NCC AIR QUALITY PLAN - POSSIBLE CHANGES FOR WOODBURNER RULES

A DISCUSSION PAPER ON ADVERSE HEALTH EFFECTS RELATED TO POOR AIR QUALITY AND COLD HOUSES - Dr Ed Kiddle, Medical Officer of Health, May 2014

I Introduction

1. The Nelson City Council (Council) is currently looking at the possibility of a relaxation in the Nelson Air Quality Plan (NAQP) rules relating to woodburners.
2. Concerns have been raised about affordability of home heating for some people and this has led to the current discussion in Council over possible relaxation of some rules.
3. From a health perspective, both poor air quality (air pollution) and cold homes can have adverse health consequences. These consequences are likely to impact most on the elderly, the very young, and people with medical conditions – particularly respiratory and cardiac conditions.
4. The Council has been exemplary in its efforts to comply with the National Environmental Standards on Air Quality (NESAQ). Council is a national leader and has taken it's responsibly to ensure clean healthy air for its citizens very seriously. In achieving this goal, tight rules around woodburners have been essential.
5. However there are citizens in Nelson who face affordability issues around home heating or fuel poverty (where a household spends more than 10% of its income on household energy requirements). This results in people living in cold homes and they also will be subject to adverse health effects as a result.
6. It is important to continue to work on the two inextricably linked issues of poor air quality and cold homes.
7. Council will be aware there are similar problems in Christchurch which have been exacerbated by damage to houses from the earthquakes. In recognition of the problem in Christchurch the Canterbury District Health Board has produced a position statement on home heating and air quality **(Appendix 1**) which contains 15 succinct statements as they relate to health and wellbeing.
8. Currently Environment Canterbury are reviewing their air plan and associated with this a Health Impact Assessment (HIA) is being undertaken by the Community and Public Health section of the Canterbury District Health Board. This HIA is on how changes to the air plan may affect health and wellbeing of Christchurch households, particularly those using woodburners.
9. The HIA report is due for release within the next few months and aspects of this work may be relevant to Nelson.

II Research on Adverse Health Effects of Poor Air Quality

1. The adverse health effects from poor air quality are well recognised and studies in recent years have reinforced the health effects of air pollution. The World Health Organisation

(WHO) reported in March 2014[i] that air pollution is the single biggest environmental health risk globally, killing an estimated 7 million people in 2012. This toll was greatest in developing countries but is not insignificant in developed countries.

2. The WHO Global Burden of Disease study from 2012[ii] identified ambient particulate matter pollution as a high-risk factor for poor health in Europe. In recent years, improved studies and analysis have shown the health consequences of air pollution to be higher than previously thought.

3. The WHO's Environmental and Social Public Health Department has stated "the evidence signals the need for concerted action to clean up the air we all breathe. The risks from air pollution are now far greater than previously thought or understood, particularly for heart disease and strokes"[i]

4. Also, the Lancet Respiratory Medicine Journal in December 2013[iii] reported on air pollution and health indicating that the present safe limits for different pollutants are associated with substantial morbidity and mortality. The article also reported on the increasing research into the health consequences of extremely small ($PM_{2.5}$) particulate matter that can penetrate deep into the lungs and into the blood stream leading to significant respiratory and cardiovascular problems.

5. In a paper by Wickham in Feb 2014[iv] it is stated that, "the evidence base for the association between respirable particulate matter (PM_{10} and $PM_{2.5}$) and short-term and long-term health impacts has become larger and broader. Recent long-term studies show associations between respirable particulate matter and mortality at levels well below current annual WHO guidelines".

6. In addition, respirable particulate matter exposure is associated with an increased risk of lung cancer. The International Agency for Research on Cancer (IARC) reported in October 2013[v] that outdoor air pollution had been classified as carcinogenic to humans. Review of the research showed that there was sufficient evidence that exposure to outdoor air pollution caused lung cancer and in addition there was a positive association with bladder cancer. Particulate matter, a major component of outdoor air pollution was evaluated separately and was also classified as carcinogenic to humans.

7. Adverse health consequences, besides lung cancer, identified as associated with particular pollutants include exacerbation of asthma, decreased lung function, increased respiratory symptoms such as cough, irregular heartbeat, heart attacks, strokes, and premature death in people with heart and lung disease. In addition, an increased risk of low birth-weight babies has been shown in recent studies.[vi] Also related effects include increased visits to the doctor, increased hospital admissions, school and work absenteeism and restriction of daily activities.

8. To quote from Wickham again "*the adverse health effects caused by respirable particulate matter are distributed unevenly with the largest proportion of the population affected by less severe outcomes (e.g. symptoms, reduced lung function) and much less people being affected by more severe outcomes such as hospital admissions and death.*

9. It is usually the more susceptible groups who experience the more severe outcomes. Susceptible groups include the very young (in particular babies, infants and children), *pregnant women, the health-compromised (e.g. diabetics, asthmatics and people suffering from cardio-pulmonary disease) and the elderly.*

10. *Importantly, although the relative risks for cardiovascular disease for respirable particulate matter exposure are small (as compared to say tobacco smoking or obesity), the resulting health burden is large because the entire population is exposed 24 hours a day, seven days a week.*

11. *The exposure-response relationship between particulate matter and health consequences is regarded as essentially linear (ie, increasing respirable particulate matter exposure is associated with an increased frequency of effects). The 2013 WHO Review concluded that studies do not indicate any apparent threshold below which effects do not occur.*

12. *In simple terms, this means that there is* ***no 'safe' level*** *of respirable particulate matter".*

13. A national study on health and air pollution in New Zealand was updated in 2012[vii] It looked at health impacts and social costs associated with air pollution for 2006. An earlier study based on 2001 data was the first comprehensive study of the issue for New Zealand and had estimated that air pollution caused approximately 1400 premature deaths per year of which 1100 were attributable to anthropogenic (caused or produced by humans) sources of pollution.

14. The updated 2012 study was able to use more data from ambient air monitoring programmes and reported that total health impacts for the country associated with anthropogenic air pollution were 1175 premature deaths in adults and babies, 607 extra hospital admissions for respiratory and cardiac illness and 1.49 million restricted activity days.

15. The study also reported costs associated with these impacts and contributions to this cost by source of the pollution. Domestic fires dominate the health impacts associated with anthropogenic air pollution in NZ except for Auckland where motor vehicles are the main source.

16. The study estimated for Nelson in 2006, sixteen adults aged greater than 30 years old died prematurely because of anthropogenic air pollution.

17. In 2013 a study supported by the Australian Research Council was reported in the British Medical Journal[viii]. The study illustrated a reduced risk of death associated with reduction in air pollution from wood heaters. It compared the population of Launceston in Tasmania, where there had been a series of interventions to reduce wood smoke pollution since 2001, with that of Hobart which did not have any air quality interventions. Researchers looked at mortality between 1994 and 2001 and 2001 to 2007 and found a reduction in all causes, but particularly cardiovascular and respiratory mortality during the period of improved air quality. This was a greatest in winter and for males.

III Research on Adverse Health Effects of Cold Houses

1. Adverse health effects from living in cold, damp houses are well recognised with numerous studies both internationally and in New Zealand. Generally the consequences

have been on respiratory health which can also be affected by moulds (which are more likely to occur in damp houses) and by indoor air pollutants such as nitrogen dioxide from unflued gas heaters which people may be using to heat the home.

2. Living in a cold home can affect people of any age. A report by Marmot and others[ix] on the health impacts of cold homes and fuel poverty reported that for the elderly, extra deaths were linked to cardiovascular and respiratory disease but many more people had more minor conditions that lead to a high burden of disease and associated costs to the health system.

3. For children, respiratory problems were twice that of those who lived in warm homes and mental health problems were another issue that arose for all age groups but particularly so for adolescents. Other health problems are more likely to occur in cold houses such as risk of accidents and falls.

4. New Zealand studies have identified significant impacts from cold houses. Admissions to hospital for asthma and pneumonia are also linked to cold homes[x].

5. A study on exposure to harmful housing conditions and hospital admissions in Wellington for children[xi] showed that respiratory conditions were the most common (34 % of admissions) and 50% of parents felt the house was colder than preferred around the time of admission. About one third of these parents had also noted mould and dampness in their house.

6. The study also showed that people living in high deprivation areas were more affected as were Maori and Pacific people. Other risk factors from harmful housing were smoking in the house, injury hazards and overcrowding, Overcrowding is more likely to occur when family households are cold. This can lead to other health impacts such as an increase in communicable disease.

