GASTROENTERITIS

Introduction

Gastroenteritis is a non-specific term indicating various pathological states of the gastrointestinal tract. Its primary manifestation is diarrhoea and it may also be associated with nausea, anorexia, fever, abdominal pain and vomiting [171,172]. Acute gastroenteritis is normally of infectious origin and the causative agent may be viral, bacterial or parasitic. Infection is transmitted via the faecal-oral route and in young children, acute infectious gastroenteritis is much the most common cause of diarrhoea, with or without vomiting [173]. Severe gastroenteritis in infants and young children can rapidly lead to dehydration, which is a potentially life-threatening condition and a common cause of infant mortality in the third world [173].

In New Zealand, gastroenteritis is one of the top 10 causes of potentially avoidable hospital admissions in children [174]. It is more common in younger children, with most children requiring hospitalisation being under 2 years of age [175]. Hospital admissions are also higher for Pacific children and children from more deprived areas [97] [175]. Admissions are also higher in the winter months [176]. The most significant risk factor for gastroenteritis is contact with another person with gastroenteritis, hence the increased risks associated with attending childcare and overcrowding [177]. In contrast, breastfeeding is a protective factor, particularly for infants less than 6 months of age [25].

In New Zealand, rotavirus is the commonest cause of severe gastroenteritis in infants [178] with New Zealand estimates of the proportion of gastroenteritis admissions attributable to rotavirus ranging from 34% [176] to 58% [175]. In terms of prevention, two commercially available Rotavirus vaccines are available: RotaTeq® and Rotarix®. These are both oral vaccines, requiring either 2 (Rotarix®) or 3 doses (RotaTeq®). They are available, but not funded, in New Zealand and cost parents around $100 per dose [179].

The World Health Organisation recommends that rotavirus vaccination be included in all national immunisation programmes [180]. In 2006, the New Zealand Immunisation Technical Working Group placed Rotavirus fourth on its prioritised recommendations for the 2008 National Immunisation Schedule [181]. An analysis of the cost-effectiveness of introducing a rotavirus vaccine into the national immunisation schedule estimated that the vaccination would save money from a societal perspective, if the price was less than $32.39 per dose [182]. In the absence of vaccination, strategies that could reduce admission rates for gastroenteritis include the promotion of breastfeeding, educating parents about oral rehydration methods, improving access to primary care and encouraging the use of oral rehydration solutions in primary care settings.

The following section explores gastroenteritis rates in children and young people using information from the National Minimum Dataset and Mortality Collection. The section concludes with a brief overview of policy documents and evidence-based reviews which consider interventions to address gastroenteritis at the population level.

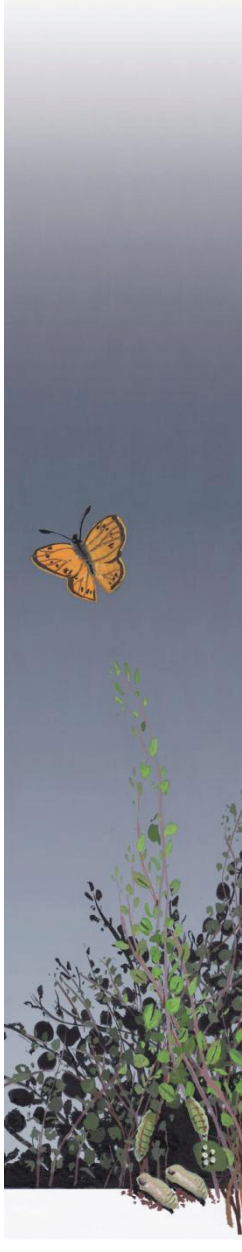
Data Sources and Methods

Indicator

1. *Acute and Semi Acute Hospital Admissions for Gastroenteritis in Children and Young People 0–24 Years*

Numerator: National Minimum Dataset: Acute and semi-acute hospital admissions in children and young people aged 0–24 years with an ICD-10-AM primary diagnosis of Gastroenteritis (A00–A09, R11, K529).

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



2. Mortality from Gastroenteritis in Children and Young People 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 Gastroenteritis (A00–A09, R11, K529).

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

Notes on Interpretation

Note 1: The gastroenteritis codes used here differ from those used previously, as the result of a change from ICD-10-AM Version 3 to Version 6, which occurred in the National Minimum Dataset in 2008. Prior to this change, a large proportion of gastroenteritis cases were coded to A09 (diarrhoea and gastroenteritis of presumed infectious origin). From 2008 however, the Ministry of Health began to back-map the majority of these cases to K529 (non-infective gastroenteritis and colitis unspecified). Because K529 only accounted for a minority of cases prior to 2008 (n ≈50–60 cases per year), and because the majority of gastroenteritis cases in the paediatric population are presumed to be of infectious origin, the K529 code was not included in previous reports. The coding change however resulted in a large reduction in the number A09 mapped cases and a large increase in the number of K529 mapped cases after 2008. Thus, in order to preserve time series continuity (even though the clinical appropriateness of such a coding change remains debatable) the current year's analysis includes both the A09 and K529 gastroenteritis codes (with this coding change being extended back to 2000). As a result, the results presented here may differ from those reported previously.

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

In New Zealand, gastroenteritis admissions increased gradually during the early-mid 2000s but became relatively static after 2006-07 in both children and young people. During 2000–2008, on average two children or young people per year died as a result of gastroenteritis, although this fell to around one death per year, if only the years 2002–08 were included (**Figure 99**).

