

# **Vitamin D Status of New Zealand Adults**

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Findings from the 2008/09  
New Zealand Adult Nutrition  
Survey

## Acknowledgements

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# Summary

This report presents the most recent data about the vitamin D status of New Zealand adults, from the 2008/09 New Zealand Adult Nutrition Survey. These results use the new guideline levels for vitamin D for New Zealand, as outlined in the *Consensus Statement on Vitamin D and Sun Exposure in New Zealand* (Ministry of Health and Cancer Society of New Zealand 2012).

Vitamin D plays a key role in bone health. A deficiency in vitamin D can cause weak and softened bones, which can lead to rickets in children, and osteomalacia and osteoporosis in adults.

In 2008/09:

- the majority of New Zealand adults (68.1 percent) had good levels of vitamin D
- 4.9 percent of adults had vitamin D deficiency, including 0.2 percent of adults who had severe deficiency
- one in four adults (27.1 percent) were below the recommended level of vitamin D but did not have a vitamin D deficiency.

There were seasonal effects in vitamin D status, as people were much more likely to have vitamin D deficiency in late winter and early spring (August to October) than in other periods. This trend was particularly apparent in the South Island south of Nelson Marlborough District Health Board.

Vitamin D status also differed by population group.

- Pacific adults were 2.3 times as likely to have vitamin D deficiency as non-Pacific adults, adjusting for age.
- People living in the most socioeconomically deprived areas were more likely to have vitamin D deficiency than people living in the least socioeconomically deprived areas (using NZDep2006 quintiles).
- People who were obese had a lower mean level of vitamin D than people who were in the normal weight range or underweight.
- However, the prevalence of vitamin D deficiency did not vary significantly by sex or age group.

In the 2008/09 New Zealand Adult Nutrition Survey, there were not enough people of Asian ethnicity who provided blood to enable reliable estimates of vitamin D status for this ethnic group.



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# Introduction

## Vitamin D is important for good bones

Vitamin D is important for good bone health. The main source of vitamin D is sunlight exposure, although our diet can also provide small amounts of vitamin D. A person's vitamin D levels can be affected by latitude (distance from the equator), use of sunscreen, outdoor activity, clothing and skin pigmentation.

Evidence suggests that vitamin D deficiency can harm people's health. For young children, the most serious health outcome is rickets, which causes bowed legs and knocked knees. For adults, vitamin D deficiency can cause osteomalacia (bone weakness) and osteoporosis (thinning of bone tissue and loss of bone density).

## What is presented in this report?

This report presents the most recent information about the vitamin D status of New Zealand adults. This information comes from the 2008/09 New Zealand Adult Nutrition Survey, a national population survey about the nutritional status of New Zealand adults aged 15 years and over. It was carried out from October 2008 to October 2009, and included the collection of blood samples, from which vitamin D status could be measured.

This report includes data on the prevalence of vitamin D deficiency and being below the recommended level of vitamin D, as well as the annual mean level of vitamin D. Results are presented by sex, age, ethnic group, socioeconomic status, body size, region and season.

The survey data have been weighted to represent the total population. All analyses have also been standardised for month. This means that for each analysis, the data set has been reweighted to ensure the data are equally distributed across the 12 months of the survey, to give an accurate annual picture of vitamin D status. Comparisons have been adjusted for other factors that may have influenced the results; these are noted in the text, and are also explained in Appendix 2.

Results in this report are based on a sample and not the entire population, and therefore are subject to some uncertainty. The sampling error is represented in this report with 95 percent confidence intervals, which are presented on graphs and in the data tables in Appendix 1.

Appendix 2 provides more information about the 2008/09 New Zealand Adult Nutrition Survey and the methods used in analyses in this report.

## How are vitamin D levels reported?

Vitamin D levels can be measured in the blood (by measuring levels of serum-25-hydroxyvitamin D or serum 25-OHD). There are several ways of assessing vitamin D levels; in the 2008/09 New Zealand Adult Nutrition Survey, serum 25-OHD levels were measured using the high-performance liquid chromatography (HPLC) tandem-mass spectrometry method (University of Otago and Ministry of Health 2011b).

The *Consensus Statement on Vitamin D and Sun Exposure in New Zealand* (Ministry of Health and Cancer Society of New Zealand 2012) updates New Zealand guidelines for vitamin D levels in blood, defining new levels at which a person is considered to be deficient in vitamin D.

Evidence suggests that serum 25-OHD levels below 25 nanomols per litre (nmol/L) can impact on health, and this is the basis of the new recommendations. The Ministry of Health recommends that individuals have an annual mean vitamin D (serum 25-OHD) level of 50 nmol/L or greater.

This report presents information on the following indicators for New Zealand adults in 2008/09:

- mean level of vitamin D (serum 25-OHD)
- vitamin D deficiency (serum 25-OHD levels less than 25.0 nmol/L), including:
  - severe deficiency (serum 25-OHD levels less than 12.5 nmol/L)
  - mild to moderate deficiency (serum 25-OHD levels of 12.5–24.9 nmol/L)
- below recommended level but not deficient (serum 25-OHD levels of 25.0–49.9 nmol/L)
- equal to or above the recommended level (serum 25-OHD levels of 50.0+ nmol/L)
- high levels of vitamin D (serum 25-OHD levels of 125+ nmol/L).

Time trends in vitamin D deficiency have not been included in this report but could be the focus of future work in this area.

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# Key findings

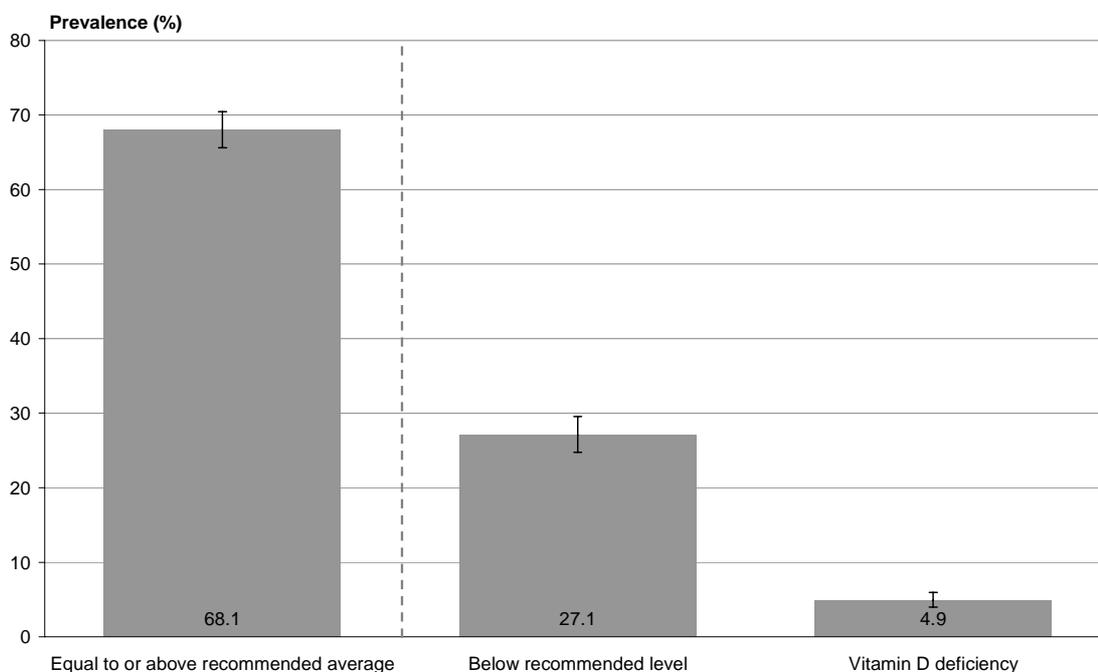
## Most people had good levels of vitamin D

In 2008/09 the overall annual mean level of vitamin D for New Zealand adults was 63.0 nmol/L.