7. Another consequence for children with health problems from cold homes (or poor air quality) is that they are likely to miss school and hence there are negative effects on educational attainment.

8. In summary, the health consequences of cold, damp homes can affect all age groups but essentially they are linked to fuel poverty. If the household cannot afford to heat the house it will be cold and adverse health effects may arise.

IV Home Heating

1) A range of home heating methods are available and factors determining these include Council rules, capital and cost and running costs (wood, electricity etc). In addition house design and insulation has a significant influence on the warmth of a home.

2) A draft paper prepared by Environet Ltd on Heating Choices and Costs for Christchurch 2013 is attached (**Appendix 2).** In this paper, wood burning is reported as one of the most affordable, commonly available forms of heating in New Zealand; second only to heat pumps in terms of operating costs, compared to the cost of buying firewood (if the household is buying wood to burn rather than accessing free firewood).

3) Fuel poverty affects a significant number of NZ households (reported as 25%)[(xii)] Part of this is linked to significant increases in the cost of electricity with poorly insulated houses, poverty and income inequality also being important factors.

V Nelson & Marlborough Hospital Data Analysis on Respiratory Admissions

1. An analysis of seasonal variation in admissions to hospital for respiratory disease in Nelson Marlborough has been completed as part of this paper[(xiii)] and is attached (**Appendix 3).** There will be a range of factors contributing to these admissions including air quality, cold homes and mean air temperatures.

2. In addition, year to year variation in the incidence of circulating influenza and other respiratory viruses, smoking prevalence and changing socio-economic factors that influence access to seeking medical care are likely to play a role.

3. In view of these multiple factors it is not considered possible to identify the specific contributions of air quality or housing conditions to increased winter hospital admission rates by examining trends over time. It is important to note that socio economic factors are also important regarding a householder's ability to heat their home.

4. This data analysis shows the current burden of winter hospital admissions due to respiratory disease (whilst acknowledging that the exact contribution of air pollution or other risk factors is not quantifiable), in order to further inform the debate about the use of woodburners for home heating.

5. Whilst acute cardiac disease admissions (including for heart failure) have also been shown to be related to air pollution, these have not been included in this analysis since the seasonal relationship for cardiac admissions is weaker than for respiratory diseases and the numbers of admissions attributable to air pollution is smaller as identified in the HAPINZ Report 2007[(xiv).]

6. The conclusions *from this analysis* are listed below.

- *There is a strong seasonal pattern involving higher winter admission rates for respiratory diseases which imposes a significant burden on the health care system in Nelson and Marlborough.*
- *Over the period 1999 – 2013 there has been a small increase in respiratory admission rates. Interpretation of these time trends is difficult because they are likely to reflect changing population demographics (eg population aging) and socio-economic factors (including access to healthcare, smoking prevalence, housing quality and use of heating), as well as year to year changes in viral illness outbreaks and the climatic and air quality environment,*
- *The large seasonal variation in admissions applies mainly to older people and children in the community, and to respiratory infections and obstructive airways disease diagnoses.*
- *The seasonal variation is more evident in the Nelson City Council area and Marlborough District, compared with Tasman District. This may be due to socio-economic and demographic differences between these populations.*
- *In the Nelson City Council area the seasonal variation in respiratory admissions amounts to an additional burden of 40-50 admissions over winter months and 100-150 admission-days, compared with the summer months.*

VI Conclusion

1. Adverse health effects will be occurring in Nelson from both poor air quality and from cold houses.

2. Determining specific numbers of people affected in Nelson due to both poor air quality and cold houses is not possible but a significant burden of disease is present during winter months.

3. Nelson has made significant progress on improving its air quality and this work should continue.

4. Good air quality should not be compromised at the expense of heating cold houses.

5. Recent research has shown that air pollution, particularly from small respirable particles, has greater adverse health effects than previously thought. There is no safe level of respirable particulates.

6. More information is needed to inform any assessment of who is most adversely affected in the community. Such information should include demographic profile, health status, heating type, presence of fuel poverty, owner occupied houses versus rental and state of the insulation. Such work would enable assessment of those households most at risk of problems and also those most in need of support.

7. Work on ensuring people have warm, dry housing must continue and cover such things as house insulation, curtain banks, and subsidy schemes.

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Appendix 1

CANTERBURY DISTRICT HEALTH BOARD POSITION STATEMENT
Home Heating and Air Quality

1. The Canterbury District Health Board (CDHB) acknowledges that a warm home is vital for comfort and good health whilst also recognizing that many New Zealand homes tend to be cold with temperatures regularly falling below the World Health Organization's recommendations.[1]

2. The CDHB acknowledges that the direct effects of cold homes on health include excess mortality from cardiovascular and respiratory disease amongst the elderly, increased respiratory problems in children, increased illnesses such as colds, influenza and mental health problems, and the exacerbation of existing conditions such as arthritis.

3. The CDHB recognises that home heating (temperature, humidity and ventilation), energy costs and fuel poverty are key housing issues with implications for health outcomes.

4. The CDHB wishes to emphasize the importance of home heating and energy efficiency, as a health protection measure, due to the significant public health impacts that result when dwellings do not provide a healthy environment for occupants.

5. The CDHB considers the human right to housing to be much more than simply a right to shelter but also the right to have somewhere to live that supports good health outcomes. The CDHB therefore acknowledges the inextricable link between the right to housing and the need for warm and dry, affordable, culturally appropriate and accessible housing that is part of a wider community with easy access to essential services within a healthy environment.

6. The CDHB understands that retrofitting New Zealand homes with insulation and clean heat options has been shown to increase indoor temperatures, decrease relative humidity, reduce energy use and improve the self-reported health of occupants, and consequently encourages actions to retrofit insulation and clean heat options for households.

[1] The World Health Organization has recommended a minimum indoor temperature of 18°C and a 2-3°C warmer minimal temperature for the very young and the very old. World Health Organization. 1987. *Health impact of low indoor temperatures:* Report on a WHO meeting, Copenhagen, 11-14 November 1985. Copenhagen: WHO.

7. The CDHB recognises that clean air is a requirement for health and wellbeing and that urban outdoor air pollution is the eighth most common risk factor for death in high income countries.[2]

8. The CDHB acknowledges the considerable international evidence that air pollution causes excess morbidity and mortality particularly through increases in the incidence of respiratory and cardiovascular illness.

9. The CDHB acknowledges that whilst air quality has improved in recent years the most recent best estimate (2005) indicates that air pollution in Christchurch results in 158 premature deaths annually in those aged 30 years and over. The proportion of these deaths associated with smoke, caused by woodburners, was calculated as 78% or 124 of these deaths.

10. The CDHB remains committed to its support of the Christchurch Air Plan, recognising the long term health benefits to Christchurch citizens, whilst acknowledging the ongoing challenge of improving air quality in order to meet the National Environmental Standards for Air Quality by 2016 and 2020.

11. The CDHB recognises the impact of the recent earthquakes on those who have lost their favoured primary heating source, due to the loss of their home, particularly when that appliance cannot be replaced under the Christchurch Air Plan.

12. The CDHB wishes to highlight the risks of unflued gas heaters to human health, due to the high levels of moisture and harmful combustion products which are produced by these appliances and the associated significant reduction in the quality of the indoor environment.

13. The CDHB acknowledges the risks that the affordability and fragility of our electricity system pose to the health of the most vulnerable community members and seeks to work with partner agencies to develop mitigation strategies.

[2] World Health Organization. 2009. *Global Health Risks: Mortality and burden of disease attributed to selected major risks*. Geneva: WHO.

Appendix 2

Heating choices and Costs for Christchurch

Prepared for Canterbury Regional Council and Canterbury District Health Board

Prepared by Emily Wilton, Environet Ltd, September 2013

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1 INTRODUCTION

1.1 Scope

This report outlines available information on heating choices and factors influencing home heating costs for Christchurch households. It includes summary information on preferred heating choices made as part of the Clean Heat programme. The report comprises two key assessments:

- Home heating options for Christchurch – preferred options
- Costs of heating methods – summary information on factors influencing heating costs

The purpose of collating this information is to assist in the development of a methodology for assessing the likely impacts of changes in heating methods on household warmth.

1.2 Sources of information

The information on heating options considers summaries prepared in the Good Practice Guide for Designing and Implementing an Incentives programme but considers options in the context of the existing Christchurch situation, which has limits on solid fuel options. The information draws on summaries of Clean Heat programmes from The Good Practice Guide for Designing and Implementing an Incentives programme.