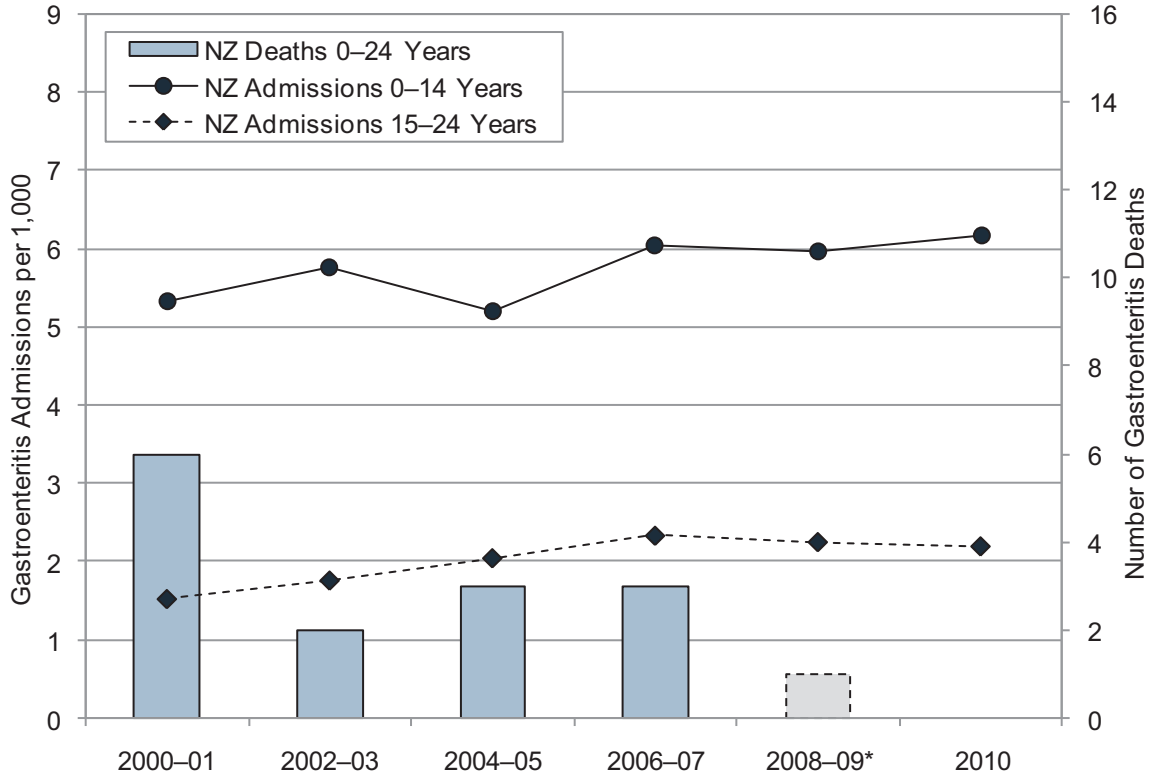
New Zealand Distribution by Age

In New Zealand during 2006–2010, hospital admissions for gastroenteritis were highest in infants <1 year, with rates then tapering off rapidly during the preschool years, to reach their lowest point in those in their early teens. Mortality was also highest in infants <1 year, although a small number of deaths also occurred during early childhood (**Figure 100**).

New Zealand Distribution by Ethnicity, NZDep Index Decile and Gender

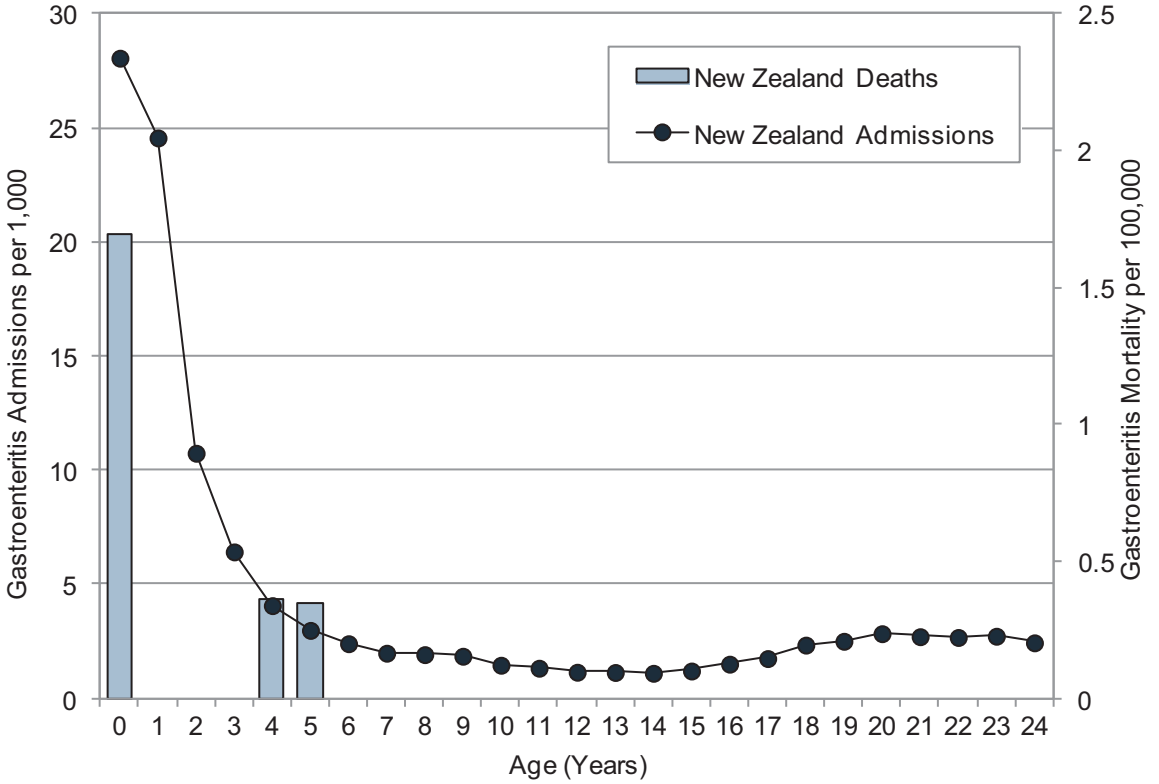
In New Zealand during 2006–2010, hospital admissions for gastroenteritis in children were *significantly* higher for males, Pacific > Asian/Indian and European > Māori children and those living in average-to-more deprived (NZDep decile 4–10) areas. In contrast, gastroenteritis admissions in young people were *significantly* higher for females, European > Pacific and Māori > Asian/Indian young people, and those living in average-to-more deprived (NZDep decile 4–10) areas (**Table 103**). When both age groups were combined, gastroenteritis admissions during 2000–2010 were consistently higher for Pacific than for European, Māori and Asian/Indian children and young people (**Figure 101**).

Figure 99. Acute and Semi-Acute Hospital Admissions (2000−2010) and Deaths (2000–2008) from Gastroenteritis in New Zealand Children and Young People Aged 0–24 Years



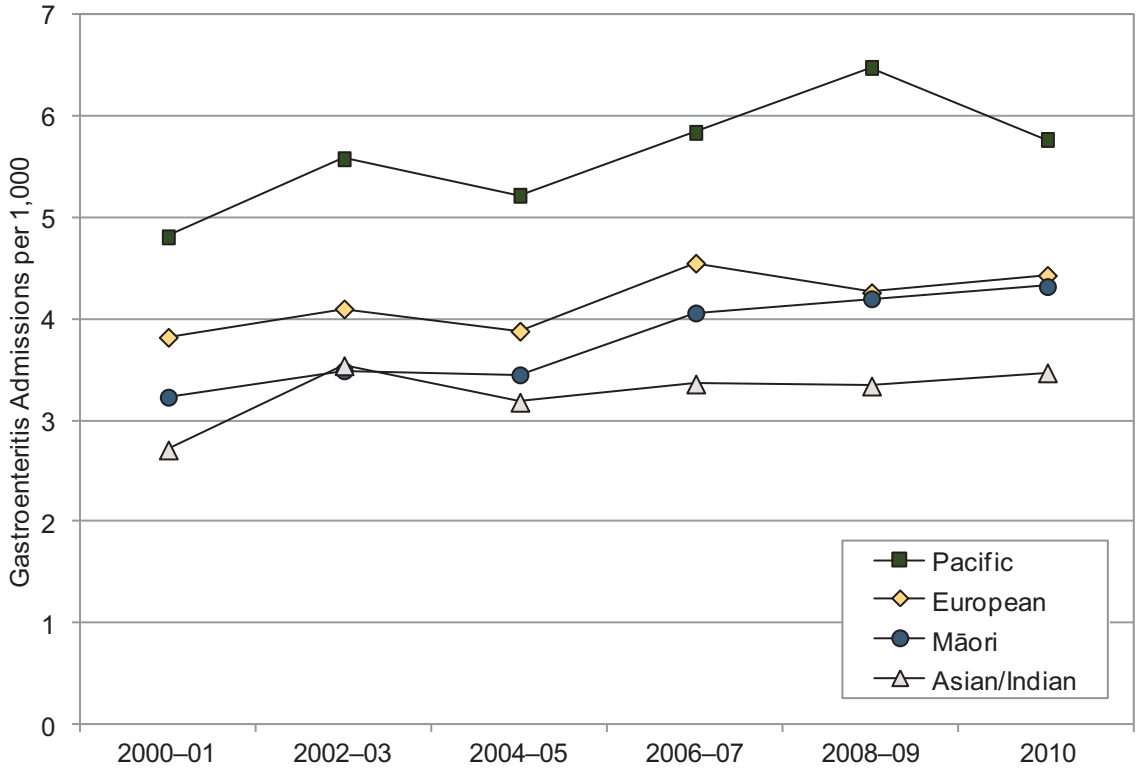
Source: Numerators: National Minimum Dataset (Acute and semi-acute admissions only) and National Mortality Collection; Denominator: Statistics NZ Estimated Resident Population; *Note: Number of Deaths is per 2 year period, with the exception of 2008–09, which is for a single year (2008) only.