The majority of adults (68.1 percent) had equal to or above the recommended level of vitamin D (ie, a serum 25-OHD level of 50 nmol/L or greater) (Figure 1).

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**Figure 1: Vitamin D status and deficiency in New Zealand among adults aged 15 years and over (unadjusted prevalence), 2008/09**



Note: Vitamin D deficiency was defined as serum 25-OHD concentration less than 25 nmol/L; below the recommended level was defined as serum 25-OHD values of 25–49 nmol/L.

Source: 2008/09 New Zealand Adult Nutrition Survey

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About 5 percent of adults had vitamin D deficiency, which included a very small proportion of adults (0.2 percent) who had a severe deficiency (Table 1). A further 27.1 percent of people were below the recommended level of vitamin D although not deficient in vitamin D. A small proportion of adults (1.7 percent) had high levels of vitamin D.

**Table 1: Vitamin D status of New Zealand adults aged 15 years and over (unadjusted prevalence), 2008/09**

Category	Definition (serum 25-OHD levels)	Prevalence (%)
Vitamin D deficiency	Less than 25 nmol/L	4.9 (4.0–5.9)
• Severe deficiency	Less than 12.5 nmol/L	0.2 (0.1–0.5)
• Mild to moderate deficiency	Equal to or greater than 12.5 and less than 25 nmol/L	4.6 (3.8–5.7)
Below recommended level	Equal to or greater than 25 and less than 50 nmol/L	27.1 (24.7–29.5)
Equal to or above recommended level	Equal to or greater than 50 nmol/L	68.1 (65.6–70.5)
High level of vitamin D	Equal to or greater than 125 nmol/L	1.7 (1.0–2.8)

Note: 95% confidence intervals are shown in brackets. Due to rounding, individual figures may not sum to stated totals.

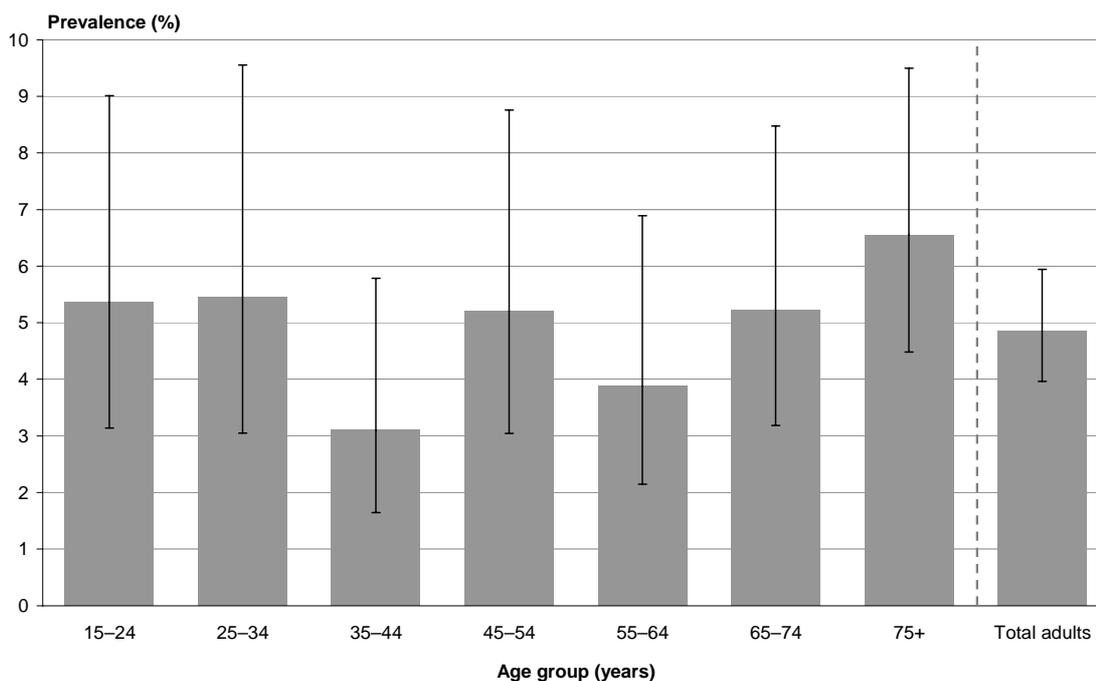
Source: 2008/09 New Zealand Adult Nutrition Survey

Percentile values for all adults and by population group are presented in Table A3 in Appendix 1.

## There were similar levels of vitamin D deficiency across age groups

The prevalence of vitamin D deficiency did not vary significantly by age group (Figure 2).

**Figure 2: Prevalence of vitamin D deficiency by age group among adults aged 15 years and over (unadjusted prevalence), 2008/09**



Note: Vitamin D deficiency was defined as serum 25-OHD concentration less than 25 nmol/L.

Source: 2008/09 New Zealand Adult Nutrition Survey

## Men and women had similar levels of vitamin D deficiency

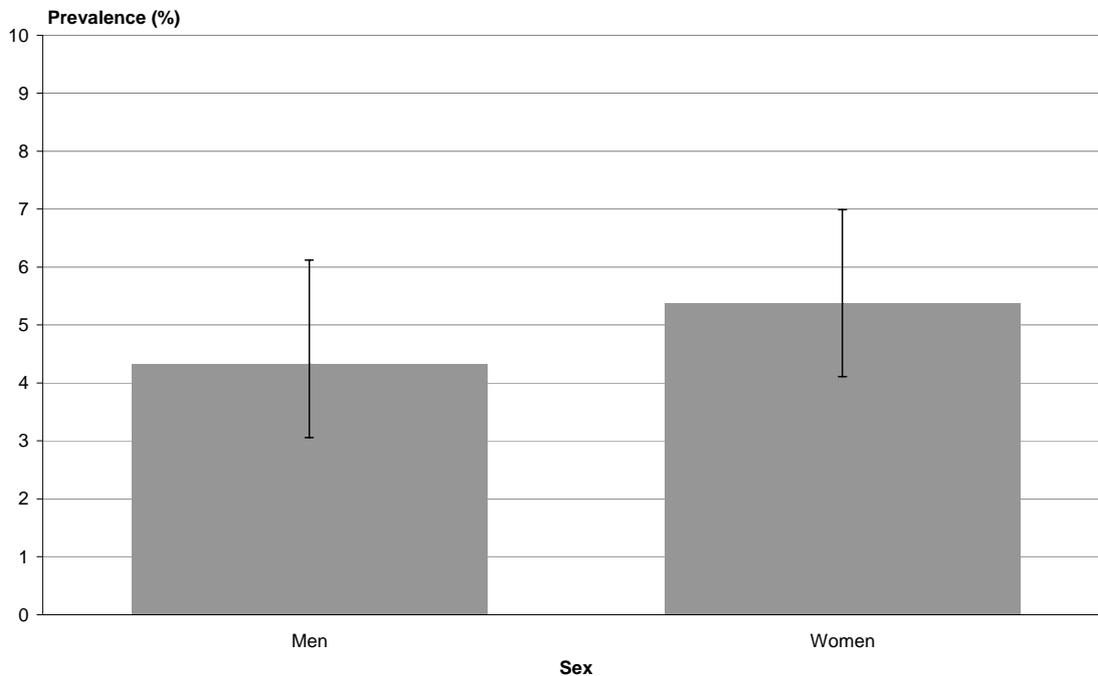
The mean level of vitamin D was 63.6 nmol/L for men and 62.4 nmol/L for women.

About 4.3 percent of men and 5.4 percent of women had vitamin D deficiency (Figure 3). A further 25.2 percent of men and 28.5 percent of women were below the recommended level but did not have a deficiency.

There were no significant differences between men and women in the mean levels of vitamin D or in the prevalence of deficiency, when adjusting for age.

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**Figure 3: Prevalence of vitamin D deficiency by sex among adults aged 15 years and over (unadjusted prevalence), 2008/09**



Note: Vitamin D deficiency was defined as serum 25-OHD concentration less than 25 nmol/L.

