8 Nutrition-related Health Outcomes

Nutrition-related health status was also assessed using a range of anthropometric, clinical and biochemical measures. These objective measures are not influenced by self-report and provide valuable information on nutritional status. While some of the indicators (eg, blood pressure and cholesterol) are influenced by a range of lifestyle factors, they have been included here because diet is a key modifiable determinant.

At the end of the 24-hour dietary recall and questionnaires, participants (excluding pregnant women) had their blood pressure measured and their height, weight and waist measured (see the Methodology Report for details). Overall, 4407 and 4503 participants had valid blood pressure and anthropometric measurements taken, respectively.

Participants were also asked to provide a blood and urine sample. Consenting participants were provided with a specimen collection kit and asked to visit a Canterbury Health Laboratory affiliated laboratory in their area within two weeks of the interview. Overall, 70% of participants (44% of those sampled) provided a blood and urine sample (see the Methodology Report for more information). Overall 3359 and 3315 participants had valid blood and urine samples, respectively

8.1 Body size

A healthy body size is important for good health and wellbeing. Obesity is associated with a long list of health conditions, including: cardiovascular disease (ischaemic heart disease, high blood pressure and stroke), various types of cancer, type 2 diabetes, osteoarthritis, sleep apnoea, and psychological and social problems (World Health Organization 2000; World Cancer Research Fund and American Institute for Cancer Research 2007).

Body measurements were made in the home, with the participant wearing light clothing and no shoes.

- Height was measured to the nearest 0.1 cm using a portable stadiometer (Seca 214).
- Weight was measured to the nearest 0.1 kg using electronic weighting scales (Tanita HD-351).
- Waist circumference was measured to the nearest 0.1 cm using a tape measure (W606PM anthropometric measuring tape).

Body mass index (BMI) is a measure of weight, adjusted for height, and is calculated by dividing weight in kilograms by height in metres squared (kg/m^2). BMI is used internationally to classify underweight, normal, overweight and obesity. Since BMI does not distinguish between weight associated with muscle and weight associated with fat, it provides only a crude measure of body fatness in individuals. However, it does provide a good estimate of the proportion of the population with increased risk of health conditions associated with obesity (World Health Organization 2000).

The following World Health Organization (2007) BMI cut-off points were used to define weight status for adults aged 19 years and over:

- underweight: BMI < 18.50 kg/m^2
- normal weight: BMI 18.50–24.99 kg/m^2
- overweight: BMI 25–29.99 kg/m^2
- obese: BMI ≥ 30.00 kg/m^2.

For participants aged 15–18 years, the sex and age-specific BMI cut-off points developed by the International Obesity Taskforce (IOTF) were used to define underweight, normal range, overweight and obesity (Cole et al 2000; Cole et al 2007). The IOTF BMI cut-off points coincide with the World Health Organization BMI cut-off points for adults at age 18 years.

Height and weight

Males on average were 13.5 cm taller and 12.5 kg heavier than females. Males and females aged 71+ years had the lowest mean height (males 170.9 cm; females 157.5 cm) (Table 8.1).

Younger males (15–30 years) were lighter than males aged 31–50 years. Females aged 15–18 years and females aged 71+ years were lighter than females aged 31–70 years.

Body mass index

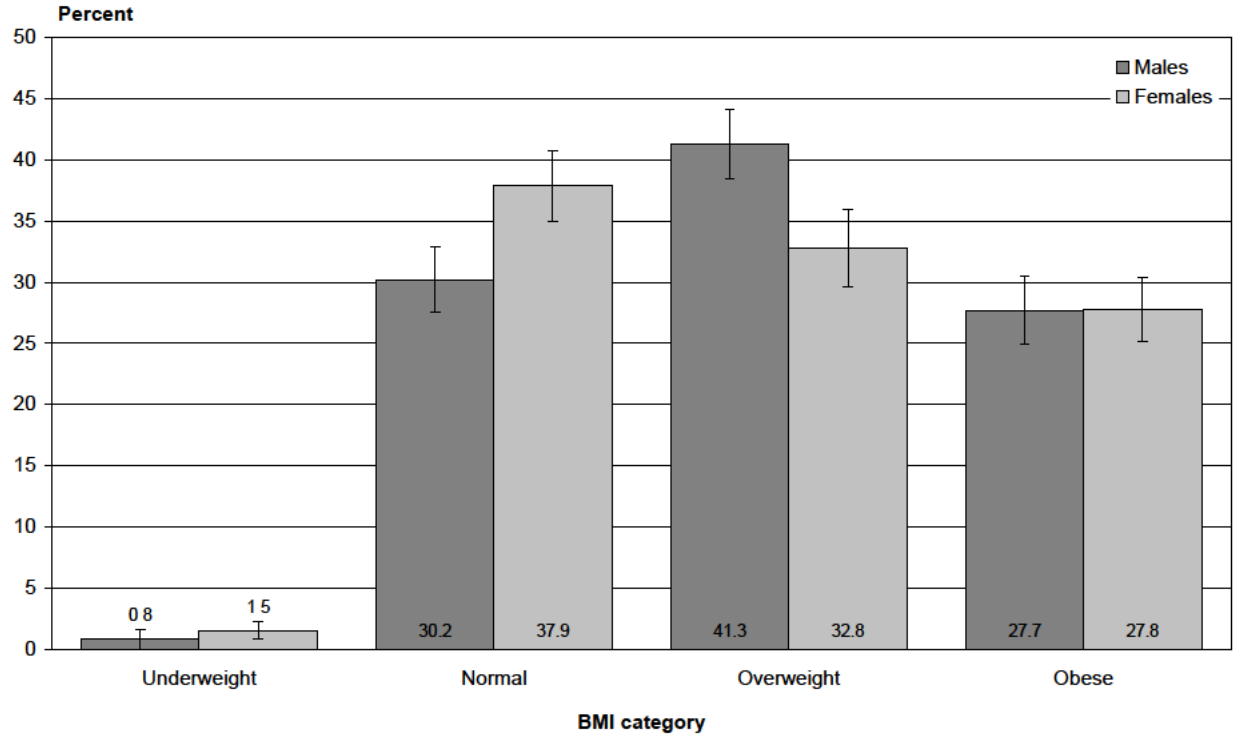
Mean BMI was 27.6 kg/m^2 for both males and females (Table 8.1). For males, those aged 15–18 years had the lowest mean BMI (23.4 kg/m^2). Males aged 19–30 years had a lower mean BMI than males in all older age groups. Among females, those aged 15–18 years also had the lowest mean BMI (24.6 kg/m^2).

Mean BMI was higher in males and females living in NZDep2006 quintile 5 than those living in quintile 1. Overall, mean BMI increased with increasing neighbourhood deprivation, after adjusting for age, sex and ethnic group.

BMI category

Among New Zealanders aged 15 years and over, 1.2% were classified as underweight (males 0.8%; females 1.5%), 34.1% were classified as normal weight (males 30.2%; females 37.9%), 37.0% were classified as overweight (males 41.3%; females 32.8%), and 27.8% were classified as obese (males 27.7%; females 27.8%) (Table 8.1; Figure 8.1).

Figure 8.1: BMI category, by sex

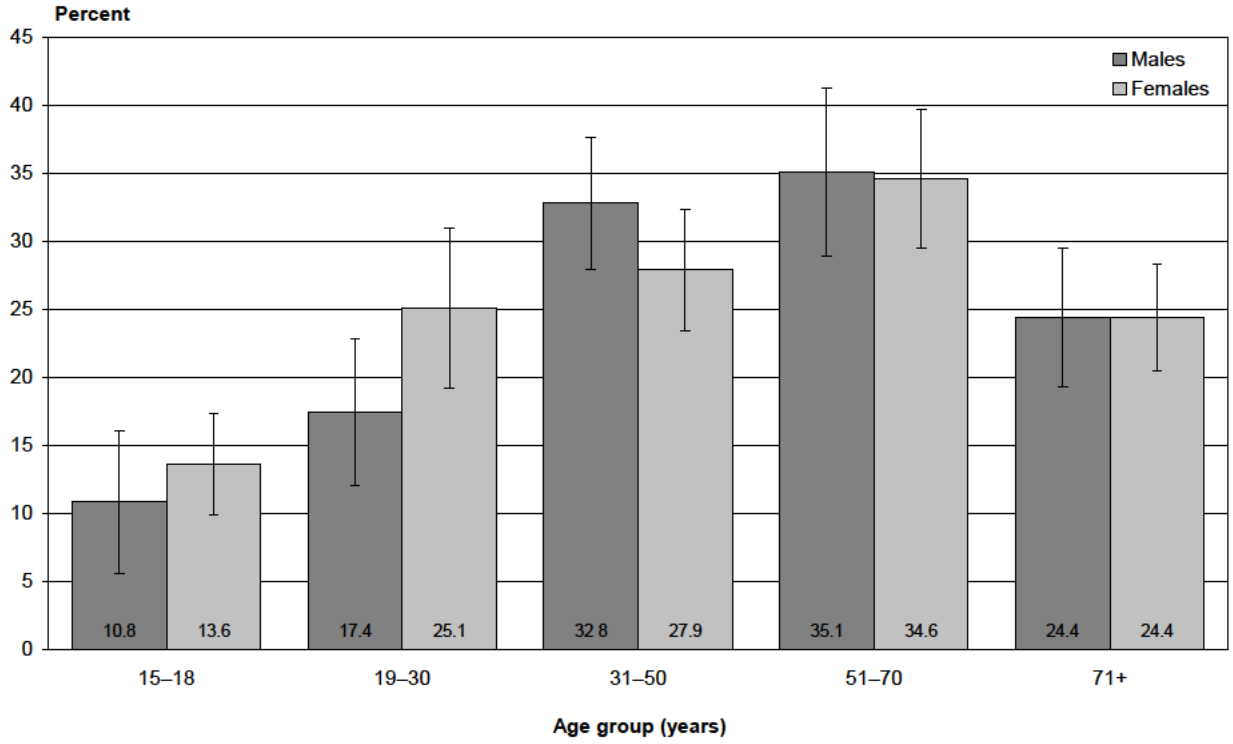


The prevalence of overweight and obesity varied across age groups for both males and females.