Figure 100. Acute and Semi-Acute Hospital Admissions (2006–2010) and Deaths (2004−2008) from Gastroenteritis 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 101. Acute and Semi-Acute Hospital Admissions for Gastroenteritis 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 102. Acute and Semi-Acute Hospital Admissions for Gastroenteritis in Children 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
Gastroenteritis							
Children 0–14 Years							
NZ Deprivation Index Decile				NZ Deprivation Index Quintile			
Decile 1	4.07	1.00		Decile 1–2	3.96	1.00	
Decile 2	3.85	0.95	0.88–1.01	Decile 3–4	4.64	1.17	1.12–1.23
Decile 3	4.27	1.05	0.98–1.12	Decile 5–6	5.87	1.48	1.42–1.55
Decile 4	4.99	1.22	1.15–1.30	Decile 7–8	6.95	1.76	1.68–1.83
Decile 5	5.45	1.34	1.26–1.43	Decile 9–10	8.01	2.02	1.94–2.10
Decile 6	6.23	1.53	1.44–1.62	Prioritised Ethnicity			
Decile 7	6.41	1.57	1.48–1.67	European	5.75	1.00	
Decile 8	7.42	1.82	1.72–1.93	Māori	5.29	0.92	0.89–0.95
Decile 9	8.31	2.04	1.93–2.16	Pacific	8.38	1.46	1.41–1.51
Decile 10	7.75	1.90	1.80–2.01	Asian/Indian	6.00	1.04	1.00–1.09
Gender							
Female	5.75	1.00					
Male	6.31	1.10	1.07–1.12				

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 103. Acute and Semi-Acute Hospital Admissions for Gastroenteritis in Young People Aged 15−24 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
Gastroenteritis							
Young People 15–24 Years							
NZ Deprivation Index Decile				NZ Deprivation Index Quintile			
Decile 1	1.64	1.00		Decile 1–2	1.63	1.00	
Decile 2	1.62	0.99	0.87–1.13	Decile 3–4	1.98	1.21	1.11–1.32
Decile 3	1.87	1.14	1.00–1.30	Decile 5–6	2.34	1.44	1.32–1.57
Decile 4	2.07	1.26	1.12–1.43	Decile 7–8	2.39	1.47	1.35–1.59
Decile 5	2.42	1.47	1.31–1.67	Decile 9–10	2.65	1.63	1.50–1.76
Decile 6	2.28	1.39	1.24–1.57	Prioritised Ethnicity			
Decile 7	2.44	1.49	1.32–1.68	European	2.52	1.00	
Decile 8	2.34	1.43	1.27–1.60	Māori	2.18	0.87	0.82–0.92
Decile 9	2.46	1.50	1.34–1.68	Pacific	2.20	0.87	0.80–0.95
Decile 10	2.87	1.75	1.57–1.96	Asian/Indian	1.12	0.44	0.41–0.49
Gender							
Female	2.68	1.00					
Male	1.88	0.70	0.67–0.74				

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.