Source: 2008/09 New Zealand Adult Nutrition Survey

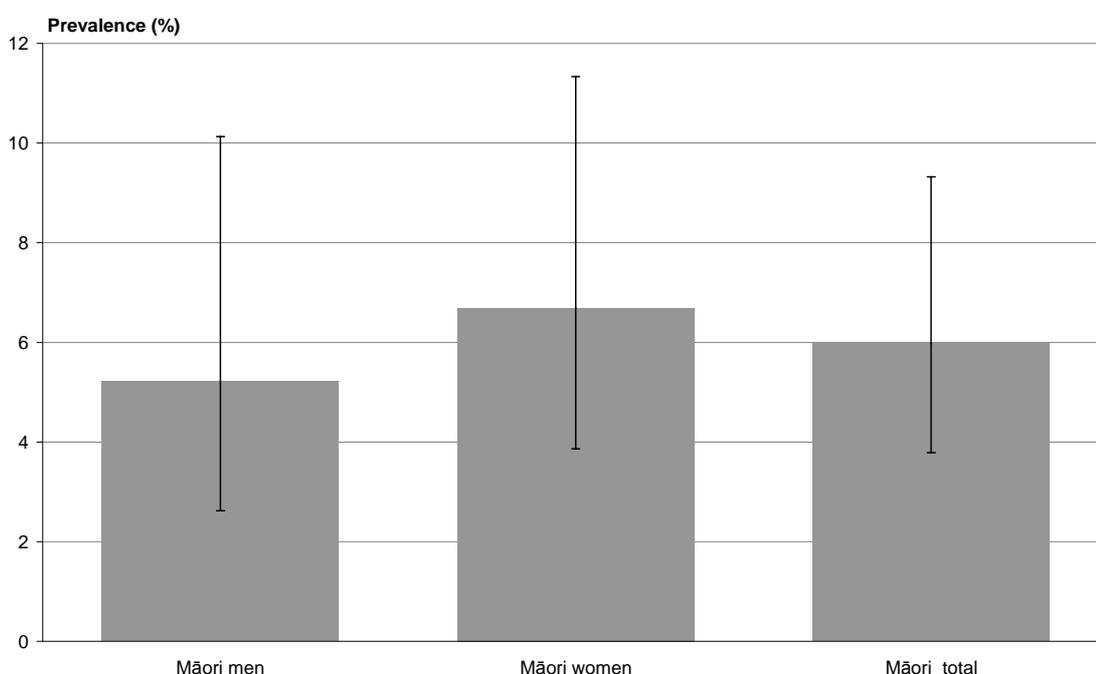
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## There were some ethnic differences in vitamin D levels

The mean level of vitamin D was 60.9 nmol/L for Māori men and 57.2 nmol/L for Māori women. Adjusting for age, Māori women had a significantly lower mean level of vitamin D than non-Māori women; there was no significant difference between Māori and non-Māori men.

Figure 4 shows that 5.2 percent of Māori men and 6.7 percent of Māori women were deficient in vitamin D in 2008/09. Adjusting for age, there were no significant differences in the prevalence of vitamin D deficiency between Māori and non-Māori men and women.

**Figure 4: Prevalence of vitamin D deficiency among Māori men and women aged 15 years and over (unadjusted prevalence), 2008/09**



Note: Vitamin D deficiency was defined as serum 25-OHD values less than 25 nmol/L. Total response ethnicity has been used for outputting results for Māori.

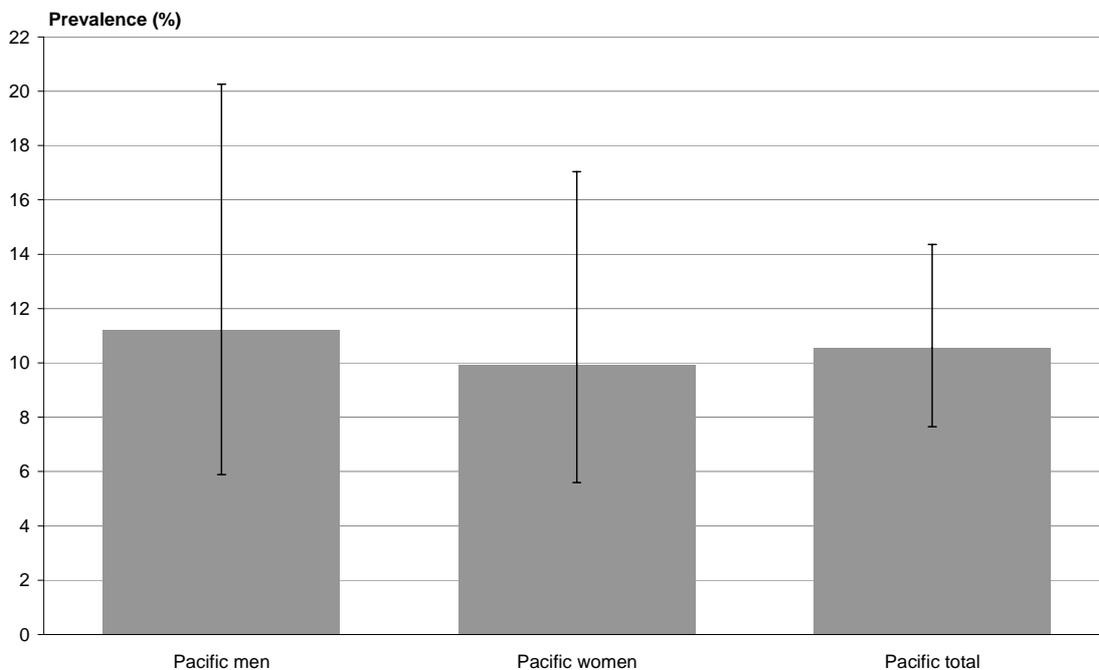
Source: 2008/09 New Zealand Adult Nutrition Survey

For Pacific peoples, the mean level of vitamin D was 49.6 nmol/L for men and 46.0 nmol/L for women. Adjusting for age, Pacific men and women had significantly lower mean levels of vitamin D than non-Pacific men and women respectively (see Table A2 in Appendix 1 for rate ratios).

About 10 percent of Pacific men and women had vitamin D deficiency (Figure 5). Adjusting for age, Pacific adults were 2.3 times as likely to have vitamin D deficiency as non-Pacific adults.

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**Figure 5: Prevalence of vitamin D deficiency among Pacific men and women aged 15 years and over (unadjusted prevalence), 2008/09**



Note: Vitamin D deficiency was defined as serum 25-OHD values less than 25 nmol/L. Total response ethnicity has been used for outputting results for Pacific peoples.