Males aged 15–18 years had the lowest prevalence of overweight (23.2%), rising to 51.9% among those aged 71+ years. Females aged 19–30 years had a lower prevalence of overweight than those aged 31+ years.

The prevalence of obesity was lower for males aged 15–30 years than for males aged 31+ years (Figure 8.2). The prevalence of obesity was lower for females aged 15–18 years than for all other females, and lower for females aged 71+ years compared to females aged 51–70 years.

Figure 8.2: Prevalence of obesity, by age group and sex



There was no gradient across NZDep2006 quintiles in the prevalence of overweight, after adjusting for age, sex and ethnic group. The prevalence of obesity was higher in females living in NZDep2006 quintile 5 than in quintile 1. Overall, the prevalence of obesity increased with increasing neighbourhood deprivation, after adjusting for age, sex and ethnic group.

Table 8.1: Body size, by age group, ethnic group, NZDep2006 and sex

		Height (cm)	Weight (kg)	BMI (kg/m^2)	Weight status[1]			
		Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	Under-weight % (95% CI)	Normal % (95% CI)	Over-weight% (95% CI)	Obese% (95% CI)
Total population		168.8 (168.4–169.2)	78.7 (77.9–79.5)	27.6 (27.3–27.8)	1.2 (0.7–1.6)	34.1 (31.8–36.4)	37.0 (34.8–39.2)	27.8 (25.7–29.8)
Age group (years)								
Males	15–18	176.7 (175.7–177.7)	73.3 (70.8–75.7)	23.4 (22.8–24.0)	2.5 (0.5–4.5)	63.5 (56.9–70.2)	23.2 (18.2–28.1)	10.8 (5.6–15.9)
	19–30	177.6 (176.6–178.6)	81.9 (79.6–84.1)	25.9 (25.3–26.6)	0.1 (0.0–0.7)	46.8 (38.8–54.7)	35.7 (28.2–43.2)	17.4 (12.0–22.8)
	31–50	177.3 (176.5–178.0)	89.4 (87.5–91.2)	28.4 (27.9–29.0)	1.0 (0.2–3.4)	24.2 (19.2–29.2)	42.0 (36.5–47.6)	32.8 (27.6–37.9)
	51–70	173.4 (172.6–174.3)	86.8 (84.8–88.7)	28.8 (28.2–29.4)	0.4 (0.0–2.3)	17.9 (12.6–23.2)	46.6 (39.7–53.5)	35.1 (28.7–41.4)
	71+	170.9 (170.1–171.6)	80.8 (79.6–82.0)	27.7 (27.3–28.1)	0.5 (0.1–1.7)	23.2 (18.4–28.1)	51.9 (46.2–57.5)	24.4 (19.7–29.1)
	Total	175.7 (175.3–176.1)	85.1 (84.1–86.1)	27.6 (27.2–27.9)	0.8 (0.2–1.3)	30.2 (27.2–33.1)	41.3 (38.2–44.5)	27.7 (24.9–30.6)
Females	15–18	164.4 (163.7–165.2)	66.6 (64.7–68.4)	24.6 (23.9–25.2)	1.4 (0.4–2.4)	58.1 (52.1–64.1)	26.9 (21.5–32.3)	13.6 (9.7–17.4)
	19–30	164.0 (163.0–164.9)	71.4 (68.4–74.4)	26.4 (25.5–27.4)	4.1 (1.0–7.2)	48.4 (41.0–55.9)	22.4 (16.6–28.1)	25.1 (18.8–31.4)
	31–50	163.6 (162.9–164.2)	74.7 (73.0–76.4)	27.9 (27.3–28.6)	0.4 (0.1–1.2)	36.4 (31.0–41.7)	35.3 (29.8–40.8)	27.9 (23.2–32.6)
	51–70	160.4 (159.7–161.2)	73.9 (72.4–75.4)	28.8 (28.1–29.4)	0.8 (0.1–2.7)	28.4 (23.0–33.9)	36.1 (30.5–41.8)	34.6 (29.3–39.9)
	71+	157.5 (156.8–158.2)	67.7 (66.4–69.0)	27.2 (26.7–27.7)	2.6 (1.2–4.0)	34.0 (29.1–38.9)	39.1 (34.1–44.1)	24.4 (20.3–28.5)
	Total	162.2 (161.8–162.6)	72.6 (71.6–73.5)	27.6 (27.2–27.9)	1.5 (0.8–2.3)	37.9 (34.9–40.8)	32.8 (29.8–35.9)	27.8 (25.1–30.4)
Māori								
Male	15–18	175.5 (173.8–177.2)	75.2 (70.6–79.8)	24.4 (23.0–25.8)	0.0	62.4 (41.6–79.2)	28.2 (13.8–42.5)	9.4 (0.5–18.3)
	19–30	175.9 (174.7–177.0)	89.3 (85.0–93.5)	28.8 (27.5–30.0)	0.0	24.1 (10.9–37.4)	44.0 (29.9–58.0)	31.9 (20.6–43.1)
	31–50	176.3 (174.8–177.8)	99.9 (94.8–105.0)	32.2 (30.6–33.9)	0.0	10.3 (2.3–18.4)	36.6 (27.6–45.6)	53.0 (42.3–63.8)
	51+	171.7 (170.1–173.3)	91.4 (85.0–97.8)	30.9 (28.9–32.9)	0.0	23.7 (10.1–37.3)	24.5 (14.9–34.1)	51.8 (39.0–64.6)
	Total	175.1 (174.3–175.9)	91.6 (88.7–94.6)	29.9 (28.9–30.8)	0.0	24.4 (17.6–31.2)	34.9 (28.6–41.1)	40.7 (34.5–46.9)
Female	15–18	165.1 (163.0–167.2)	69.5 (65.9–73.1)	25.5 (24.4–26.6)	0.9 (0.0–4.8)	46.2 (31.2–61.2)	35.7 (19.5–51.9)	17.2 (7.9–26.4)
	19–30	165.5 (164.3–166.6)	82.0 (77.5–86.5)	30.0 (28.3–31.7)	0.0	26.6 (16.7–36.4)	30.0 (20.7–39.3)	43.4 (32.4–54.5)
	31–50	163.9 (163.1–164.7)	85.3 (82.1–88.6)	31.8 (30.5–33.1)	0.5 (0.1–1.9)	15.0 (9.1–20.9)	32.1 (22.3–41.9)	52.4 (41.8–62.9)
	51+	159.2 (158.1–160.2)	81.7 (78.4–85.1)	32.3 (31.0–33.6)	1.0 (0.1–3.6)	14.5 (5.1–23.8)	21.2 (14.2–28.3)	63.3 (53.0–73.6)
	Total	163.4 (162.8–164.1)	81.8 (79.7–83.9)	30.7 (29.8–31.5)	0.5 (0.1–1.0)	21.7 (16.7–26.7)	29.7 (24.5–34.8)	48.1 (41.9–54.4)

