Environmental Protection estimated that 800 to 2,000 truck trips are needed for a single-well shale gas pad.²⁷ A report by the University of Manchester's Tyndall Centre²⁸ indicated that between 4,300 and 6,600 truck visits occur during pre-production for a six-pad shale gas well arrangement. 10% of the United Kingdom's gas production would require a total of 2 to 4 million truck journeys. Assuming a maximum concentration of 20 wells on one pad, with six frackings over 30 years, there could be between 38,400 to 172,800 tanker truck trips over the life of the well pad.^{29,30,31,32}

Risks to Health

Most chemicals used in unconventional gas mining have not been assessed for their toxicity, persistence, or long-term health impacts. There has been no assessment of new compounds that form when mining chemicals interact with other substances or with natural catalysts such as sunlight, water, air, and radioactive elements.

The US House of Representatives Committee on Energy and Commerce³³ identified over 750 chemical products used in gas mining, with 650 containing hazardous substances including carcinogens, neurotoxins, irritants/sensitisers, reproductive toxins, and endocrine disruptors. Some of these chemicals are dangerous at concentrations below detection limits.

A UK study³⁴ of chemicals supplied to New York State for shale gas mining found that 58 of the 260 substances listed were a risk to health: 17 were classified as toxic to aquatic organisms, 38 were classified as acute toxins to humans, 8 were known carcinogens, 6 were suspected carcinogens, 7 were classified as mutagenic, and 5 were classified as having reproductive effects.

Colborn, et al.'s (2011)³⁵ review of chemicals used in US shale gas fracking found that:

“More than 75% of the chemicals could affect the skin, eyes, and other sensory organs, and the respiratory and gastrointestinal systems. Approximately 40-50% could affect the brain/nervous system, immune and cardiovascular systems, and the kidneys; 37% could affect the endocrine system; and 25% could cause cancer and mutations.”

Dr Colborn, et al. (2011)³⁶ commented that:

“Numerous systems, most notably the endocrine system, are extremely sensitive to very low levels of chemicals, in parts-per billion or less. The damage may not be evident at the time of exposure but can have unpredictable delayed, life-long effects on the individual and/or their offspring. Health impairments could remain hidden for decades and span generations.”³⁷

According to Dr Effie Ablett (2013)³⁸, “A few of these chemicals (used in Australian CSG mining) have been studied and listed as possible carcinogens, but most, including those likely to be the most potent carcinogens, remain untested and therefore are largely not taken into account in assessing potential health risks.” Currently legislated “safe” or maximum contamination levels are close to the level of detection for the few known carcinogens listed, and more potent carcinogens such as Poly Aromatic Hydrocarbons “are likely to cause cancer at concentrations that are orders of magnitude below their detectable levels in drinking water”.³⁹

Law (2013)⁴⁰ described how endocrine disrupting chemicals can interfere with hormone action even at very low concentrations, and these effects can be specific to particular stages of a child’s physical development.

Only two of the 23 most commonly used fracking chemicals said to be used in Australia have been assessed by the National Industrial Chemical Notification and Assessment Scheme (NICNAS), and neither of these has been specifically assessed for use in fracking.⁴¹ Chemicals used by the Australian unconventional gas industry (e.g., glutaraldehyde, brominated biocides, propargyl alcohol, 2-butoxyethanol and heavy naphtha) have been found to be dangerous at concentrations near or below chemical detection limits by the State University of New York.⁴²

Brown (2013)⁴³ noted that understanding gas field toxicology is complicated because:

- We have incomplete identification of the chemicals present
- Chemicals can interact with other chemicals in complex unknown ways
- The presence of one agent can greatly increase the toxicity of another agent
- Agents have multiple physiological actions on various target organs
- Health effects of exposure to many chemicals is unknown
- How certain chemicals alter the biological processing of other chemicals is unknown
- Substances that inhibit metabolism or excretion magnify the effects of other chemicals
- Some agents can change the physiologic distribution of other chemicals
- Some agents can cause chemicals that would not normally do so to enter the brain
- Medications can affect the impact of toxic substances

Potentially harmful chemicals used in or liberated by unconventional gas mining include:^{44,45,46}

- **Volatile Organic Compounds (VOCs)** - Some VOCs are very toxic and bioactive. VOC exposure can cause eye, nose, and throat irritation, headaches, visual disorders, memory impairment, loss of coordination, nausea, and damage to liver, kidneys, and the central nervous system.⁴⁷ The US EPA noted that some VOCs can cause cancer and other serious, irreversible health effects, including neurological problems and birth defects.⁴⁸

Some VOCs are known to cause cancer in animals (e.g., methylene chloride), or in humans (e.g., formaldehyde), or are suspected human carcinogens (e.g., chloroform, bromodichloromethane). VOCs are also key ingredients in forming ozone and smog, and fine particle pollution, which is linked to asthma attacks, and other health effects.

- **Benzene, toluene, ethylbenzene, and xylene (BTEX)** - Benzene and toluene are particularly problematic VOCs because they tend to be activated into other substances and impact on certain tissues in unique ways.⁴⁹ Short-term health effects of exposure include dizziness, headache, loss of coordination, respiratory distress, and skin, eye, and nose and throat irritation. Long-term health effects of exposure to BTEX chemicals include kidney, liver, and blood system damage. Long term exposure to benzene can affect bone marrow, causing anaemia and increasing the risk of leukaemia and diseases such as non-Hodgkin's lymphoma.⁵⁰ Benzene is a health hazard even in minute quantities. The Australian drinking water guidelines for benzene state that “no safe concentration for benzene in drinking water can be confidently set” so the guideline is set below the level of detection at 1ppb (the equivalent of a drop of water in a swimming pool).^{51,52,53}

US researchers have found an association between exposure to benzene and delivery of a child with birth defects.⁵⁴ In France, researchers using closeness of residence to a major highway as an approximate measure of exposure to benzene, found a relationship between increased exposure and lighter, smaller children with smaller head circumference.⁵⁵

- **Poly Aromatic Hydrocarbons (PAH)** - PAHs and their derivatives “are among the most potent carcinogens, having structures that resemble the base pair in DNA and readily intercalating and/or covalently bonding to DNA causing mutation.”⁵⁶ Neuro-developmental disorders and lowered IQ in babies has been associated with the mother's exposure to PAHs during pregnancy.⁵⁷
- **Methanol** - A highly toxic VOC readily absorbed via ingestion, inhalation, and skin exposure. Causes central nervous system depression and degenerative changes in the brain and visual system. In the body methanol is metabolized to formaldehyde and formic acid, and is toxic in very small doses if ingested. Chronic exposure causes headache, insomnia, gastrointestinal problems, and blindness in humans, and hepatic and brain alterations in animals.⁵⁸ Methanol is highly mobile in soil. Methanol volatilizes from water and once in the air, exists in the vapor phase with a half-life of over 2 weeks. Methanol reacts with photo-chemically produced smog to produce formaldehyde and can also react with nitrogen dioxide in polluted air to form methyl nitrite.
- **Ethylene Glycol** - A human respiratory toxicant and teratogen (i.e., an agent that causes malformation of an embryo or foetus) in animal tests. Associated with increased risks of spontaneous abortion and sub-fertility in female workers. When ethylene glycol breaks down in the body, it forms chemicals that crystallise, collecting in the kidneys and affecting kidney function. It also forms acidic chemicals in the body, affecting the nervous system, lungs and heart.⁵⁹
- **2-Butoxyethanol** - Readily absorbed and rapidly distributed in the human body. It destroys red blood cells at relatively low levels of exposure; can damage spleen, liver and bone marrow; and cause reproductive problems and birth defects in animals.⁶⁰