Source: 2008/09 New Zealand Adult Nutrition Survey

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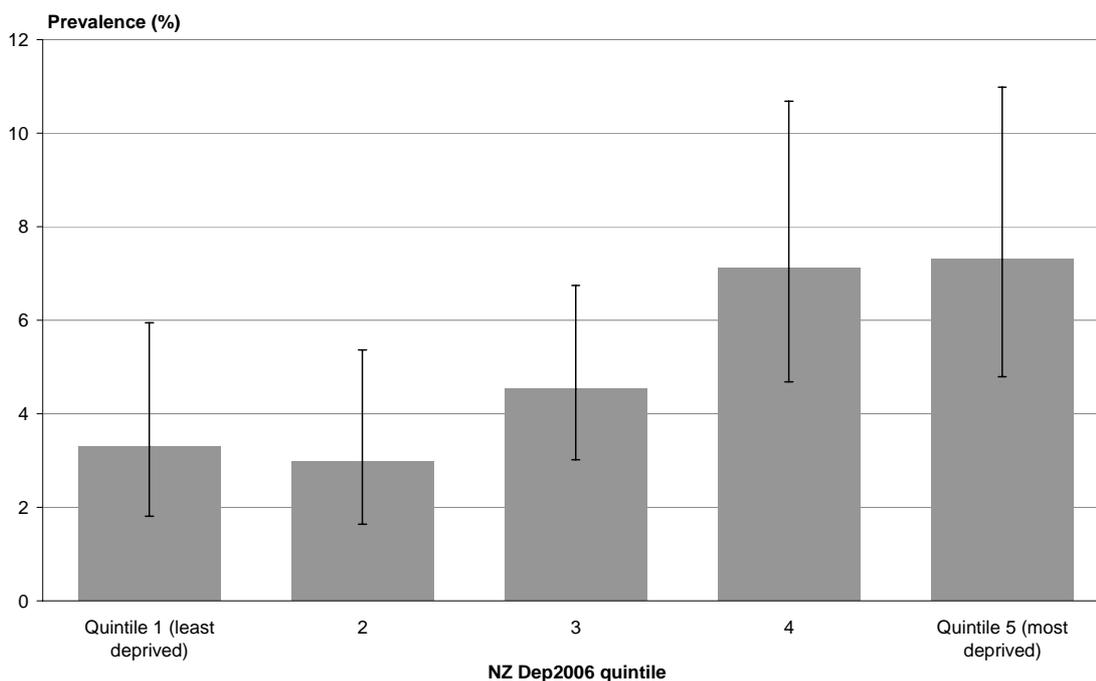
In the 2008/09 New Zealand Adult Nutrition Survey there were not enough people of Asian ethnicity who provided blood to enable reliable estimates of vitamin D status for this ethnic group.

## People living in the most socioeconomically deprived areas were more likely to have vitamin D deficiency than those in the least deprived areas

The mean level of vitamin D was 56.6 nmol/L for people living in the most deprived areas (NZDep2006 quintile 5) and 69.9 nmol/L for people living in the least deprived areas (quintile 1). Adjusting for sex, age and ethnic group, people living in the most deprived areas had a significantly lower annual mean level of vitamin D than those in the least deprived areas (see Table A2 in Appendix 1 for rate ratios).

Figure 6 presents the prevalence of vitamin D deficiency by NZDep2006 quintile. About 7 percent of people living in the most deprived areas (NZDep2006 quintile 5) were deficient in vitamin D, compared with about 3 percent among people living in the least deprived areas (quintile 1). After adjustment, people living in most deprived areas were 3.2 times as likely to have vitamin D deficiency as people living in least deprived areas.

**Figure 6: Prevalence of vitamin D deficiency by neighbourhood deprivation (NZDep2006 quintiles) among adults aged 15 years and over (unadjusted prevalence), 2008/09**



Note: Vitamin D deficiency was defined as serum 25-OHD values less than 25 nmol/L.

Source: 2008/09 New Zealand Adult Nutrition Survey

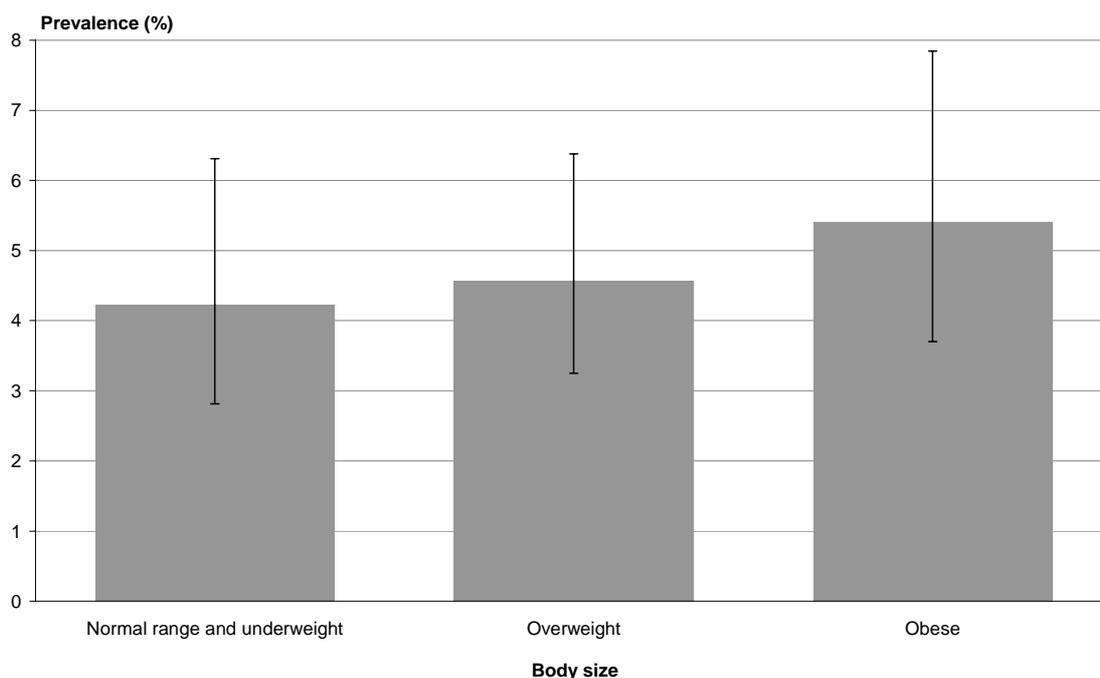
## Vitamin D status was related to body size

Overweight and obesity have been linked to lower serum 25-OHD concentrations (Institute of Medicine 2011).

In the 2008/09 New Zealand Adult Nutrition Survey, the annual mean level was 57.0 nmol/L for people who were obese, 64.1 nmol/L for people who were overweight, and 66.3 nmol/L for people who were normal weight or underweight. People who were obese had a significantly lower annual mean level of vitamin D than people who were in the normal range or underweight, after adjusting for age, sex and ethnic group (see Table A2 in Appendix 1 for rate ratios).

Overall, about 4.2 percent of people in the normal range or underweight were deficient in vitamin D, while 5.4 percent of obese people were in this category (Figure 7). After adjustment, there were no significant differences in the prevalence of vitamin D deficiency by body size.

**Figure 7: Prevalence of vitamin D deficiency by body size among adults aged 15 years and over (unadjusted prevalence), 2008/09**



Note: Vitamin D deficiency was defined as serum 25-OHD values less than 25 nmol/L. Obesity was defined as a body mass index (BMI) of 30 kg/m<sup>2</sup> or greater; overweight was defined as a BMI of 25.0–29.9 kg/m<sup>2</sup>; normal range was defined as a BMI of 18.5–24.9 kg/m<sup>2</sup>; underweight was defined as a BMI less than 18.5 kg/m<sup>2</sup>. A very small proportion of New Zealand adults were in the 'underweight' category.