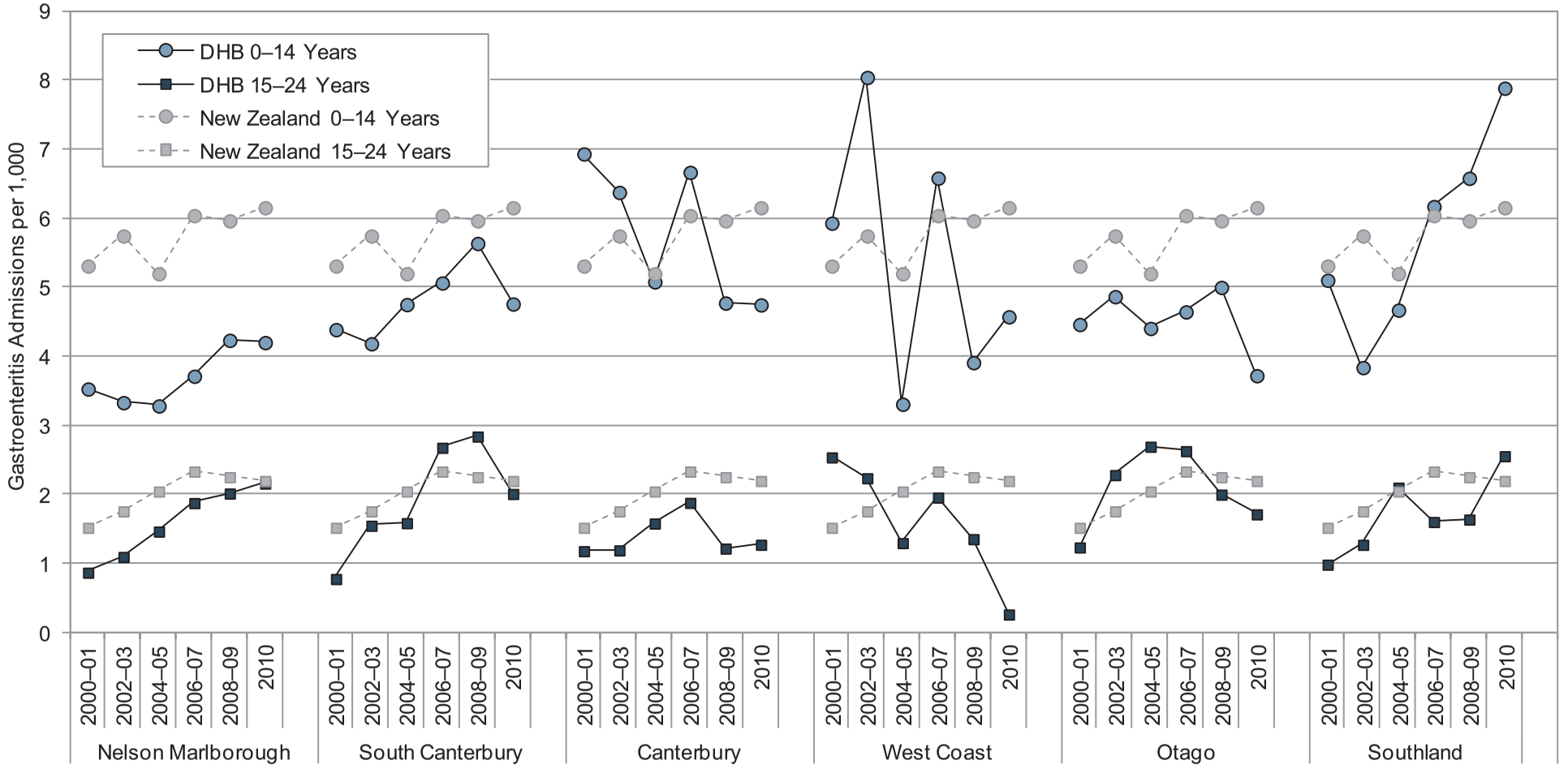
South Island Distribution and Trends

Table 104. Acute and Semi-Acute Hospital Admissions for Gastroenteritis 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
Gastroenteritis					
Children 0–14 Years					
Nelson Marlborough	519	103.8	4.02	0.67	0.61–0.73
West Coast	162	32.4	5.14	0.85	0.73–0.99
Canterbury	2,647	529.4	5.52	0.91	0.88–0.95
South Canterbury	271	54.2	5.24	0.87	0.77–0.98
Otago	739	147.8	4.61	0.76	0.71–0.82
Southland	726	145.2	6.67	1.11	1.03–1.19
New Zealand	26,945	5,389.0	6.04	1.00	
Young People 15–24 Years					
Nelson Marlborough	157	31.4	1.99	0.88	0.75–1.03
West Coast	25	5.0	1.37	0.60	0.41–0.89
Canterbury	543	108.6	1.49	0.65	0.60–0.71
South Canterbury	82	16.4	2.61	1.15	0.92–1.43
Otago	372	74.4	2.19	0.96	0.87–1.07
Southland	132	26.4	1.81	0.80	0.67–0.95
New Zealand	7,203	1,440.6	2.27	1.00	

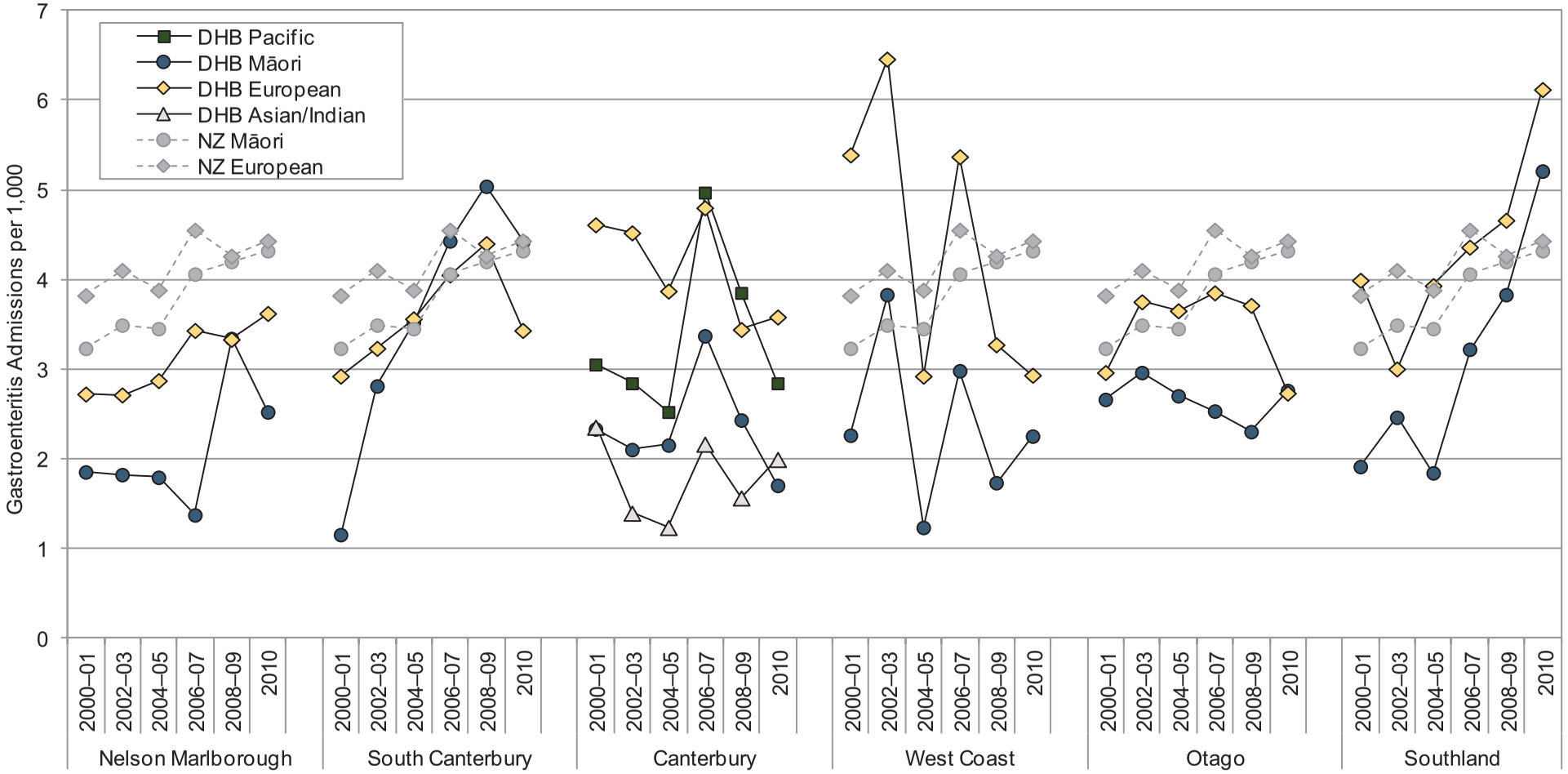
Source: Numerator: National Minimum Dataset (Acute and semi-acute admissions only); Denominator: Statistics NZ Estimated Resident Population

Figure 102. Acute and Semi-Acute Hospital Admissions for Gastroenteritis in Children and Young People Aged 0−24 Years, South Island DHBs vs. New Zealand 2000−2010



