PNEUMONIA

Introduction

While most respiratory infections in children are acute upper respiratory infections, children presenting to hospital emergency departments commonly have lower tract respiratory infections, including pneumonia. Pneumonia is an inflammation of the lung tissue, which is usually the result of a viral or bacterial infection following an acute upper respiratory infection. Most cases of pneumonia are due to viruses, but bacterial pneumonias cause most pneumonia deaths [127].

The causative organisms vary with the age of the child. In neonates bacteria (group B *Streptococcus* and gram-negative enteric bacteria) are the most common cause, while in infants older than four months and young children viruses, particularly respiratory syncytial virus, are more common. Outside of the neonatal period, the most common bacterial cause is *Streptococcus pneumonia,* although in children older than five years *Mycoplasma pneumoniae*, and *Chlamydophila pneumoniae* are also common [128]. Clinical features include a high respiratory rate, respiratory distress, fever, chills, cough, chest pain, and abdominal pain and distension. Some infants with bacterial pneumonia may have vomiting, anorexia and diarrhoea [129].

In New Zealand, there are significant ethnic disparities in hospitalisations for pneumonia in children with Māori and Pacific children having higher admission rates than European children [130] and more severe disease once admitted [131]. Risk factors for pneumonia worldwide include low socio-economic status, low birth weight, lack of breastfeeding, living in crowded homes, indoor smoke and poor hygiene (particularly lack of hand washing) [132]. In New Zealand it has been suggested that factors such as poor housing (cold, damp, mould, overcrowding), a lack of access to primary healthcare and poor nutrition (e.g. iron deficiency) play significant roles [102,130].

The following section explores bacterial and viral pneumonia in children and young people using information from the National Minimum Dataset and Mortality Collection. The section concludes with a review of policy and evidence-based review documents which consider the prevention and management of pneumonia in this age group.

Data Sources and Methods

Indicator

1. *Acute and Semi Acute Hospital Admissions for Bacterial/Non-Viral/Unspecified Pneumonia in Children and Young People Aged 0–24 Years*

2. *Acute and Semi Acute Hospital Admissions for Viral Pneumonia in Children and Young People Aged 0–24 Years*

Numerator: National Minimum Dataset: Acute and semi-acute hospital admissions for children and young people aged 0–24 years with a primary diagnosis of Bacterial/Non-Viral/Unspecified Pneumonia (ICD-10-AM J13–J16, J18) or Viral Pneumonia (ICD-10-AM J12, J100, J110).

Denominator: Statistics NZ Estimated Resident Population (with linear extrapolation being used to calculate denominators between Census years).

3. Mortality from Bacterial/Non-Viral/Unspecified Pneumonia in Children and Young People Aged 0–24 Years

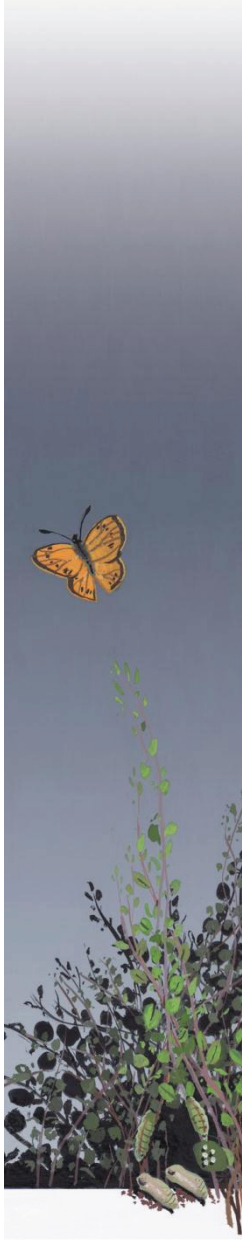
4. Mortality from Viral Pneumonia in Children and Young People Aged 0–24 Years

Numerator: National Mortality Collection; Deaths in children and young people aged 0–24 years where the main underlying cause of death was Bacterial/Non-Viral/Unspecified Pneumonia (ICD-10-AM J13–J16, J18) or Viral Pneumonia (ICD-10-AM J12, J100, J110).

Denominator: Statistics NZ Estimated Resident Population (with linear extrapolation being used to calculate denominators between Census years).

Notes on Interpretation

Note 1: In this section, a separation has been maintained between bacterial/non-viral/unspecified pneumonia and viral pneumonia, because the former is considered to be ambulatory sensitive (e.g. early antibiotics in primary care may potentially prevent a hospital admission), while viral pneumonia is thought to be less amenable to such primary care interventions. In reality however, a large proportion of the former category



comprises admissions with a primary diagnosis of J18: Pneumonia organism unspecified, meaning that there is likely to be considerable overlap between the two categories. It is thus recommended that trends in these two conditions be reviewed concurrently, with the artificial separation being maintained for those wishing to explore the contribution that pneumonia makes to trends in ambulatory sensitive hospital admissions.

Note 2: An acute admission is an unplanned admission occurring on the day of presentation, while a semi-acute admission (referred to in the NMDS as an arranged admission) is a non-acute admission with an admission date <7 days after the date the decision was made that the admission was necessary.

Note 3: **Appendix 3** outlines the limitations of the hospital admission data used. The reader is urged to review this Appendix before interpreting any trends based on hospital admission data.

Note 4: 95% confidence intervals have been provided for the rate ratios in this section and where appropriate, the terms *significant* or not *significant* have been used to communicate the significance of the observed associations. Tests of statistical significance have not been applied to other data in this section, and thus (unless the terms *significant* or non-*significant* are specifically used) the associations described do not imply statistical significance or non-significance (see **Appendix 2** for further discussion of this issue).

New Zealand Distribution and Trends

New Zealand Trends

Bacterial/Non-Viral/Unspecified Pneumonia: In New Zealand, bacterial/non-viral/unspecified pneumonia admissions in children declined during 2000–2007. A small upswing in rates was evident in 2008–09, before admissions declined again in 2010. Similar patterns were seen for young people. During 2000–2008 on average eight children or young people died each year, as the result of bacterial/non-viral/unspecified pneumonia (**Figure 54**).

Viral Pneumonia: In New Zealand during 2000–2010, viral pneumonia admissions increased in both children and young people, with the most rapid increases in children occurring between 2004–05 and 2008–09. During 2000–2008, on average two or three children or young people each year died as the result of viral pneumonia (**Figure 55**). While the number of deaths from viral pneumonia may appear high compared to those arising from bacterial/non-viral/unspecified pneumonia, given the much lower admission rates for the former category, it must be remembered that a large proportion of bacterial/non-viral/unspecified pneumonia admissions were coded J18: Pneumonia organism unspecified, meaning there may be considerable overlap between these two categories.

New Zealand Distribution by Age

In New Zealand during 2006–2010, viral and bacterial/non-viral/unspecified pneumonia admissions were both highest in one year olds, with the next highest rates being seen in infants <1 year. Admissions tapered off rapidly during the preschool years, with the lowest rates being seen in those in their teens and early twenties. During 2004–2008, mortality for both outcomes was highest in infants < 1 year (**Figure 56**).

New Zealand Distribution by Ethnicity, NZDep Index Decile and Gender

In New Zealand during 2006–2010, hospital admissions for bacterial/non-viral/unspecified pneumonia in children were *significantly* higher for males, for Pacific > Māori > Asian/Indian > European children and those living in average-to-more deprived (NZDep decile 3–10) areas. For young people, admissions were *significantly* higher for Pacific > Māori > European > Asian/Indian young people, and those living in average-to-more deprived (NZDep decile 5–10) areas (**Table 70**). Hospital admissions for viral pneumonia were also higher for Pacific > Māori > European and Asian/Indian children and those living in average-to-more deprived (NZDep decile 6–10) areas, although small numbers precluded a valid analysis for young people (**Table 71**). When both age groups were combined, during 2000–2010 viral and bacterial/non-viral/unspecified pneumonia admissions were both higher for Pacific > Māori > European and Asian/Indian children and young people (**Figure 57**).