		Height (cm)	Weight (kg)	BMI (kg/m^2)	Weight status[1]			
		Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	Under-weight % (95% CI)	Normal % (95% CI)	Over-weight% (95% CI)	Obese% (95% CI)
Pacific								
Males	15–18	177.5 (175.1–179.8)	83.7 (78.1–89.3)	26.5 (24.9–28.0)	0.0	42.1 (20.8–63.5)	35.3 (17.8–52.8)	22.6 (8.3–36.8)
	19–30	178.8 (177.2–180.4)	99.7 (94.8–104.6)	31.3 (29.6–32.9)	0.0	12.9 (1.4–24.4)	29.9 (17.0–42.8)	57.2 (42.5–71.8)
	31–50	175.5 (174.2–176.8)	102.2 (97.3–107.2)	33.1 (31.6–34.5)	0.5 (0.0–2.6)	8.1 (0.8–15.4)	26.3 (13.9–38.6)	65.2 (53.0–77.4)
	51+	172.7 (171.0–174.5)	96.7 (90.6–102.8)	32.3 (30.7–33.9)	0.0	2.5 (0.2–9.8)	36.6 (22.9–50.2)	60.9 (47.3–74.6)
	Total	176.3 (175.3–177.2)	98.0 (95.2–100.7)	31.5 (30.6–32.3)	0.2 (0.0–1.0)	13.1 (7.7–18.5)	30.5 (23.6–37.4)	56.2 (49.4–63.1)
Females	15–18	166.7 (164.4–169.0)	77.3 (71.6–83.1)	27.8 (25.8–29.9)	0.0	34.3 (18.9–49.8)	37.4 (20.5–54.3)	28.3 (12.7–43.9)
	19–30	166.0 (164.6–167.3)	88.5 (84.1–92.9)	32.1 (30.6–33.6)	0.8 (0.0–4.4)	15.3 (8.2–22.3)	25.7 (16.4–34.9)	58.3 (47.6–68.9)
	31–50	163.3 (162.3–164.4)	91.9 (88.1–95.6)	34.4 (33.1–35.8)	0.0	10.3 (4.0–16.7)	23.6 (16.0–31.2)	66.1 (57.4–74.7)
	51+	160.4 (159.0–161.8)	89.3 (85.2–93.3)	34.7 (33.2–36.2)	0.0	5.3 (0.1–10.6)	26.7 (15.8–37.6)	68.0 (56.3–79.6)
	Total	163.9 (163.2–164.6)	88.6 (86.3–90.8)	33.0 (32.2–33.8)	0.2 (0.0–1.3)	13.7 (9.8–17.6)	26.5 (21.5–31.6)	59.5 (53.9–65.1)
NZEO								
Males	15–18	177.0 (175.8–178.2)	72.0 (69.2–74.7)	22.9 (22.2–23.6)	3.1 (0.7–5.6)	66.1 (59.1–73.2)	21.2 (16.0–26.4)	9.5 (3.6–15.4)
	19–30	177.8 (176.7–179.0)	79.9 (77.5–82.4)	25.3 (24.5–26.0)	0.1 (0.0–0.8)	51.4 (42.3–60.5)	35.6 (27.0–44.1)	12.9 (7.0–18.7)
	31–50	177.5 (176.7–178.3)	87.7 (85.7–89.7)	27.8 (27.2–28.4)	1.1 (0.2–3.9)	26.5 (20.9–32.1)	43.8 (37.6–49.9)	28.6 (22.9–34.3)
	51+	172.9 (172.2–173.7)	84.6 (83.0–86.2)	28.2 (27.8–28.7)	0.5 (0.0–1.8)	19.8 (15.2–24.3)	49.4 (43.6–55.2)	30.3 (25.1–35.6)
	Total	175.8 (175.3–176.3)	83.9 (82. 8–85.0)	27.1 (26.8–27.4)	0.8 (0.2–1.5)	31.7 (28.5–35.0)	42.6 (39.1–46.1)	24.8 (21.6–27.9)
Females	15–18	164.3 (163.4–165.1)	65.1 (63.2–66.9)	24.1 (23.4–24.8)	1.7 (0.5–2.9)	61.1 (54.6–67.6)	26.3 (20.5–32.1)	10.9 (6.9–14.8)
	19–30	163.7 (162.5–164.8)	68.5 (65.2–71.7)	25.4 (24.4–26.5)	4.8 (1.2–8.5)	54.2 (45.7–62.8)	21.4 (14.7–28.2)	19.5 (12.6–26.5)
	31–50	163.6 (162.8–164.4)	72.4 (70.5–74.2)	27.0 (26.4–27.7)	0.4 (0.1–1.4)	40.4 (34.3–46.4)	36.7 (30.5–43.0)	22.5 (17.5–27.4)
	51+	159.6 (159.0–160.2)	71.2 (70.0–72.3)	27.9 (27.5–28.4)	1.4 (0.5–2.3)	31.6 (27.1–36.1)	38.0 (33.2–42.8)	29.0 (24.9–33.1)
	Total	162.1 (161.7–162.6)	70.7 (69.7–71.7)	26.9 (26.5–27.3)	1.7 (0.9–2.5)	41.0 (37.7–44.2)	33.7 (30.3–37.1)	23.7 (20.9–26.4)

		Height (cm)	Weight (kg)	BMI (kg/m^2)	Weight status[1]			
		Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	Under-weight % (95% CI)	Normal % (95% CI)	Over-weight% (95% CI)	Obese% (95% CI)
By NZDep2006 quintile								
Males	1	176.5 (175.7–177.4)	84.8 (83.0–86.5)	27.2 (26.7–27.7)	0.4 (0.1–1.2)	31.5 (25.5–37.4)	40.8 (34.5–47.2)	27.3 (20.4–34.2)
	2	175.7 (174.7–176.7)	83.5 (81.4–85.6)	27.0 (26.4–27.7)	0.5 (0.1–1.5)	32.9 (26.5–39.3)	42.6 (35.5–49.6)	24.1 (18.3–29.9)
	3	175.4 (174.4–176.4)	83.2 (80.9–85.4)	27.0 (26.3–27.7)	0.0	33.4 (25.3–41.5)	42.9 (34.1–51.7)	23.7 (17.5–29.9)
	4	176.0 (175.0–176.9)	86.6 (83.7–89.6)	27.9 (27.1–28.8)	1.9 (0.2–6.9)	27.5 (20.4–34.5)	39.2 (32.6–45.7)	31.4 (24.7–38.2)
	5	174.7 (173.8–175.7)	88.1 (85.7–90.5)	28.8 (28.1–29.5)	1.3 (0.2–4.2)	24.3 (19.2–29.4	41.0 (35.1–46.9)	33.4 (27.0–39.8)
Females	1	163.0 (162.0–164.0)	68.3 (66.4–70.3)	25.7 (25.0–26.4)	1.6 (0.3–5.1)	48.5 (41.1–55.8)	33.5 (26.4–40.5)	16.5 (11.8–21.1)
	2	162.0 (161.1–162.9)	70.0 (68.3–71.7)	26.7 (26.0–27.4)	2.4 (0.5–4.3)	39.6 (33.7–45.5)	39.7 (32.9–46.5)	18.3 (13.8–22.8)
	3	161.8 (160.9–162.7)	73.3 (70.8–75.7)	27.9 (27.1–28.8)	0.4 (0.1–0.6)	37.3 (30.0–44.7)	31.7 (24.4–39.1)	30.6 (23.9–37.2)
	4	162.3 (161.5–163.2)	73.2 (70.9–75.5)	27.8 (26.9–28.6)	2.3 (0.1–4.5)	37.7 (31.8–43.6)	27.4 (21.4–33.5)	32.5 (26.5–38.5)
	5	162.3 (161.5–163.0)	78.0 (75.9–80.0)	29.6 (28.8–30.4)	1.0 (0.2–1.9)	26.8 (20.5–33.1)	31.0 (25.3–36.7)	41.2 (35.6–46.8)

1 15–18 years: Cole et al 2007 BMI cut-offs. 19+ years: underweight BMI < 18.50 kg/m^2; normal BMI 18.50–24.99 kg/m^2; overweight BMI 25.00–29.99 kg/m^2; obese BMI $\geq$ 30 kg/m^2 (World Health Organization 2000).

8.2 Blood pressure

High blood pressure is an important risk factor for heart disease, as well as for stroke and renal failure. The relationship between blood pressure and cardiovascular disease is continuous, with the risk increasing as blood pressure increases even among those within the 'normal' range. Systolic blood pressure is a better predictor of cardiovascular disease risk than diastolic blood pressure (Prospective Studies Collaboration 2002; Neaton and Wentworth 1992).

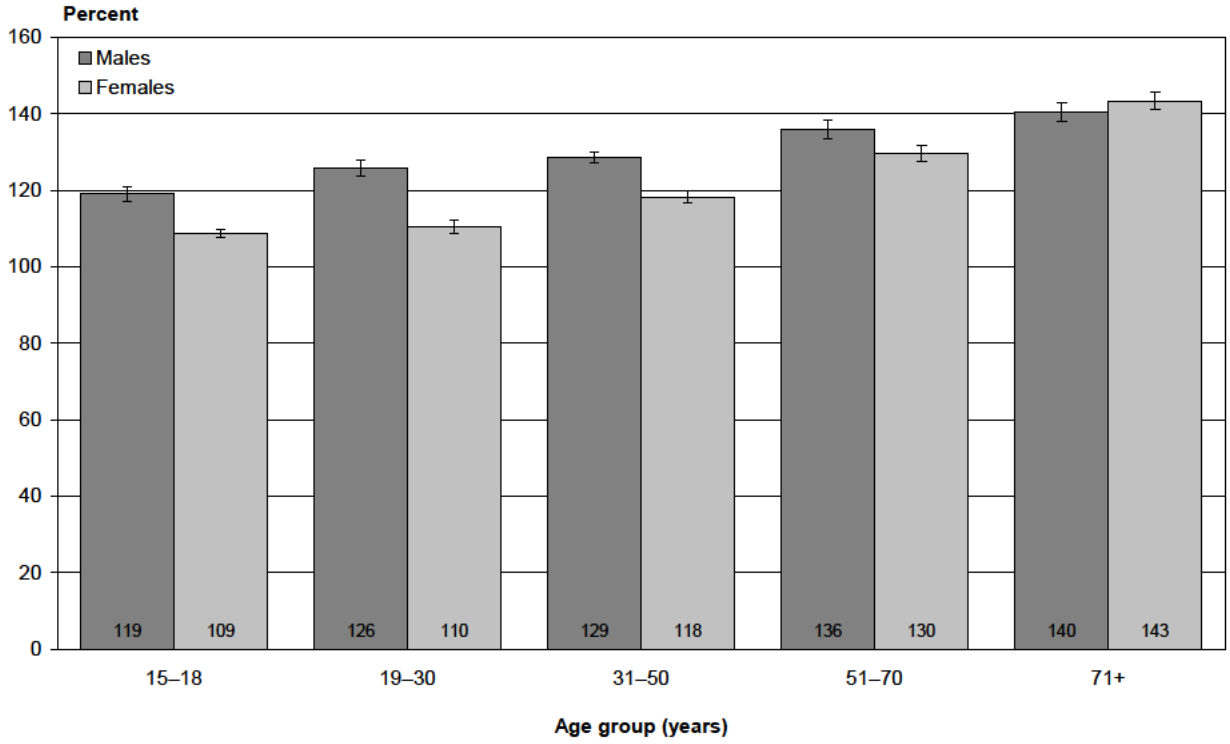
Blood pressure was measured using an OMRON HEM 907 instrument. Blood pressure was not measured in pregnant women because pregnancy alters a woman's blood pressure. Three measurements were taken for each participant, with the mean of the second and third measurements used to calculate diastolic and systolic blood pressure. Note that the results presented below are for all participants, regardless of whether or not they were taking prescribed blood pressure medication.

Systolic blood pressure

Mean systolic blood pressure was 126 mmHg (males 130 mmHg; females 122 mmHg) (Table 8.2). Systolic blood pressure increased with age and was highest for males and females aged 71+ years (141 mmHg and 143 mmHg, respectively) (Figure 8.3). This pattern was similar for Māori and Pacific males and females, with those aged 51+ years having higher systolic blood pressure than younger age groups.