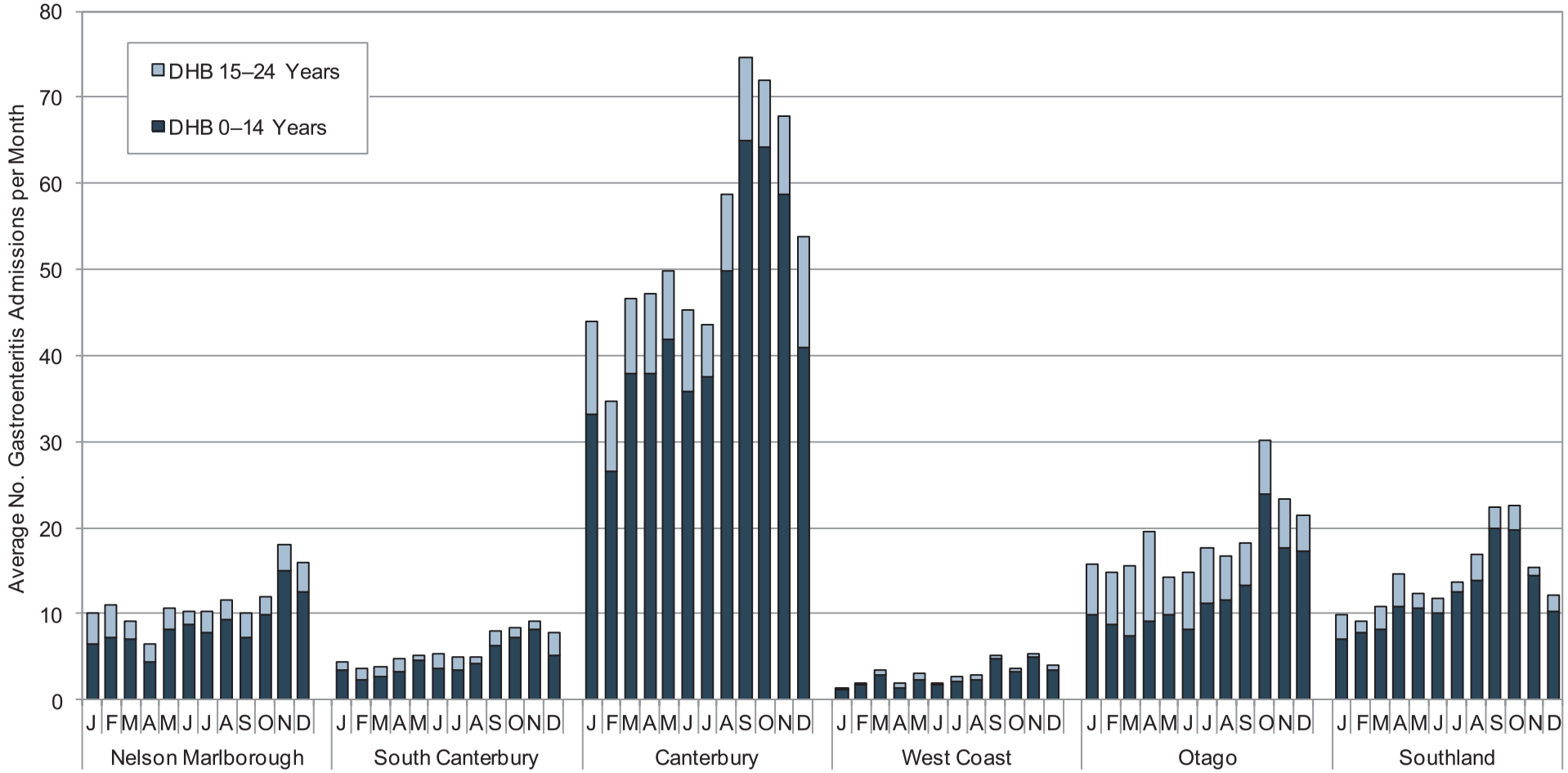
Source: Numerator: National Minimum Dataset (Acute and semi-acute admissions only); Denominator: Statistics NZ Estimated Resident Population

Figure 103. Acute and Semi-Acute Hospital Admissions for Gastroenteritis 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 104. Average Number of Acute and Semi-Acute Hospital Admissions for Gastroenteritis 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 DHBs vs. New Zealand

During 2006–2010, gastroenteritis admissions in children were *significantly* lower than the New Zealand rate in all of the South Island DHBs except Southland, where admissions were *significantly* higher. Admissions in young people were *significantly* lower than the New Zealand rate in the West Coast, Canterbury, and Southland, while rates in Nelson Marlborough, South Canterbury and Otago were not *significantly* different from the New Zealand rate (**Table 104**).

South Island Trends

In Nelson Marlborough, South Canterbury and Southland during 2000–2010, gastroenteritis admissions in children and young people increased. While admissions in Canterbury, West Coast and Otago children fluctuated, rates in West Coast young people exhibited a general downward trend (**Figure 102**).

South Island Distribution by Ethnicity

In Canterbury during 2000–2010, gastroenteritis admissions were generally higher for European and Pacific > Māori and Asian/Indian children and young people, while in Nelson Marlborough, the West Coast, Otago and Southland rates were higher for European than for Māori children and young people. Ethnic differences in South Canterbury were less consistent during this period (**Figure 103**).

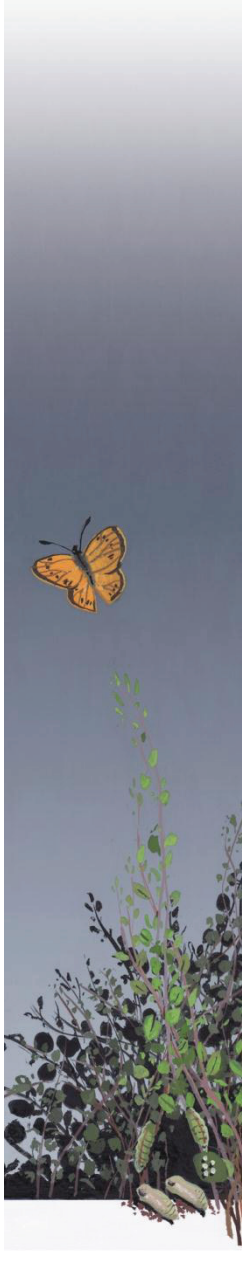
South Island Distribution by Season

In the South Island DHBs during 2006–2010, gastroenteritis admissions in children and young people were generally higher in spring and early summer (**Figure 104**).

Summary

In New Zealand, gastroenteritis admissions increased gradually during the early-mid 2000s but became relatively static after 2006-07 in both children and young people. During 2002–2008, on average one child or young person per year died as a result of gastroenteritis. During 2006–2010, gastroenteritis admissions were highest in infants <1 year of age, with rates then tapering off rapidly during the preschool years. Mortality was also highest in infants <1 year. Admissions in children were also *significantly* higher for males, Pacific > Asian/Indian and European > Māori children and those from average-to-more deprived (NZDep decile 4–10) areas. In contrast, admissions in young people were *significantly* higher for females, European > Pacific and Māori > Asian/Indian young people, and those from average-to-more deprived (NZDep decile 4–10) areas.

During 2006–2010, gastroenteritis admissions in children were *significantly* lower than the New Zealand rate in all of the South Island DHBs except Southland, where admissions were *significantly* higher. Admissions in young people were *significantly* lower than the New Zealand rate in the West Coast, Canterbury, and Southland, while rates in Nelson Marlborough, South Canterbury and Otago were not *significantly* different from the New Zealand rate. In Canterbury, admissions were generally higher for European and Pacific > Māori and Asian/Indian children and young people, while in Nelson Marlborough, the West Coast, Otago and Southland rates were higher for European than for Māori children and young people. Ethnic differences in South Canterbury were less consistent. Admissions were also generally higher in spring and early summer in all DHBs.



Local Policy Documents and Evidence-Based Reviews Relevant to Gastroenteritis

In New Zealand there are no policy documents which focus solely on the prevention of gastroenteritis. A range of documents however consider approaches to infectious diseases and their risk factors more generally, and these have been reviewed in other sections:

1. **Generic Approaches to Infectious Disease:** Table 46 on Page 166
2. **Interventions Aimed at Housing and Household Crowding:** Table 48 on Page 170
3. **Interventions to Improve Breastfeeding:** Table 27 on Page 107

In addition, a range of international reviews consider the most effective approaches for the prevention and management of gastroenteritis and these are summarised in **Table 105**.