- **Ethoxylated 4-nonylphenol** - A persistent, bio-accumulative, endocrine disruptor which is very toxic to aquatic organisms, and has been found to increase the incidence of breast cancer in lab animals. This chemical mimics estrogen, and can cause the feminization of fish, even at concentrations not detected by normal monitoring of the fluid.⁶¹
- **Isopropanol** - A central nervous system depressant that can cause degenerative changes in the brains of lab animals.
- **Formamide** - A teratogen with the potential to affect the unborn child. Can be absorbed into the body by inhalation and through the skin.
- **Naphthalene** - Causes nasal and lung tumours and is listed as a possible human carcinogen. Readily absorbed via oral dose or inhalation. Chronic exposure of workers reported to cause cataracts and damage to the retina.
- **Ammonium persulfate and Sodium persulfate** - Harmful if swallowed, and inhalation or skin contact can cause sensitization. Can irritate the skin and eyes and cause allergic reactions, rashes and eczema. Long-term exposure can affect lung function leading to disease of the airways and/or asthma.
- **Limonene** - A skin sensitiser and respiratory irritant.
- **Glutaraldehyde** - Highly irritating to the eyes, skin, and respiratory tract. Repeated skin contact can cause allergic reactions.⁶²
- **Acetaldehyde (Aldehyde)** - Primary acute effect of inhalation exposure is irritation of the eyes, skin, and respiratory tract in humans. At higher exposure levels, erythema, coughing, pulmonary edema, and necrosis may also occur. Acetaldehyde is considered a probable human carcinogen (Group B2). No information is available on the reproductive or developmental effects of acetaldehyde in humans. Acetaldehyde has been shown, in animals, to cross the placenta to the fetus, and animal studies suggest that acetaldehyde may be a potential developmental toxin.⁶³
- **Formaldehyde** - Classified as a known human carcinogen by the International Agency for Research on Cancer (IARC) and as a probable human carcinogen by the US EPA. An association between formaldehyde exposure and several cancers, including nasopharyngeal cancer and leukemia, has been found in exposed workers. Exposure occurs primarily via inhalation of gas or vapour, or by skin absorption.

When formaldehyde is present in the air at levels exceeding 0.1 ppm, some individuals may experience adverse effects such as watery eyes; burning sensations in the eyes, nose, and throat; coughing and wheezing; nausea; and skin irritation. Some people are very sensitive. Less is known about formaldehyde's potential long-term health effects. The US EPA classified formaldehyde as a probable human carcinogen under conditions of high or prolonged exposure. The IARC classifies formaldehyde as a human carcinogen. Exposure to formaldehyde may cause leukemia, particularly myeloid leukemia, and possibly nasopharyngeal cancer in humans.⁶⁴

- **Tetrakis (hydroxymethyl) phosphonium sulfate (THPS)** - Toxic to microorganisms, and repeated skin exposure to THPS resulted in severe skin reaction and sensitization in guinea pigs. Identified as a severe eye irritant in rabbits.⁶⁵ Has mutagenic potential (in vitro) and cancer potential in rats. No exposure information is available for either humans or organisms in the environment.⁶⁶ Little is known about the effects of the break down products of THPS.
- **Methylene chloride** - The second most frequently appearing compound in water around gas drilling sites. A central nervous system (CNS) depressant, it decomposes to phosgene, a very toxic substance, and breaks down to carbon monoxide in the body. Linked to reproductive effects. The short-term effects of methylene chloride inhalation in humans consist mainly of nervous system effects including decreased visual, auditory, and motor functions. The effects of long-term exposure suggest that the CNS is a potential target in humans and animals. Human data are inconclusive regarding methylene chloride and cancer. Animal studies found increases in liver and lung cancer and mammary gland tumors following inhalation of methylene chloride.⁶⁷
- **Fumaric acid** - An irritant of skin and mucous membranes.⁶⁸
- **Persistent Organic Pollutants (POPs)** - Perfluorooctane sulfonic acid, permitted in hydraulic fracturing, and chlorinated paraffins used in drilling fluids, are amongst the most dangerous of all man made chemicals.⁶⁹
- **Carbon monoxide** - Released by incomplete combustion of gas and machinery emissions. Cleared from the body slowly. Episodic exposures to high levels, particularly in children, can produce neurological effects due to the blood's decreased ability to carry oxygen.⁷⁰
- **Radium** - A very toxic, water-soluble carcinogen associated with increased incidence of bone, liver and breast cancer. Radon, a decay product of radium, is the leading cause of lung cancer amongst non-smokers and the second leading cause of lung cancer amongst smokers.

“Radon decay elements deposit as a film on the inner surface of inlet lines, treating units, pumps, and valves principally associated with propylene, ethane, and propane processing streams. Because the radioactive materials become concentrated on gas-field equipment, the highest risk of exposure to radioactive substances is to workers who cut and ream pipe, remove solids from tanks and pits, and refurbish gas processing equipment.”⁷¹
- **Barium, Arsenic, Lead and Fluoride** - Tend to act by replacing normal physiological systems in the body. Consequently, inhibition of calcium is frequently seen, and the substances are likely to be detected in target organs and are difficult to detect in urine. Some compounds of fluoride are not very toxic, but fluorine is a very potent halogen that can cause deep burning of the skin.⁷²
- **Dust and Particulates** - Fine particles become hydrated and can absorb soluble toxins present in the surrounding air. When such hydrated fine particles are inhaled, toxic chemicals can be transported deep into the body where they would not otherwise normally penetrate. Particles that fall to the ground can be tracked into the house, where they can be inhaled after vacuuming.⁷³

- **Silica** - Inhaling silica is a known cause of lung cancer and a suspected contributor to autoimmune diseases, chronic obstructive pulmonary disease and chronic kidney disease. If inhaled into the deep lung it releases a lysosome that initiates progressive scarring. The effects of silica exposure on children or people with compromised lung function are unknown.⁷⁴ Symptoms of chronic silicosis include shortness of breath, fatigue, cough, and, in some cases, respiratory failure.
- **Diesel fumes and particulates** - In 2012 the World Health Organization (WHO) classified diesel engine exhaust as carcinogenic to humans (Group 1) due to an increased risk of lung cancer. Diesel motors emit particles which are very harmful due both to their size and chemical content. If inhaled, fine (PM2.5) particles get into lung tissue and set up inflammatory foci which spread damage throughout the body, including the brain. Ultra-fine particles (PM0.1) can get inside cells and change genetic material. Diesel particles are carried to the brain where they are particularly damaging to young children. Exposure to diesel particles has been associated with lowered IQ in infants and an increase in autistic and antisocial behaviours.⁷⁵
- **Ozone** - Produced from mixing VOCs with nitrogen oxides from diesel exhaust. Gas field ozone has created a previously unseen air pollution problem in rural areas, similar to that found in large urban areas, and can spread up to 200 miles beyond the immediate region where gas is being produced.⁷⁶ One highly reactive molecule of ground level ozone can burn the deep alveolar tissue in the lungs, causing premature ageing. Chronic exposure can lead to asthma and emphysema, and is particularly damaging to children, active young adults who spend time outdoors, and the aged. As children's lungs develop in the presence of ozone, alveolar production is reduced, and chronic ozone exposure can result in a child developing brittle lungs like those of an elderly adult.⁷⁷
- **Methane** - Methane toxicity is usually thought of in terms of inhalation and the asphyxiation hazard created by the displacement of oxygen, but "we know virtually nothing about how methane might affect people who ingest it."⁷⁸

There is no doubt that CSG and Shale Gas mining involve the use and liberation of potentially dangerous substances. The following section reviews evidence regarding the potential for humans to come into contact with these hazardous substances via environmental pathways of water, air, and soil contamination.

Pathways to Human Contamination

"Under natural conditions, fossil fuels contribute a relatively small volume of PAHs (Poly Aromatic Hydrocarbons) to the environment. Because most coal and oil deposits are trapped deep beneath layers of rock, there is little chance to emit PAHs to the surface environment. For the first time, Coal Seam Gas mining will allow large amounts of these chemicals to be solubilised from coal seams and leached out into ground water, and fracking chemicals to be released into our atmosphere. This poses a new major health risk for NSW, with a possible increase in cancer cases on par with or greater than asbestos.

Dr Effie Ablett, 2013⁷⁹

Dangerous substances used or liberated by unconventional gas mining can escape into air, soil, and water systems during most stages of the gas production process - from exploration drilling, production testing, well completion, processing, venting, flaring, and waste water storage, through to transportation and supply of the processed gas.

Human exposure to gas industry contaminants can occur in a variety of ways including through direct skin contact with chemicals or wastes, drinking or bathing in polluted surface or bore water, breathing in vapours and contaminated dust particles, and from ingesting tainted foods.

There are many reported incidents of gas mining contaminants being released into the environment by accidental spillage, leaking pipes, and from legal discharges into the atmosphere during such processes as drilling and flaring, and into rivers to dispose of waste water. But beyond these sources of contamination, it looks as if unconventional gas mining technology is fundamentally flawed and unsafe.