Source: 2008/09 New Zealand Adult Nutrition Survey

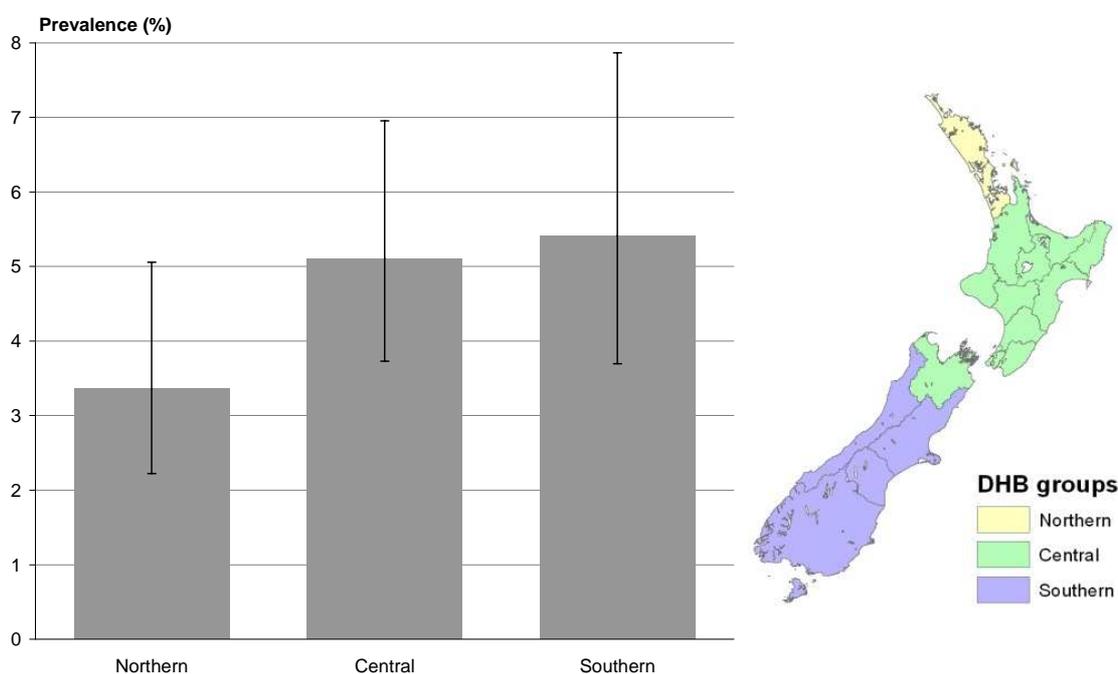
## Small differences exist in overall annual vitamin D levels by latitude

Latitude is an important factor in the amount of sun exposure that people have. The following analysis examined whether there were any differences in the prevalence of vitamin D deficiency by region in New Zealand. For this analysis, New Zealand was divided into three regions (northern, central and southern), based on latitude and district health board (DHB) boundaries (see the map with Figure 8 and the Glossary for more information).

The annual mean level of vitamin D was 65.1 nmol/L for people living in the northern region, 62.6 nmol/L in the central region and 60.5 nmol/L in the southern region. The annual mean level was significantly lower for people living in the central and southern regions than in the northern regions, after adjusting for sex, age and ethnic group (see Table A2 in Appendix 1 for rate ratios).

Overall, the prevalence of deficiency was not significantly different between the three regions (Figure 8). After adjusting for age, sex and ethnic group, there remained no significant differences in the prevalence of vitamin D deficiency between the regions.

**Figure 8: Prevalence of vitamin D deficiency by region among adults aged 15 years and over (unadjusted prevalence), 2008/09**



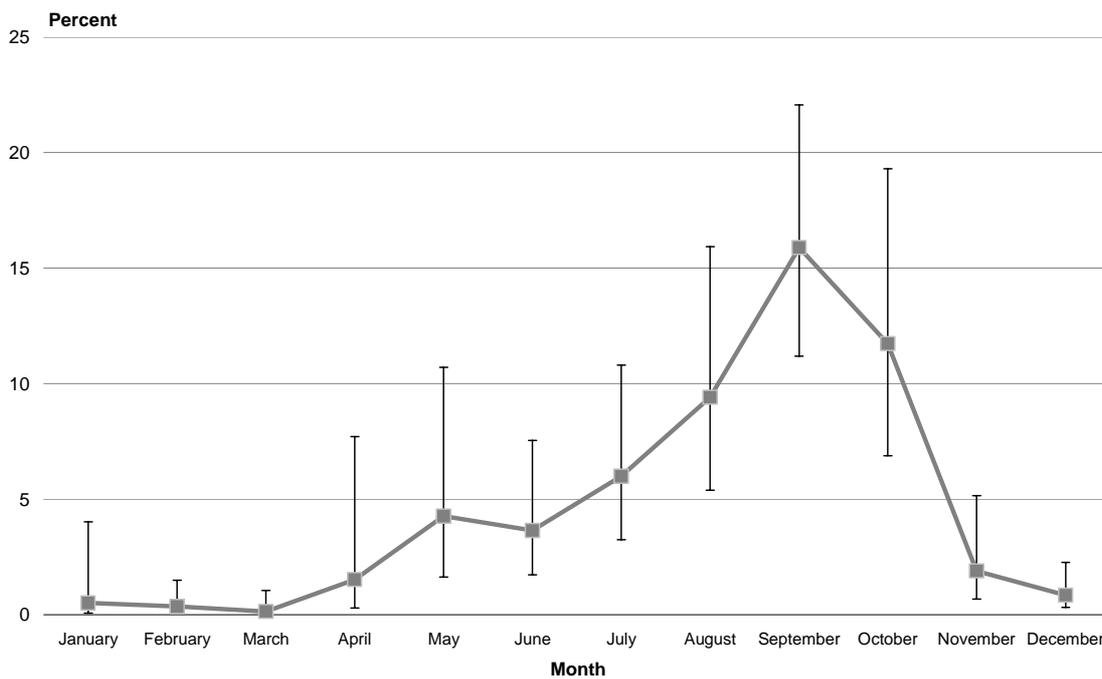
Note: Vitamin D deficiency was defined as serum 25-OHD values less than 25 nmol/L.

Source: 2008/09 New Zealand Adult Nutrition Survey

## Vitamin D deficiency levels were higher from August to October

Overall, the prevalence of vitamin D deficiency peaked in the months of August, September and October (Figure 9). This finding is likely to reflect fewer sunlight hours and less exposure to sun during the winter, and a gradual loss of the vitamin D levels accumulated over the summer months.

**Figure 9: Prevalence of vitamin D deficiency by month among adults aged 15 years and over (unadjusted prevalence), 2008/09**

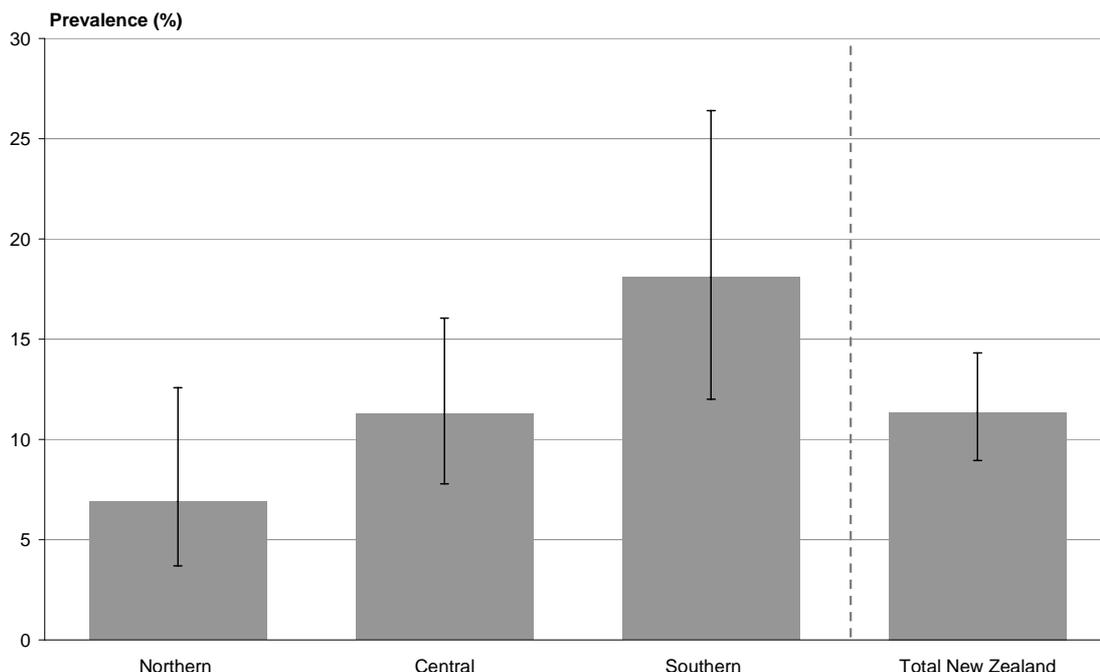


Note: Vitamin D deficiency was defined as serum 25-OHD values less than 25 nmol/L.