1.2.1 Good Practice Guide for Designing and Implementing an Incentives Programme for Domestic Heating

The Good Practice Guide for Designing and Implementing an Incentives Programme for Domestic Heating was prepared in 2009 by Wilton, Baynes, & Bluett, (2010) and includes an assessment of heating choices, nationally and an indication of the preferred methods selected by households taking up incentives through clean heat programmes. A summary of information from that report adapted for the context of this work is presented in section 2.

1.2.2 Home heating surveys

A number of home heating surveys have been carried out for Christchurch and nationally which provide an indication of the preferred heating methods, both locally and nationally. This provides insight into preferences over time and does not necessarily reflect the distribution of heating choices if they were to be made at the present time. It is useful, however, in terms of providing an indication of the relative popularity of methods for those that have been around for some time.

1.2.3 Cost information

Cost information from EECA and Community Energy Action has been collated and presented in a previous report (Wilton, 2013) prepared for this project. This report collates further information obtained from EECA on the energy required to heat a home with different levels of insulation and from Branz on insulation levels within homes.

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2 HOME HEATING CHOICES

2.1 Solid fuel burners – heating choices for Christchurch

2.1.1 Open fires

Open fires are not a heating choice for Christchurch households. The installation of new open fires in Christchurch Clean Air Zones was prohibited under the Clean Air Act (1972), the provisions of which were carried over to the Transitional Regional Plan. The Natural Resources Regional Plan: Air also specifies no new installations of open fires in Christchurch.

Open fires are an inefficient method of home heating. The heat output from open fires is difficult to accurately control and is not constant. Open fires are labour intensive as they require constant refuelling and can result in increased indoor PM_{10} concentrations. A large amount of air that is drawn through the fire and up the chimney and this can result in cooling of other areas of the house as cooler outdoor air is required to be drawn into the house to replace the airflow going up the chimney.

Traditionally, incentives programmes have targeted the conversion of open fires to clean heat in the first instance. This approach has merit in that it can quickly remove the most inefficient form of heating and therefore effectively target both warm homes and air quality objectives. In Christchurch the Natural Resources Regional Plan: Air prohibits the use of open fires was during the winter months.

2.1.2 Wood burners

Wood burners are only a heating choice for Christchurch householders as a replacement method for an existing solid fuel heating method (excluding pellet burners). All wood burners installed in the Christchurch Clean Air Zones must meet the standard of 1.0g/kg when tested to NZS 4013, and have a thermal efficiency of at least 65%.

Wood burners are a popular heating option particularly in larger and older less well insulated dwellings where more heat is required. Wood burners typically have heat outputs in the range of 4-18kW and efficiencies of 65-77%. Many households that use wood burners in their main living area also use other heating methods for other areas of the dwelling.

Historically oversizing of wood burners (installation of wood burners with a heat output greater than that required to heat the room size) has been common, with retailers promoting the concept "bigger is best" and that additional heat can be used to warm other areas of the dwelling. However, unless heat transfer systems are installed excess heat typically remains in the living area and overheating occurs. Education around this issue has improved and a number of organisations such as EECA and Consumer now promote correct sizing of heating appliances, including wood burners and highlight cost issues associated with over-heating. The EECA website includes a heating size calculator which indicates the heat output required for a given room size, insulation, window prevalence and number of exterior walls. For example the heat output requirements for a 50 m2 room with three exterior walls, large windows and ceiling, floor and wall insulation to achieve a 20 degree temperature for Christchurch under minimum temperature of -4 degrees is 6.5 kW compared with 7.5 kW for the same dwelling without insulation.

Wood burning is more time intensive than most heating options. To optimise performance wood must be stored correctly, dried, cut to the appropriate size to fit in the burners and restocked. Kindling is required for start-up. Wood must also comply with Council regulations; Environment Canterbury require the water content of wood to be less than 25% by weight. Home heating surveys for Christchurch indicate that around one quarter of householders that use wood to heat their home collect it for free.

2.1.3 Pellet burners

Pellet burners appear similar to conventional wood burners and are available in free standing or inbuilt models. Pellet burners are fired by specifically designed wood pellets that are mechanically fed into the fire via a hopper. Good levels of heating efficiency can be achieved with pellet fires, through the ability to adjust the rate that pellets are consumed, control room temperature through a thermostat and using timers to turn the heating appliance on and off.

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The approximate heat output for pellet burners ranges from 10 to 30 kilowatts (kW). Space heating efficiencies range from 65% to 88%.

Pellet burners are a more expensive heating option than wood burners and cost around 14-20 cents per kWh compared with around 12-14 c/kWh for modern wood burners. Other possible disadvantages of pellet burners is that they require electricity to power the fuel feed auger, although some models include battery back-up to ensure operation during times of power black outs. Another possible disadvantage is the risk of increased prices for fuel as pellets are manufactured by a limited number of firms (Strategic Energy & EnergyConsult, 2005).

2.1.4 Multi fuel burners

Multi fuel burners include coal ranges, incinerators and potbelly stoves as well as conventional looking solid fuel burners designed to burn both wood and coal. Under the Natural Resources Regional Plan: Air, multi fuel burners are not a heating option for Christchurch households owing to their potential for high PM_{10} emissions.

2.2 Non solid fuel burners

Non solid fuel options include diesel burners, flued and unflued gas heaters, heat pumps and electric heating.

2.2.1 Diesel burners

Diesel burners are not a particularly popular heating method with the 2005 survey indicating less than 1% of household in Christchurch used that method. The capital cost of diesel fired burners tend to be more expensive than most wood burners and pellet fires, and cost around $4200 installed in 2009 (pers. comm., Smiths City, 2009). Anecdotal evidence suggests that in recent years the demand for diesel heaters has declined as the price of diesel has increased in recent years.

Diesel fired burners were included in the Canterbury ‘Clean Heat’ project, but were not included as a heating option for EECA projects. Diesel burners only account for 0.2 % of conversion to clean heat under the Environment Canterbury ‘Clean Heat’ project.

2.2.2 Gas heaters

In 2005 gas heaters were used by around a quarter of Christchurch households with 17% using unflued gas heating and 8% having flued gas heaters. Unflued gas heaters (including portable gas cabinet heaters) are not recommended as home heating methods because of the impact of their discharges on indoor air quality.

Flued gas heaters can be flame effect and appear similar to an enclosed burner, space heaters, or central heating units. Flame effect heaters tend to have a lower efficiency than gas space or central heating units (Wilton & Baynes, 2009). In New Zealand gas is available either through the reticulated natural gas network that covers parts of the North Island, through bottled LPG, and in some areas, through piped LPG. Although some areas of Christchurch have piped LPG the majority rely on bottled LPG.

During recent years the use of gas heaters has become less popular, mainly due to the large increase in gas prices (Wilton & Baynes, 2009). For example, research undertaken by Wilton and Baynes (2009) found that by that by 2008 around 200,000 households (13%) that used gas as a heating method in their main living area in 2006 were no longer using it. The main decrease was in households with unflued bottled LPG methods (e.g., portable gas heaters), with a 57% reduction in use, although a substantial reduction (30%) in unflued reticulated gas heating was also observed. Natural gas is less expensive than LPG (Wilton & Baynes, 2009).

Flued gas heaters do not appear to be popular choices in Christchurch, for example the Christchurch ‘Clean Heat’ project has only had a three percent uptake in gas heating (pers. comm., Mike Gaudin, Environment Canterbury, 2009). Wilton et al., (2010) suggest that flued gas is unlikely to be a popular choice amongst the general population and that potential sectors of the community that may be interested in switching to gas heating include high income homeowners who still want the aesthetic value of flame fires and can afford to pay higher fuel costs.

2.2.3 Heat pumps

A heat pump works by extracting heat in the air from outside a house and bringing it inside. Through the use of refrigerant gas, heat pumps shift more heat than the electrical energy consumed in the operation of them (www.consumer.org.nz). This makes them a highly efficient form of heating that can produce up to five times as much energy in optimal operating conditions (EECA, 2009). Heat pumps are thermostatically controlled to bring the temperature of a room to a certain level and maintain it within one to two degrees of that temperature. Prices typically range from around $2500 to $7000 installed.

Wilton et al., (2010) outline the main advantages and disadvantages of a heat pump as:

Advantages

- An energy efficient form of home heating. Some heat pumps can produce up to 5kW of heating for every 1 kW of electricity they use.
- Lower heating costs if the temperature of the room is not increased to a higher temperature than before the heat pump was installed.
- Reducing PM_{10} concentrations and other contaminants caused by the use of solid fuel.
- If appropriately sized, they can quickly bring a room up to a comfortable temperature.
- Can be used as a dehumidifier to reduce moisture in the home.
- Improvements to the quality of indoor air through washable filters.
- The potential to add value to a house.