Unconventional gas wells are essentially metal pipes inserted into very deep boreholes - about 1,000m for CSG and 3,000m for Shale Gas. Drilling continues horizontally when the well reaches gas-bearing strata. Gas is extracted after water is pumped from the coal seam aquifer to the surface. The resulting depressurising of coal and shale seams inevitably leads to a drop in aquifer water levels closer to the surface.⁸⁰ In the “fracking” process, water, silica compounds, and chemicals are injected under high pressure to further fracture the seam to facilitate the release of gas.

To prevent gases from the coal and shale seams escaping into the atmosphere via the borehole, and to protect aquifers from contamination, for the entire vertical length of the well the space between pipe and rock has to be effectively and permanently sealed. This is purportedly achieved by pumping cement into the gap between pipe and rock - two inches wide at the top and three-quarters of an inch wide hundreds of metres down. Any flaw or deterioration over time in the cement barrier or metal pipe provides a potential pathway for contaminants to escape into the environment.

In July 2013, Metgasco workers had to run for their lives when 200 m of bore pipe was forcibly ejected high into the air during decommissioning of a CSG well in Casino. The well had experienced continuously rising pressure during its lifespan due to a loss of well integrity. The Mine Safety Investigation Unit report on the accident noted that, “Loss of integrity...meant that gas under pressure could migrate between the inside and outside of the (well) casing”. Efforts to monitor and control this building pressure had failed in part because there was “insufficient understanding” of the pressure build-up, and the plug used to seal the bore was installed too close to the surface.⁸¹

Air Pollution

During unconventional gas drilling, the evaporation of “flowback” (i.e., the injected fluid that returns to the surface with substances from the coal and shale seams) can cause severe air pollution.⁸² Flaring, the burning off of gases, releases hydrogen sulfide, methane and BTEX chemicals, as well as metals such as mercury, arsenic and chromium, into the air.⁸³

In the US, monitoring of air quality at gas drilling sites over a 12 month period⁸⁴ detected 44 hazardous pollutants including methane, methylene chloride, ethane, methanol, ethanol, acetone, propane, formaldehyde, acetaldehyde, and PAHs/naphthalene.

A multi-year air monitoring program in Utah reported elevated levels of ozone near gas mining activities, and concluded that oil and gas operations were responsible for 98-99% of Volatile Organic Compound (VOC) emissions and 57-61% of nitrogen oxide emissions.⁸⁵

Colborn et. al. (2012)⁸⁶ reviewed weekly air sampling results performed 1.1km away from a gas well pad before, during, and after drilling and hydraulic fracturing of 16 wells over the course of a year. Methane, non-methane hydrocarbons and polycyclic aromatic hydrocarbons (PAHs) were detected. As well, methylene chloride, a toxic solvent not reported in products used in drilling or hydraulic fracturing, was detected in 73% of samples, and several times in high concentrations.

In Pennsylvania, a US Health Survey⁸⁷ collected 34 air tests at 35 households in 9 counties and found VOCs including 2-butanone acetone, chloromethane, carbon tetrachloride, trichlorofluoromethane, toluene, methylene chloride, dichlorodifluoromethane, n-hexane, benzene, tetrachloroethylene, 1,2,4-trimethylbenzene, ethylbenzene, trichloroethylene, xylene and 1,2-dichloroethane. The researchers found a strong association between proximity of residence to gas facilities and severity of symptoms including nasal and throat irritation, sinus problems, eyes burning, shortness of breath, difficulty breathing, severe headaches, sleep disturbance, frequent nausea, skin irritation and rashes, and dizziness.

A 2009 air quality study⁸⁸ in Dish, Texas, a town which has no industrial activity other than nearby gas mining, and can therefore be considered informative of the effects of gas mining⁸⁹, found “the presence in high concentrations of carcinogenic and neurotoxin compounds in ambient air and/or residential properties.” “Many of these compounds verified in laboratory analysis were metabolites of known human carcinogens and exceeded both short-term and long-term effective screening levels according to TECQ (Texas Commission on Environmental Quality) regulations. Of particular concern are those compounds with potential for disaster as defined by TECQ”.⁹⁰

Queensland Gas Company (QGC) reports to the Australian National Pollutant Inventory indicate that significant quantities of pollutants are being deliberately released into the atmosphere from their CSG operations. These estimates do not include “fugitive” gas emissions that vent into the atmosphere away from company facilities.

Amongst other chemicals and substances, QGC provided the following estimates of air emissions from specific facilities over one year from 2011 to 2012⁹¹:

- QGC’s Kenya Processing Plant and Compressor Stations in Tara, QLD - Carbon monoxide (520,000kg), Formaldehyde (methyl aldehyde) (47,000kg), Oxides of Nitrogen (840,000kg), Particulate Matter - 10.0 um (2,700kg), Particulate Matter - 2.5 um (2,700kg), Sulfur dioxide (690kg), Volatile Organic Compounds (110,000kg), Fluoride compounds (17,000kg).
- QGC’s Windibri Processing Plant and Compressor Stations in Condamine, QLD - On-site long term waste storage (17,000kg), Carbon monoxide (500,000kg), Formaldehyde (methyl aldehyde) (42,000kg), Oxides of Nitrogen (850,000kg), Particulate Matter - 10.0 um (8,300kg), Particulate Matter - 2.5 um (8,200kg), Sulfur dioxide (640kg), Volatile Organic Compounds (99,000kg).

Australia's National Toxics Network⁹² reported that "limited sampling of ambient air undertaken around the Tara estate near CSG activities have detected VOCs, including ethanol, acetone, benzene, toluene, xylene, ethylbenzene, dichlorodifluoromethane, 1,2,4-trimethylbenzene, naphthalene, phenylmaleic anhydride, methyl ethyl ketone, phenol, butane, pentane, hexane."

Toluene, a neurotoxin was found in the air around a number of Tara homes, and the level of toluene measured in the air above a resident's water bore⁹³ (0.33ppm) was well above the "Chronic Reference Exposure Limits" used for long-term exposure by US states California, Massachusetts and Michigan.

Limited sampling used for a 2013 Queensland Department of Health Report⁹⁴ detected a wide range of VOCs in the air around homes in Tara, and concluded that testing "did provide some evidence that might associate some of the (Tara) residents' symptoms to exposures to airborne contaminants arising from CSG activities." In reviewing these findings, Dr Lloyd-Smith⁹⁵ noted that "for many of the chemicals assessed the level of detection used by the laboratories was well above the level set for the protection of health". Benzene, a confirmed human carcinogen, was detected at levels above the health criteria.

From July to December 2012, the Queensland Government collected air samples over brief periods in summa canisters from Wieambilla, a residential estate in Tara. Dr Lloyd-Smith commented, "Despite the nature of this testing, many VOCs were again detected in the air. While, most were below relevant guidelines and the criteria used, the number and type of compounds was diverse."⁹⁶ Summa canister sampling found the VOCs hexane, propene, chloromethane, dichlorodifluoromethane, methylene chloride, ethanol, acetone, methyl ethyl ketone, acrolein, and vinyl acetate (vinyl acetate exceeded the annual criteria in one case). Passive air samplers also detected VOCs including pentane, hexane, heptane, tetradecane, hexadecane, heptadecane, cyclohexane, 2-methylbutane, 3-methylpentane, 3-methylhexane, methylcyclohexane, tetrachloroethylene, 2-ethyl-1-hexanol, ethylacetate, benzene, toluene, xylene, ethylbenzene, 1,2,4-trimethylbenzene, phenol, benzothiazole, naphthalene, and alpha-pinene.⁹⁷

In Australia, many wells in Queensland CSG fields are leaking⁹⁸, and the final report of the CSG Well Head Safety Program (April 2011) found that more than 120 wells were reported to be leaking methane.⁹⁹ Video of leaking CSG wells in Queensland gas fields and ignitable bores has been shown on the ABC 4 Corners program, "The Gas Rush"¹⁰⁰ and the 60 Minutes program, "Undermined"¹⁰¹. In the Four Corners program, Scott Lloyd, a Queensland farmer, reported that QGC wells on his property had been leaking since 2006, and gas that was originally coming from the well head was now "coming straight out of the ground all around the site".¹⁰²

In Australia, a set of observations and research findings suggest that unconventional gas mining involving large numbers of wells with the associated depressurisation of coal seam aquifers could be causing uncontrollable, landscape scale venting of coal seam gases into the atmosphere. These gases potentially escape into the air via natural cracks and fissures in the rock strata, faulty cement bore casings, existing water bores, aquifers, old uncapped drill holes, cracks created by fracking and horizontal drilling, and direct seepage through the soil and rock strata.