Source: 2008/09 New Zealand Adult Nutrition Survey

Figure 10 shows there was a latitude effect with the prevalence of deficiency from August to October, with higher levels of vitamin D deficiency in the southern region over this time period. Adjusting for sex, age and ethnic group, people living in the southern region were 3.1 times more likely to have vitamin D deficiency during the months of August, September and October than people in the northern region.

**Figure 10: Prevalence of vitamin D deficiency by region during August, September and October among adults aged 15 years and over (unadjusted prevalence), 2008/09**



Note: Vitamin D deficiency was defined as serum 25-OHD values less than 25 nmol/L.

Source: 2008/09 New Zealand Adult Nutrition Survey

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# Glossary

## Vitamin D measures

**Serum 25-OHD:** serum 25-hydroxyvitamin D concentration in blood, measured in nanomols per litre (nmol/L).

**Equal to or above recommended level:** a level of serum 25-OHD equal to or greater than 50 nmol/L ( $x \geq 50$  nmol/L).

**Below recommended level:** a level of serum 25-OHD less than 50 nmol/L but greater than or equal to 25 nmol/L ( $25 \leq x < 50$  nmol/L). This group does not include deficiency.

**Vitamin D deficiency:** a level of serum 25-OHD less than 25 nmol/L ( $x < 25$  nmol/L).

**Mild to moderate vitamin D deficiency:** a level of serum 25-OHD greater than or equal to 12.5 nmol/L but less than 25 nmol/L ( $12.5 \leq x < 25$  nmol/L).

**Severe vitamin D deficiency:** a level of serum 25-OHD less than 12.5 nmol/L ( $x < 12.5$  nmol/L).

## Other terms

**95 percent confidence interval:** an indicator of the accuracy of a survey estimate. The 95 percent confidence interval is the interval that would be expected to contain the true population value 95 percent of the time, if many samples were taken.

**Adjusted rate ratio:** a ratio of the prevalence estimates for two population groups. A value greater than 1.00 means the value is higher for the group of interest than the comparison group. A value less than 1.00 means the value is lower for the group of interest than for the comparison group.

**Adjusted ratio of means:** a ratio of the estimates of means for two population groups. It can be interpreted in the same way as an adjusted rate ratio.

**Adjustment:** a statistical method applied to rates or results to take account of differences in the distribution of other factors (eg, age) between different groups (eg, ethnic groups) that may also affect the outcome of interest.

**Body mass index (BMI):** a measure of weight adjusted for height, calculated by dividing weight in kilograms by height in metres squared ( $\text{kg}/\text{m}^2$ ).

**Central region:** in this report, the region that encompasses the following district health boards: Waikato, Bay of Plenty, Lakes, Taranaki, Tairāwhiti, Hawke's Bay, Whanganui, MidCentral, Wairarapa, Hutt, Capital and Coast, Nelson Marlborough.

**Normal/underweight:** a body mass index (BMI) of less than 25 kg/m<sup>2</sup>.

**Northern region:** in this report, the region that encompasses the following district health boards: Northland, Waitemata, Auckland, Counties Manukau.

**NZDep2006:** the New Zealand Index of Deprivation 2006. This area-based index of deprivation measures the level of socioeconomic deprivation for each neighbourhood (meshblock) according to a combination of the following 2006 Census variables: income, benefit receipt, transport (access to a car), household crowding, home ownership, employment status, qualifications, support (sole-parent families) and access to a telephone (Salmond et al 2007).

**Obesity:** a body mass index (BMI) of 30 kg/m<sup>2</sup> or greater.

**Overweight:** a body mass index (BMI) of 25.0–29.9 kg/m<sup>2</sup>.

**Percentile:** the value at which a certain percentage of observations fall. For example, in Table A3 in Appendix 1, the 10th percentile is the value below which 10 percent of the population of interest lies.

**Prevalence:** the proportion of people with a health-related state within a specific population. It is defined as the total number of cases in the population divided by the number of individuals in the population. In this report, prevalence estimates are presented as percentages (%).

**Quintile:** a category that contains a fifth (20 percent) of the data. For NZDep2006, each quintile contains about 20 percent of the total New Zealand population.

**Southern region:** in this report, the region that encompasses the following district health boards: Canterbury, South Canterbury, West Coast, Southern.

# Appendix 1: Data tables

Table A1 presents the vitamin D status of New Zealand adults aged 15 years and over in 2008/09 by population group. In particular, the table presents the unadjusted mean annual level of vitamin D, and the unadjusted prevalence of vitamin D deficiency and being below the recommended level of vitamin D.

**Table A1: Vitamin D status (mean level, prevalence of deficiency, prevalence of being below recommended level) among adults aged 15 years and over (unadjusted prevalence), 2008/09**

Group	Mean annual level (nmol/L)	Prevalence of vitamin D deficiency (%)	Prevalence of being below recommended level (%)
Total	63.0 (61.4–64.5)	4.9 (4.0–5.9)	27.1 (24.7–29.5)
Men	63.6 (61.6–65.5)	4.3 (3.1–6.1)	25.2 (21.9–28.8)
Women	62.4 (60.3–64.5)	5.4 (4.1–7.0)	28.5 (25.5–31.6)
15–24 years	64.6 (60.6–68.5)	5.4 (3.1–9.0)	28.4 (22.5–35.1)
25–34 years	60.7 (57.3–64.1)	5.5 (3.1–9.6)	29.4 (22.9–37.0)
35–44 years	61.1 (58.9–63.3)	3.1 (1.6–5.8)	28.7 (24.3–33.6)
45–54 years	61.2 (57.8–64.6)	5.2 (3.0–8.8)	25.2 (20.3–30.8)
55–64 years	63.1 (58.9–67.3)	3.9 (2.1–6.9)	25.0 (19.0–32.2)
65–74 years	66.4 (63.0–69.8)	5.2 (3.2–8.5)	22.7 (17.3–29.3)
75+ years	61.7 (58.9–64.6)	6.6 (4.5–9.5)	29.6 (24.3–35.4)
Māori adults	59.4 (56.1–62.7)	6.0 (3.8–9.3)	33.7 (28.9–38.9)
Māori men	60.9 (57.2–64.6)	5.2 (2.6–10.1)	27.8 (20.8–36.2)
Māori women	57.2 (52.7–61.8)	6.7 (3.9–11.3)	39.0 (33.1–45.3)
Pacific adults	47.9 (46.1–49.8)	10.5 (7.6–14.4)	46.6 (41.7–51.5)
Pacific men	49.6 (46.0–53.1)	11.2 (5.9–20.3)	39.3 (31.4–47.7)
Pacific women	46.0 (42.5–49.4)	9.9 (5.6–17.0)	53.2 (45.7–60.6)
NZDep2006 quintile 1	69.9 (66.4–73.4)	3.3 (1.8–5.9)	20.1 (15.1–26.1)
NZDep2006 quintile 2	63.2 (60.5–65.9)	3.0 (1.6–5.4)	24.2 (19.0–30.1)
NZDep2006 quintile 3	61.5 (58.4–64.7)	4.5 (3.0–6.7)	27.0 (22.0–32.8)
NZDep2006 quintile 4	62.2 (59.0–65.4)	7.1 (4.7–10.7)	27.7 (22.9–33.2)
NZDep2006 quintile 5	56.6 (53.7–59.5)	7.3 (4.8–11.0)	35.2 (29.9–40.8)
Obese	57.0 (55.0–59.0)	5.4 (3.7–7.8)	31.0 (27.2–35.1)
Overweight	64.1 (62.1–66.1)	4.6 (3.2–6.4)	24.8 (21.6–28.3)
Normal weight or below	66.3 (63.4–69.3)	4.2 (2.8–6.3)	26.3 (22.5–30.6)

Group	Mean annual level (nmol/L)	Prevalence of vitamin D deficiency (%)	Prevalence of being below recommended level (%)
Northern region	65.1 (62.2–68.0)	3.4 (2.2–5.1)	27.1 (22.8–31.8)
Central region	62.6 (60.8–64.4)	5.1 (3.7–7.0)	26.1 (23.4–29.1)
Southern region	60.5 (56.1–65.0)	5.4 (3.7–7.9)	27.9 (27.1–35.1)
Northern region (August–October)	56.1 (51.5–60.6)	6.9 (3.7–12.6)	37.2 (28.4–47.0)
Central region (August–October)	50.5 (46.1–55.0)	11.3 (7.8–16.0)	46.6 (39.3–54.1)
Southern region (August–October)	45.5 (40.2–50.8)	18.1 (12.0–26.4)	46.3 (37.0–55.8)

Note: Vitamin D deficiency was defined as serum 25-OHD values less than 25 nmol/L; below the recommended level was defined as serum 25-OHD values of 25–49 nmol/L. Total response ethnicity has been used to define the Māori and Pacific ethnic groups. 95% confidence intervals are given in brackets.