There were no differences in mean systolic blood pressure by NZDep2006 quintile for either males or females. Overall, there was no gradient in mean systolic blood pressure across NZDep2006 quintiles after adjusting for age, sex and ethnic group.

Figure 8.3: Mean systolic blood pressure (mmHg), by age group and sex



Diastolic blood pressure

Mean diastolic blood pressure was 74 mmHg (males 75 mmHg; females 73 mmHg) (Table 8.2). Diastolic blood pressure was highest for males and females aged 51–70 years (79 mmHg and 76 mmHg, respectively). There were no differences in mean diastolic blood pressure by NZDep2006 quintile for either males or females. Overall, there was no gradient in mean diastolic blood pressure across NZDep2006 quintiles after adjusting for age, sex and ethnic group.

Table 8.2: Blood pressure, by age group, ethnic group, NZDep2006 and sex

		Systolic (mmHg) Mean[1] (95% CI)	Diastolic (mmHg) Mean[1] (95% CI)
Total population		126 (125–127)	74 (73–75)
By age group (years)			
Males	15–18	119 (117–121)	64 (62–65)
	19–30	126 (124–128)	71 (69–72)
	31–50	129 (127–130)	78 (76–79)
	51–70	136 (134–138)	79 (77–80)
	71+	140 (138–143)	71 (70–73)
	Total	130 (129–131)	75 (74–76)
Females	15–18	109 (108–110)	65 (64–66)
	19–30	110 (109–112)	70 (69–72)
	31–50	118 (117–120)	74 (73–76)
	51–70	130 (128–132)	76 (75–77)
	71+	143 (141–146)	73 (72–75)
	Total	122 (120–123)	73 (73–74)
Māori			
Male	15–18	122 (117–126)	66 (62–70)
	19–30	128 (123–133)	74 (71–77)
	31–50	130 (127–133)	81 (78–84)
	51+	142 (137–147)	83 (79–87)
	Total	131 (129–133)	77 (76–79)
Female	15–18	109 (106–111)	67 (65–69)
	19–30	112 (110–114)	71 (69–73)
	31–50	122 (119–126)	79 (76–81)
	51+	134 (129–139)	81 (77–84)
	Total	120 (118–123)	76 (74–77)
Pacific			
Males	15–18	114 (111–118)	62 (59–66)
	19–30	124 (122–126)	71 (69–73)
	31–50	129 (127–131)	80 (77–82)
	51+	136 (130–141)	79 (76–82)
	Total	127 (125–129)	75 (73–76)
Females	15–18	106 (103–109)	65 (62–68)
	19–30	110 (108–112)	71 (69–74)
	31–50	119 (116–122)	76 (73–78)
	51+	132 (127–137)	77 (74–80)
	Total	117 (116–119)	73 (72–75)

		Systolic (mmHg) Mean[1] (95% CI)	Diastolic (mmHg) Mean[1] (95% CI)
NZEO			
Males	15–18	120 (117–122)	63 (62–65)
	19–30	126 (123–128)	70 (68–72)
	31–50	128 (127–130)	77 (76–78)
	51+	137 (135–139)	76 (75–78)
	Total	130 (129–132)	74 (74–75)
Females	15–18	109 (108–110)	65 (64–67)
	19–30	110 (108–112)	70 (68–72)
	31–50	118 (116–119)	74 (73–75)
	51+	133 (132–135)	75 (74–76)
	Total	122 (121–123)	73 (72–74)
By NZDep2006 quintile			
Males	1	130 (128–132)	74 (72–76)
	2	130 (127–132)	74 (72–76)
	3	133 (130–135)	76 (74–78)
	4	129 (127–131)	74 (72–76)
	5	130 (127–133)	75 (73–77)
Females	1	123 (120–125)	73 (71–75)
	2	121 (119–123)	72 (70–73)
	3	121 (118–123)	73 (72–75)
	4	120 (118–122)	73 (72–75)
	5	123 (121–125)	75 (74–76)

1 Systolic and diastolic pressures are the means of the participants' second and third readings.

8.3 Iron status

Iron is an essential component of haemoglobin, the part of red blood cells that transports oxygen. Iron also has an important role in cognitive development. Iron needs are higher in women of child-bearing age (to replace iron lost during menstruation) and during pregnancy (to replace iron lost to the developing foetus and during delivery) (Mann and Truswell 2007).

Iron deficiency is the most frequently encountered nutritional deficiency world-wide (Mann and Truswell 2007). There are three stages of iron deficiency. In the first stage, body iron stores start to become depleted but red cell production is not affected. In the second stage (iron deficiency without anaemia), body iron stores are depleted and levels of circulating iron start to fall, although blood haemoglobin concentrations are maintained. In the final stage (iron deficiency anaemia), body iron stores are severely depleted and the amount of iron circulating is very low, which results in reduced red cell production and low haemoglobin concentrations.

Iron-deficiency anaemia is associated with decreased work capacity, fatigue, and some specific cognitive learning effects (Mann and Truswell 2007).

A range of biochemical indices are needed to assess all stages of iron deficiency. The cut-offs used to indicate iron status are shown in Table 8.3. Note that iron-deficiency anaemia is a subset of iron deficiency.

Table 8.3: Iron status measures

Status	Measures and cut-offs
Low serum ferritin	Serum ferritin < 12 µg/L
Low haemoglobin	Haemoglobin: < 136 g/L (15–19 years male) < 137 g/L (20–49 years male) < 133 g/L (50–69 years male) < 124 g/L (70+ years male) < 120 g/L (15–69 years female) < 118 g/L (70+ years female)
Iron deficiency (with or without anaemia)	Serum ferritin < 12 µg/L *and* zinc protoporphyrin > 60 µmol/mol
Iron-deficiency anaemia	Serum ferritin < 12 µg/L *and* zinc protoporphyrin > 60 µmol/mol *and* low haemoglobin

Notes:

References for cut-offs are as follows: serum ferritin (Looker et al 1997); zinc protoporphyrin (Hastka et al 1996); haemoglobin (Looker et al 1997).

Participants with a serum C-reactive protein > 8 mg/L were not included in calculations of mean serum ferritin, low serum ferritin or iron deficiency (Martinez and Coli 1987).

Ferritin

Serum ferritin is an indicator of iron stores. Mean serum ferritin concentration was 177 µg/L for males and 80 µg/L for females (Table 8.4). There was a marked upward trend in mean serum ferritin concentrations in both males and females, from 15–18 years (61 µg/L and 39 µg/L, respectively) to 51–70 years (216 µg/L and 129 µg/L, respectively). Five percent of the New Zealand population had low iron stores, as indicated by serum ferritin concentrations of < 12 µg/L (males 1.5%; females 8.4%).

Haemoglobin

Mean haemoglobin concentration was 149 g/L for males and 133 g/L for females (Table 8.4). Among males, those aged 71+ years (139 g/L) had lower concentrations of haemoglobin than all other age groups. Among females, those aged 71+ years (131 g/L) and 31–50 years (also 131 g/L) had lower concentrations than those aged 51–70 years (135 g/L).

Iron deficiency

Overall, the prevalence of iron deficiency was 4.2% and the prevalence of iron-deficiency anaemia was 2.0% (Table 8.5). Iron deficiency was more common in females (7.2% and 3.5% for iron deficiency and iron-deficiency anaemia, respectively) than males (1.1%; 0.6%). Across age groups, the prevalence of iron deficiency and iron-deficiency anaemia was greatest in females aged 15–18 years (10.6% and 4.9%, respectively) and 31–50 years (12.1% and 6.0%, respectively).

The prevalence of iron deficiency among Māori reflected that among the whole population, with the highest prevalence in females aged 15–18 years and 31–50 years.

Overall, there was no gradient across NZDep2006 quintiles in the prevalence of iron deficiency or the prevalence of iron-deficiency anaemia, after adjusting for age, sex and ethnic group.

Table 8.4: Ferritin and haemoglobin, by age group, ethnic group, NZDep2006 and sex

		Ferritin (µg/L)		Haemoglobin (g/L)	
		Mean (95% CI)	% Low iron stores[1] (95% CI)	Mean (95% CI) (95% CI)	% Low[2] (95% CI)
Total population		127 (120–134)	5.0 (4.0–6.1)	141 (140–141)	7.6 (6.4–8.9)
By age group (years)					
Males	15–18	61 (55–68)	0.6 (0.0–3.2)	150 (149–151)	6.0 (2.2–9.8)
	19–30	135 (121–150)	2.0 (0.1–7.3)	152 (151–154)	3.8 (0.6–6.9)
	31–50	198 (180–215)	1.9 (0.0–3.8)	151 (150–152)	4.7 (2.0–7.5)
	51–70	216 (180–251)	1.3 (0.3–3.6)	148 (146–149)	6.7 (3.3–10.0)
	71+	179 (161–197)	0.4 (0.0–1.7)	139 (137–141)	26.0 (20.6–31.4)
	Total	177 (165–189)	1.5 (0.5–2.5)	149 (148–150)	7.1 (5.5–8.7)
Females	15–18	39 (34–43)	12.2 (7.0–17.4)	133 (131–134)	6.9 (2.6–11.2)
	19–30	52 (46–58)	7.7 (3.4–11.9)	134 (132–135)	4.8 (1.6–7.9)
	31–50	59 (53–66)	13.4 (9.4–17.5)	131 (130–132)	10.2 (6.5–13.9)
	51–70	129 (118–139)	2.9 (0.4–5.4)	135 (134–136)	7.0 (4.0–9.9)
	71+	117 (108–126)	1.7 (0.5–2.9)	131 (130–132)	10.8 (7.2–14.4)
	Total	79 (75–84)	8.4 (6.5–10.3)	133 (132–133)	8.1 (6.4–9.9)
Māori					
Male	15–18	66 (54–78)	0.0	151 (148–155)	5.7 (0.0–30.2)
	19–30	154 (126–182)	0.0	149 (144–153)	19.1 (4.5–33.7)
	31–50	229 (186–271)	0.7 (0.0–4.1)	151 (149–154)	2.6 (0.2–5.1)
	51+	240 (194–287)	0.0	148 (145–151)	7.2 (1.4–13.1)
	Total	187 (168–207)	0.2 (0.0–1.5)	150 (148–152)	8.6 (4.3–12.9)
Female	15–18	39 (28–49)	14.6 (3.1–36.9)	131 (126–136)	15.2 (0.2–30.1)
	19–30	51 (43–60)	10.8 (2.5–19.1)	133 (131–135)	5.3 (0.9–15.7)
	31–50	72 (59–85)	12.9 (6.9–18.9)	134 (131–136)	6.0 (2.1–9.9)
	51+	145 (117–174)	1.3 (0.1–5.0)	133 (131–136)	10.9 (2.6–19.2)
	Total	77 (66–88)	10.1 (6.1–14.1)	133 (132–134)	7.9 (4.6–11.3)