Disadvantages

- The ongoing increasing costs of electricity.
- Reliance on one type of energy source for home heating, and concerns about how to heat homes during power blackouts.
- Requirement for cleaning of filters and maintenance.
- The need to be selective in choice of certain heat pumps that should be avoided:
- models that do not work effectively in low temperature areas if installing in a low temperature.
- noisy models.

2.2.4 Other electric heaters

Other electric heater types include radiant, convector, fan, under floor, and night store heaters. These are all high cost options in terms of on-going operation.

The main advantages of radiant, convector and fan electric heating include low capital costs and the convenience of quickly heating a small room or particular area. The disadvantages of these heating methods are the increasing cost of electricity, increased demand on the electricity network, and the limited way they many of them can be operated. Many only have a on or off setting, although basic thermostatic controls have become more prevalent in recent years.

Electric underfloor heating is a heating option for new homes but is not really an option for a wood burner replacement as retrofitting is not cost effective. The main advantage of underfloor heating is that it provides a warm, comfortable radiant heat. Underfloor heating tends to be expensive to install and operating costs are high.

Night store heaters operate by storing heat from night rate electricity and release it during the day. They are most advantageous for households that are occupied during the day and in locations where there is a cheaper night rate for electricity. Apart from vulnerability to price increases, one of the main disadvantages is that they have to be run all of the time, which can mean that they are heating areas during the day when there is enough warmth outside to heat the house without requiring heat from the night store heater.

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2.3 Home Heating Methods

Table 2.1 gives an indication of the relative popularity of different heating methods across New Zealand based on the situation in 2008. The distribution of heating options will be slightly different to Christchurch as multi fuel burners and open fires are no longer permitted heating options during the winter months and the use of flued gas may be lower owing to the lack of a reticulated gas supply in Christchurch.

Table 2-1: Home heating methods in New Zealand in 2008 (from Wilton & Baynes, 2009)

	National - 2008 Heating Methods	
	%	Total
Electricity	57%	854,427
Total Gas	21%	308,543
Total Flued gas	8%	123,121
- Flame effect – Flued	2%	31,151
- Ducted Central Heater - Flued	2%	31,151
- Other Space Heater - Flued	4%	91,970
- Unflued gas	13%	185,423
Oil	1%	19,284
Open fire	6%	93,453
Wood burner	25%	373,812
Multi fuel burners	8%	124,604
Pellet burners	1%	17,801
Number of heating types per home	1.2	1,791,923
No heating reported	13%	

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3 HOME HEATING COST ASSESSMENT

Basic cost information is provided in Table 3.1. However, the actual costs of operating using the different methods will vary for households depending on: size of the area to be heating, heating level required, household insulation levels and the climate or outdoor temperatures in the area where the dwelling is.

Table 3-1: Capital and operating costs of different heating methods (Community Energy Action, November 2011)

Fuel	Heating Type	Energy Efficiency (Energy in/Heat out)	Cost (to install)	Capacity (kw)	Fuel cost (av)* $	Cost: $ per kWh	Cost per hr ($ per kWh x capacity (kw))
Electricity	Fan heater	100%	$30	2.4	0.24	0.24	0.57
	Oil column	100%	$60	1.5	0.24	0.24	0.36
			$170	2.4	0.24	0.24	0.57
	Radiant (bar)	100%	$30	1.2	0.24	0.24	0.28
			$80	2.4	0.24	0.24	0.57
	Nightstore	80%	$1440	3.4	0.14	0.18	0.61
	Heatpump (wall)	370%	$2750	5.4	0.24	0.06	0.34
			$3200	6.8	0.24	0.06	0.43
	Heatpump (floor)	370%	$4000	5.6	0.24	0.06	0.36
	Heatpump (central)	330%	$15,000	14	0.24	0.07	1.00
	Ground source Heatpump (central)	400%	$32,000	15	0.24	0.06	0.89
Gas	Flued gas	80%	$5,400	7	2.43	0.24	1.66
	Unflued gas	90%	$250	4	3.89	0.34	1.35
	Flued gas (central)	93%	$13,000	15	2.43	0.20	3.06
	Flued gas	80%	$5,400	7	2.43	0.24	1.66
	Unflued gas	90%	$250	4	3.89	0.34	1.35
Solid fuel	Logburner Free-standing	70%	$3500	16	63.25	0.05	0.86
	Enclosed	65%	$3,500	14	63.25	0.06	0.81
Wood Pellet	Pellet Fire	82%	$5,100	9.5	0.53	0.12	1.16
	Central heat-pellet	96%	$27,000	15	0.53	0.12	1.56
Diesel	Diesel - cabinet	93%	$4,800	9.5	1.49	0.16	1.53
	Diesel - central heat	91%	$16,000	15	1.49	0.16	2.47

electricity: price per kWh (including GST). *gas: price per kg (including GST). *wood: price per m³ (including GST). *pellets: price per kg (including GST). *diesel: price per litre (including GST). *central=underfloor central heating except heatpump = ducted central heating

3.1 EECA home heating database

Information on the amount of energy required to heat a home with different levels of insulation, based on a temperature of 18 degrees Celsius in the living area and 16 degrees in other rooms using different heating methods, is required to estimate the on-going operating costs for different heating methods. Table 3.2 details information provided by EECA on the kWh heat requirement (per square metre of floor area) for single and two storey houses.

Table 3-2: Heat requirements per m^2 for different house types and heating regimes to achieve 18 degrees C in living areas and 16 degrees C in other rooms

Design option description	Heating schedule	Heating kWh/m2 floor area	
		One storey	Two storey
01 Base design	24hr living, evening only bedrooms+kitchen	257.97	150.69
01 Base design	Evening only living+bedrooms+kitchen	95.43	65.30
01 Base design	Evening only living	50.44	25.93
02 CI1 0-75mm existing	24hr living, evening only bedrooms+kitchen	159.37	100.96
02 CI1 0-75mm existing	Evening only living+bedrooms+kitchen	60.01	45.42
02 CI1 0-75mm existing	Evening only living	29.20	16.02
03 CI2 75-120mm existing	24hr living, evening only bedrooms+kitchen	141.93	92.27
03 CI2 75-120mm existing	Evening only living+bedrooms+kitchen	53.38	41.65
03 CI2 75-120mm existing	Evening only living	25.83	14.46
04 CI3 R2.9 climate zones 1+2	24hr living, evening only bedrooms+kitchen	133.19	87.93
04 CI3 R2.9 climate zones 1+2	Evening only living+bedrooms+kitchen	50.07	39.76
04 CI3 R2.9 climate zones 1+2	Evening only living	24.19	13.70
05 CI4 R3.3 climate zone 3	24hr living, evening only bedrooms+kitchen	132.08	87.38
05 CI4 R3.3 climate zone 3	Evening only living+bedrooms+kitchen	49.65	39.52
05 CI4 R3.3 climate zone 3	Evening only living	23.98	13.60
12 UF1 foil poor	24hr living, evening only bedrooms+kitchen	244.49	145.54
12 UF1 foil poor	Evening only living+bedrooms+kitchen	89.13	62.30
12 UF1 foil poor	Evening only living	46.12	24.63
13 UF2 foil good	24hr living, evening only bedrooms+kitchen	225.44	139.94
13 UF2 foil good	Evening only living+bedrooms+kitchen	80.51	59.21
13 UF2 foil good	Evening only living	41.22	23.46
14 UF3 bulk poor	24hr living, evening only bedrooms+kitchen	226.67	140.36
14 UF3 bulk poor	Evening only living+bedrooms+kitchen	81.07	59.46
14 UF3 bulk poor	Evening only living	41.52	23.54
15 UF4 R1.3	24hr living, evening only bedrooms+kitchen	223.57	139.37
15 UF4 R1.3	Evening only living+bedrooms+kitchen	79.53	58.90
15 UF4 R1.3	Evening only living	40.72	23.35
16 UF5 concrete slab	24hr living, evening only bedrooms+kitchen	222.57	139.95
16 UF5 concrete slab	Evening only living+bedrooms+kitchen	87.10	60.85
16 UF5 concrete slab	Evening only living	44.59	23.82
22 WA1 1978-1999	24hr living, evening only bedrooms+kitchen	226.40	123.50
22 WA1 1978-1999	Evening only living+bedrooms+kitchen	81.31	51.57
22 WA1 1978-1999	Evening only living	44.40	21.44
26 WIN1 Double Glaz	24hr living, evening only bedrooms+kitchen	246.12	143.38
26 WIN1 Double Glaz	Evening only living+bedrooms+kitchen	90.78	62.20
26 WIN1 Double Glaz	Evening only living	47.80	24.43
28 AIRT1 draughtstopped	24hr living, evening only bedrooms+kitchen	255.35	149.70
28 AIRT1 draughtstopped	Evening only living+bedrooms+kitchen	94.32	64.86
28 AIRT1 draughtstopped	Evening only living	49.85	25.73

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The classifications used includes several grades of insulation for each component. The home heating survey will provide information on the existence or otherwise of different types of insulation but further details such as the degree of thickness or R value of the insulation is unlikely to be able to be sourced via survey owing to most householders not knowing this information. The Branz 2010 Housing condition survey was used in conjunction with house age data to estimate the likely extent of insulation for households reporting the presence of ceiling, wall, window and underfloor insulation.