Source: 2008/09 New Zealand Adult Nutrition Survey

Table A2 compares the vitamin D status of different population groups in New Zealand. These comparisons are presented as ratios of means and rates, to give a measure of the relative difference in burden for the group of interest. A rate ratio is a ratio of the prevalence estimates for two population groups, while a ratio of means is the ratio of the means for two population groups.

These ratios can be interpreted in the following way:

- a value of 1.00 shows that there is no difference between the group of interest (eg, men) and the comparison group (eg, women)
- a value higher than 1.00 means that the result is higher for the group of interest than for the comparison group
- a value lower than 1.00 means that the result is lower for the group of interest than for the comparison group
- if the 95 percent confidence interval (in brackets) does not contain 1.00, the ratio is statistically significant; these significant values are noted in the table with an asterisk (\*).

The ratios presented in Table A2 are adjusted for possible confounding factors (listed in the column ‘adjustment variables’) to make comparisons more accurate and meaningful.

**Table A2: Vitamin D status (mean level, prevalence of deficiency, prevalence of being below recommended level) among adults aged 15 years and over (adjusted ratios of means and prevalence), 2008/09**

Group of interest	Comparison group	Adjustment variables	Adjusted ratio of mean annual levels (nmol/L)	Adjusted rate ratio	
				Vitamin D deficiency	Below recommended level
Men	Women	Age	1.02 (0.98–1.06)	0.80 (0.51–1.27)	0.88 (0.76–1.03)
Māori adults	Non-Māori adults	Age	0.94 (0.88–0.99)*	1.28 (0.77–2.13)	1.26 (1.06–1.51)*
Māori men	Non-Māori men	Age	0.97 (0.90–1.04)	1.34 (0.58–3.09)	1.05 (0.76–1.46)
Māori women	Non-Māori women	Age	0.91 (0.83–0.99)*	1.23 (0.64–2.36)	1.44 (1.17–1.77)*
Pacific adults	Non-Pacific adults	Age	0.75 (0.72–0.79)*	2.32 (1.56–3.46)*	1.77 (1.55–2.01)*
Pacific men	Non-Pacific men	Age	0.78 (0.72–0.84)*	2.92 (1.36–6.28)*	1.59 (1.25–2.01)*
Pacific women	Non-Pacific women	Age	0.73 (0.67–0.79)*	1.86 (0.96–3.61)	1.94 (1.64–2.30)*
Most deprived (NZDep2006 quintile 5) <sup>†</sup>	Least deprived (NZDep2006 quintile 1)	Age, sex, ethnic group	0.96 (0.94–0.98)*	3.15 (1.30–7.64)*	1.66 (1.16–2.39)*
Obese	Normal weight or below	Age, sex, ethnic group	0.86 (0.81–0.91)*	1.27 (0.68–2.38)	1.18 (0.95–1.45)
Overweight			0.96 (0.91–1.02)		
Central region	Northern region	Age, sex, ethnic group	0.95 (0.90–1.00)*	1.69 (0.99–2.88)	1.00 (0.83–1.20)
Southern region	Northern region		0.92 (0.84–0.99)*		
Central region (August–October)	Northern region (August–October)	Age, sex, ethnic group	0.88 (0.78–1.00)*	1.83 (0.91–3.68)	1.28 (0.95–1.72)
Southern region (August–October)	Northern region (August–October)		0.80 (0.67–0.95)*		

Note: Vitamin D deficiency was defined as serum 25-OHD values less than 25 nmol/L; below the recommended level was defined as serum 25-OHD values of 25–49 nmol/L. Total response ethnicity has been used to define the Māori and Pacific ethnic groups. 95% confidence intervals are given in brackets. An asterisk (\*) indicates a statistically significant result ( $p < 0.05$ ).

<sup>†</sup> For the NZDep comparison, relative indexes of inequality (RIIs) are presented. These use all the NZDep2006 quintiles to estimate a line of best fit and thus the RII, which can be interpreted in the same way as an adjusted ratio of rates or means.

Source: 2008/09 New Zealand Adult Nutrition Survey

Table A3 presents the percentiles of vitamin D serum 25-OHD levels for different population groups in New Zealand.

**Table A3: Percentiles of vitamin D level (nmol/L) among adults aged 15 years and over (unadjusted prevalence), 2008/09**

Group	Sample size (n)	Percentile (nmol/L)						
		5th	10th	25th	50th	75th	90th	95th
Total	3099	25.0	32.0	45.0	61.0	79.0	95.0	108.0
Men	1365	27.0	33.0	45.0	62.0	79.0	94.7	104.0
Women	1734	24.0	31.0	44.0	60.0	79.0	97.0	109.0
15–24 years	553	23.0	31.0	42.2	63.0	84.0	103.0	112.0
25–34 years	385	22.0	30.0	44.0	59.7	76.0	90.0	101.6
35–44 years	433	27.0	36.0	45.0	59.0	75.0	86.0	94.9
45–54 years	334	24.0	32.0	46.0	61.0	77.0	87.8	103.1
55–64 years	321	26.0	31.0	46.0	62.0	77.6	95.0	107.0
65–74 years	516	26.3	34.0	47.0	64.5	82.0	103.0	114.2
75+ years	557	23.3	29.0	41.0	60.0	80.0	95.3	105.7
Māori adults	571	23.3	30.0	42.0	57.0	73.6	90.0	98.5
Pacific adults	383	19.0	24.0	34.0	46.0	60.0	72.0	80.9
NZDep2006 quintile 1	472	28.0	38.0	51.0	68.9	86.0	104.0	117.7
NZDep2006 quintile 2	579	28.0	34.0	47.0	62.0	77.5	92.3	102.3
NZDep2006 quintile 3	534	26.0	32.0	44.0	62.0	77.2	88.3	103.0
NZDep2006 quintile 4	701	22.6	29.0	44.0	61.0	78.4	91.0	111.0
NZDep2006 quintile 5	813	22.0	28.0	39.0	55.0	72.0	89.0	97.0
Obese	1000	24.0	30.0	42.0	56.0	70.0	87.0	93.0
Overweight	1101	25.0	33.0	47.0	63.0	80.0	95.0	106.0
Normal weight or below	942	26.2	32.0	45.0	63.0	84.0	104.0	116.9
Northern	1135	26.0	34.0	46.0	62.0	80.0	99.0	110.3
Central	1418	25.4	31.0	45.0	62.0	79.0	92.0	103.0
Southern	546	24.0	31.0	43.0	58.6	77.0	91.0	106.3

Note: Total response ethnicity has been used to define the Māori and Pacific ethnic groups.

Source: 2008/09 New Zealand Adult Nutrition Survey

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# Appendix 2: Methodology

## Background to the 2008/09 New Zealand Adult Nutrition Survey

The 2008/09 New Zealand Adult Nutrition Survey was a national population survey about the nutritional status of New Zealand adults. The survey used a multi-stage, stratified, probability-proportional-to-size (PPS) sample design, with increased sampling of some ethnic groups and age groups, primarily through a 'screened' sample. The target population for the 2008/09 New Zealand Adult Nutrition Survey was the usually resident civilian population aged 15 years and over living in permanent private dwellings in New Zealand. The survey was a joint project of the Ministry of Health, the University of Otago and CBG Health Research Limited.