		Ferritin (µg/L)		Haemoglobin (g/L)	
		Mean (95% CI)	% Low iron stores[1] (95% CI)	Mean (95% CI) (95% CI)	% Low[2] (95% CI)
Pacific					
Males	15–18	[3]	[3]	[3]	[3]
	19–30	226 (186–266)	0.0	155 (151–158)	0.0
	31–50	323 (278–369)	0.0	154 (152–156)	4.7 (0.9–8.5)
	51+	333 (270–396)	0.0	154 (149–160)	5.4 (0.9–16.0)
	Total	255 (225–284)	0.0	154 (153–156)	2.3 (0.6–4.0)
Females	15–18	[3]	[3]	[3]	[3]
	19–30	59 (43–74)	10.2 (2.8–17.6)	131 (128–133)	15.5 (6.9–24.0)
	31–50	85 (58–112)	12.6 (4.5–20.7)	131 (128–133)	14.6 (6.9–22.3)
	51+	207 (167–247)	0.0	132 (129–136)	15.9 (4.9–27.0)
	Total	94 (78–109)	9.8 (5.2–14.5)	131 (130–133)	14.5 (9.5–19.5)
NZEO					
Males	15–18	59 (52–66)	0.7 (0.0–4.0)	149 (148–151)	7.3 (2.8–11.9)
	19–30	120 (105–135)	2.4 (0.2–9.0)	153 (151–155)	2.2 (0.2–8.2)
	31–50	186 (168–205)	2.0 (0.4–5.6)	151 (149–152)	4.9 (1.8–8.0)
	51+	200 (171–229)	1.2 (0.0–2.3)	145 (144–146)	11.8 (8.7–14.8)
	Total	169 (156–183)	1.7 (0.6–2.8)	149 (148–150)	7.2 (5.5–8.9)
Females	15–18	37 (33–42)	12.9 (7.2–18.6)	133 (131–134)	6.9 (2.1–11.7)
	19–30	52 (46–59)	6.7 (2.0–11.5)	134 (133–135)	3.4 (0.8–8.9)
	31–50	57 (49–64)	13.6 (9.0–18.2)	131 (130–132)	10.3 (6.1–14.5)
	51+	122 (114–131)	2.7 (0.7–4.6)	134 (133–135)	7.8 (5.3–10.3)
	Total	78 (73–83)	8.2 (6.1–10.3)	133 (132–133)	7.8 (5.9–9.8)
By NZDep2006 quintile					
Males	1	177 (154–201)	0.2 (0.0–1.2)	149 (147–150)	6.9 (3.5–10.4)
	2	179 (155–203)	0.2 (0.0–1.1)	150 (149–152)	4.6 (2.1–7.2)
	3	189 (148–231)	0.6 (0.1–2.0)	149 (148–151)	6.5 (3.8–9.2)
	4	175 (151–199)	3.7 (0.3–7.1)	149 (146–151)	10.0 (5.1–14.9)
	5	164 (147–181)	3.2 (0.7–9.1)	149 (148–151)	7.5 (3.9–11.1)
Females	1	83 (70–97)	12.7 (6.5–18.9)	132 (130–134)	8.2 (2.7–13.8)
	2	86 (76–97)	5.6 (2.2–9.0)	132 (131–133)	7.7 (4.2–11.2)
	3	72 (63–81)	8.8 (4.4–13.3)	133 (132–134)	8.5 (4.8–12.1)
	4	75 (67–84)	8.0 (4.4–11.6)	133 (132–134)	8.1 (4.2–11.9)
	5	81 (72–90)	7.7 (4.2–11.2)	133 (132–135)	8.3 (5.2–11.3)

1 Serum ferritin < 12 µg/L. Serum ferritin concentration data for participants with serum C-reactive protein > 8 mg/L were not included in calculations of either serum ferritin or iron status.

2 < 136 g/L males 15–19 years; < 137g/L males 20–49 years; < 133g/L males 50–69 years; < 124 g/L males 70+ years; < 120 g/L females 15–69 years; < 118 g/L females 70+ years.

3 Results not reported due to small sample size.

Table 8.5: Prevalence of iron deficiency, by age group, ethnic group, NZDep2006 and sex

		With or without anaemia[1] (%), (95% CI)	With anaemia[2] (%), (95% CI)
Total population		4.2 (3.2–5.2)	2.1 (1.4–2.8)
By age group (years)			
Males	15–18	0.0	0.0
	19–30	1.0 (0.0–6.0)	0.0
	31–50	1.9 (0.5–4.9)	1.3 (0.2–4.1)
	51–70	0.7 (0.1–2.1)	0.3 (0.0–1.6)
	71+	0.4 (0.0–1.7)	0.4 (0.0–1.7)
	Total	1.1 (0.3–1.9)	0.6 (0.0–1.2)
Females	15–18	10.6 (5.5–15.7)	5.2 (0.8–9.7)
	19–30	5.2 (1.7–8.7)	1.2 (0.0–2.4)
	31–50	12.1 (8.1–16.0)	6.3 (3.2–9.4)
	51–70	2.9 (0.4–5.4)	2.1 (0.1–4.1)
	71+	1.6 (0.4–2.7)	0.4 (0.1–1.3)
	Total	7.2 (5.4–9.0)	3.5 (2.2–4.8)
Māori			
Males	15–18	0.0	0.0
	19–30	0.0	0.0
	31–50	0.7 (0.0–3.9)	0.7 (0.0–4.1)
	51+	0.0	0.0
	Total	0.2 (0.0–1.4)	0.2 (0.0–1.5)
Females	15–18	14.6 (3.0–37.7)	10.9 (0.8–36.6)
	19–30	10.8 (2.5–19.1)	5.1 (0.6–17.0)
	31–50	11.1 (5.3–16.8)	4.9 (0.7–9.0)
	51+	1.3 (0.1–5.0)	0.7 (0.0–4.0)
	Total	9.4 (5.4–13.3)	4.8 (1.6–8.0)
Pacific			
Males	15–18	[3]	[3]
	19–30	0.0	0.0
	31–50	0.0	0.0
	51+	0.0	0.0
	Total	0.0	0.0
Females	15–18	[3]	[3]
	19–30	8.9 (2.0–15.8)	4.7 (1.0–13.1)
	31–50	12.6 (4.5–20.7)	11.1 (3.0–19.1)
	51+	0.0	0.0
	Total	9.4 (4.8–14.1)	6.9 (2.6–11.2)

		With or without anaemia[1] (%), (95% CI)	With anaemia[2] (%), (95% CI)
NZEO			
Males	15–18	0.0	0.0
	19–30	1.2 (0.0–6.7)	0.0
	31–50	2.0 (0.4–5.6)	1.4 (0.2–4.7)
	51+	0.7 (0.0–1.3)	0.3 (0.0–1.1)
	Total	1.2 (0.3–2.2)	0.6 (0.0–1.3)
Females	15–18	11.0 (5.4–16.7)	5.3 (0.3–10.3)
	19–30	3.8 (0.1–7.5)	0.0
	31–50	12.1 (7.7–16.6)	6.2 (2.7–9.7)
	51+	2.6 (0.7–4.6)	1.7 (0.2–3.3)
	Total	6.9 (5.0–8.9)	3.2 (1.8–4.7)
By NZDep2006 quintile			
Males	1	0.0	0.0
	2	0.2 (0.0–1.1)	0.0
	3	0.6 (0.1–2.0)	0.6 (0.1–2.0)
	4	2.9 (0.6–7.9)	2.5 (0.3–8.0)
	5	2.2 (0.2–8.1)	0.0
Females	1	12.4 (6.2–18.6)	7.1 (2.0–12.3)
	2	4.6 (1.6–7.6)	2.2 (0.1–4.4)
	3	6.8 (3.0–10.6)	3.1 (0.3–5.8)
	4	7.4 (3.9–10.9)	3.1 (0.7–5.5)
	5	5.9 (2.8–9.0)	2.8 (1.1–4.5)

1 Serum ferritin < 12 µg/L and zinc protoporphyrin > 60 µmol/mol.

2 Serum ferritin < 12 µg/L and zinc protoporphyrin > 60 µmol/mol and haemoglobin < 136 g/L males 15–19 years; < 137 g/L males 20–49 years; < 133g/L males 50–69 years; < 124 g/L males 70+ years; < 120 g/L females 15–69 years; < 118 g/L females 70+ years.