In August 2012, a 30-year-old coal mining exploration hole in a CSG field, west of Dalby, was found to be alight with leaking methane.¹⁰³ In May 2012, Dayne Pratsky's video¹⁰⁴ recorded the large-scale venting of coal seam gases along a section of the Condamine River.

Leaking around the CSG wells on Scott Lloyd's property and in the Condamine River are only visible because the gases are bubbling through water, and the Dalby CSG leak was only detected because it ignited. There is no reason to expect that leaking coal seam gases are confined to the Condamine River, to puddles, or to old mining shafts. Rather, these observations complement research findings indicating that coal seam gases are venting across the countryside in Queensland gas fields.

Scientists from the Southern Cross University (SCU) reported very high levels of methane, CO₂, and radon in the atmosphere across landscapes affected by CSG mining near Tara in Queensland.^{105,106} The presence of methane and radon with a "chemical fingerprint" (i.e., methane-CO₂ isotope ratio) confirming that they are from coal seams, can reasonably be interpreted as indicating the presence of other coal seam gases and substances. According to Dr Damien Maher, "We are talking about enrichment (levels of methane) over scales of 10, 15, 30 kilometres. So this suggests that we don't have just one leaking well, it suggests that we have got wide scale enrichment of atmospheric methane."¹⁰⁷

Global atmospheric methane concentration has risen nearly 160% since pre-industrial times, to a current level of 1.8 ppm.¹⁰⁸ Santos and Maher (2012)¹⁰⁹ reported atmospheric methane concentrations in the range of 1.78 ppm to 1.94 ppm along the 500 km they drove travelling to the Tara gas fields. In the Tara area, they recorded methane concentrations three times higher than in surrounding countryside, with hotspot concentrations of methane as high as 6.89 ppm - a new "world record" that exceeded the previous highest reading of 2.89 ppm methane recorded in a Siberian gas field.

The SCU researchers reported that the chemical fingerprint of the atmospheric methane emissions in Tara were coal seam gases. Methane concentrations of 53 ppm were recorded over bubbles in the Condamine River, and chemical analysis confirmed that these were CSG.

The Australian SCU scientists also found atmospheric enrichment of radon gas and carbon dioxide in the Tara coal seam gas fields.¹¹⁰ Continuous 24 hour air monitoring at sites inside and outside the gas field indicated a 3-fold increase in maximum radon within the field as compared to outside. Levels of both radon and CO₂ were more elevated at night, indicating the need for continuous, rather than discrete sampling of air when testing for gas field pollutants. The researchers concluded that their findings pointed to the possibility that emissions in gas fields could be entering the atmosphere from both point sources, such as leaking wells and infrastructure, and from "enhanced diffuse soil gas exchange processes", which allow venting through the soil across the landscape.

Water Pollution

"However, the people of the Central Coast cannot be sacrificed on the altar of economic expediency. Their entitlement to clean, safe water must be paramount." ... "It is well-known that in the northern Pilliga forest, massive environmental damage was caused by Eastern Star Gas at its Bohena No. 2 drill site as a result of exploration practices. Experiences in the USA, and in the State of Wyoming especially, clearly demonstrate disastrous problems associated with this industry through groundwater loss, contamination and waste water. Water is used extensively in gas exploration, as it is in gas mining and development... This is in a country that is short of water... Therefore the ground water issue is not an irrelevancy or one to be dismissed in a single rhetorical phrase. It is at the very heart of this debate."

Mr Chris Hartcher, NSW Resources Minister, Parliamentary Speech, 3 May 2005.¹¹¹

“It is critical that any chemicals used in drilling and CSG well stimulation activities do not migrate to the bores of groundwater users. It is critical also that naturally occurring chemicals and compounds in coal seams and strata formations are not mobilised to water aquifers tapped by water bores. Many homes use bore water, the livestock we eventually eat as steak, chicken, lamb and pork from supermarkets more often than not drink it, and the plants we grow for grain and vegetables soak up bore water through their roots and foliage systems under irrigation.”

Ms A. Bridle’s submission to the Senate Standing Committee Inquiry¹¹²

The lowering of water tables has been described as “a necessary process and an unavoidable impact associated with the depressurisation of the coal seam” by gas mining company Santos¹¹³, and as a “reasonably foreseeable impact” by the Queensland Department of Infrastructure.¹¹⁴

In 2011 Bill Heffernan, the chairman of the Commonwealth Government Senate Committee said: “We don’t want to look back in 50 years time and regret what we are doing. When the CSIRO tells the committee that we don’t really know the long term impacts on the aquifers - it could take 300 years for some aquifers to recharge - these are all things that need to be understood before the industry goes ahead.”¹¹⁵

But the impacts of coal seam gas mining on water systems involve more than the lowering of water tables and the depletion of bores used for domestic and agricultural purposes.

According to Shenhua Watermark Coal, a CSG company operating in Australia, “Drill holes or fractures may intersect with one or multiple aquifers potentially mixing groundwater from different strata or altering the groundwater chemistry through exposure to the air, gas, fracking chemicals and drilling fluids or the release of natural compounds like BTEX.”¹¹⁶

As the Australian Government Senate report concluded, “there is a risk that residues of chemicals used in fracking may contaminate groundwater and aquifers used for human or stock consumption or irrigation. There are examples where water has been contaminated. It is acknowledged that in one case in Australia, fracking resulted in damage to the Walloon Coal measures, causing leakage between that and the Springbok aquifer.”¹¹⁷

Potential pathways for contamination of ground and surface water include: leakage of drilling fluids from the well bore into near surface aquifers; ineffective, damaged or degraded pipe and cement barriers in well casings; contamination from flow back fluid; accidental spills of fluids or solids at the surface; surface and subsurface blow outs; industrial chemicals used in drilling and fracking remaining underground; naturally occurring contaminants finding their way into drinking water aquifers; and discharge of waste water into surface water or underground aquifers.

Accumulation of contaminants in aquifers can have long-term impacts. Studies on the transport and fate of volatile organic compounds have found that they can persist in aquifers for more than 50 years and can travel long distances, exceeding 10 km.¹¹⁸ “Once a well is drilled, carcinogenic chemicals can leak out for years afterwards, and for wells in the catchment of urban water supplies this poses a huge long-term risk to public health.”¹¹⁹

There are cases in the US^{120,121} and in Australia^{122,123} of gas field pollutants contaminating ground and surface water systems.

In the US, Osborn et al., (2011)¹²⁴ reported “systematic evidence for methane contamination of drinking water associated with shale gas extraction”. In areas with one or more gas wells within 1 km, average (19.2 mg CH₄ L⁻¹) and maximum (64 mg CH₄ L⁻¹) methane concentrations in drinking-water wells increased with proximity to the nearest gas well, to a level indicating “a potential explosion hazard”. In contrast, dissolved methane samples in neighbouring sites with no gas wells within 1 km, and within similar “geologic formations and hydrogeologic regimes”, averaged only 1.1 mg L⁻¹.

In 2009, the US EPA sampled drinking water wells in Wyoming and detected chemicals in 11 of 39 wells tested, including 2-butoxyethanol, methane, and diesel range organics used in hydraulic fracturing.¹²⁵

A 2013 US EPA investigation¹²⁶ of water contamination in 23 drinking water wells near a natural gas extraction site in Pavillion, Wyoming, concluded that both inorganic and organic compounds associated with hydraulic fracturing have contaminated the aquifer at or below the depths used for domestic water supply.^{127,128} These substances included BTEX, isopropanol, diethylene glycol, triethylene glycol, tert-butyl alcohol and tert-butyl hydroperoxide plus diesel and gasoline organics. Detection of high concentrations of benzene, xylenes, gasoline range organics, diesel range organics, and total purgeable hydrocarbons in ground water samples from shallow monitoring wells near pits indicated that they were a source of shallow ground water contamination. Generally higher levels of dissolved methane were found in domestic wells that were in closer proximity to gas production wells. Residents were advised to use alternate sources of water for drinking and cooking, and to have adequate ventilation when showering.¹²⁹

In Pennsylvania, Jackson et al. (2013)¹³⁰ found methane in 115 of 141 shallow residential drinking water wells in an area affected by shale gas mining. Methane was detected in 82% of samples, with average concentrations six times higher for homes less than 1 km from gas wells. Ethane was 23 times higher in homes less than 1 km from gas wells, and propane was detected in 10 water wells, all within approximately 1 km distance. The closer that people lived to a well that had been fracked, the more likely it was that their drinking water was contaminated with methane and other shale seam gases. Isotopic analysis indicated that the methane originated in the shale seams being mined.