The survey collected information on energy and nutrient intake; dietary sources of nutrients; dietary habits; dietary supplement use; food security; nutritional status; and nutrition-related health outcomes. The survey also included measurements (height, weight, waist circumference and blood pressure) and the collection of blood and urine samples. These data allow analysis of body size, and provide biochemical indicators of nutritional and health status.

The survey was carried out from October 2008 to October 2009, collecting information from 4721 adult New Zealanders aged 15 years and over. This total included 1040 Māori and 757 Pacific peoples. Overall, 3348 participants gave a blood sample, of whom 3099 respondents had a suitable measurement of vitamin D for analysis.

A final response rate of 61 percent was achieved for the survey interview, while the blood and urine samples had a final response rate of 44 percent. These response rates are considered good for a national nutrition survey.

The vitamin D measures (of serum 25-OHD) presented in this report were obtained through collection of blood samples. Each survey participant who gave informed consent to provide a blood and urine sample was provided with a specimen collection kit. Participants visited the most convenient specimen collection site (a local laboratory affiliated with Canterbury Health Laboratories). Blood samples were analysed by Canterbury Health Laboratories or affiliated laboratories. Serum 25-hydroxyvitamin D was analysed using the HPLC tandem-mass spectrometry method. This method differed from the radioimmunoassay kit method used to analyse vitamin D status in the 1997 National Nutrition Survey (Rockell et al 2006) and the 2002 National Children's Nutrition Survey (Rockell et al 2005).

More information about the 2008/09 New Zealand Adult Nutrition Survey is available on the Ministry of Health's website. More details about the blood collection and the survey design are available in the methodology report (University of Otago and Ministry of Health 2011b).

## **Methods of analysis for this report**

### **Weighting of the data set**

All results have been weighted to be representative of New Zealand's estimated resident population aged 15 years and over living in permanent private dwellings at 31 June 2007.

### **Standardising for month**

Additionally, for each analysis, the data set was standardised for month; that is, the data set was weighted to ensure that blood sample tests were distributed equally across the year for each population group. For this purpose, each month's data for the population group of interest was weighted to one-twelfth of the overall weighting. This method helped to ensure that the sample represented the full year, and that the results were not biased by any fluctuations in the month of blood sampling in each population group.

### **Definition of variables**

Vitamin D status was based on the concentration of serum 25-OHD for respondents who had a blood sample. A serum 25-OHD level of less than 25 nmol/L was considered deficient, while a level of 25–49 nmol/L was considered to be below the recommended level.

The ethnic groups of Māori and Pacific peoples were output using total response ethnicity. In this methodology, each person is allocated to all ethnic groups that they have identified with. If someone identifies as being both Māori and Pacific, they are classified as both Māori and Pacific for the purpose of analysis. Therefore, the Māori and Pacific ethnic groups may overlap, if some people report being of both Māori and Pacific ethnicity.

For comparisons, Māori were compared with all other people (ie, non-Māori) and Pacific peoples were compared with all people who had not reported being of Pacific ethnicity (non-Pacific). When analyses were adjusted for ethnicity (for example, the body mass index (BMI) comparison analyses), prioritised ethnicity was used instead, using the order: Māori, Pacific and Other to record ethnicity. Some additional analyses were also carried out to analyse Māori and Pacific results compared with non-Māori non-Pacific adults. The results of these analyses were not substantially different to the results presented in this report.

In the 2008/09 New Zealand Adult Nutrition Survey there were not enough people of Asian ethnicity who provided blood to enable reliable estimates of vitamin D status for this ethnic group.

NZDep2006 quintiles were used as a measure of neighbourhood socioeconomic deprivation (Salmond et al 2007).

BMI status was derived from the height and weight measurements collected as part of the survey. Obesity was defined as a BMI of 30 kg/m<sup>2</sup> or more, while overweight was defined as a BMI of 25.0–29.9 kg/m<sup>2</sup>. For youth aged 15–17 years, sex- and age-specific BMI cut-offs for children and adolescents were used (Cole et al 2000).

Each respondent's region was derived from their usual place of residence at the time of the survey. The month of blood sampling, used in analysis and weighting, was based on the month in which the respondent provided the blood sample. For a small number of respondents, this date was not available, so the survey interview date was used instead. Generally, the blood sample date was within two weeks after the survey interview, so this date substitution is considered not to have had a large impact on the analysis.

### **Adjusted prevalence**

The statistical software packages SAS and SUDAAN were used to produce survey estimates, including estimates adjusted for other variables like age. Adjustment aims to eliminate the impact of other variables on the analysis. It makes the data for different groups more comparable, and the underlying patterns more visible.

Adjusted ratios of rates and means are presented throughout this report and in Table A2 in Appendix 1. These adjust for possible confounding factors, to make comparisons more accurate and meaningful. Confounding factors include sex and age, which are important and fundamental determinants of health. Analyses did not examine whether respondents took vitamin D supplements.

For neighbourhood deprivation comparisons using NZDep2006, the relative index of inequality (RII) is presented instead of the adjusted rate ratio. This is a summary measure of socioeconomic inequality in health, and can be interpreted in the same way as rate ratios and mean ratios. This method means that instead of only comparing quintiles 1 and 5, data from all quintiles (1–5) were used in order to fit a line of best fit, from which the RII can be estimated.

### **Accuracy of survey data**

Survey data are subject to two types of possible error: sampling error and non-sampling error. Sampling error results from selecting a sample to represent the entire population, and is influenced by the complex design of the survey (resulting in some people having a higher chance of selection than others). In this report, sampling error is reported as 95 percent confidence intervals.

Non-sampling error includes coverage errors, response bias and measurement errors. Although these elements cannot be measured, it is useful to be aware of them when interpreting the results of the survey. Substantial effort is made to reduce non-sampling error by carefully designing and testing the survey, questionnaire and processes, and ensuring quality control of procedures and data.

### **Comparisons with previous national nutrition surveys**

This report has not included comparisons of vitamin D status with the 1997 National Nutrition Survey. There are a number of factors that may have influenced trends over time, including methodological changes in the way vitamin D is measured. In the 1997 National Nutrition Survey, serum 25-OHD levels were determined using a radioimmunoassay kit (DiaSorin Stillwater, MN, USA) (Rockell et al 2006). By contrast, in the 2008/09 New Zealand Adult Nutrition Survey, serum 25-OHD levels were measured using the high-performance liquid chromatography (HPLC) tandem-mass spectrometry method (University of Otago and Ministry of Health 2011b). Further analysis could investigate whether there have been any changes over time in the vitamin D status of New Zealand adults.

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# Appendix 3: Related links

## Related information

The *Consensus Statement on Vitamin D and Sun Exposure in New Zealand* (Ministry of Health and Cancer Society of New Zealand 2012) gives the Ministry of Health's advice on vitamin D and sun exposure. It updates and replaces the Cancer Society's *Position Statement: The Risks and Benefits of Sun Exposure in New Zealand* (2008).

## Past releases from the 2008/09 New Zealand Adult Nutrition Survey

*A Focus on Nutrition* (University of Otago and Ministry of Health 2011a) presents the key results from the 2008/09 New Zealand Adult Nutrition Survey. It was published in September 2011.

*A Focus on Māori Nutrition: Findings from the 2008/09 New Zealand Adult Nutrition Survey* (Ministry of Health 2012a) and *A Focus on Pacific Nutrition: Findings from the 2008/09 New Zealand Adult Nutrition Survey* (Ministry of Health 2012b) present key results for Māori and Pacific peoples from the 2008/09 New Zealand Adult Nutrition Survey. These publications were released in February 2012.

See Nutrition data and stats on the Ministry of Health's website for more information on vitamin D status and other results from the 2008/09 New Zealand Adult Nutrition Survey.

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