Table 105. Local Policy Documents and Evidence-Based Reviews Relevant to the Prevention and Management of Gastroenteritis

Ministry of Health Policy and Other Documents
In New Zealand there are aspects of the Local Government Act 2002, the Local Government Amendment Act 2004 and the Health (drinking water) Amendment Act 2007 that may have implications for gastroenteritis and other infectious diseases. These Acts require that water companies must ensure that households have adequate water to meet minimum drinking, food preparation and sanitary needs even if they do not or are unable to pay their water bill. In The Building Regulations 1992, clause G12.1 has as one of its objectives ensuring that people have hot water for personal hygiene.
Ministry of Health. 1998. **Communicable Disease Control Manual**. Wellington: Ministry of Health. http://www.moh.govt.nz/moh.nsf/49ba80c00757b8804c256673001d47d0/019e54d1de5e73534c25666e00835b79/$FILE/cdcm.pdf This manual provides information on the prevention of communicable diseases in New Zealand and protocols for their control. Part Two covers food and waterborne diseases including acute gastroenteritis, Campylobacteriosis, Giardiasis and Salmonellosis.
Ministry of Health. 2011. **Immunisation Handbook 2011**. Wellington: Ministry of Health. http://www.moh.govt.nz/moh.nsf/Files/immunise-handbook/$file/19Rotavirus.pdf Chapter 19 of the Immunisation Handbook provides information on rotavirus gastroenteritis, New Zealand rotavirus epidemiology and the two vaccines which are available, but unfunded, in New Zealand: Rotarix® and RotaTeq®.
Ministry of Health. 1998. **Child Health Programme Review**. Wellington: Ministry of Health. http://www.moh.govt.nz/moh.nsf/82f4780aa066f8d7cc2570bb006b5d4d/0b8626c506d2e5854c25666e000c2b20/$FILE/chpr.pdf The Child Health Programme Review considered research on the effectiveness of preventive interventions in child health. Chapter 2: Control of Communicable Diseases, lists provision of safe water supplies and enforcement of adequate food safety measures as being essential elements in communicable disease control and also emphasises the importance of encouraging breastfeeding and the early identification, treatment and control of communicable disease outbreaks. It suggests considering the use of a rotavirus vaccine.
Evidence-Based and Other Publications Relevant to Rotavirus Vaccination
Buttery JP, Lambert SB, Grimwood K, et al. 2011. **Reduction in rotavirus-associated acute gastroenteritis following introduction of rotavirus vaccine into Australia's National Childhood vaccine schedule**. Pediatric Infectious Disease Journal, 30(1 Suppl), S25-9. Rotavirus vaccination was added to the Australian National Immunisation Program in July 2007. Due to vaccine purchasing arrangements, Queensland, Victoria and South Australia use the3-dose RotaTeq® while the other states and the ACT use the 2-dose Rotarix®. Eighteen months after the vaccines' introduction the Australian Childhood Immunisation Register estimated that 87% of those eligible had received at least 1 dose by 4 months of age and 84% had received a full vaccine course by 13 months of age. This study assessed the impact of vaccination on laboratory confirmed rotavirus disease using studies at 3 sites. All studies showed reductions in rotavirus-positive tests and hospital encounters and also in non-rotavirus-coded episodes of gastroenteritis (suggesting that testing and coding practices tend to underestimate rates of rotavirus infection). These reductions occurred not only for children in the age group eligible for vaccination but also for older children, indicating a degree of herd protection. There were also marked reductions in emergency department presentations and short stay unit admissions due to gastroenteritis.
Soares-Weiser K, Maclehose H, Ben-Aharon I, et al. 2010. **Vaccines for preventing rotavirus diarrhoea: vaccines in use**. Cochrane Database of Systematic Reviews, 2010(5), Art. No.: CD008521. DOI: 10.1002/14651858.CD008521. This review evaluated the rotavirus vaccines ®, RotaTeq® and Lanzhou Lamb Rotavirus (LLR) for the prevention of rotavirus diarrhoea. All included trials compared the vaccine with a placebo. There were 26 RCTs (99,841 participants) testing Rotarix®, and 8 RCTs (76,103 participants) testing RotaTeq®. No trials compared the effectiveness of different vaccines. Rotarix® and RotaTeq® were both effective at reducing rotavirus diarrhoea (both severe and any diarrhoea). They reduced need for medical attention and for hospitalisation due to rotavirus diarrhoea and also reduced severe diarrhoea from any cause (although there was little data on Rotarix® and all-cause diarrhoea). Both vaccines were similar in terms of rates of deaths and adverse events, and reactogenicity profiles (i.e. fever, diarrhoea and vomiting following vaccination). Both were immunogenic as indicated by seroconversion and/or virus shedding in stools.

Peter G, Aguado T, Bhutta L, et al. 2009. **Detailed Review Paper on Rotavirus Vaccines to be presented to the WHO Strategic Advisory Group of Experts (SAGE) on Immunization**, April 2009. Geneva: World Health Organisation. http://www.who.int/immunization/sage/3_Detailed_Review_Paper_on_Rota_Vaccines_17_3_2009.pdf

This review paper has comprehensive information on rotavirus epidemiology and on issues relating to vaccination including efficacy and safety, data from clinical trials and post-introduction vaccine effectiveness evaluations, schedules, programme implementation and logistics, cost-effectiveness, and surveillance. The two vaccines assessed are Rotarix® and RotaTeq®. It states that rates of rotavirus infection are similar in developed and less developed countries (although children in developed countries have an older median age at first infection) and that hygienic measures are unlikely to decrease infections because of the ubiquity of the virus and the ease with which it is transmitted. Almost all children worldwide have been infected by the age of 3-5 years. A child's first infection is most likely to result in severe gastroenteritis; subsequent episodes tend to be progressively milder.

In June 2009 the WHO recommended that the rotavirus vaccination be included in all national immunisation programmes (see following link for press release). http://www.rotavirusvaccine.org/files/WHO_GAVI_PATH_Press-Release-on-SAGE_FINAL_4June09_000.pdf

Milne RJ, Grimwood K. 2009. **Budget impact and cost-effectiveness of including a pentavalent rotavirus vaccine in the New Zealand childhood immunization schedule**. Value in Health, 12(6), 888-98.

This study estimated the burden of rotavirus gastroenteritis in New Zealand and the budget impact and cost-effectiveness of including a pentavalent rotavirus vaccine (i.e. RotaTeq®) in the childhood immunisation schedule (3 oral doses administered with other vaccines at 6 weeks, 3 months and 5 months of age). It considered the costs of hospital admissions, emergency department presentations, GP costs and caregiver costs (transport to hospital, lost wages). Using a static equilibrium model with the price of the vaccine at $50 per dose the authors estimated cost-effectiveness from a societal perspective at year 5 of a vaccination programme. They calculated that it would cost $2509 to avert one hospitalisation and $305 to prevent one case seeking health care assistance. The break-even price per vaccine dose was $32.29 at 2006 prices.

Centers for Disease Control and Prevention. 2009. **Prevention of Rotavirus Gastroenteritis Among Infants and Children: Recommendations of the Advisory Committee on Immunization Practices (ACIP).** MMWR - Morbidity & Mortality Weekly Report, 58(RR-2), 1-25.

This U.S. report states that prior to the introduction of vaccination, approximately 80% of U.S. children had had rotavirus gastroenteritis by the age of 5 years and 1 in 70 had been hospitalised because of it. RotaTeq® was licensed for use in the U.S. as a 3-dose series in infants (given at ages 2, 4 and 6 months) in 2006 and Rotarix® was licensed for use as a 2-dose series (given at ages 2 and 4 months) in 2008. The report includes tables summarising the major efficacy trials and the adverse events reported in association with vaccination for the 2 vaccines. Data from the National Respiratory and Enteric Virus Surveillance System indicated a substantial reduction in the percentage of faecal specimens from children with gastroenteritis testing positive for rotavirus following the introduction of vaccination (from 51% in 2006 to 6% in 2008). The ACIP recommends routine vaccination of U.S. children but does not express a preference for either RotaTeq® or Rotarix®. Table 7 sets out the details of the recommendations (including maximum age for doses, contraindications, precautions and special situations) and the level and strength of the evidence on which each recommendation is based is indicated. The report contains a comprehensive list of references.