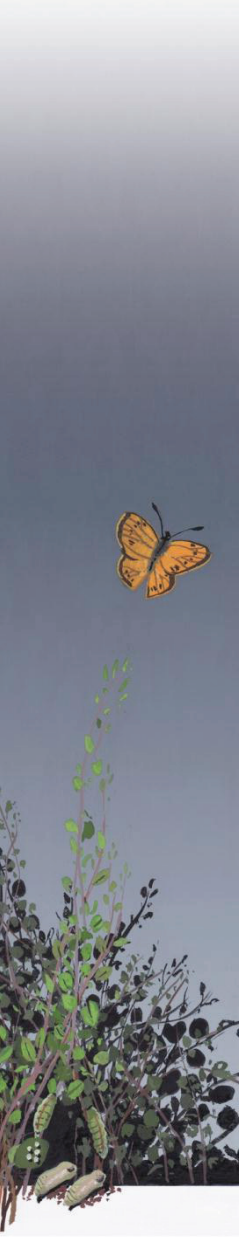
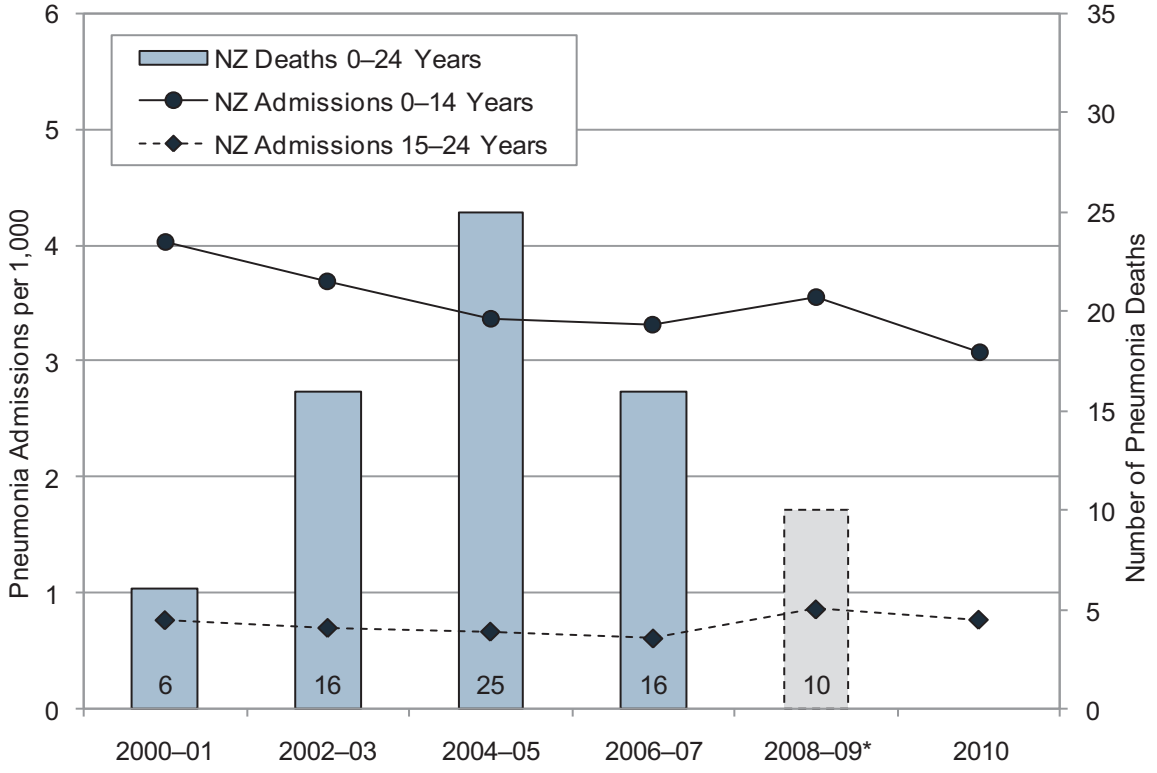
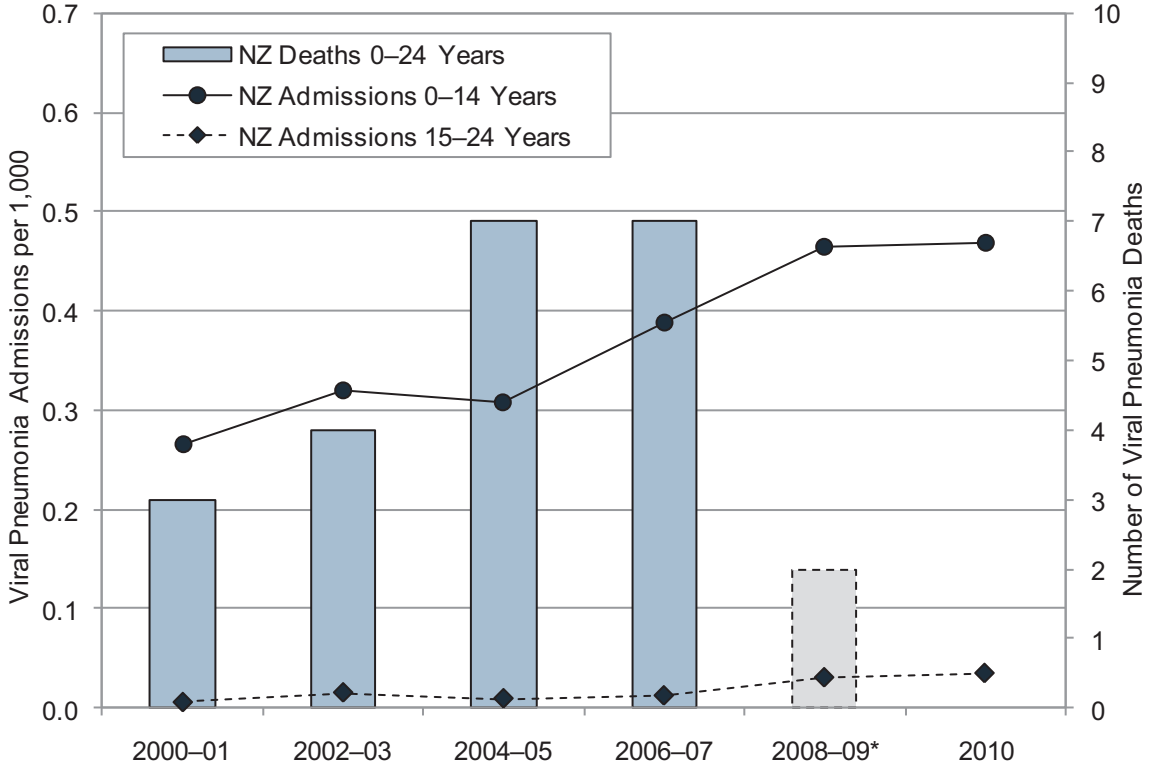


Figure 54. Acute and Semi-Acute Hospital Admissions (2000–2010) and Deaths (2000−2008) from Bacterial/Non-Viral/Unspecified Pneumonia in New Zealand Children and Young People Aged 0−24 Years



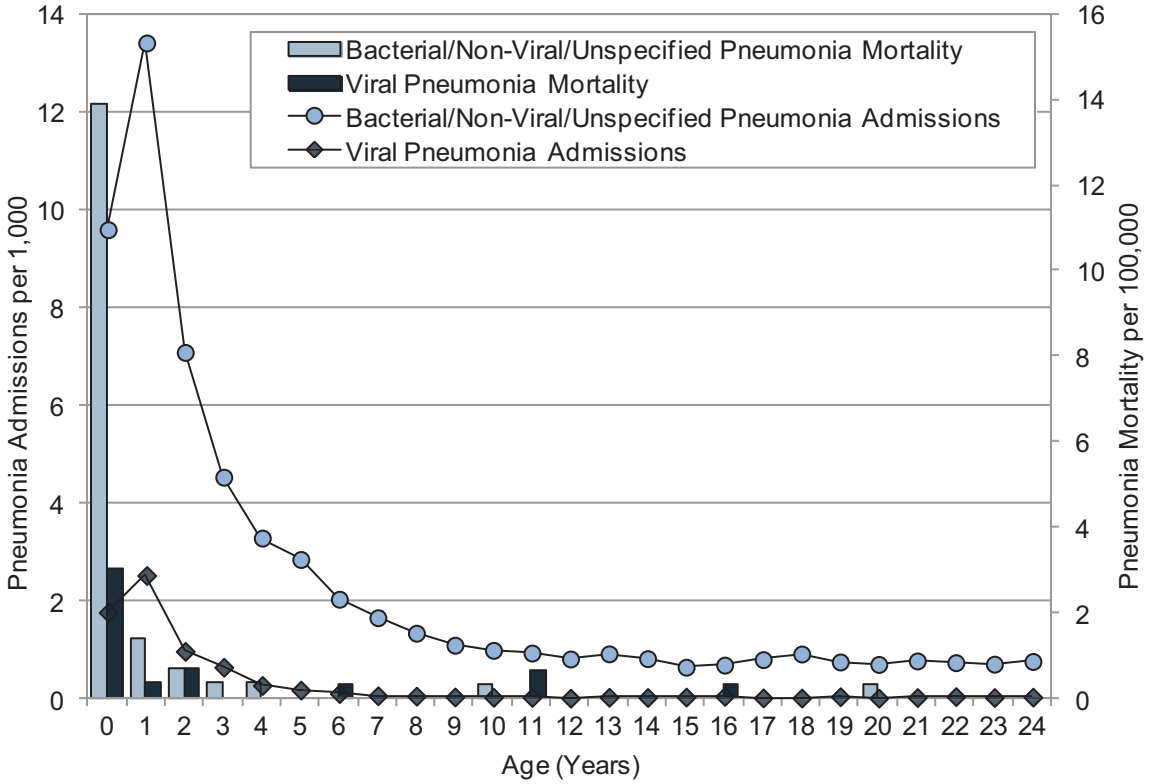
Source: Numerators: National Minimum Dataset (Acute and semi-acute admissions only) and National Mortality Collection; Denominator: Statistics NZ Estimated Resident Population.*Note: Number of Deaths is per 2 year period, with the exception of 2008–09, which is for a single year (2008) only.