3 Results not reported due to small sample size.

8.4 Cholesterol

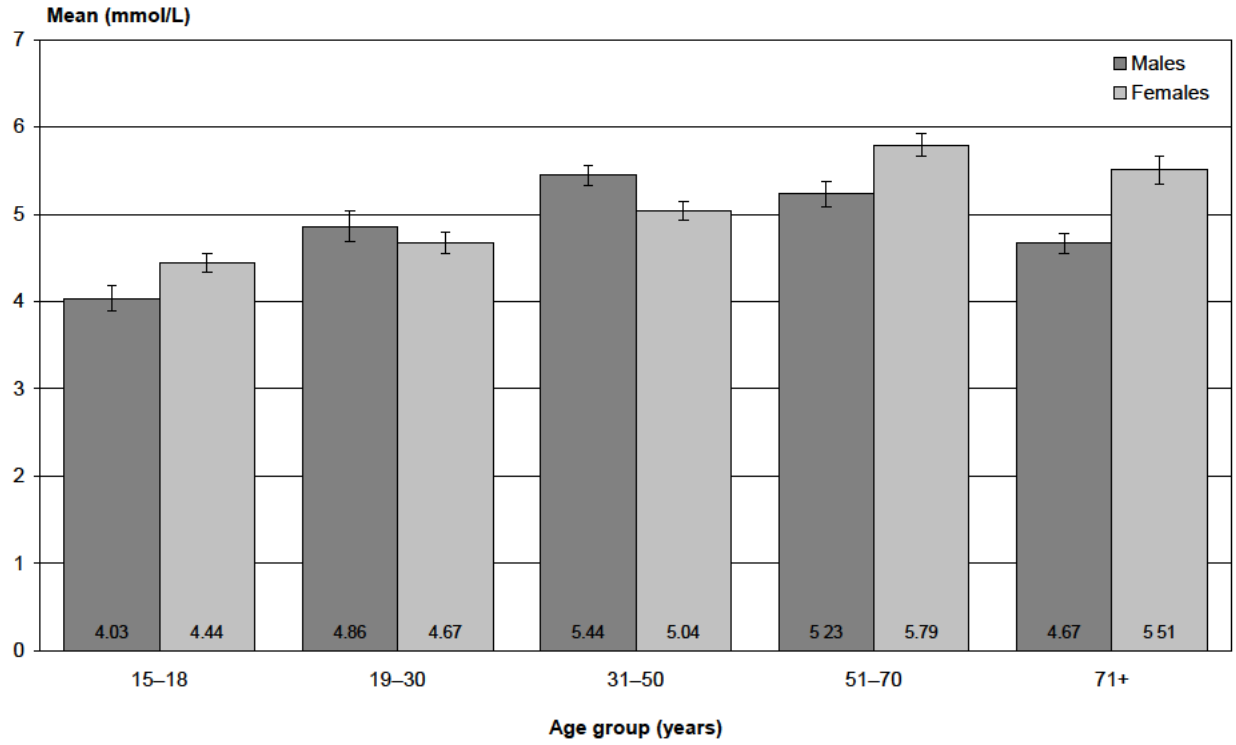
Blood cholesterol is an important risk factor for cardiovascular disease, particularly ischaemic heart disease. The relationship between cholesterol and cardiovascular disease is continuous, with the risk increasing as cholesterol increases, even among those within the 'normal' range. Modifiable determinants of blood cholesterol include diet (in particular dietary fat intake), body weight and physical activity levels. Blood cholesterol concentrations can also be influenced by lipid-lowering medications.

Total cholesterol consists largely of the cholesterol in low-density lipoprotein particles (LDL cholesterol) plus the cholesterol in high-density lipoprotein (HDL cholesterol). LDL cholesterol is associated with a higher risk of cardiovascular disease and HDL with a lower risk (Mann and Truswell 2007). The ratio of total:HDL cholesterol is also a strong predictor of vascular disease mortality (Prospective Studies Collaboration et al 2007; Erqou et al 2009), with the optimum ratio < 4.5 (New Zealand Guidelines Group 2003). Because blood samples in the 2008/09 NZANS were non-fasting, LDL cholesterol could not be measured.

Serum total cholesterol

The mean serum total cholesterol concentration was 5.13 mmol/L, with similar levels for males (5.09 mmol/L) and females (5.17 mmol/L) (Table 8.6). Serum total cholesterol peaked in males aged 31–50 years (5.44 mmol/L) and females aged 51–70 years (5.79 mmol/L), and declined in older age groups (Figure 8.4).

Figure 8.4: Mean total blood cholesterol (mmol/L), by age group and sex



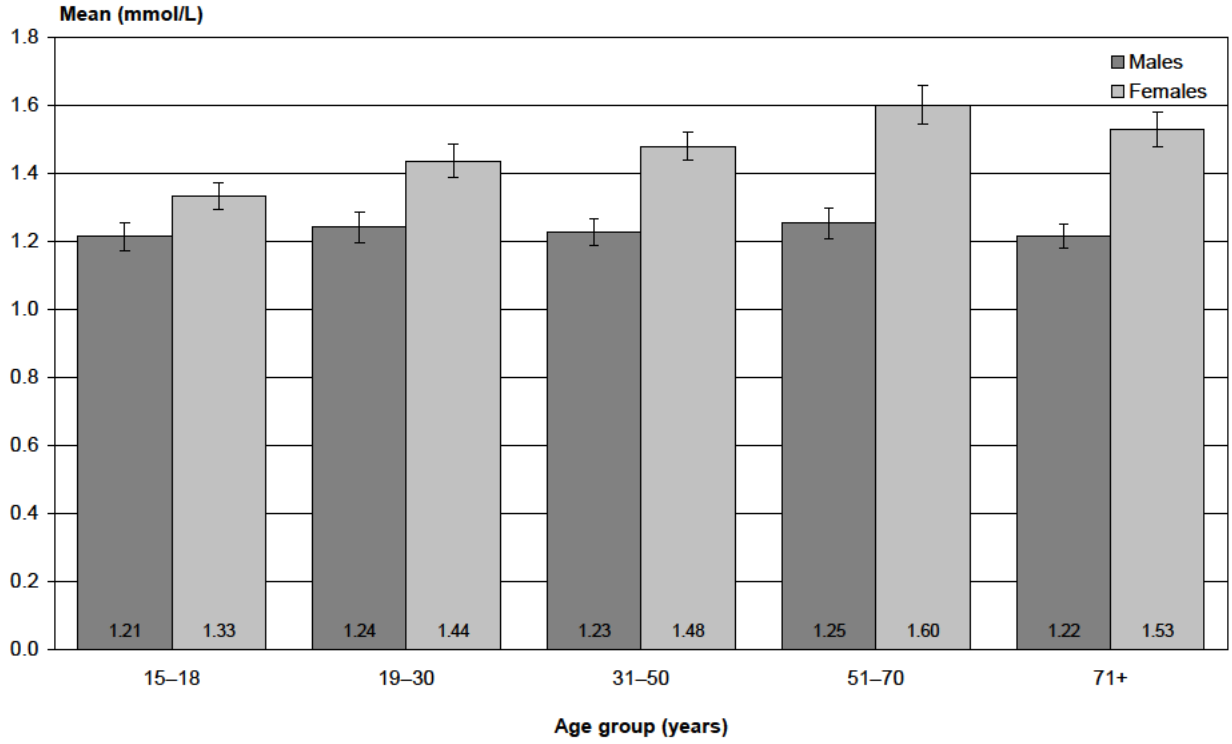
Mean serum total cholesterol was higher in Māori males aged 31–50 years (5.44 mmol/L) and in Māori females aged 51+ years (5.79 mmol/L) than in other Māori male and female age groups. Pacific males and females aged 31–50 years (5.21 mmol/L and 4.99 mmol/L, respectively) had the highest mean total serum cholesterol concentration of all other Pacific age groups.

Overall, there was no gradient across NZDep2006 quintiles in serum total cholesterol concentrations, after adjusting for age, sex and ethnic group.

Serum HDL cholesterol

The mean serum HDL cholesterol concentration was 1.37 mmol/L and was greater in females (1.50 mmol/L) than males (1.23 mmol/L) (Table 8.6). Serum HDL cholesterol increased across the age groups in females but not in males. Females aged 15–18 years had lower HDL cholesterol (1.33 mmol/L) than females in other age groups (Figure 8.5).

Figure 8.5: Mean HDL cholesterol (mmol/L), by age group and sex



Mean HDL cholesterol was lower in males and females living in NZDep2006 quintile 5 than in those living in quintile 1. Overall, mean HDL cholesterol decreased with increasing neighbourhood deprivation, after adjusting for age, sex and ethnic group.

Total:HDL cholesterol ratio

The mean total:HDL cholesterol ratio of New Zealand adults was 3.95 (males 4.32; females 3.61) (Table 8.6). Among females the group aged 51–70 years had a higher ratio than those aged 15–50 years.

Māori males aged 51+ years had a lower ratio (4.19) than those aged 31–50 years (5.00). Māori females aged 31+ years had a higher ratio than those aged 15–30 years.

The total:HDL cholesterol ratio was higher in males and females living in NZDep2006 quintile 5 than in those living in quintile 1.