In Australia, groundwater systems and bores have been contaminated by CSG operations. The Queensland government reported that during the first six months of 2011 there were forty-five CSG compliance-related incidents, including twenty-three spills of CSG water during operations, four uncontrolled discharges of CSG water, three exceedances of discharge limits, three overflows of storage ponds, and other incidents of BTEX contamination.¹³¹

Testing performed by the Queensland Department of Natural Resources and Mines found toluene and methane in a resident's private water bore.¹³² In 2010, BTEX chemicals were found in 5 of 14 monitoring bores in gas fields near Dalby, with benzene being detected at levels between 6 to 15 times the Australian Drinking Water Guidelines (1 ppb).^{133,134}

The ABC Four Corners program aired on 21 February 2011 reported an incident in which a bore was contaminated by CSG pollutants. As a result of persistent enquiries by resident Anne Bridle, gas company QGC admitted that it had “unintentionally provided a route for water in the aquifer, as well as the coal measures to enter the well.”¹³⁵

In addition to accidental contamination of groundwater, in Australia CSG mining pollutants have also been legally¹³⁶ and illegally¹³⁷ discharged into surface water systems.

In at least two Queensland CSG projects¹³⁸, permits have been given for release of CSG waste water into the Murray Darling river system.

As Lloyd-Smith and Senjen (2011) reported, in a permit for one CSG company,¹³⁹

“The release of treated water into the Condamine River was authorised for a period of 18 months at a maximum volume of 20 megalitres (ML) per day. Over 80 chemical compounds as well as radionuclides were listed in the permit and included a range of persistent, bioaccumulative toxic substances such as nonylphenols, bisphenol A (BPA), chlorobenzenes, bromides, lead, cadmium, chromium, mercury, BTEX. There was no requirement for an assessment of the cumulative load or the potential to contaminate sediment, plants, aquatic species and/or animals prior to release.”¹⁴⁰ “The permits allowed the release of an unquantified and unassessed mixture of persistent toxic chemicals into a river used for irrigation and farming without any prior assessment of the cumulative chemical load or its possible long-term impacts on water quality, sediment, soil, stock and ecosystems.”¹⁴¹

Lloyd-Smith and Senjen (2011)¹⁴² calculated that for the 18 month period the CSG company was authorised to discharge the following quantities of chemicals and substances into the Condamine River - BPA (2.298 tonnes), bromide (76.65 tonnes), chlorobenzenes (20.148 tonnes), monochloramine (32.85 tonnes), nitrate (5,475 tonnes), uranium (219kg), toluene (8.76 tonnes), xylene (6.57 tonnes), ethylbenzene (3.285 tonnes), benzene (10.95kg), cyanide (876kg) and lead (109.5kg).

Ten thousand litres of CSG waste water leaked into the environment at the Narrabri CSG Project operated by Eastern Star Gas¹⁴³ - an incident that gas mining company Santos failed to report.¹⁴⁴ In the Northern Rivers, Metgasco was fined by the NSW EPA¹⁴⁵ after the company over a year illegally dumped at least 1,300,000 litres of CSG water into the Richmond River via the Casino sewerage plant.^{146,147} When Metgasco was ordered to draw down an over full CSG dam in Casino they had no option for reducing the level of waste water, so the NSW Government permitted them to discharge a further five million litres into the Richmond River.¹⁴⁸

Analysis of soil and water contaminated by wastewater spills in the Pilliga CSG operations in NSW found high levels of salts, and a variety of heavy metals including arsenic, lead and chromium, as well as petrochemicals.^{149,150} Sampling of CSG released water from Bohena Creek in the Pilliga Forest detected methane at the Eastern Star Gas discharge site at 68 micrograms per litre (ug/l), whereas it was not detected in the upstream control sample.”¹⁵¹

The CSG industry has touted the use of reverse osmosis filtration technology to render gas mining waste water safe for discharge into the environment, even though this form of filtration cannot remove all dangerous contaminants.¹⁵² Chemicals that are unable to be successfully treated by reverse osmosis filtration include bromoform, chloroform, naphthalene, nonylphenol, octylphenol, dichloroacetic acid, trichloroethylene, tris (2-chloroethyl)-phosphate, and water soluble substances such as the methanol and ethylene glycol are also poorly removed.¹⁵³ A 2011 report showed that even after reverse-osmosis treatment, CSG wastewater being released into waterways in Queensland contained a range of toxic substances, including boron and cadmium.¹⁵⁴

Soil Pollution

Soil contamination by gas mining contaminants can occur accidentally, via spillage or leakage of chemicals and wastewater, and deliberately, by spraying wastewater onto roads and disposing of drilling muds in landfills or by spraying them on agricultural or rural lands.

Morning dew on pastures is an unassessed potential pathway for gas mining air contaminants to pollute soils and to enter the human food chain. Nothing is known about the nature, quantity, or range of distribution of gas mining air pollutants that are dissolved in and transported by dew. Wind can deposit dust containing dried sediments from waste water ponds onto soils.

The transmission of dangerous substances to crops and livestock, and the ultimate potential impacts on the quality of food for human consumption, is unstudied and unknown.

Toxicologist, Dr David Brown (2013)¹⁵⁵ observed that finer particulates transported on the breeze from gas mining activities can be directly inhaled, whereas coarser particulates tend to fall to the ground where they are available for transportation into homes on shoes. Brown (2013) noted that vacuuming of the contaminated floor can mobilise these particulates into the air where they can be breathed in. Dr Brown recommended that people should not be allowed to wear shoes into residences in areas affected by gas mining.

Cases of Human Disease Associated with Gas Mining

Unconventional gas mining pollutants have complex differential health effects on individuals depending on such factors as: the toxicity of the pollutant; the concentration, duration and frequency of exposure; and the vulnerability of exposed people. Continuous monitoring of air quality, rather than discrete sampling, is necessary because weather conditions can affect the concentration of polluted air by a factor of up to 20 times, such that a reading of 2 parts per million (ppm) could be 200 ppm at a different time during the day.¹⁵⁶

People with existing health problems, gas industry workers, children, and people who tend to be active outdoors are particularly vulnerable. Gas industry workers are at particular risk of exposure to pollutants absorbed through the skin and via inhalation, and their families can be exposed to hazardous substances transported home on clothing. Workers who do not wear appropriate protective clothing or use respirators and dosimeters, are potentially exposed to a greater unassessed risk.

In August 2008, Cathy Behr, an emergency room nurse in Colorado, almost died after treating a gas worker who had been splashed in a fracking fluid spill. A few days after Behr had stripped the man and stuffed his clothes into plastic bags she lay in hospital in critical condition suffering multiple organ failure.¹⁵⁷

Esswein et al., (2013)¹⁵⁸, from the US National Institute for Occupational Safety and Health, collected 111 personal breathing zone samples at 11 gas drilling sites in 5 states and found that at every site full-shift samples exceeded occupational permissible exposure limits for crystalline silica air pollution, in some cases, by 10 or more times occupational health criteria. The level of exposure was sufficient to overwhelm the maximum use concentration ratings for the air-purifying respirators that workers typically wore.