Figure 55. Acute and Semi-Acute Hospital Admissions (2000−2010) and Deaths (2000–2008) from Viral Pneumonia in New Zealand Children and Young People Aged 0–24 Years



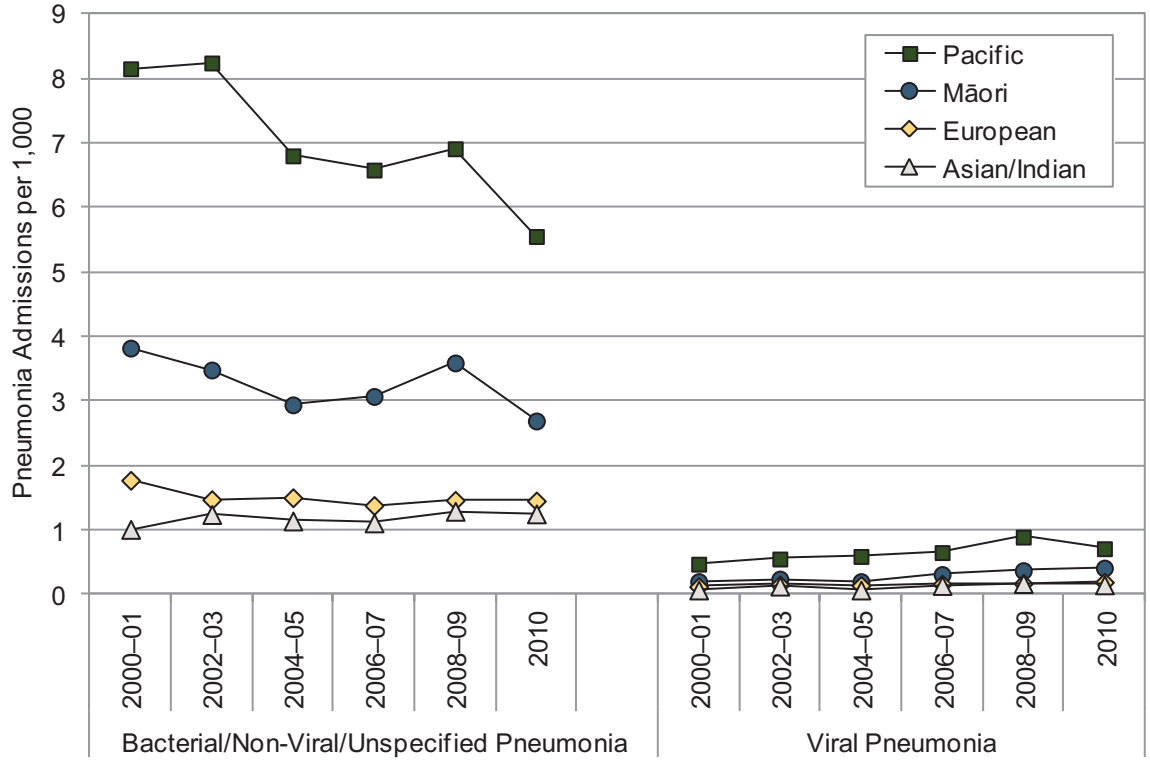
Source: Numerators: National Minimum Dataset (Acute and semi-acute admissions only) and National Mortality Collection; Denominator: Statistics NZ Estimated Resident Population; *Note: Number of Deaths is per 2 year period, with the exception of 2008–09, which is for a single year (2008) only.

Figure 56. Acute and Semi-Acute Hospital Admissions (2006–2010) and Deaths (2004−2008) from Pneumonia in New Zealand Children and Young People by Age



Source: Numerators: National Minimum Dataset (Acute and semi-acute admissions only) and National Mortality Collection; Denominator: Statistics NZ Estimated Resident Population

Figure 57. Acute and Semi-Acute Hospital Admissions for Pneumonia in Children and Young People Aged 0–24 Years by Ethnicity, New Zealand 2000–2010



Source: Numerator: National Minimum Dataset (Acute and semi-acute admissions only); Denominator: Statistics NZ Estimated Resident Population. Note: Ethnicity is Level 1 Prioritised.

Table 70. Acute and Semi-Acute Hospital Admissions for Bacterial/Non-Viral/Unspecified Pneumonia in Children and Young People Aged 0–24 Years by Ethnicity, NZ Deprivation Index Decile and Gender, New Zealand 2006–2010

Variable	Rate	Rate Ratio	95% CI	Variable	Rate	Rate Ratio	95% CI
Bacterial/Non-Viral/Unspecified Pneumonia							
Children 0–14 Years							
NZ Deprivation Index Decile				NZ Deprivation Index Quintile			
Decile 1	1.82	1.00		Decile 1–2	1.77	1.00	
Decile 2	1.72	0.95	0.85–1.04	Decile 3–4	2.09	1.18	1.10–1.26
Decile 3	2.08	1.14	1.04–1.26	Decile 5–6	2.74	1.55	1.45–1.65
Decile 4	2.10	1.16	1.05–1.27	Decile 7–8	3.61	2.04	1.92–2.17
Decile 5	2.58	1.42	1.29–1.56	Decile 9–10	5.95	3.37	3.18–3.56
Decile 6	2.87	1.58	1.45–1.73	Prioritised Ethnicity			
Decile 7	3.13	1.73	1.58–1.88	European	2.07	1.00	
Decile 8	4.02	2.21	2.04–2.40	Māori	4.30	2.08	2.00–2.17
Decile 9	5.13	2.82	2.61–3.06	Pacific	9.20	4.46	4.28–4.65
Decile 10	6.64	3.66	3.39–3.95	Asian/Indian	2.39	1.16	1.08–1.24
Gender							
Female	3.17	1.00					
Male	3.55	1.12	1.08–1.15				
Young People 15–24 Years							
NZ Deprivation Index Decile				NZ Deprivation Index Quintile			
Decile 1	0.47	1.00		Decile 1–2	0.41	1.00	
Decile 2	0.36	0.76	0.58–0.98	Decile 3–4	0.49	1.20	1.00–1.43
Decile 3	0.40	0.84	0.65–1.09	Decile 5–6	0.62	1.51	1.28–1.78
Decile 4	0.58	1.23	0.98–1.56	Decile 7–8	0.77	1.88	1.61–2.20
Decile 5	0.62	1.31	1.04–1.65	Decile 9–10	1.17	2.84	2.46–3.29
Decile 6	0.62	1.32	1.06–1.66	Prioritised Ethnicity			
Decile 7	0.82	1.73	1.40–2.15	European	0.53	1.00	
Decile 8	0.74	1.57	1.27–1.94	Māori	1.25	2.37	2.16–2.61
Decile 9	0.91	1.92	1.57–2.35	Pacific	1.94	3.68	3.30–4.11
Decile 10	1.49	3.17	2.61–3.85	Asian/Indian	0.20	0.38	0.31–0.47
Gender							
Female	0.72	1.00					
Male	0.76	1.05	0.97–1.14				

Source: Numerator: National Minimum Dataset (Acute and semi-acute admissions only); Denominator: Statistics NZ Estimated Resident Population. Note: Rate is per 1,000; Ethnicity is Level 1 Prioritised; Decile is NZDep2001.