Table 8.6: Cholesterol, by age group, ethnic group, NZDep2006 and sex

		Total cholesterol (mmol/L) Mean (95% CI)	HDL cholesterol (mmol/L) Mean (95% CI)	Total:HDL ratio Mean (95% CI)
Total population		5.13 (5.08–5.18)	1.37 (1.35–1.39)	3.95 (3.89–4.01)
By age group (years)				
Males	15–18	4.03 (3.89–4.18)	1.21 (1.17–1.26)	3.44 (3.28–3.59)
	19–30	4.86 (4.68–5.04)	1.24 (1.20–1.29)	4.07 (3.85–4.29)
	31–50	5.44 (5.33–5.56)	1.23 (1.19–1.27)	4.65 (4.51–4.80)
	51–70	5.23 (5.09–5.37)	1.25 (1.21–1.30)	4.41 (4.21–4.61)
	71+	4.67 (4.56–4.78)	1.22 (1.18–1.25)	4.05 (3.86–4.24)
	Total	5.09 (5.01–5.16)	1.23 (1.21–1.26)	4.32 (4.22–4.41)
Females	15–18	4.44 (4.33–4.56)	1.33 (1.29–1.37)	3.43 (3.32–3.53)
	19–30	4.67 (4.54–4.80)	1.44 (1.39–1.49)	3.39 (3.25–3.53)
	31–50	5.04 (4.94–5.14)	1.48 (1.44–1.52)	3.56 (3.45–3.67)
	51–70	5.79 (5.66–5.93)	1.60 (1.55–1.66)	3.85 (3.71–4.00)
	71+	5.51 (5.34–5.67)	1.53 (1.48–1.58)	3.74 (3.63–3.86)
	Total	5.17 (5.10–5.24)	1.50 (1.47–1.52)	3.61 (3.55–3.68)
Māori				
Male	15–18	4.32 (3.87–4.78)	1.24 (1.11–1.37)	3.63 (3.15–4.10)
	19–30	4.97 (4.66–5.29)	1.19 (1.14–1.24)	4.36 (3.83–4.88)
	31–50	5.54 (5.34–5.74)	1.17 (1.11–1.23)	5.00 (4.69–5.30)
	51+	5.30 (4.91–5.70)	1.32 (1.18–1.46)	4.19 (3.89–4.48)
	Total	5.17 (4.99–5.35)	1.22 (1.17–1.26)	4.47 (4.24–4.69)
Female	15–18	4.18 (3.92–4.43)	1.33 (1.23–1.43)	3.21 (3.03–3.39)
	19–30	4.38 (4.20–4.57)	1.39 (1.30–1.48)	3.30 (3.08–3.52)
	31–50	4.91 (4.76–5.07)	1.34 (1.29–1.39)	3.80 (3.66–3.95)
	51+	5.53 (5.20–5.86)	1.41 (1.35–1.47)	4.08 (3.78–4.39)
	Total	4.81 (4.67–4.94)	1.37 (1.33–1.40)	3.65 (3.52–3.78)
Pacific				
Males	15–18	[1]	[1]	[1]
	19–30	5.06 (4.70–5.42)	1.13 (1.05–1.21)	4.70 (4.17–5.22)
	31–50	5.21 (4.98–5.44)	1.29 (1.15–1.44)	4.30 (3.84–4.76)
	51+	5.06 (4.73–5.39)	1.16 (1.07–1.25)	4.53 (4.21–4.86)
	Total	4.97 (4.77–5.17)	1.20 (1.13–1.26)	4.38 (4.09–4.67)
Females	15–18	[1]	[1]	[1]
	19–30	4.43 (4.17–4.68)	1.24 (1.16–1.31)	3.75 (3.47–4.02)
	31–50	4.99 (4.76–5.21)	1.24 (1.19–1.28)	4.16 (3.93–4.39)
	51+	4.84 (4.54–5.15)	1.32 (1.21–1.42)	3.84 (3.54–4.14)
	Total	4.68 (4.52–4.84)	1.27 (1.22–1.31)	3.84 (3.69–3.99)

		Total cholesterol (mmol/L) Mean (95% CI)	HDL cholesterol (mmol/L) Mean (95% CI)	Total:HDL ratio Mean (95% CI)
NZEO				
Males	15–18	4.07 (3.90–4.24)	1.22 (1.17–1.27)	3.45 (3.27–3.62)
	19–30	4.81 (4.60–5.02)	1.25 (1.20–1.31)	3.96 (3.72–4.20)
	31–50	5.45 (5.32–5.58)	1.23 (1.19–1.27)	4.63 (4.47–4.79)
	51+	5.09 (4.98–5.21)	1.24 (1.21–1.28)	4.32 (4.15–4.49)
	Total	5.09 (5.01–5.18)	1.24 (1.22–1.26)	4.30 (4.20–4.41)
Females	15–18	4.49 (4.37–4.61)	1.34 (1.30–1.38)	3.46 (3.34–3.57)
	19–30	4.74 (4.59–4.88)	1.46 (1.40–1.52)	3.38 (3.22–3.55)
	31–50	5.06 (4.95–5.18)	1.51 (1.47–1.56)	3.50 (3.37–3.62)
	51+	5.75 (5.64–5.86)	1.60 (1.55–1.65)	3.81 (3.69–3.93)
	Total	5.22 (5.15–5.30)	1.52 (1.50–1.55)	3.59 (3.52–3.67)
By NZDep2006 quintile				
Males	1	5.10 (4.93–5.27)	1.26 (1.22–1.30)	4.19 (4.00–4.38)
	2	5.06 (4.89–5.23)	1.24 (1.18–1.29)	4.33 (4.08–4.57)
	3	5.12 (4.93–5.31)	1.29 (1.23–1.34)	4.18 (3.99–4.38)
	4	5.02 (4.85–5.18)	1.22 (1.17–1.26)	4.31 (4.10–4.52)
	5	5.14 (4.97–5.31)	1.16 (1.13–1.20)	4.60 (4.39–4.82)
Females	1	5.30 (5.11–5.49)	1.62 (1.56–1.68)	3.38 (3.22–3.55)
	2	5.26 (5.09–5.42)	1.54 (1.47–1.60)	3.61 (3.45–3.77)
	3	5.22 (5.09–5.35)	1.52 (1.47–1.58)	3.61 (3.46–3.76)
	4	5.07 (4.95–5.20)	1.43 (1.40–1.47)	3.68 (3.55–3.81)
	5	5.00 (4.87–5.14)	1.39 (1.34–1.44)	3.75 (3.62–3.88)

1 Results not reported due to small sample size.

8.5 Folate status

Folate[1] is essential for DNA synthesis, and is especially important during periods of increased cell replication and growth. Folate has a role in erythropoiesis (red blood cell formation/production), and therefore a deficiency in this vitamin can result in megaloblastic anaemia (Mann and Truswell 2007).

In addition, inadequate folic acid levels during pregnancy have been associated with an increased risk of neural tube defects (NTDs), a major group of birth defects in the developing foetus (MRC Vitamin Study Research Group 1991). To reduce the incidence of NTDs, the Ministry of Health recommends that women of child-bearing age who plan to become pregnant take 800 µg of folic acid daily for at least four weeks prior to conception and for 12 weeks after conceiving.

[1] 'Folate' is a generic term for compounds that have a common vitamin activity (COMA 2000) and includes both folic acid (a synthetic compound) and naturally occurring compounds in food.

Since 1996 voluntary fortification of selected foods (eg, breakfast cereals, flour, breads) with folic acid has been permitted. A standard for the mandatory fortification of bread with folic acid was to come into effect in September 2009, but the implementation of the standard was deferred for review in May 2012. In the interim, the bread industry has agreed to increase the fortification of bread with folic acid voluntarily. Because the 2008/09 NZANS took place before any increase in uptake of voluntary folic acid fortification, the results presented in this report will provide a baseline to which the effects of this increased voluntary fortification can be compared.

Reliable data on intake of naturally occurring folate and of folic acid (from fortified foods) are not available due to limitations in analytical techniques and because data for folic acid is largely based on the manufacturer's information on product labels, which is often higher than analytical values. However, folate status can be assessed by direct measurement of folate in serum and red blood cells. Red blood folate concentration is an indicator of long-term status, while serum folate indicates folate status at the time the blood sample was drawn.

Red blood folate concentration was calculated using measurements of whole blood folate, serum folate and haematocrit, as follows (Senti and Pilch 1985):

$$\text{RBC folate (units)} = \frac{\text{WB folate (units)} - (\text{serum folate (units)} \times (1 - \text{Hct}))}{\text{Hct}}$$

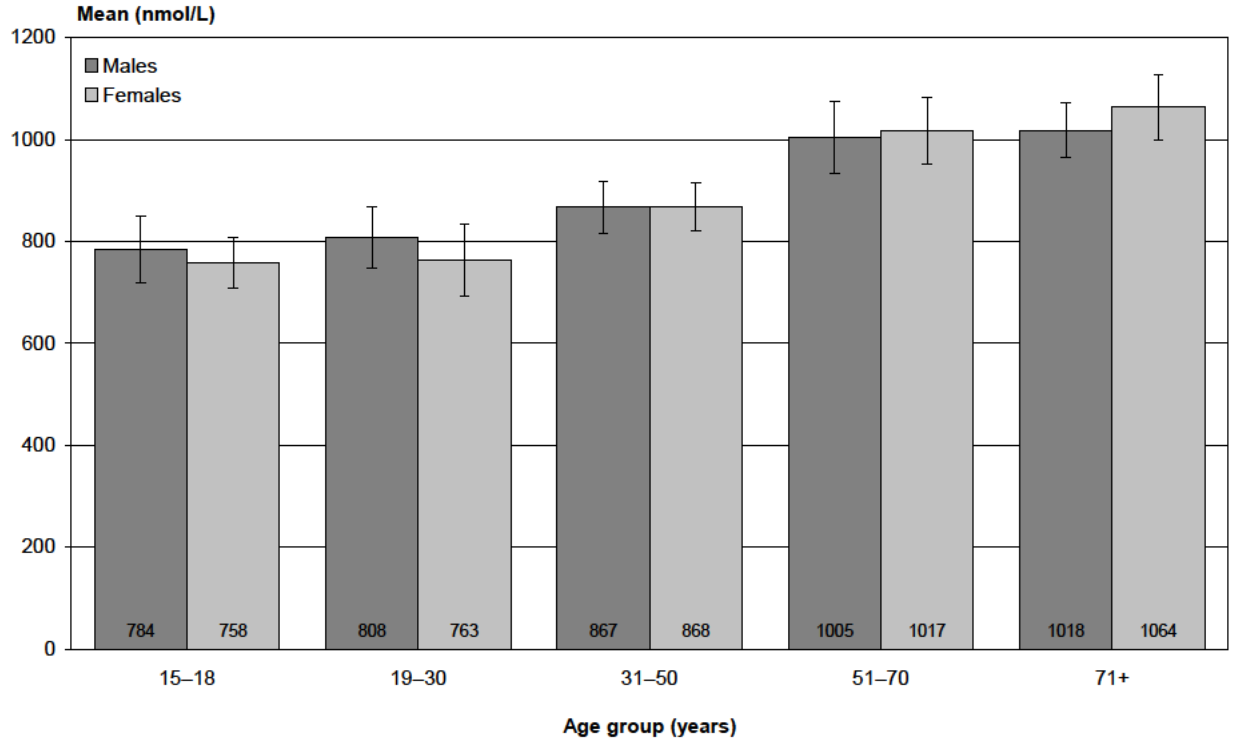
Measures of low folate status were defined as follows (Wright et al 1998):

- low red blood folate: < 317 nmol/L
- low serum folate: < 6.8 mmol/L.