3.2 Branz 2010 housing condition report

The Branz 2010 housing condition report (Buckett, Jones, & Marston, 2012) compares the condition of around 500 rental and owner-occupied houses throughout New Zealand. Figures 3.1-3.3 are extracted from that report and summarise the study results with respect to insulation in the dwellings nationally.

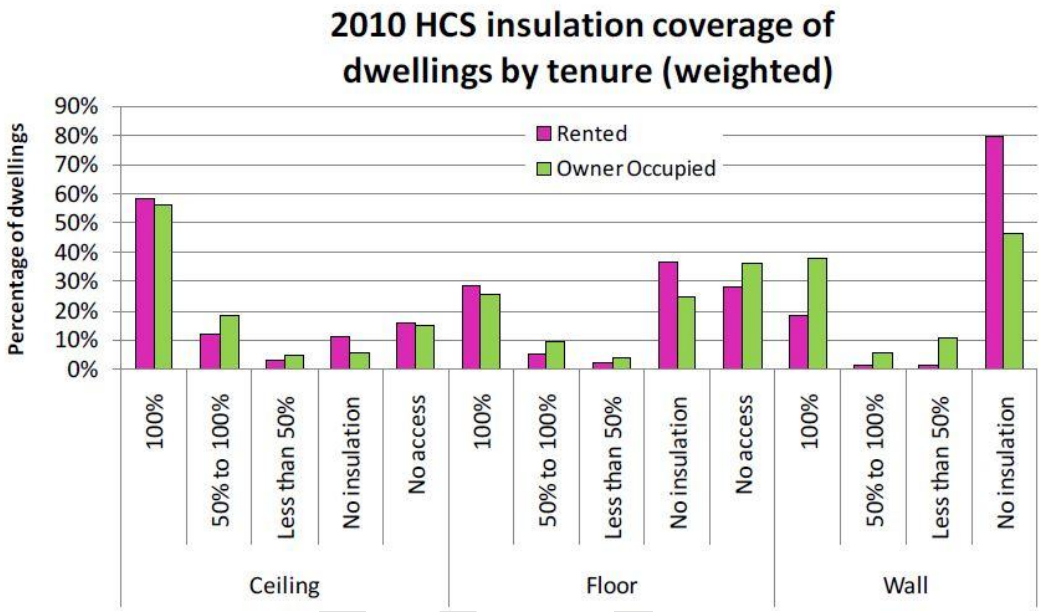

Figure 3-1: Insulation coverage within dwellings by tenure

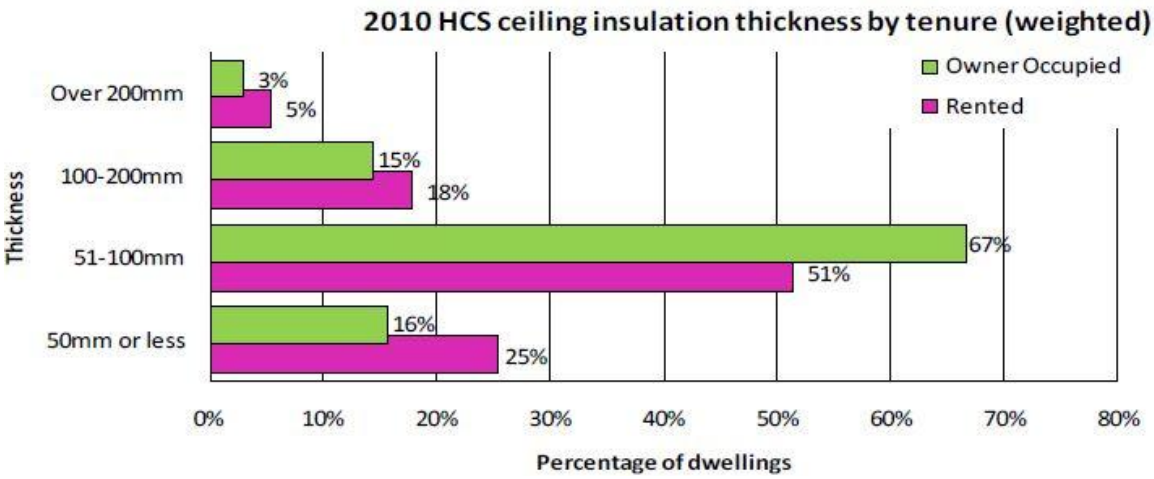

Figure 3-2: Ceiling insulation thickness within dwellings by tenure

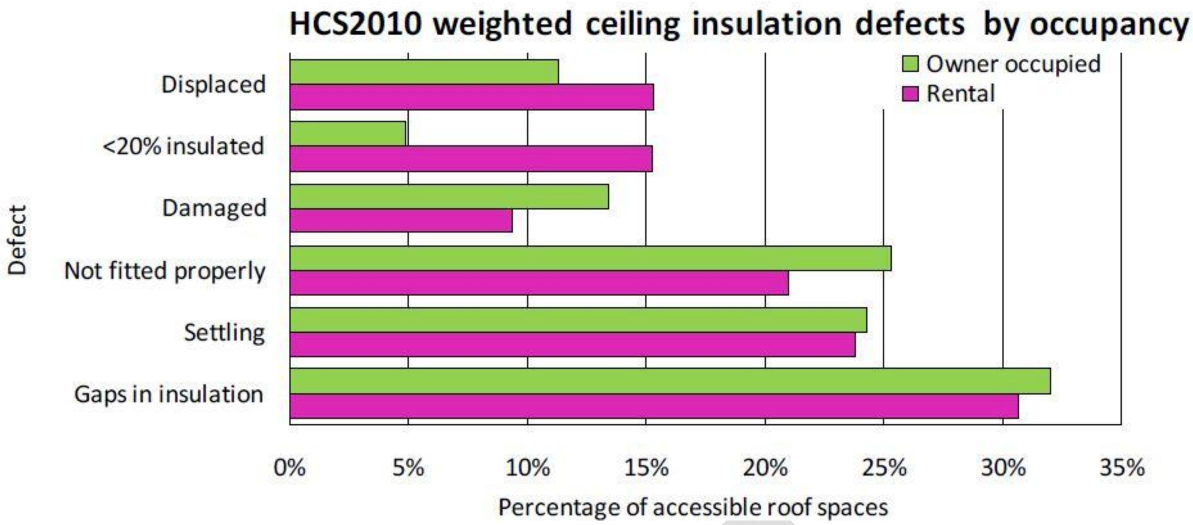

Figure 3-3: Insulation defects within dwellings by tenure

3.3 Impact of building standards

Insulation requirements were included in the New Zealand Building Code in 1978. Prior to this no insulation was required. The 1978 building code changes with respect to insulation nationwide was the requirement of ceiling insulation – R = 1.9, floor insulation of R = 0.9 and wall insulation of R = 1.5. In 2001 climate zones were introduced and the requirements for insulation depended on zone. The requirements for zone three (south island) increased to: ceiling – R = 2.5 and wall – R = 1.9. In 2007/08 the requirements for zone three increased to ceiling -R= 3.3, floor – R = 1.3, walls R = 2 and windows – R = 0.26.

4 SUMMARY

4.1 Home heating options

Home heating options for Christchurch households replacing wood burners include:

- Pellet fires – high capital cost, average operating cost.
- Heat pumps – average capital cost, low operating cost, good temperature control.
- Flued gas heaters – high capital cost, high operating cost.
- Diesel burners – high capital cost, high operating cost.
- Wood burners – high capital cost, low operating cost.
- Other electric options – low capital cost, high operating cost.
- Unflued gas heaters – low capital cost, high operating cost.