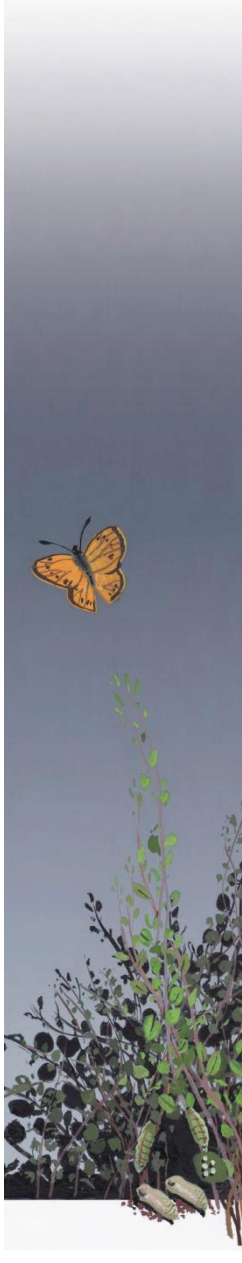


Table 71. Acute and Semi-Acute Hospital Admissions for Viral Pneumonia in Children and Young People Aged 0−14 Years by Ethnicity, NZ Deprivation Index Decile and Gender, New Zealand 2006−2010

Variable	Rate	Rate Ratio	95% CI	Variable	Rate	Rate Ratio	95% CI
Viral Pneumonia							
Children 0–14 Years							
NZ Deprivation Index Decile				NZ Deprivation Index Quintile			
Decile 1	0.25	1.00		Decile 1–2	0.24	1.00	
Decile 2	0.22	0.89	0.68–1.17	Decile 3–4	0.30	1.25	1.04–1.50
Decile 3	0.30	1.18	0.91–1.52	Decile 5–6	0.38	1.57	1.31–1.87
Decile 4	0.30	1.18	0.92–1.52	Decile 7–8	0.48	1.99	1.69–2.35
Decile 5	0.33	1.29	1.00–1.66	Decile 9–10	0.71	2.95	2.53–3.45
Decile 6	0.42	1.65	1.30–2.08	Prioritised Ethnicity			
Decile 7	0.38	1.51	1.19–1.93	European	0.27	1.00	
Decile 8	0.56	2.20	1.76–2.74	Māori	0.54	1.96	1.76–2.19
Decile 9	0.68	2.67	2.15–3.31	Pacific	1.19	4.36	3.88–4.89
Decile 10	0.73	2.90	2.35–3.57	Asian/Indian	0.32	1.19	0.99–1.43
Gender							
Female	0.42	1.00					
Male	0.45	1.05	0.96–1.15				
Young People 15–24 Years							
Small numbers precluded a valid analysis for this age group							

Source: Numerator: National Minimum Dataset (Acute and semi-acute admissions only); Denominator: Statistics NZ Estimated Resident Population. Note: Rate is per 1,000; Ethnicity is Level 1 Prioritised; Decile is NZDep2001.

South Island Distribution and Trends

South Island DHBs vs. New Zealand

Bacterial/Non-Viral/Unspecified Pneumonia: In all of the South Island DHBs during 2006−2010, hospital admissions for bacterial/non-viral/unspecified pneumonia in children were *significantly* lower than the New Zealand rate. While admissions in young people were also lower than the New Zealand rate, only in Canterbury, South Canterbury and Otago did these differences reach statistical significance (**Table 72**).

Viral Pneumonia: In the South Island during 2006–2010, while hospital admissions for viral pneumonia in children were also lower than the New Zealand rate in all DHBs, only in the case of Nelson Marlborough, Canterbury, Otago and Southland did these differences reach statistical significance. Small numbers precluded a valid analysis for young people (**Table 72**).

South Island Trends

Bacterial/Non-Viral/Unspecified Pneumonia: In Nelson Marlborough, hospital admissions for bacterial/non-viral/unspecified pneumonia in children and young people increased during the mid-2000s, but then declined in 2010. In South Canterbury, admissions in children decreased during the early-mid 2000s, but increased in 2008–09, before tapering off again. In Canterbury admissions declined, while admissions in young people declined during the early 2000s, reached their lowest point in 2004-05 and then increased again. Large year to year variations in the West Coast however made trends more difficult to interpret. In Otago, admissions fluctuated during the early-mid 2000s, but decreased after 2006-07, while admissions in young people were more static. In Southland admissions in children increased during the mid-2000s, but declined in 2010, while admissions in young people increased throughout 2000–2010 (**Figure 58**).

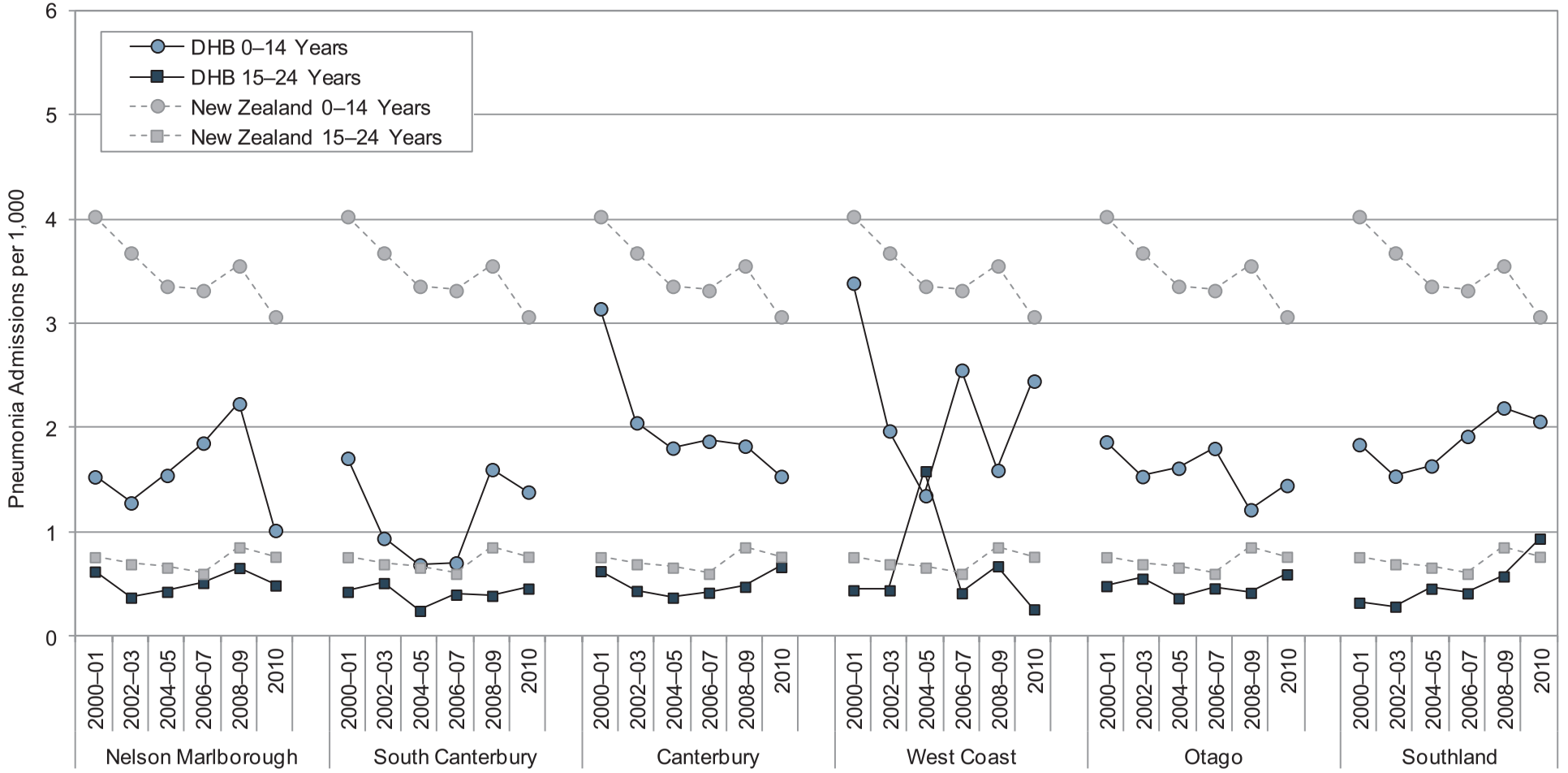
Viral Pneumonia: In Nelson Marlborough, hospital admissions for viral pneumonia in children declined during the mid-2000s before gradually increasing again after 2006–07, while in Canterbury, South Canterbury and the West Coast admissions fluctuated from year to year. In Otago and Southland, hospital admissions for viral pneumonia in children increased during the mid-late 2000s (**Figure 59**).