Children are more at risk from gas mining pollutants than are adults, and due to their higher rates of exposure, children are often the first members of a family to become ill.^{159,160} Children living in gas mining affected areas have been likened to “sentinels”¹⁶¹, because their falling ill is likely to be the first indication of harm to human health. Relative to adults, children are closer to the ground and are more likely to be active outside. Children drink more water, breathe more air, and eat more food per kilo of body weight than do adults. Children have a longer “shelf-life”, and their living longer than adults puts them at greater risk from illnesses such as cancer that develop many years after exposure to a pollutant.¹⁶²

As was the case with thalidomide, a child is particularly sensitive to harm when exposed to pollutants during critical stages of physical development. There is little research examining the health impact of exposure to gas mining pollutants during critical developmental periods. A child’s health can be affected by its mother’s exposure during pregnancy, and even by the exposure of its mother and father prior to the child’s conception.¹⁶³ Hill (2013)¹⁶⁴ found that infants born to mothers, who during pregnancy lived within 2.5 km of a shale gas well in Pennsylvania, weighed less and were more likely to have a low birth weight. Paulson (2013)¹⁶⁵ noted that children growing up in more polluted environments have smaller lungs at maturity, and this can make them more vulnerable to respiratory illnesses later in life.

Animals tend to suffer more direct exposure to environmental pollutants, and have shorter life and reproductive cycles, than humans. Illness in cows, horses, poultry, and other wildlife can foreshadow impacts to human health.

Bamberger and Oswald (2012) investigated the impact of gas drilling on animal health in six US states, and documented cases of reproductive (e.g., irregular cycles, failure to breed, stillbirths), neurological (e.g., seizures, incoordination, ataxia), gastrointestinal (e.g., vomiting, diarrhea), and dermatological (e.g., hair and feather loss, rashes) problems among livestock exposed to gas mining contaminants.¹⁶⁶ Bamberger¹⁶⁷ described cases of cows that died within one hour after exposure to diluted fracking fluid, while other cattle nearby who were not exposed remained healthy. Bamberger noted that no one is testing the quality of beef and agricultural produce that comes out of gas field affected farming areas, and she queried the safety of feeding pigs and chickens with the rendered flesh of animals that grazed pastures in such areas.

In a case described by Bamberger and Oswald (2012)¹⁶⁸, reports of local animal deaths following gas drilling prompted a doctor to order tests that led to a diagnosis of arsenic poisoning in a child who had been exposed to misted wastewater (misting is used in the US to accelerate evaporation of wastewater). The child, who lived less than 1 mile from a well pad, became unwell with fatigue, severe abdominal pain, sore throat and backache, and after admission to hospital six months later with delirium tested positive for arsenic poisoning. The families of this child and another family 1 mile away were monitored and urine tests revealed high levels of phenol, a metabolite of benzene, which was consistent with their reported symptoms of headaches, fatigue, nosebleeds, rashes, loss of smell and hearing. The affected people were advised to move away. Those who did get better, while those who stayed got worse.

Health researchers are reporting similar symptom clusters across diverse communities that live near unconventional gas operations. US researcher Ronald Bishop (2011)¹⁶⁹ tentatively identified as “down-winder’s syndrome”, symptoms reported in studies in Texas¹⁷⁰ and Wyoming¹⁷¹, which included irritated eyes, sore throat, frequent intense headaches, nosebleeds, skin rashes, peripheral neuropathy, lethargy, nausea, reduced appetite and mental confusion.

Steinzor et al (2013)¹⁷² investigated symptoms suffered by people living in proximity to gas facilities in Pennsylvania. The 25 most prevalent individual symptoms among all participants were increased fatigue (62% of respondents), nasal irritation (61%), throat irritation (60%), sinus problems (58%), eyes burning (53%), shortness of breath (52%), joint pain (52%), feeling weak and tired (52%), severe headaches (51%), sleep disturbance (51%), lumbar pain (49%), forgetfulness (48%), muscle aches and pains (44%), difficulty breathing (41%), sleep disorders (41%), frequent irritation (39%), weakness (39%), frequent nausea (39%), skin irritation (38%), skin rashes (37%), depression (37%), memory problems (36%), severe anxiety (35%), tension (35%), and dizziness (34%). Many symptoms showed a strong statistical association between the rate of symptom reporting and how close affected people lived to oil and gas facilities.

Illnesses, including cancer, which can take years to develop, have been associated with exposure to gas mining pollutants. Lefall et al. (2010)¹⁷³ compared nationwide cancer mortality statistics with the incidence of cancer in three New York counties that had a distinctively rural character and a history of intensive gas and oil industry activity. Based on nation-wide statistics from 1950 to 1994 for 55 different types of cancer, women in these three counties were consistently in the top bracket for deaths caused by cancer of breast, cervix, colon, endocrine glands, larynx, ovary, rectum, uterus and vagina. Men from the same region were consistently in the highest statistical bracket for deaths caused by bladder, prostate, rectum, stomach, and thyroid cancers.¹⁷⁴

In Texas, emissions from shale gas operations are being checked for contaminants after blood and urine samples taken from household residents near shale wells revealed that toluene was present in 65% of those tested and xylene present in 53%.¹⁷⁵

In Australia, the residents of estates near Tara on the Western Downs of Queensland have become involuntary subjects in a de facto experiment on the health effects of living amongst CSG gas fields. Gas drilling commenced in the area in 2006, and since 2008 residents have been complaining of symptoms that, as Dr Helen Redmond noted, are similar to the symptoms reported in communities living near US gas fields.¹⁷⁶

In 2013 medical tests found a high level of hippuric acid, a metabolite produced following exposure to toluene, in the blood of a young boy who lived in the Tara estates.¹⁷⁷ In 2013, Dr Gerylann McCarron obtained information from 113 people (48 younger than 18 years, 65 adults) from 35 households in the Tara residential estates and the Kogan/Montrose region, and from three families who had left the area.^{178,179} 58% of surveyed residents reported that their health was definitely adversely affected by CSG mining, and a further 19% were uncertain. The reported symptoms were outside the scope of what would be expected for a small rural community, and resembled the “down-winder’s syndrome” found in overseas communities exposed to gas mining pollutants.

In the McCarron (2013) Tara study, there were reported increases across all age groups in coughing, chest tightness, rashes, difficulty sleeping, joint pains, muscle pains and spasms, and nausea and vomiting. Approximately one third of people over 6 years of age were reported to have spontaneous nose bleeds, and almost three quarters were reported to have skin irritation. Over half the children were reported to suffer eye irritation. A range of symptoms were reported which can be related to neurotoxicity (i.e., damage to the nervous system), including severe fatigue, weakness, headaches, numbness and paraesthesia (i.e., abnormal sensations such as pins and needles, burning or tingling).

The illnesses of children documented in the McCarron (2013) study were cause for particular concern. Approximately a third of all 48 children to age 18 years (15/48) reported symptoms of paraesthesia. Almost all the 31 children aged 6-18 were reported to suffer from headaches, and for over half of these children the headaches were severe. Parents of a number of young children reported twitching or unusual movements, and clumsiness or unsteadiness.

For the 31 children aged 6 to 18 years there was a marked change in reported symptoms following the commencement of CSG mining in the area. Before mining, 90% never and 10% only occasionally suffered nosebleeds, while after mining 32% occasionally and 29% often suffered nosebleeds. Before mining, no child reported constant severe headaches, and only 3% reported often suffering severe headaches. After CSG, 36% reported often and 13% reported constantly suffering severe headaches. Before CSG, no child reported often or constantly suffering skin irritation, but after CSG 19% reported often and 29% reported constantly suffering skin irritation. Before CSG, 97% of children reported that they never experienced symptoms of paraesthesia. After CSG, 22% and 10% of children respectively reported occasionally and often experiencing paraesthesia symptoms. 97% of children reported that they never suffered nausea prior to CSG, and after CSG 23% reported often and 3% reported constant symptoms of nausea.

A before and after CSG mining comparison was not possible for the 17 youngest children in the 0 to 5 age group. The health concerns reported by parents of these children included (with number of children suffering the symptom in parentheses): twitching and unusual movements (6), poor colour/blueness of mouth or limbs (6), blood from the nose (9), headaches (8), tingling/numbness/ pins and needles (5), unusual clumsiness or unsteadiness in children who were walking (5), unexplained inconsolable crying (10), rashes (11), unusual irritability (10), unusual lethargy (7), eye irritation (11), streaming eyes (8), cough (5), difficulty breathing (2), sore limbs (6), muscle spasms (3), and burning nose (7).

Statistics inform thinking about health risks, but they can dull our emotional sensitivity to the suffering borne by real families and their children. Parents' comments about their children's health problems in Tara provide a disturbing glimpse into what life is like for families who have to live among heavily industrialised gas fields.