The main heating choices for budget conscious households replacing wood burners with non-solid fuel alternatives are likely to be:

- **Heat Pumps**. Heat pumps are the main heating option for households with sufficient capital outlay or loan mechanisms that allow for repayment at rates that are affordable. On-going heating costs will be similar to a wood burner if wood was purchased. Household warmth may improve with increased ability to control temperature and ability to access heat quickly.
- **Other electrical options.** For households unable to afford heat pumps or in rented accommodation where alternatives are not supplied, other electrical options (fan heaters, oil column heaters, ceramic heaters) are likely to be selected. These have low capital costs but higher operating costs.

Historically unflued gas heaters were also a low capital cost option. Increases in the cost of LPG since 2005 make this option less attractive than other electrical options. Some households may still choose this heating option as awareness of the relative costs of heating methods is likely to be low. As this option would result in more households entering fuel poverty some assessment is required. Flued gas heating and pellet fires may be an option for higher income households that wish to retain some of the aesthetics of a fire. Capital costs and operating costs of this method are high.

4.2 Factors influencing heating costs

The main factors influencing heating costs are heating method, dwelling size, insulation and number of storeys. Information on the impact of insulation and number of storeys on the heating requirement per m^2 dwelling size has been obtained from EECA and is summarised in this report.

This information can be combined with information on insulation levels obtained by survey to estimate the approximate costs of changing heating methods for households using wood.

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Appendix 3

AN ANALYSIS OF SEASONAL VARIATION IN ADMISSIONS TO NELSON-MARLBOROUGH HOSPITALS FOR RESPIRATORY DISEASES

Dr Al Norrish, Public Health Analyst, Public Health Service Nelson Marlborough DHB, 28 April 2014

Background

The Nelson City Council is currently considering revising local policies concerning the use of woodburners for home heating in the city. Previously the use of woodburners has been restricted in order to improve air quality during the winter season. With the use of low-emission woodburners and alternative forms of home heating, air quality has improved over the past 10 years, but there has been recent concern about the affordability for residents of home heating.

Although part of the concern about air quality relates to known adverse effects of air pollution on respiratory and cardiac disease, there is also evidence that health is adversely affected by cold and damp housing conditions. In any given year, winter admissions to hospital for respiratory disease are likely to be affected by air quality as well as other factors including mean air temperatures. In addition, year to year variation in the incidence of circulating influenza and other respiratory viruses, smoking prevalence and changing socio-economic factors that influence access to primary and secondary medical care are likely to play a role. In view of these multiple effects, it is not considered possible to identify the specific contributions of air quality or housing conditions to winter admission rates by examining trends over time.

The aims of this analysis are to describe the current burden of winter hospital admissions in Nelson City due to respiratory disease (whilst acknowledging that the exact contribution of air pollution or other risk factors is not quantifiable), in order to further inform the debate about the use of woodburners for home heating.

Whilst acute cardiac disease admissions (including for heart failure) have also been shown to be related to air pollution, these have not been included in the current analyses since the seasonal relationship for cardiac admissions is weaker than for respiratory diseases and the numbers of admissions attributable to air pollution is smaller (Ref: HAPINZ Report 2007).

Aims

To describe the following:

- Time trends in seasonal hospital admission rates for respiratory disease 1999-2013 for the NMDHB district and for individual Territorial Authority areas,
- Time trends in seasonal age-specific hospital admission rates for respiratory disease, 2006-2013 for the NMDHB district,
- Seasonal burden due to the number of respiratory disease admissions and admission-days for the Nelson City Council area, 2001-2013,

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Methods

The Tableau workbook clinical dashboard tool was initially examined for respiratory diseases, ischaemic heart disease and heart failure to investigate the seasonality of hospital admissions.

More detailed data was extracted from the OraCare database for hospital admissions for respiratory disease ICD-10 codes (J00-J99) for the period 1999-2013, including demographics (age, gender, ethnic group), domicile, primary diagnosis and length of stay. Domicile data were only available after 2001.

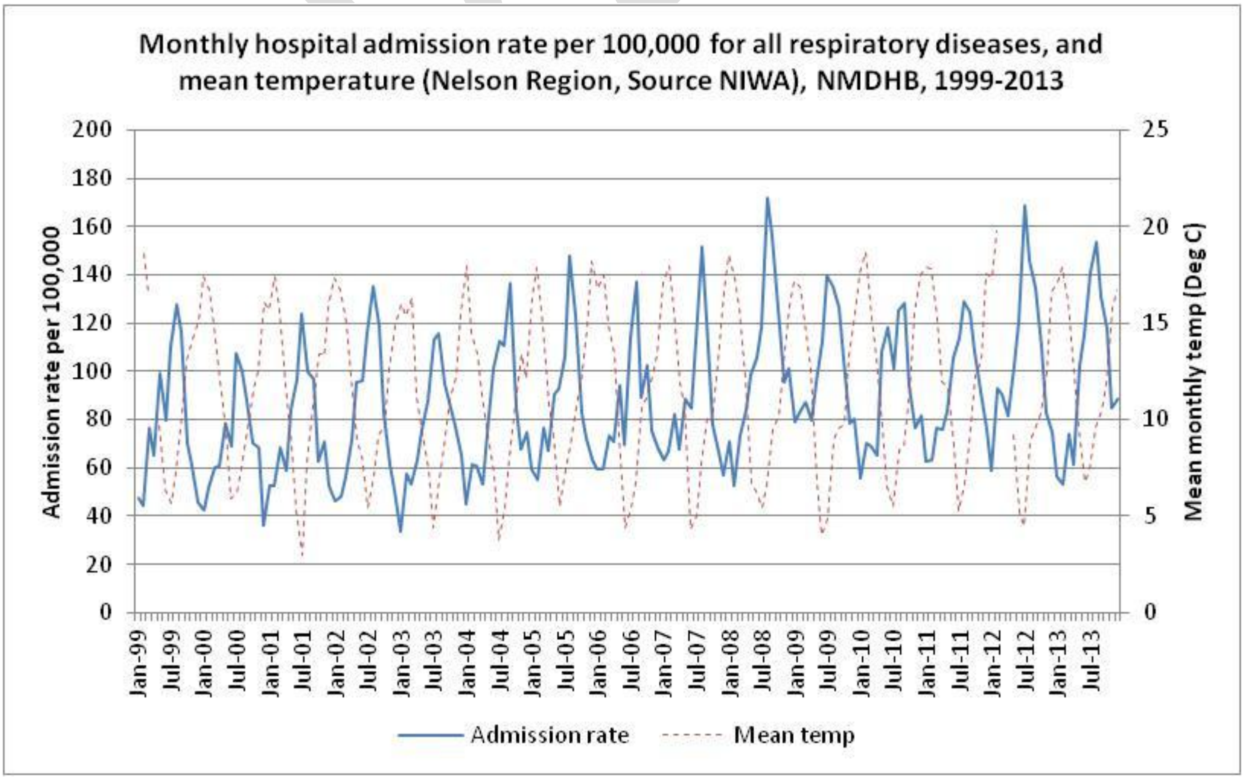
Analyses were carried out for all respiratory diseases, and for a restricted group of respiratory infections and obstructive airways disease (asthma and COPD) diagnoses expected to show more definite seasonal patterns of admission, as follows:

- Acute upper respiratory infection
- Chronic lower respiratory diseases
- Influenza and pnuemonia
- Other acute lower respiratory infections
- Suppurative and necrotic LRT.

In order to generate admission rates, denominator data was obtained from annual projections from the 2000, 2006 and 2013 Census data, as published online by Statistics New Zealand. Age group data were only available for 2006-2013.

Data for historical mean monthly temperatures were obtained online from the NIWA website for the Nelson region.