Table 72. Acute and Semi-Acute Hospital Admissions for Pneumonia in Children and Young People Aged 0−24 Years, South Island DHBs vs. New Zealand 2006−2010

DHB	Number: Total 2006–2010	Number: Annual Average	Rate per 1,000	Rate Ratio	95% CI
Bacterial/Non-Viral/Unspecified Pneumonia					
Children 0–14 Years					
Nelson Marlborough	238	47.6	1.84	0.55	0.48–0.62
West Coast	68	13.6	2.16	0.64	0.51–0.81
Canterbury	858	171.6	1.79	0.53	0.50–0.57
South Canterbury	62	12.4	1.20	0.36	0.28–0.46
Otago	241	48.2	1.50	0.45	0.39–0.51
Southland	224	44.8	2.06	0.61	0.54–0.70
New Zealand	15,016	3,003.2	3.36	1.00	
Young People 15–24 Years					
Nelson Marlborough	45	9.0	0.57	0.77	0.57–1.03
West Coast	9	1.8	0.49	0.66	0.34–1.28
Canterbury	182	36.4	0.50	0.67	0.58–0.78
South Canterbury	13	2.6	0.41	0.56	0.32–0.96
Otago	81	16.2	0.48	0.64	0.51–0.80
Southland	43	8.6	0.59	0.80	0.59–1.08
New Zealand	2,351	470.2	0.74	1.00	
Viral Pneumonia					
Children 0–14 Years					
Nelson Marlborough	31	6.2	0.24	0.55	0.39–0.79
West Coast	7	1.4	0.22	0.51	0.24–1.07
Canterbury	130	26.0	0.27	0.62	0.52–0.74
South Canterbury	15	3.0	0.29	0.67	0.40–1.11
Otago	43	8.6	0.27	0.62	0.46–0.83
Southland	24	4.8	0.22	0.51	0.34–0.76
New Zealand	1,942	388.4	0.44	1.00	
Young People 15–24 Years					
Small numbers precluded a valid analysis for this age group					

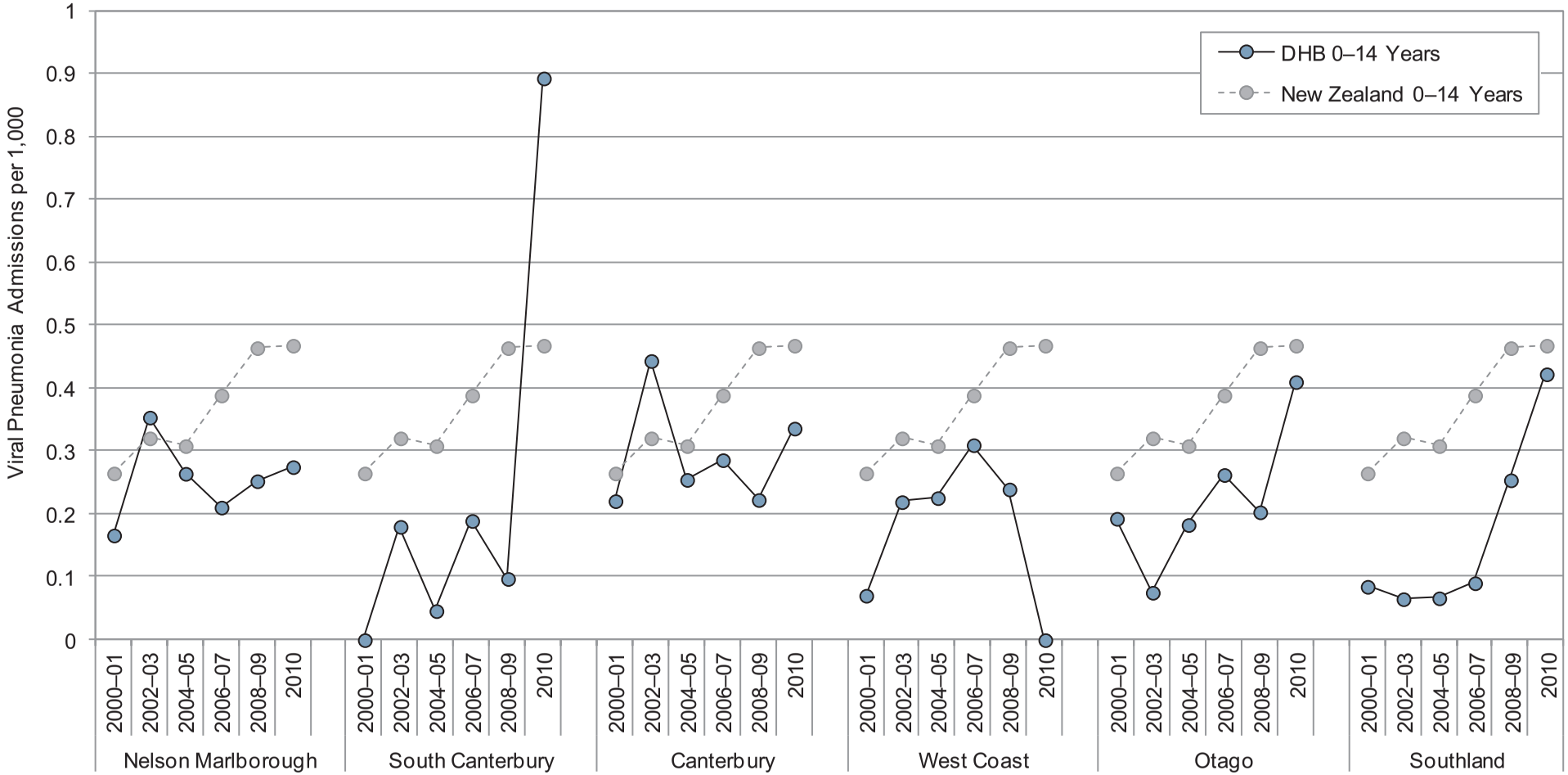
Source: Numerator: National Minimum Dataset (Acute and semi-acute admissions only); Denominator: Statistics NZ Estimated Resident Population

Figure 58. Acute and Semi-Acute Hospital Admissions for Bacterial/Non-Viral/Unspecified Pneumonia in Children and Young People Aged 0−24 Years, South Island DHBs vs. New Zealand 2000−2010



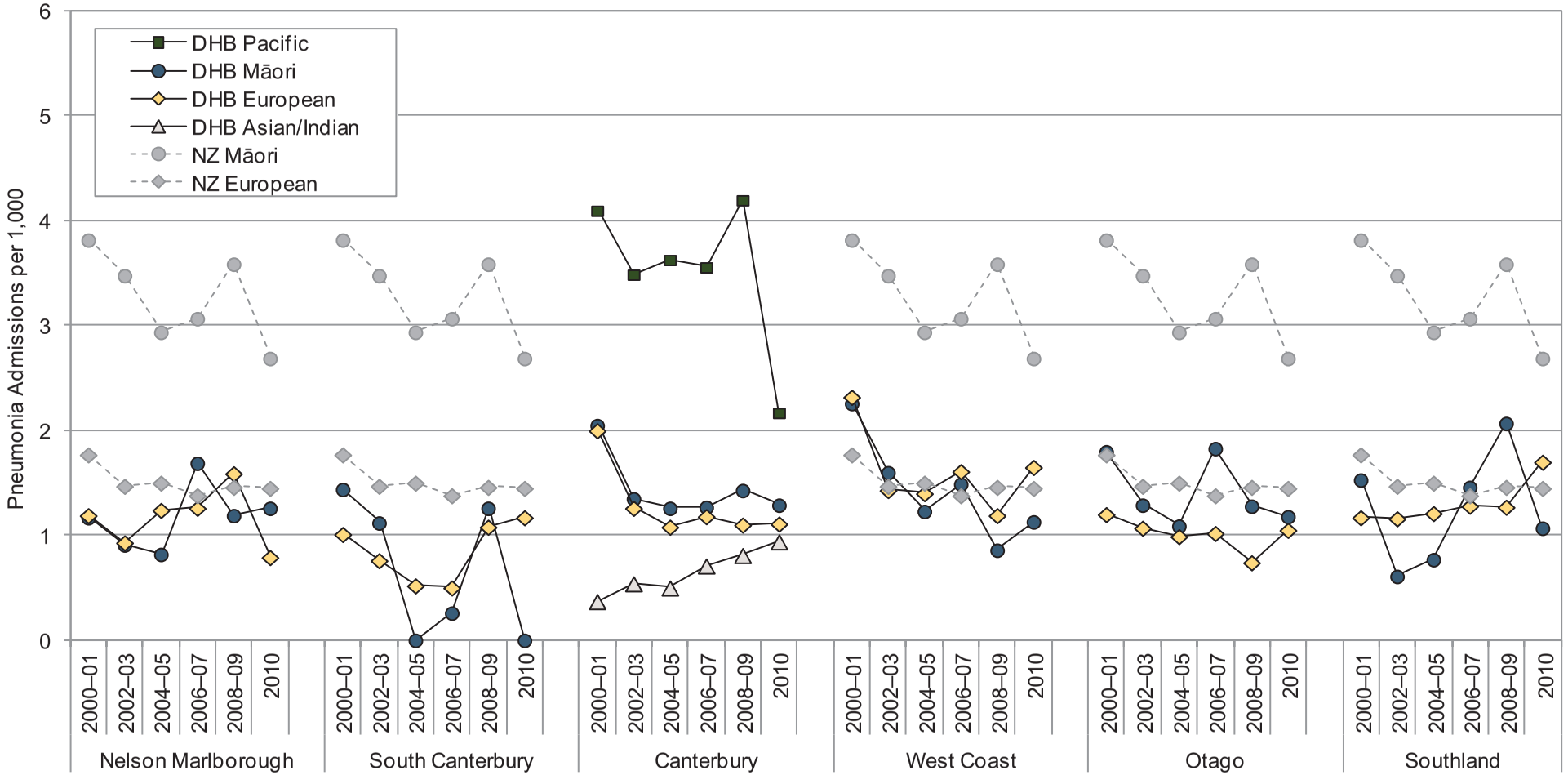
Source: Numerator: National Minimum Dataset (Acute and semi-acute admissions only); Denominator: Statistics NZ Estimated Resident Population