What peace of mind is possible for parents in a place where children come in from playing outside with nosebleeds if the wind comes from a particular direction, or where an adolescent suffers nosebleeds every day for three months? What is the quality of life for the Tara children and adults who have to avoid going outdoors?

For many of the children surveyed in Tara it is now normal to wake out of sleep with headaches, and an infant was reported to wake screaming, feeling that he has to dip his fingers in water. Some children constantly rub their fingers and complain of ants in their hands. Eye and skin irritation, sometimes so severe that children feel as if they could rip their skin, has become a constant background complaint. Infants, children and adults alike suffer from headaches, some of which are so intense that they have been investigated with CT scans and lumbar puncture. For many residents, extreme fatigue and having difficulty focusing and concentrating are persistent debilitating symptoms. Undiagnosed coughs, repeated diagnosis of "flu", pneumonia, pleurisy and exacerbation of asthma are recurring experiences.

Senses of taste and smell, tuned by evolution, protect us from potentially dangerous foods and substances, and the detection of odours as a potential health issue has been investigated.¹⁸⁰

In Tara, residents reported that their symptoms were worse when odours were present, and some people could identify distinct individual odours at different times, variously described as “rotten eggs, sickly sweet, like pine tarsal, acetone, creosote, after burn from cigarette lighter.” Many people noted an association between their symptoms and the wind blowing from CSG waste water ponds. Some people commented on the link between road spraying and their symptoms. Children and adults complained of a recurring metallic taste which made them nauseous.

The children surveyed in Tara miss a lot of school. Sleep disturbance is endemic within the families surveyed, and many people directly related their sleep problems to the noise and vibrations from CSG traffic, drilling operations, and compressor stations. For others, sleep was disturbed by the constant strain of living and dealing with the impact of CSG on their lives, and the helplessness they felt from being unable to protect their children from illness.

The situation in Tara provides compelling evidence that operating gas fields in populated areas poses a significant risk to human health. It is undeniable that the gas mining industry uses and liberates many dangerous substances from coal seams. In Tara, the potential for humans to come into contact with these dangerous substances via contaminated air, water, and soil is substantial and well documented. In fact, these pathways to contamination are guaranteed by government policies which permit discharges of large quantities of dangerous substances into the environment. The health problems of the Tara residents mirror the “down-winder’s syndrome” seen across gas field affected communities in the US, and are consistent with the effects of exposure to pollutants known to be present in the local environment. People who live where unconventional gas is mined and processed pay a high price.

Protecting Your Family’s Health

Governments and industry plan to massively expand unconventional gas mining, and protecting your family’s health is going to be an ongoing challenge.

Be informed, keep yourself up-to-date regarding local developments, and take action as soon as you can. Keep a written, dated record of observations you make, actions you take, or any other things that might be relevant.

Understand the health risks

To better protect your family’s health you need to understand the nature of the risks so that you can recognise potential dangers. You have read the current report, and you can download copies of many of the referenced research papers, videos, and other information. There are also many other avenues to do your own research.

Assess the level of threat - Do you need to be concerned?

Once you understand the nature of the threat, do your own risk assessment. Ask whether there is any real chance that your family’s health could be affected by unconventional gas mining now or in the future. Generally, the risk is greater for people who work in the industry and for people who live near to gas mining operations. The level of risk is likely to be highest in areas of intense gas mining activity, and minimal where there has been no gas mining and none is planned. In many areas, such as the Northern Rivers which has about 60 capped CSG wells but no current mining, the level of risk needs to be assessed case-by-case.

In assessing risk you might consider the following questions: How near are you to gas mining operations such as wells, processing plants, evaporation ponds, compressor stations, vents or flares? Are any local active or capped wells leaking coal seam gases? (Tip - Look for bubbles around the well when it is raining and the ground is wet) Do you live upstream or downstream from gas fields? Do you ever notice odours when the wind is coming from a gas field?

Remove or avoid dangers

Think about how you can minimise your family's exposure to gas field pollutants and other potentially harmful industrial processes. For example, you might insulate your house against noise, avoid outside odours, use air conditioners during odour events, leave foot wear outside the house, avoid raising dust within the house, use damp cloths for dusting, consider using hepa filters on your vacuum cleaner, test the quality of the water you use for drinking and showering, use first pass filters for collected rain water, filter drinking water, etc.

You might consider writing to your local member of parliament and to the Government to express your concerns and to ask that they require proper risk assessments and health impact studies before approving CSG or Shale Gas developments. If they have not already received this report, perhaps you could send them a copy.

If you are harmed, seek prompt treatment

The current report and many of the referenced resources will be sent to medical practitioners. If your doctor has not received this information, you might pass it onto them.

Nurse/practitioner Ms Denise DeJohn from the South West Pennsylvania Environmental Health Project¹⁸¹ recommended that individuals keep a health diary in which they record health issues and associated environmental conditions (e.g., wind direction, odours, time of showering etc). Ms DeJohn advised patients not to request from their doctor a battery of tests because it is not possible to know which chemicals are involved, some chemicals have no specific identifying tests, and the half life of many chemicals is too short to catch with testing.

Use the Health Questionnaires

The Health Impacts Report and associated questionnaires are educational materials only, and are not any form of medical or legal advice. You might use these materials to help you assess gas mining risks to health, and to plan how you can better protect your family from possible harm.

You should discuss with your family doctor any concerns that you have about your mental or physical health, including any symptom in the questionnaires or change in your health status. These self-help risk assessment materials are not a substitute for any health impact assessment program, baseline data survey, or any other government service that addresses the health impacts of gas mining in your community.

No guarantee is given or implied that the completed questionnaires carry any legal weight, and you should seek professional legal advice for any concerns that you have.

If repeated at intervals, should gas development occur, the questionnaires can provide either ongoing reassurance of a clean bill of health, or alternatively early recognition of a significant change in health status.

You might consider reviewing the questionnaires at least once a year, or more frequently if there are changes in gas field activities in your area. You might also consider having your dated completed questionnaires signed and witnessed by someone who could attest to the accuracy of your responses. It is important that you give your doctor any information that might assist diagnosis. Discussing changes in your health status could allow this information to be recorded in your medical files.

The report and associated questionnaires are provided free of charge in the interests of community health. You can copy and distribute this document provided that the materials are reproduced in full, without alteration and with all citations and references, and no fee is charged.

Copies of these materials and many of the referenced publications are available for download by clicking the links on Page 41 “Selected References on Gas Mining Health Impacts”.

Symptom Checklist

The Symptom Checklist is educational material only, and is not any form of medical assessment, advice or treatment. This checklist is intended to be used as a tool for self-directed assessment and management of possible health risks associated with exposure to unconventional gas mining pollutants and processes. The information you record in this checklist could potentially be useful in alerting you to any change in your health status. In all cases, you should discuss any concerns that you have about symptoms or your mental or physical health with your family doctor. It is recommended that you avail yourself of any health impact assessment program, baseline data survey, or any other government service that addresses the health impacts of gas mining in your community. No guarantee is given or implied that the completed questionnaire carries any legal weight, and you should seek professional legal advice for any concerns that you have regarding legal matters.

The Symptom Checklist is provided free of charge in the interests of community health. You can copy and distribute this checklist provided that it is reproduced in full. Please note that there is no Medicare item for a doctor to review the Symptoms Checklist or any other associated questionnaire or checklist.

The Symptom Checklist consists of symptoms reported in: McCarron, G. (2013) Symptomology of a Gas Field: An Independent Health Survey in the Tara Rural Residential Estates and Environs; and the 25 most commonly reported symptoms in Steinzor, N., et al. (2013) Investigating Links Between Shale Gas Development and Health Impacts Through a Community Survey Project in Pennsylvania, *New Solutions*, Vol. 23(1) 55-83, 2013.

The symptoms in the checklist are grouped in no particular order, and do not represent any comprehensive or characteristic listing of symptoms associated with exposure to gas field pollutants and processes. The full nature and extent of acute and long-term health impacts from operating gas fields in populated areas are uncertain. It is reasonable to assume that exposure to gas field pollutants and processes could result in symptoms of illness that are not represented in this symptom checklist.