Results



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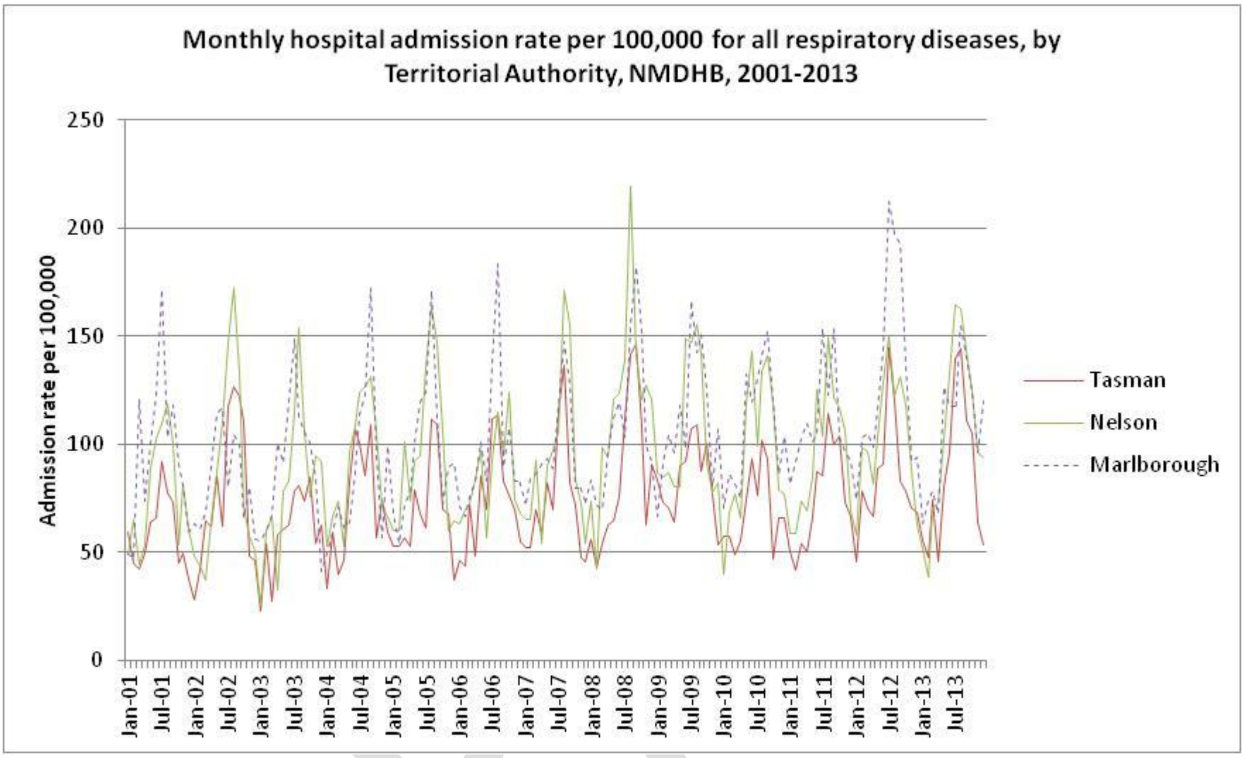
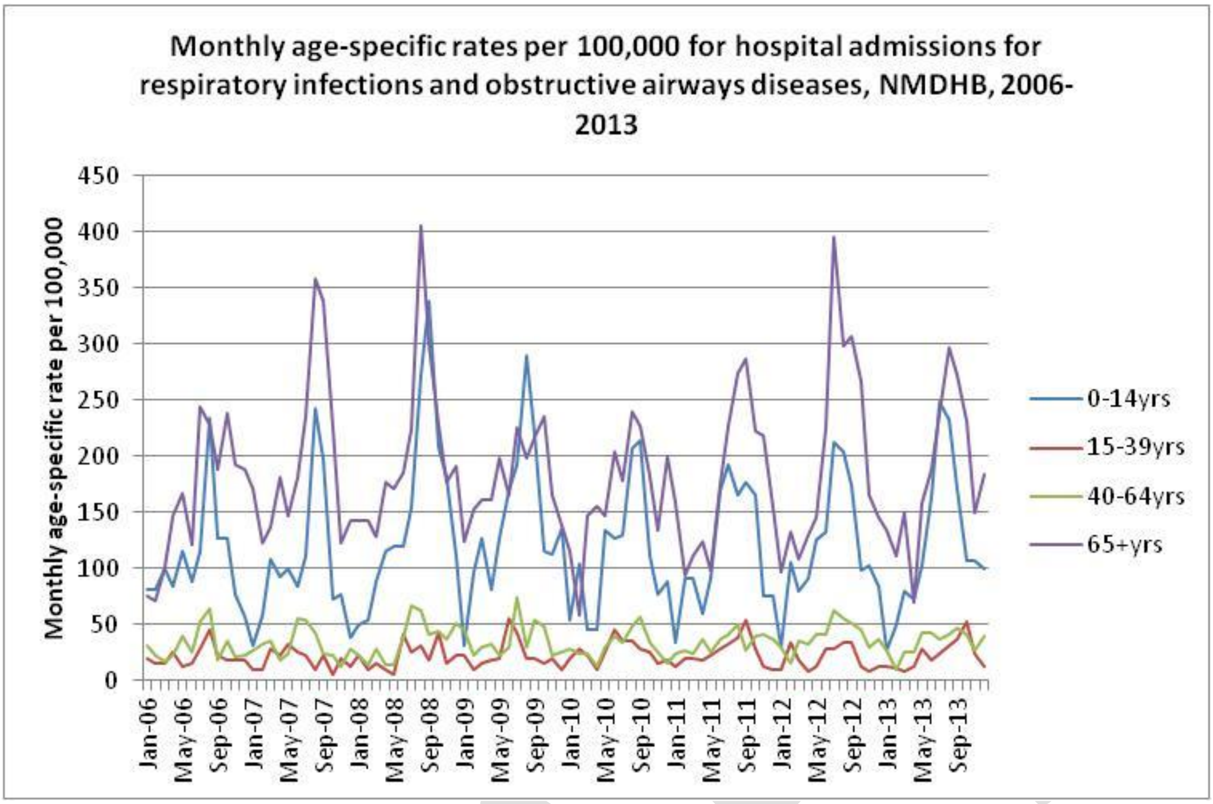
Comment:

In the NMDHB District, there is a clear increase (approximate doubling) in respiratory disease admission rates during winter months, and this shows an inverse relationship with mean monthly temperature. There appears to have been a small increase in admission rates over the period 1999 – 2013, which may be best explained by changing demographic and socio-economic factors.



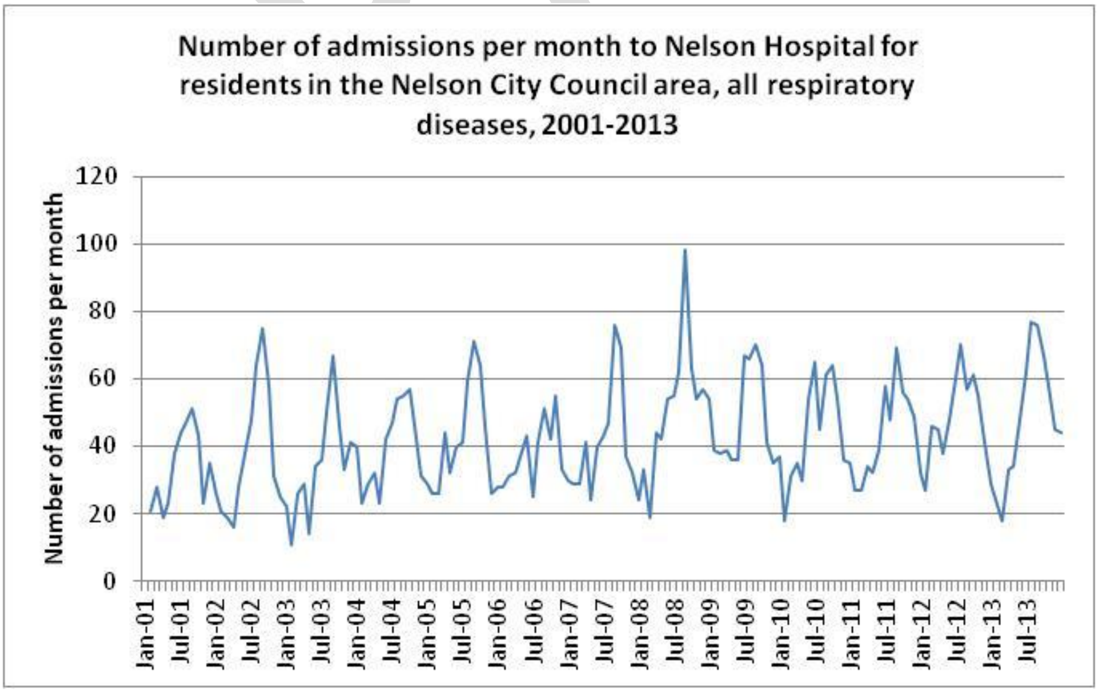
Comment:

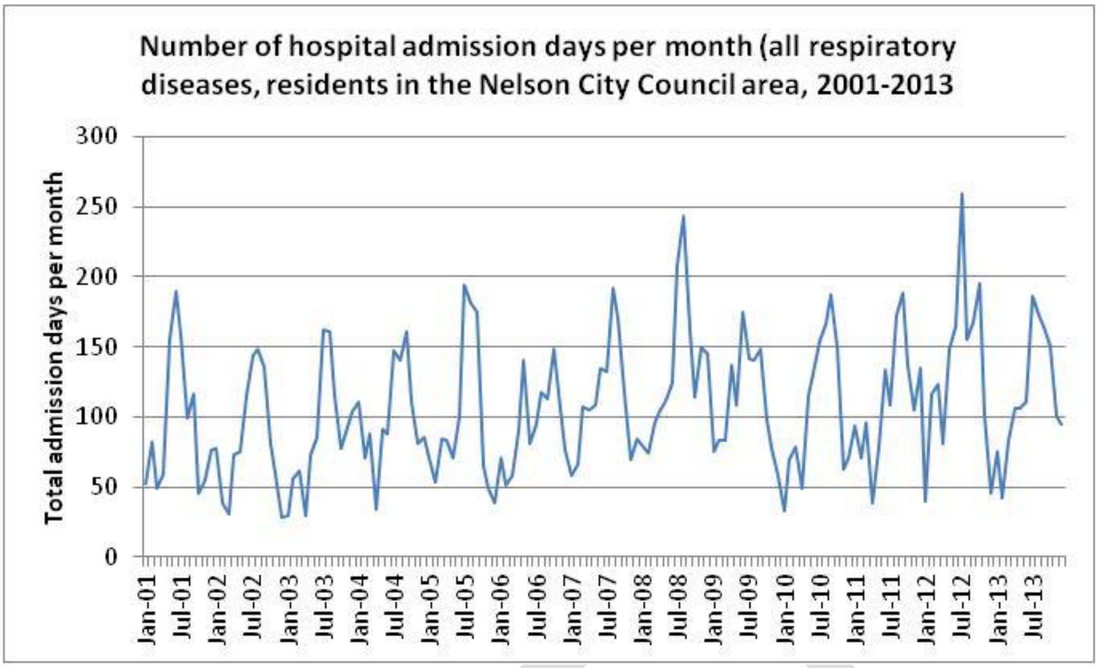
On most years, the rate of summer respiratory disease admissions is similar for residents of all three TAs, but during the winter months, Nelson City and Marlborough Districts have higher peaks than Tasman District. The reasons for this are unknown but may be due to demographic and socio-economic differences in the populations including age structure, access to healthcare and housing quality.



Comment:

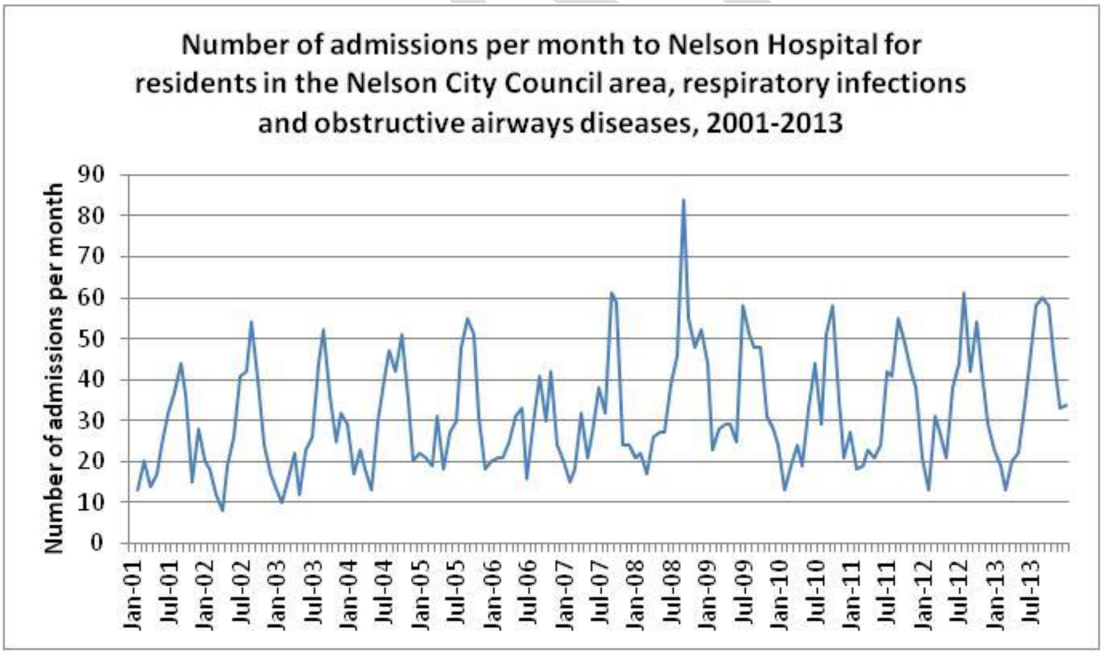
The highest admission rates and greatest seasonal variability are seen amongst the older population (65+ years) and children (0-14 years).

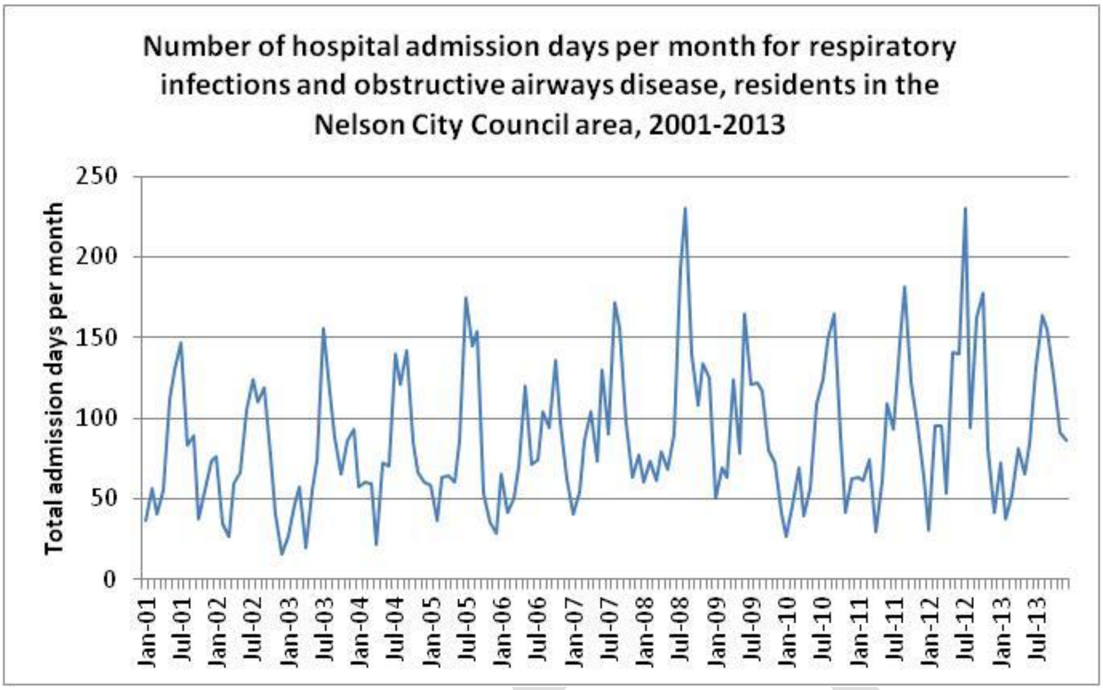




Comment:

For residents in the Nelson City Council area, compared with the summer months, there is a 2-3-fold increase in numbers of respiratory disease admissions during the winter, amounting to 40-50 excess admissions each month, and 100-150 excess admission-days





Comment:

When restricted to admissions for respiratory infection and obstructive airways disease diagnoses, the seasonal variation is greater, since these diagnoses are expected to be more strongly related to colder weather, circulating viral illness and poorer air quality during the winter months.

Conclusions

- There is a strong seasonal pattern involving higher winter admission rates for respiratory diseases which imposes a significant burden on the health care system in Nelson and Marlborough.
- Over the period 1999 – 2013 there has been a small increase in respiratory admission rates. Interpretation of these time trends is difficult because they are likely to reflect changing population demographics (eg population aging) and socio-economic factors (including access to healthcare, smoking prevalence, housing quality and use of heating), as well as year to year changes in viral illness outbreaks and the climatic and air quality environment,
- The large seasonal variation in admissions applies mainly to older people and children in the community, and to respiratory infections and obstructive airways disease diagnoses.
- The seasonal variation is more evident in the Nelson City area and Marlborough District, compared with Tasman District. This may be due to socio-economic and demographic differences between these populations.
- In the Nelson City Council area the seasonal variation in respiratory admissions amounts to an additional burden of 40-50 admissions over winter months and 100-150 admission-days, compared with the summer months.

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