Figure 59. Acute and Semi-Acute Hospital Admissions for Viral Pneumonia in Children Aged 0−14 Years, South Island DHBs vs. New Zealand 2000−2010



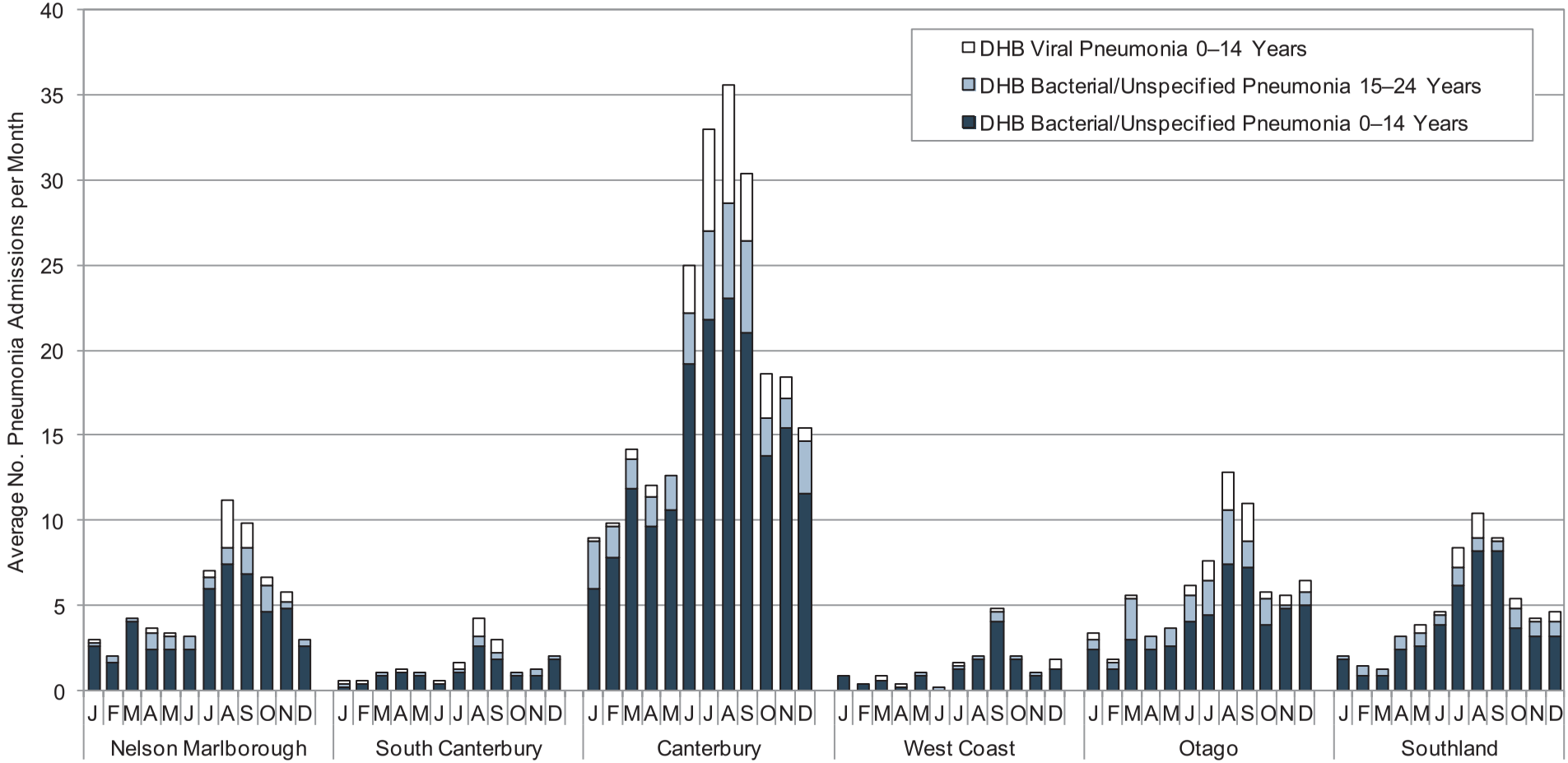
Source: Numerator: National Minimum Dataset (Acute and semi-acute admissions only); Denominator: Statistics NZ Estimated Resident Population

Figure 60. Acute and Semi-Acute Hospital Admissions for Bacterial/Non-Viral/Unspecified Pneumonia in Children and Young People Aged 0–24 Years by Ethnicity, South Island DHBs vs. New Zealand 2000–2010



Source: Numerator: National Minimum Dataset (Acute and semi-acute admissions only); Denominator: Statistics NZ Estimated Resident Population. Note: Ethnicity is Level 1 Prioritised.

Figure 61. Average Number of Acute and Semi-Acute Hospital Admissions for Pneumonia in Children and Young People Aged 0−24 Years by Month, the South Island DHBs 2006−2010



Source: National Minimum Dataset (Acute and semi-acute admissions only)

South Island Distribution by Ethnicity

In Canterbury during 2000–2010, hospital admissions for bacterial/non-viral/unspecified pneumonia were generally higher for Pacific > Māori and European > Asian/Indian children and young people, while in Nelson Marlborough, South Canterbury, the West Coast and Southland there were no consistent differences in admission rates between Māori and European children and young people. Admissions in Otago however, were generally higher for Māori than for European children and young people (**Figure 60**). Small numbers precluded a valid analysis of ethnic differences for viral pneumonia.

South Island Distribution by Season

In the South Island during 2006–2010, hospital admissions for viral and bacterial/non-viral/unspecified pneumonia were higher in winter and early spring in all DHBs (**Figure 61**).

Summary

In New Zealand, bacterial/non-viral/unspecified pneumonia admissions in children declined during 2000–2007. A small upswing in rates was evident in 2008–09, before rates declined again in 2010. Similar patterns were seen for young people. In contrast, viral pneumonia admissions increased in both children and young people, with the most rapid increases in children occurring between 2004–05 and 2008–09. During 2000–2008, on average, eight children or young people died each year from bacterial/non-viral/unspecified pneumonia, and two to three died as a result of viral pneumonia.

During 2006–2010, viral and bacterial/non-viral/unspecified pneumonia admissions were highest in one year olds, with the next highest rates being in infants <1 year. Admissions tapered off rapidly during the preschool years, with the lowest rates being seen in those in their teens and early twenties. Mortality for both outcomes was highest in infants < 1 year. Admissions for bacterial/non-viral/unspecified pneumonia in children were also *significantly* higher for males, for Pacific > Māori > Asian/Indian > European children and those in average-to-more deprived (NZDep decile 3–10) areas. For young people, admissions were *significantly* higher for Pacific > Māori > European >Asian/Indian young people, and those in average-to-more deprived (NZDep decile 5–10) areas. Admissions for viral pneumonia were higher for Pacific > Māori > European and Asian/Indian children and those in average-to-more deprived (NZDep decile 6–10) areas.

In all of the South Island DHBs during 2006–2010, hospital admissions for bacterial/non-viral/unspecified pneumonia in children were *significantly* lower than the New Zealand rate. While admissions in young people were also lower than the New Zealand rate, only in Canterbury, South Canterbury and Otago did these differences reach statistical significance. Similarly, while admissions for viral pneumonia in children were also lower than the New Zealand rate in all DHBs, only in the case of Nelson Marlborough, Canterbury, Otago and Southland did these differences reach statistical significance.