International Evidence-based Guidelines for Gastroenteritis

National Collaborating Centre for Women's and Children's Health. 2009. **Diarrhoea and vomiting caused by gastroenteritis: diagnosis, assessment and management in children younger than 5 years**. London: National Institute for Health and Clinical Excellence. http://www.nice.org.uk/nicemedia/live/11846/43817/43817.pdf

These guidelines are intended for healthcare professionals, those responsible for commissioning and planning healthcare services, and parents/carers and families of children. They are very detailed with 10 chapters covering diagnosis, assessment, management, therapeutic agents, indications for hospitalisation, and advice for parents and carers. Recommendations are based on the best available evidence where it exists and on the consensus of the Guideline Development Group where it does not. The guidelines include overviews of the relevant studies (with summaries of results and data) in each area. The recommendations do not include a grading for the evidence on which they are based however chapter 1 explains the methodology used and states that more detailed results and data are presented in tables in the CD-ROM accompanying the printed guideline. Appendix A is an analysis of the cost-effectiveness of IV vs. oral rehydration which concludes that oral rehydration is more cost-effective. Appendix B considers the health economics of ondansetron and concludes that its use is likely to have both clinical and economic benefits but that more research is needed on its effects on diarrhoea.

Guarino A, Albano F, Ashkenazi S, et al. 2008. **European Society for Paediatric Gastroenterology, Hepatology, and Nutrition/European Society for Paediatric Infectious Diseases evidence-based guidelines for the management of acute gastroenteritis in children in Europe**. Journal of Pediatric Gastroenterology & Nutrition, 46 Suppl 2, S81-122.

These comprehensive European guidelines were designed for practitioners in Europe. They are structured as a series of clinical questions, each followed by answers (accompanied by a grade indicating the strength of the evidence on which they are based) and recommendations (also graded) and a discussion of the relevant studies. The clinical questions are grouped into the following categories: definition and epidemiology, risk factors for severe and/or persistent disease, clinical evaluation and disease severity, diagnostic workup, indications for medical visits and hospitalisation, rehydration, nutritional management, drugs and other therapies and prevention.

King CK, Glass R, Bresee JS, et al. 2003. **Managing acute gastroenteritis among children: oral rehydration, maintenance, and nutritional therapy**. Morbidity & Mortality Weekly Report. Recommendations & Reports, 52(RR-16), 1-16.www.cdc.gov/mmwr/PDF/RR/RR5216.pdf

These guidelines are endorsed by the American Academy of Pediatrics. They review the historical background of oral rehydration therapy and its scientific basis and provide a framework for assessing and treating infants and children with acute diarrhoea. There is a comprehensive list of references.

Systematic and Other Reviews on Gastroenteritis From the International Literature

Gregorio GV, Dans LF, Silvestre MA. 2011. **Early versus Delayed Refeeding for Children with Acute Diarrhoea**. Cochrane Database of Systematic Reviews, 2011(7), Art. No.: CD007296. DOI: 10.1002/14651858.CD007296.pub2.

It used to be common practice to starve children with diarrhoea for fear of exacerbating the illness and prolonging its course. This review considered RCTs comparing early re-feeding (within 12 hours of the start of rehydration) with late re-feeding (12+ hours after the start of rehydration) in children with acute diarrhoea aged less than ten years. Twelve trials including 1283 participants were included and data relating to 1226 participants were included in a meta-analysis (724 who had early re-feeding and 502 who had late re-feeding). There was no significant difference between the early and late re-feeding groups in the proportion of participants who experienced vomiting (five trials, 466 participants), the proportion who needed intravenous fluids (six trials, 813 participants) or the proportion who developed persistent diarrhoea (four trials, 522 participants). Data from two trials (246 participants) indicated that the mean length of hospital stay was also similar. The authors concluded there was no evidence that early re-feeding increased the risk of vomiting, necessity for intravenous fluids or the development of persistent diarrhoea. They were unable to draw any conclusions about the duration of diarrhoea.

Freedman SB, Steiner MJ, Chan KJ. 2010. Freedman SB, Steiner MJ, Chan KJ. 2010. **Oral ondansetron administration in emergency departments to children with gastroenteritis: an economic analysis**. PLoS Medicine / Public Library of Science, 7(10).

Ondansetron is an orally administered anti-emetic which, if given to children with vomiting, can increase the chances of oral rehydration being successful and decrease the likelihood of a child needing intravenous rehydration. Despite this, clinical practice guidelines in North America and Europe do not recommend its use, possibly because of concerns about the cost and because of memories of the severe side-effects of older anti-emetics such as promethazine and prochlorperazine. This study involved conducting cost analyses for the use of Ondansetron in the emergency department (ED) from both the societal perspective and the health care payer's perspective in both the U.S. and Canada. The results showed that in both countries administration of Ondansetron in the ED would save money. In Canada (where the health system is similar to New Zealand's) it was estimated that it would prevent 4,065 IV insertions and 1,003 hospital admissions, saving society CDN$1.72 million and the health care system CDN$ 1.18 million p.a.

Gregorio GV, Gonzales MLM, Dans LF, et al. 2009. **Polymer-based oral rehydration solution for treating acute watery diarrhoea**. Cochrane Database of Systematic Reviews, 2009(2), Art. No.: CD006519. DOI: 10.1002/14651858.CD006519.pub2.

Polymer-based oral rehydration solutions (ORS) contain compounds such as whole rice, wheat, maize and sorghum which release glucose slowly into the gut as they are digested and thereby improve the absorption of water and salt from the solution. This review aimed to compare the effectiveness of polymer-based ORS with glucose-based ORS with the same electrolyte content. This review included 34 RCTs with 4212 participants, 27 of which involved children, 5 adults and 2 both adults and children. Combining the results of 19 trials with 2235 participants (some of which involved ORS with osmolarity ≥ 310 mOsm/l and some of which involved ORS with osmolarity ≤270 mOsm/l) showed that there were fewer unscheduled intravenous infusions in the polymer ORS group compared to the glucose ORS group (RR 0.75, 95% CI 0.59 to 0.95). Polymer-based ORS and glucose-based ORS had similar adverse effects. The authors concluded that there may be some advantages in using polymer-based ORS instead of glucose-based ORS for treating diarrhoea due to any cause and due to cholera although the evidence was limited for ORS of osmolarity ≤270 mOsm/l.

Alhashimi D, Al-Hashimi H, Fedorowicz Z. 2009. **Antiemetics for reducing vomiting related to acute gastroenteritis in children and adolescents**. Cochrane Database of Systematic Reviews, 2009(2), Art.No.: CD005506. DOI: 10.1002/14651858.CD005506.pub4.