	No	Yes	Comment
Skin rashes			
Peeling skin			
Skin irritation - discomfort, sensitivity, itch, inflammation of skin without visible rash.			
Pins and needles			
Paraesthesia (abnormal sensations such as burning or tingling)			
Chest discomfort			
Chest tightness			
Severe chest pain			
Difficulty breathing			
Cough			
Shortness of breath			
Asthma			
Lethargy			
	No	Yes	Comment
Severe fatigue			

Feeling weak			
Nasal irritation			
Burning nose			
Throat irritation			
Sinus problems			
Eyes burning			
Running or streaming eyes			
Eye irritation			
Joint pain			
Sore limbs			
Mild headaches			
Severe headaches			
Spontaneous nose bleeds			
Disturbed sleep			
Insomnia			
Waking at night in distress			
Depressed mood			
Severe anxiety and tension			
Frequent irritability			
Feelings of helplessness & hopelessness			
Lumbar pain			
Muscle aches and pains			
Muscle spasms			
Joint pain			
Sore limbs			
Numbness			
Nausea			
Memory problems			
Difficulty concentrating			
Dizziness			
Nausea			
Vomiting			
Metallic taste in the mouth			
Twitching & unusual movements			
Poor colour/blueness of mouth or limbs			
Clumsiness or unsteadiness			
Constantly rubbing fingers			
Sensations of ants in hands			

Name:

Date of Birth:

Date:

Signed by:

Name of witness:

Date:

Signature of witness:

Exposure to Gas Mining Questionnaire

The exposure to Gas Mining Questionnaire is educational material only, and is not any form of legal advice or medical assessment, advice or treatment. The questionnaire might assist you in self assessing your potential exposure to risks associated with unconventional gas mining activities, and could be useful in the medical diagnosis of any change in your health status.

In all cases, you should discuss any concerns that you have about symptoms or your mental or physical health with your family doctor. It is recommend that you avail yourself of any health impact assessment program, baseline data survey, or any other government service that addresses the health impacts of gas mining in your community. No guarantee is given or implied that the completed questionnaire carries any legal weight, and you should seek professional legal advice for any concerns that you have regarding legal matters.

The Exposure to Gas Mining questionnaire is provided free of charge in the interests of community health. You can copy and distribute this checklist provided that it is reproduced in full. Please note that there is no Medicare item for a doctor to review this questionnaire or any other associated checklists or materials.



Name: _____ Date of Birth: _____ Date: _____

Signed by: _____ Name of witness: _____

Date: _____ Signature of witness: _____

Have you worked in the gas, coal or oil mining industries? (Circle one) **YES / NO**

If YES, when, how long, and what did you do in the mining industry?

Have you worked with toxic substances? (e.g., agricultural or industrial chemicals) **YES / NO**

If YES, please give details:

Do you live near gas drilling activities? **YES / NO**

If YES, approximately how close do you live?

What are the type(s), location(s) or name(s) (if known) of the gas extraction or processing operations you live near? (e.g., drilled wells, capped wells, compressor station, pipeline, waste water pond, refinery):

The approximate date(s) that well drilling activities began near to where you live:

Approximately when did the different stages of drilling activities occur and what stages are they in at present (e.g., seismic testing, drilling, fracking, flaring, well capping etc):

Have there been any incidents such as spills that have occurred near to where you live?

YES / NO

If so, please describe the incident(s) with approximate date(s):

Do you live within 300m of a road used to service a drilling site?

YES / NO

Do you live near a road that has been sprayed with CSG waste water?

YES / NO

WATER (Mark with tick ✓)

Water in my home is from: private bore ___ town water ___ rainwater tank ___ creek/river ___

My drinking water is from: private bore ___ town water ___ rain tank ___ creek/river ___
filtered tap ___ bottled ___

My cooking water is from: private bore ___ town water ___ rain tank ___ creek/river ___
filtered tap ___ bottled ___

My water for bathing is from: bore ___ rain tank ___ town water ___ creek/river ___ other ___

Water for my animals is from: bore ___ rain tank ___ town water ___ creek/river ___ other ___

Have you noticed changes in your water?

YES / NO

If YES, specify visible changes, tastes and odours and when the changes occurred:

Has your water ever been tested by a laboratory?

YES / NO

If YES:

Date(s)

Who tested?

AIR

Do you experience unusual odours in the air?

YES / NO

If YES, when did you notice them the first time?

How frequently do you experience them?

Please describe the odours:

If you know or suspect where or what facility the odours are coming from, please describe:

Have you had any laboratory testing of either your indoor or outdoor air?

YES / NO

If YES: Date(s):

Who tested:



The CSG Concerns Questionnaire is educational material only, and is not any form of medical assessment, advice or treatment. The questionnaire could help you to self-assess the level of stress you are experiencing in relation to potential stressors associated with unconventional gas mining activities. The information you record in this questionnaire could potentially be useful in helping you to better understand factors that could be contributing to symptoms of emotional distress. In all cases, you should discuss any concerns that you have about symptoms or your mental or physical health with your family doctor. It is recommended that you avail yourself of any health impact assessment program, baseline data survey, or any other government service that addresses the health impacts of gas mining in your community. No guarantee is given or implied that the completed questionnaire carries any legal weight, and you should seek professional legal advice for any concerns that you have regarding legal matters.

The CSG Concerns Questionnaire is provided free of charge in the interests of community health. You can copy and distribute this checklist provided that it is reproduced in full. Please note that there is no Medicare item for a doctor to review this or any other associated questionnaire or checklist.

The concerns listed in this checklist are grouped in no particular order, and do not represent any comprehensive or characteristic listing of concerns that people have regarding gas field industrialisation. The acute and long-term mental health impacts associated with operating gas fields in populated areas are uncertain and largely unstudied. It is reasonable to assume that this list of concerns is incomplete and does not represent a typical, or any individual's experience.

Please note that there is no specific Medicare item for a doctor to review this or other related checklist and questionnaires.

Name: _____ Date of Birth: _____ Date: _____

Signed by: _____ Name of witness: _____

Date: _____ Signature of witness: _____



Concerns About CSG and Shale Gas Mining

The Depression Anxiety Stress Scale-21 (DASS-21) is a standardised assessment of symptoms of emotional distress used by health professionals.

The DASS may be administered and scored by non-psychologists, but decisions based on particular score profiles should be made only by experienced clinicians or physicians who have carried out an appropriate clinical examination.

As used here, the DASS-21 questionnaire is educational material only, and is not any form of medical assessment, advice or treatment. The questionnaire is to be used as a tool for self-directed assessment and management of possible health risks associated with exposure to unconventional gas mining pollutants and processes. The information you record in this checklist could potentially be useful in alerting you to any change in your emotional functioning. In all cases, you should discuss any concerns that you have about symptoms or your mental or physical health with your family doctor. It is recommended that you avail yourself of any health impact assessment program, baseline data survey, or any other government service that addresses the health impacts of gas mining in your community. No guarantee is given or implied that the completed questionnaire carries any legal weight, and you should seek professional legal advice for any concerns that you have regarding legal matters. Please note that there is no Medicare item for a doctor to review this or any other associated questionnaire or checklist.



DASS₂₁

Name:

Date:

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you *over the past week*. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

- 0 Did not apply to me at all
- 1 Applied to me to some degree, or some of the time
- 2 Applied to me to a considerable degree, or a good part of time
- 3 Applied to me very much, or most of the time

1	I found it hard to wind down	0	1	2	3
2	I was aware of dryness of my mouth	0	1	2	3
3	I couldn't seem to experience any positive feeling at all	0	1	2	3
4	I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5	I found it difficult to work up the initiative to do things	0	1	2	3
6	I tended to over-react to situations	0	1	2	3
7	I experienced trembling (eg, in the hands)	0	1	2	3
8	I felt that I was using a lot of nervous energy	0	1	2	3
9	I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
10	I felt that I had nothing to look forward to	0	1	2	3
11	I found myself getting agitated	0	1	2	3
12	I found it difficult to relax	0	1	2	3
13	I felt down-hearted and blue	0	1	2	3
14	I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3
15	I felt I was close to panic	0	1	2	3
16	I was unable to become enthusiastic about anything	0	1	2	3
17	I felt I wasn't worth much as a person	0	1	2	3
18	I felt that I was rather touchy	0	1	2	3
19	I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)	0	1	2	3
20	I felt scared without any good reason	0	1	2	3
21	I felt that life was meaningless	0	1	2	3

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