In Canterbury during 2000–2010, admissions for bacterial/non-viral/unspecified pneumonia were generally higher for Pacific > Māori and European > Asian/Indian children and young people, while in Nelson Marlborough, South Canterbury, the West Coast and Southland there were no consistent differences in admission rates between Māori and European children and young people. Admissions in Otago however, were generally higher for Māori than for European children and young people. Admissions for viral and bacterial/non-viral/unspecified pneumonia were generally higher in winter and early spring in all DHBs.

Local Policy Documents and Evidence-Based Reviews Relevant to Pneumonia in Children and Young People

In New Zealand there are no policy documents which focus solely on the prevention of pneumonia in children and young people, although the Immunisation Handbook considers pneumococcal disease. A range of documents however consider approaches to respiratory and infectious diseases more generally, and these are reviewed in other sections of this report:

1. **Generic Approaches to Infectious & Respiratory Disease:** Table 46 on Page 166
2. **The Prevention of Second Hand Smoke Exposure:** Table 47 on Page 168
3. **Interventions Aimed at Housing and Household Crowding:** Table 48 on Page 170
4. **Interventions to Improve Breastfeeding:** Table 27 on Page 107

A range of international reviews and guidelines also consider the most appropriate management of pneumonia in children and young people and these are considered in **Table 73**.

Table 73. Local Policy Documents and Evidence-Based Reviews Relevant to the Prevention and Management of Pneumonia

Ministry of Health Policy Documents
Ministry of Health. 2011. **Immunisation Handbook 2011**. Wellington: Ministry of Health. http://www.moh.govt.nz/moh.nsf/Files/immunise-handbook/$file/9PneumococcalDisease.pdf Chapter 9 of this Handbook covers pneumococcal disease. It provides information on the disease, its epidemiology, vaccines, recommended immunisation schedules, expected responses and adverse events post-vaccination, contraindications to vaccination, and control measures. It states that pneumococcal infection is considered to be the leading cause of pneumonia and that there are marked socio-economic and ethnic disparities in hospitalisation rates for pneumonia. Pneumococcal infection can cause meningitis and septicaemia as well as pneumonia, ear infections and sinus infections and, rarely, endocarditis and infection of other sites including joints, the peritoneal cavity and fallopian tubes. A pneumococcal conjugate vaccine, Prevenar®, was added to the immunisation schedule in 2008. This has since been replaced (2011) by Synflorix® (which provides protection against 10 serotypes) for most infants. Children eligible for the High Risk Pneumococcal Immunisation Programme (the criteria are listed in the handbook) can be given Prevenar 13® or pneumococcal polysaccharide vaccine (Pneumovax 23®, providing protection against 23 serotypes).
International Guidelines
Bradley JS, Byington CL, Shah SS, et al. 2011. **The Management of Community-Acquired Pneumonia in Infants and Children Older Than 3 Months of Age: Clinical Practice Guidelines by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America**. Clinical Infectious Diseases doi:10.1093/cid/cir531 http://cid.oxfordjournals.org/content/early/2011/08/30/cid.cir531.abstract accessed:10/10/11 These management guidelines from the U.S. relate to otherwise healthy children. They cover indications for hospitalisation, diagnostic testing, anti-infective treatment, other therapies including drainage of parapneumonic effusion, management of the child not responding to treatment, discharge criteria and prevention. Recommendations in the guidelines are followed by an indication of both the strength of the expert panel recommendation and the quality of the evidence and also a well referenced summary of the evidence. Recommendations for prevention of pneumonia in children include: children should be immunised against *Streptococcus pneumoniae, Haemophilus influenza type b* and pertussis, all children ≥ 6 months of age should have annual influenza vaccination, parents and caretakers of infants < 6 months of age, including pregnant adolescents, should be immunised against influenza and pertussis to protect their infant, and high risk infants should be offered prophylaxis with RSV-specific monoclonal antibody (Palivizumab).
Community Acquired Pneumonia Guideline Team, Cincinnati Children's Hospital Medical Center. 2005. **Evidence based clinical practice guideline. Community acquired pneumonia in children 60 days to 17 years of age**. http://www.cincinnatichildrens.org/service/j/anderson-center/evidence-based-care/community-acquired-pneumonia/ These concise guidelines cover aetiology, assessment and diagnosis, management, and prevention of community acquired pneumonia in children. Each recommendation in the guidelines is accompanied by references to the literature with a letter grade which relates to the evidence grading scale used by the Cincinnati Children's Hospital Medical Center (explained at the end of the guidelines.) The guidelines include a management algorithm. Regarding prevention, the guidelines recommend pneumococcal vaccination for all children and annual influenza vaccination for children aged 6–23 months and for children older than 23 months with particular risk factors including (but not limited to) asthma, cardiac disease, sickle cell disease, HIV and diabetes. They also recommend discussing with families the benefits of regular hand washing, breast feeding , limiting exposure to sick children (especially in day care centres, by checking the centre's hand washing policy, delaying enrolment and choosing a smaller centre) and reducing exposure to tobacco smoke.
British Thoracic Society Standards of Care Committee. 2002. **British Thoracic Society Guidelines for the Management of Community Acquired Pneumonia in Childhood**. Thorax, 57 Suppl 1, i1-24. These British guidelines deal with the management of pneumonia in previously well infants and children, but not neonates. The recommendations are based on a thorough review of the evidence and each is graded according to the strength of the evidence and the strength of the recommendation. The grading scheme is explained at the beginning of the guidelines. The guidelines cover aetiology and epidemiology, clinical features, investigations, severity assessment (indications for hospitalisation), management (general and antibiotics), complications and prevention and primary care issues. The discussion of preventive issues suggests measures to improve housing, reduce crowding and limit smoking are beneficial and that vaccines to prevent infections due to *Haemophilus influenzae*, pertussis, influenza and pneumococci are likely to reduce the burden of childhood pneumonia.

Systematic and Other Reviews from the International Literature

Russell K, Robinson J, et al. 2009. **The Cochrane Library and Treatment for Community Acquired Pneumonia in Children: An Overview of Reviews**. Evidence-Based Child Health: A Cochrane Review Journal, 4(3), 1149-64.

This is an overview of data from seven Cochrane reviews relating to the treatment of pneumonia in children. Pneumonia can be of either viral or bacterial origin. In clinical practice it is often not possible to determine whether a child has viral or bacterial pneumonia (or bronchiolitis which has a similar presentation) so treatment with antibiotics is commonly prescribed. In developed countries amoxicillin-clavulanate and azithromycin appeared to be equally effective for treating community-acquired pneumonia (CAP). One small low quality trial showed a higher cure rate with amoxicillin-clavulanate than with amoxicillin. The macrolide antibiotics azithromycin, clarithromycin, and erythromycin appeared to be equal. Azithromycin was better tolerated than was amoxicillin-clavulanate. It was not possible to reach meaningful conclusions on the effects of over-the-counter medications for cough in children with pneumonia due to insufficient number of children in the studies. The review also includes discussion of issues more relevant to developing countries.

Doan Q, Enarson P, Kissoon N, et al. 2009. **Rapid viral diagnosis for acute febrile respiratory illness in children in the Emergency Department**. Cochrane Database of Systematic Reviews, 2009(4), Art. No.: CD006452. DOI:10.1002/14651858.CD006452.pub2.

Most paediatric acute respiratory infections are due to viruses but in the emergency department (ED) investigations are usually undertaken to rule out bacterial infection and antibiotics are often ordered because of uncertainty about the diagnosis. Rapid viral testing may avoid the unnecessary use of other diagnostic testing and antibiotics since it has been reported that the risk of concurrent bacterial infection in a child with a confirmed viral infection is negligible. This review considered the effect of rapid viral testing on the use of other diagnostic investigations, the use of antibiotics and the length of emergency department stays. The review included three RCTs and one quasi-RCT, with a total of 759 children receiving viral testing and 829 control children. Rapid viral testing reduced rates of chest radiography (RR 0.77, 95% CI 0.65 to 0.91) but made no significant difference (either clinically or statistically) to antibiotic use in the ED and had no effect on length of ED visits, or rates of blood and urine testing. The review authors state that the current evidence is insufficient to support rapid viral testing as a means of reducing antibiotic use in the paediatric ED. The results suggest that rapid viral testing may be beneficial but they lack the power to show statistical significance.

Jefferson T, Rivetti A, Harnden A, et al. 2008. **Vaccines for preventing influenza in healthy children**. Cochrane Database of Systematic Reviews, 2008(2), Art. No.: CD004879. DOI: 10.1002/14651858.CD004879.pub3.