Treating children who are vomiting with anti-emetics has been a somewhat controversial issue. Older anti-emetics, such as promethazine and metoclopramide, were associated with severe side-effects including sedation and extra-pyramidal reactions (movement disorders including twitching, muscle spasms and restlessness). Newer anti-emetics, particularly ondansetron, may be better tolerated and have the potential benefits of alleviating the distress caused by vomiting and increasing the success of oral rehydration therapy. This review considered 4 RCTs, with 501 participants, which compared anti-emetics with placebo or nothing in children and adolescents with a clinical diagnosis of vomiting secondary to gastroenteritis. Three trials compared oral ondansetron with placebo and one (36 participants in total) compared Intravenous metoclopramide, ondansetron and saline. Three of the trials received financial support from pharmaceutical companies. The authors concluded that there was limited evidence favouring the use of ondansetron and metoclopramide to reduce the number of episodes of vomiting in children with gastroenteritis and that the use of ondansetronmay reduce the number of children needing intravenous rehydration and hospital admission. There was more diarrhoea in children given ondansetron or metoclopramide rather than a placebo and the authors considered that this was due to the retention of fluids and toxins that would otherwise have been eliminated by vomiting.

Ejemot RI, Ehiri JE, Meremikwu MM, et al. 2008. **Hand washing for preventing diarrhoea**. Cochrane Database of Systematic Reviews, 2008(1), Art. No.: CD004265. DOI:10.1002/14651858.CD004265.pub2.

The authors state that interventions to promote hand washing can produce a 30% reduction in episodes of diarrhoea. This conclusion is based on 14 RCTs, eight of which were institution-based in high income countries, 5 of which were community-based in low or middle-income countries and one of which was in a high-risk group (people with AIDS). When only the results of trials adjusting for cluster randomisation and confounders were considered, interventions to promote hand washing produced a 39% reduction in diarrhoea episodes in children in day-care centres in high-income countries (2 trials, 2287 children, Incidence rate ratio 0.61, 95% CI 0.40 - 0.92) and a 32% reduction in diarrhoea episodes in children living in communities in low or middle-income countries (4 trials, IRR 0.68, 95% CI 0.52 – 0.90).

Hartling L, Bellemare S, Wiebe N, et al. 2006. **Oral versus intravenous rehydration for treating dehydration due to gastroenteritis in children**. Cochrane Database of Systematic Reviews, 2006(3), Art. No.: CD004390. DOI:10.1002/14651858.CD004390.pub2.

Based on a review of 17 randomised and quasi-randomised trials (with 1811 participants), which they considered to be of poor to moderate quality, the authors of this review concluded that there were no clinically important differences between oral rehydration therapy (ORS) and intravenous rehydration therapy. Paralytic ileus occurred more often in the oral rehydration group (risk difference 3%, 95% CI 1-5) and intravenous therapy has a risk (c. 2.5%) of causing phlebitis (inflammation of the veins).The authors state that for every 25 children treated with ORS, one would fail to achieve adequate rehydration and require intravenous therapy. They recommend oral rehydration as the first choice therapy for children with mild to moderate diarrhoea due to gastroenteritis with intravenous therapy if oral rehydration fails.

Hahn S, Kim S, Garner P. 2002. **Reduced osmolarity oral rehydration solution for treating dehydration caused by acute diarrhoea in children**. Cochrane Database of Systematic Reviews, 2002(1), Art. No.: CD002847. DOI: 10.1002/14651858.CD002847.

The findings of this review are based on the results of 11 RCTs comparing reduced osmolarity oral rehydration solution (ORS) with the WHO standard ORS in which the primary outcome was unscheduled intravenous fluid infusion and the secondary outcomes were measures of clinical illness. Results of a meta-analysis of 8 trials indicated that reduced osmolarity ORS was associated with fewer unscheduled intravenous fluid infusions than WHO standard ORS (odds ratio 0.59, 95% confidence interval 0.45 to 0.79). There was no evidence for heterogeneity between trials. In 3 trials no participant required unscheduled intravenous fluid infusion therapy.

Since this review as published, the WHO has revised its ORS guidelines and now recommends a reduced osmolarity ORS with 245 mOsm/l instead of 311 mOsm/l. Details can be found in the following publication:

World Health Organisation, Unicef. 2006. **Oral Rehydration Salts Production of the new ORS**. Geneva: World Health Organisation. http://libdoc.who.int/hq/2006/WHO_FCH_CAH_06.1.pdf

In addition to the reviews mentioned above, there are a number of Cochrane reviews which consider interventions that are specific to particular situations or particular pathogens. These are listed below:

Clasen T F, Bostoen K, Schmidt W-P, et al. 2010. **Interventions to improve disposal of human excreta for preventing diarrhoea**. Cochrane Database of Systematic Reviews, 2010(6), Art. No.: CD007180. DOI: 10.1002/14651858.CD007180.pub2.

Allen SJ, Martinez EG, Gregorio GV, et al. 2010. **Probiotics for treating acute infectious diarrhoea**. Cochrane Database of Systematic Reviews, 2010(11), Art. No.: CD003048. DOI: 10.1002/14651858.CD003048.pub3

Bernaola Aponte G, Bada Mancilla CA, Carreazo Pariasca NY, et al. 2010. **Probiotics for treating persistent diarrhoea in children**. Cochrane Database of Systematic Reviews, 2010(11), Art.No.: CD007401. DOI: 10.1002/14651858.CD007401.pub2.

Christopher PR, David KV, John SM, et al. 2010. **Antibiotic therapy for Shigella dysentery**. Cochrane Database of Systematic Reviews, 2010(8), Art. No.: CD006784. DOI: 10.1002/14651858.CD006784.pub4.

Lazzerini M, Ronfani L. 2008. **Oral zinc for treating diarrhoea in children**. Cochrane Database of Systematic Reviews, 2008(3), Art. No.: CD005436. DOI: 10.1002/14651858.CD005436.pub2.

Mohan P, Haque K. 2003. **Oral immunoglobulin for the prevention of rotavirus infection in low birth weight infants**. Cochrane Database of Systematic Reviews, 2002(3), Art. No.: CD003740. DOI: 10.1002/14651858.CD003740

Mohan P, Haque K. 2002. **Oral immunoglobulin for the treatment of rotavirus infection in low birth weight infants**. Cochrane Database of Systematic Reviews, 2002(3), Art. No.: CD003742. DOI: 10.1002/14651858.CD003742.

Sirinavin S, Garner P. 1999. **Antibiotics for treating salmonella gut infections**. Cochrane Database of Systematic Reviews, 1999(1), Art. No.: CD001167. DOI: 10.1002/14651858.CD001167.

Other Relevant Publications
Neuwelt P, Simmons G. 2006. **A Public Health Portrait of Severe Paediatric Gastroenteritis in the Auckland Region: Report of the 2005 Auckland Paediatric Gastroenteritis Investigation**. Auckland: Auckland Regional Public Health Service. http://www.arphs.govt.nz/Publications_reports/reports/PaedsGastro_Apr06.pdf
This is the report of an investigation to identify the causes of gastroenteritis in children admitted to paediatric hospitals in Auckland and to investigate associations between hospitalisation for gastroenteritis and ethnicity and socioeconomic status (as measured by neighbourhood deprivation levels). The investigation found that 92.4% of children admitted with gastroenteritis were under 5 years of age and almost 80% were under two. Pacific children were overrepresented (35.9% of cases) and there was an association with socioeconomic deprivation (71% of cases lived in areas with an NZDep decile of 6 or more). Rotavirus was the most common pathogen accounting for 57.3% of cases. Preventive strategies identified included measures to improve hygiene at home and in childcare centres, vaccination, and promoting early and intensive rehydration treatment in the community through educating parents and general practice staff and removing barriers to accessing primary care.