This review included RCTs, cohort and case-control studies of any influenza vaccine in healthy children aged <16 years: in total 51 studies with 294,159 observations. The authors aimed to determine both the efficacy of the vaccine and its effectiveness. Efficacy is the prevention of laboratory confirmed influenza whereas effectiveness is the prevention of influenza-like illness (which may or may not be due to influenza virus). The analysis of vaccine efficacy and effectiveness included 16 RCTs and 18 cohort studies. RCTs indicated that live vaccines (nasal sprays containing weakened influenza virus) had an efficacy of 82% (95% CI 71% to 89%) and an effectiveness of 33% (95% CI 28% to 33%) in children older than two years. Inactivated vaccines (injections containing killed virus) had lower efficacy than live vaccines: 59% (95% CI 41% to 71%) but similar effectiveness: 36% (95% CI 24% to 46%). In children younger than two the efficacy of inactivated vaccine was similar to placebo. The authors were unable to perform meta-analysis of safety outcome data due to the variability in study designs and the ways data were presented and they stated there was extensive evidence of reporting bias for safety outcomes in the trials of live attenuated vaccines. The authors concluded that influenza vaccines are efficacious in children over two but that there is little evidence for children under two. They noted: “It was surprising to find only one study of inactivated vaccine in children <2years, given current recommendations to vaccinate healthy children from six months in the USA and Canada. If immunisation in children is to be recommended as a public health policy, large-scale studies assessing important outcomes and directly comparing vaccine types are urgently required.”

Matheson NJ, Harnden AR, Perera R, et al. 2007. **Neuraminidase inhibitors for preventing and treating influenza in children**. Cochrane Database of Systematic Reviews, 2007(1), Art. No.: CD002744. DOI:10.1002/14651858.CD002744.pub2.

Pneumonia is one of the commonest complications of influenza. This review assessed the efficacy, safety and tolerability of neuraminidase inhibitors (zanamivir and oseltamivir, trade names Relenza® and Tamiflu®) in the prevention and treatment of influenza in children. Based on the results of 3 double-blind RCTs involving 1500 children under 12 years of age with a clinical diagnosis of influenza (977 of whom had laboratory-confirmed influenza) the authors concluded that neuraminidase inhibitors are effective in shortening the duration of illness in previously healthy children with influenza but that it is unproven whether or not they help “at-risk” children with chronic medical conditions. In addition, oseltamivir is effective in reducing secondary complications and, based on one trial in 222 contacts of influenza cases, may be effective for prophylaxis. Details of how effective oseltamivir is in reducing influenza-related pneumonia are not provided.

Hemila H, Louhiala P. 2007. **Vitamin C for preventing and treating pneumonia**. Cochrane Database of Systematic Reviews, 2007(1), Art. No.: CD005532. DOI: 10.1002/14651858.CD005532.pub2.

This review considered three prophylactic trials involving a total of 2335 people. Only one of these trials was deemed to be satisfactorily randomised, double-blind and placebo controlled. Two trials involved military recruits and the third, conducted in the U.K. during World War II, involved boys from “lower wage-earning classes” attending a boarding school. All three trials found a statistically significant reduction (≥ 80%) in the incidence of pneumonia in the vitamin C group. Two therapeutic trials in adults with pneumonia, one in the U.K. which included only elderly patients and one in the former Soviet Union, found that vitamin C was beneficial but in the U.K. trial the benefit was restricted to the most severely ill patients. The review authors concluded that the current evidence is too weak to recommend prophylactic use of vitamin C to prevent pneumonia in the general population (but that this issue should be further investigated) and that therapeutic vitamin C for patients with pneumonia may be reasonable given that the costs and risks are low.

Alves Galvao MG, Rocha Crispino Santos MA, Alves da Cunha AJL. 2008. **Amantadine and rimantadine for influenza A in children and the elderly**. Cochrane Database of Systematic Reviews, 2008(1), Art. No.: CD002745. DOI:10.1002/14651858.CD002745.pub2.

There are currently two classes of anti-viral drugs for influenza: neuraminidase inhibitors (zanamivir and oseltamivir) and M2 ion channel inhibitors (Amantidine (AMT) and rimantadine (RMT)). Both classes of drugs are somewhat effective for the prevention and treatment of influenza A infections but only neuraminidase inhibitors are effective against influenza A and B. This review focussed on children and the elderly and aimed to assess the efficacy of both AMT and RMT in preventing influenza A and in shortening the duration of influenza A manifestations. It also aimed to compare the adverse effects from AMT and RMT in these age groups. The review included eight randomised trials involving children which considered treatment with AMT (2 studies), treatment with RMT (1 study), prophylaxis with AMT (1 study), prophylaxis with RMT (3 studies), adverse effects from AMT (2 studies) and adverse effects from RMT (3 studies).

The authors note that for the majority of comparisons reviewed, their ability to draw conclusions was limited by the small numbers of studies and the small numbers of participants. They concluded that, based on the available data, AMT is effective for influenza prophylaxis in children. They started that its safety was not well established but given the important role of children in transmitting infection it should be tried (in the context of pandemic situations, although this is not stated explicitly). They stated "Currently, RMT cannot be recommended as a prophylactic drug for either age group Nevertheless, if we consider: 1) it is a safe drug; 2) the results of the combined age groups, and 3) the possibility that the next pandemic virus is susceptible to this class of drug, we can still consider this 'old' drug as a less costly alternative to neuraminidase inhibitors." They concluded that the only proven benefit of either AMT or RMT was that RMT led to the abatement of fever by day three of treatment (based on the findings of 1 trial only) and that this benefit did not justify using RMT to treat all children with influenza but only those for whom fever may cause undesirable consequences. (It was unspecified who these children were.) The studies looking at possible adverse effects of AMT were all carried out in ill children and the review authors considered that this meant that there was confounding between the effects of illness and the effects of the medication and therefore it was not possible to compare side effects between AMT and RMT.

Other Relevant Publications

National Influenza Strategy Group. 2011. **Influenza Medical Website**. Auckland: Immunisation Advisory Centre. http://www.influenza.org.nz/?t=884 accessed 12/10/11.

This website provides regular updates on influenza in New Zealand and explains who is eligible for free or subsidised vaccination. It states that "Due to the reactions experienced in 2010 by some children, Fluvax® is not indicated for use in children under 5 years of age and should be used with caution in children aged 5-8 years. As an extra precaution the Ministry of Health recommends that Fluvax should not be given to children under 9 years of age in 2011." The other available vaccine, Fluarix® is approved for use in individuals 6 months and over. Some children with chronic conditions are eligible for free influenza immunisation and a list of the criteria can be found here:

http://www.influenza.org.nz/site_resources/Influenza/Influenza%202011/Eligibility_Criteria.pdf

Centers for Disease Control and Prevention. 2009. **Pneumonia hospitalizations among young children before and after introduction of pneumococcal conjugate vaccine – United States, 1997–2006**. Morbidity & Mortality Weekly Report, 58(1), 1–4. http://www.cdc.gov/mmwr/pdf/wk/mm5801.pdf

A seven-valent Pneumococcal vaccine was introduced in the U.S. in 2000. After this, population and laboratory based surveillance showed that there had been substantial reductions in invasive pneumococcal disease in both children and adults. This report discusses hospitalisations for all-cause pneumonia in children. Following the introduction of the vaccine hospitalisations for pneumonia in children under two fell and in 2006 rates were about 35% lower than in 1997-99. Most of the decrease occurred soon after the vaccine was introduced and rates have remained relatively stable since then. There was no change in all-cause pneumonia hospitalisation rates in older children (2-4 years old) after the vaccine was introduced and rates have remained steady since then. The report states that it appears that pneumococci contribute to a wider range of childhood upper respiratory illnesses than was previously thought (including otitis media) and that *Streptococcus pneumoniae* may be a co-pathogen in illnesses diagnosed as influenza. This conclusion is based on the decrease in non-pneumonia acute respiratory infection hospitalisation rates. Numbers of ambulatory care visits for pneumonia in the under-twos have also decreased since the vaccine was introduced. The reports states that new vaccines which provide protection against a greater number of serotypes may further reduce hospitalisation rates.

The Asthma and Respiratory Foundation of New Zealand, Innes Asher and Cass Byrnes, editors. 2006. **Trying to Catch our Breath: The burden of preventable breathing disorders in children and young people**. Wellington: The Asthma and Respiratory Foundation of New Zealand. http://www.asthmanz.co.nz/files/PDF-files/Burden_FullDocument.pdf

Chapter 8 of this publication deals specifically with pneumonia. It states that pneumonia is more common in New Zealand than in other developed countries and that there are significant ethnic disparities. More effective primary care services are stated to be the most effective way of reducing the significant numbers of avoidable hospital admissions for pneumonia. Some children are left with lung damage after pneumonia which can lead to life-long chronic lung disease such as bronchiectasis.