Red blood folate

The mean red blood folate concentration in the New Zealand population was 900 nmol/L, with similar levels in males (899 nmol/L) and females (901 nmol/L) (Table 8.7). Mean red blood folate increased in males from 784 nmol/L (15–18 years) to 1018 nmol/L (71+ years), and in females from 758 nmol/L (15–18 years) to 1064 nmol/L (71+ years) (Figure 8.6).

Figure 8.6: Mean red blood cell folate (nmol/L), by age group and sex



Mean red blood folate concentrations did not differ between males and females or across age groups in Māori or Pacific people.

Males living in NZDep2006 quintile 5 had a lower mean red blood folate (794 nmol/L) than those in NZDep2006 quintile 1 (957 nmol/L). Overall, mean red blood folate decreased with increasing neighbourhood deprivation, after adjusting for age, sex and ethnic group.

Only 2.2% of the New Zealand population aged 15 years and over had low red blood folate (< 317 nmol/L).

The prevalence of low red blood folate was 7.6% in males living in NZDep2006 quintile 5, while all other quintiles were 1.0% or less. Overall, there was no gradient in the prevalence of low red blood folate across NZDep2006 quintiles after adjusting for age, sex and ethnic group.

Serum folate

The mean serum folate concentration was 29.0 nmol/L (Table 8.7). Females had a higher serum folate (31.1 nmol/L) than males (26.7 nmol/L).

Mean serum folate increased in females from 24.4 nmol/L (15–18 years) to 39.7 nmol/L (71+ years). Mean serum folate concentrations did not differ between males and females or across age groups in Māori or Pacific people.

Females living in NZDep2006 quintile 1 had a mean serum folate of 36.0 nmol/L compared to 26.0 nmol/L among those living in NZDep2006 quintile 5. Overall, mean serum folate concentrations decreased with increasing neighbourhood deprivation, after adjusting for age, sex and ethnic group.

Overall, 1.6% of the population had low serum folate (< 6.8 nmol/L).

In quintile 5, 2.9% of females had low serum folate. Overall, the prevalence of low serum folate increased with increasing neighbourhood deprivation, after adjusting for age, sex and ethnic group.

Folate status among women of child-bearing age (16–44 years)

Low serum folate and red blood levels have been associated with increasing risk of NTDs in a continuous dose–response relationship (Daly et al 1995). Red blood folate levels are presented here because they represent long-term folate status and are not influenced by recent dietary intake. Red blood folate levels ≥ 906 nmol/L are associated with a very low risk of NTDs, and levels ≤ 339 nmol/L are associated with a high risk.

Among women of child-bearing age, 27% had levels associated with a low risk of NTDs (≥ 906 nmol/L) and 4% had red blood folate levels associated with a high risk of NTDs (≤ 339 nmol/L).

Table 8.7: Folate, by age group, ethnic group, NZDep2006 and sex

		Red blood cell folate (nmol/L)		Serum folate (nmol/L)	
		Mean (95% CI)	**% low[1] (95% CI)**	**Mean (95% CI)**	**% low[2] (95% CI)**
Total population		900 (877–922)	2.2 (1.4–2.9)	29.0 (27.9–30.1)	1.6 (1.1–2.2)
By age group (years)					
Males	15–18	784 (720–849)	1.0 (0.2–3.0)	26.4 (23.5–29.4)	2.3 (0.4–4.2)
	19–30	808 (747–869)	4.5 (0.2–8.0)	24.0 (21.7–26.3)	2.9 (0.5–8.5)
	31–50	867 (817–918)	1.6 (0.1–3.1)	24.7 (22.8–26.7)	1.8 (0.2–3.5)
	51–70	1005 (934–1076)	0.4 (0.1–1.1)	29.9 (25.8–33.9)	0.5 (0.0–1.1)
	71+	1018 (964–1072)	2.0 (0.6–3.3)	31.6 (27.8–35.4)	1.8 (0.6–3.0)
	Total	899 (866–931)	1.8 (0.8–2.9)	26.7 (25.2–28.2)	1.7 (0.8–2.7)
Females	15–18	758 (708–808)	3.3 (0.8–5.7)	24.4 (22.4–26.4)	1.8 (0.1–3.5)
	19–30	763 (692–834)	5.3 (1.1–9.6)	29.2 (25.2–33.2)	1.8 (0.4–5.0)
	31–50	868 (821–915)	2.4 (0.7–4.1)	29.1 (26.2–32.0)	1.8 (0.4–3.1)
	51–70	1017 (952–1083)	1.0 (0.0–2.0)	33.8 (30.8–36.8)	1.3 (0.0–2.6)
	71+	1064 (999–1128)	1.1 (0.1–2.1)	39.7 (34.2–45.1)	0.8 (0.1–1.5)
	Total	901 (870–932)	2.5 (1.4–3.6)	31.1 (29.4–32.8)	1.6 (0.8–2.3)
Māori					
Male	15–18	741 (576–906)	0.0	25.6 (17.1–34.2)	0.0
	19–30	727 (637–817)	6.4 (0.2–30.6)	22.1 (17.6–26.7)	0.0
	31–50	850 (717–982)	0.5 (0.0–3.0)	26.7 (23.3–30.2)	1.3 (0.0–7.9)
	51+	860 (735–986)	1.4 (0.0–8.3)	28.7 (23.0–34.5)	1.2 (0 .0- 7.0)
	Total	804 (737–872)	2.2 (0.2–8.6)	25.7 (23.5–27.9)	0.7 (0.1–2.9)

		Red blood cell folate (nmol/L)		Serum folate (nmol/L)	
		Mean (95% CI)	% low[1] (95% CI)	Mean (95% CI)	% low[2] (95% CI)
Female	15–18	742 (637–847)	7.6 (1.3–21.8)	20.4 (17.1–23.6)	1.3 (0.0–7.7)
	19–30	751 (672–830)	0.9 (0.0–5.7)	34.0 (19.0–49.0)	4.3 (0.7–12.8)
	31–50	763 (690–837)	3.0 (0.1–5.8)	24.2 (21.4–27.0)	2.4 (0.5–6.6)
	51+	901 (803–998)	2.2 (0.2–8.5)	29.1 (25.3–32.9)	1.4 (0.2–4.4)
	Total	785 (739–830)	2.8 (1.0–4.5)	27.5 (23.1–32.0)	2.6 (0.7–4.5)
Pacific					
Males	15–18	[3]	[3]	[3]	[3]
	19–30	753 (668–837)	0.0	20.1 (16.0–24.3)	0.0
	31–50	691 (617–765)	5.4 (0.4–19.3)	19.1 (16.0–22.3)	2.3 (0.5–6.6)
	51+	822 (691–953)	9.1 (1.5–25.2)	22.0 (17.7–26.2)	7.1 (1.2–20.8)
	Total	739 (690–787)	3.2 (0.2–6.3)	20.9 (18.6–23.1)	2.0 (0.3–5.7)
Females	15–18	[3]	[3]	[3]	[3]
	19–30	709 (629–789)	4.6 (0.3–16.7)	19.5 (16.0–23.0)	4.5 (0.3–16.8)
	31–50	711 (647–774)	0.9 (0.0–5.2)	21.5 (19.2–23.9)	1.0 (0.0–6.2)
	51+	789 (688–890)	0.0	27.0 (22.9–31.1)	0.0
	Total	734 (693–774)	2.4 (0.0–4.8)	22.3 (20.2–24.4)	1.7 (0.3–5.2)
NZEO					
Males	15–18	808 (735–880)	1.2 (0.2–3.6)	26.6 (23.4–29.8)	2.8 (0.5–5.2)
	19–30	829 (755–903)	4.4 (0.9–12.4)	24.4 (21.7–27.1)	3.5 (0.6–10.3)
	31–50	878 (822–934)	1.4 (0.2–4.2)	24.7 (22.6–26.9)	1.9 (0.1–3.8)
	51+	1025 (966–1084)	0.5 (0.1–0.8)	30.7 (27.3–34.1)	0.6 (0.2–1.1)
	Total	919 (882–955)	1.6 (0.5–2.6)	27.0 (25.4–28.7)	1.8 (0.8–2.8)
Females	15–18	749 (692–805)	3.1 (0.5–5.7)	24.8 (22.7–27.0)	2.1 (0.2–4.1)
	19–30	771 (688–854)	5.7 (0.7–10.7)	29.5 (25.7–33.2)	1.1 (0.0–5.5)
	31–50	889 (836–942)	2.3 (0.4–4.3)	30.1 (26.8–33.3)	1.8 (0.3–3.4)
	51+	1043 (988–1099)	1.0 (0.2–1.7)	36.1 (33.2–39.0)	1.3 (0.2–2.3)
	Total	918 (884–953)	2.5 (1.3–3.7)	31.9 (30.1–33.7)	1.5 (0.7–2.3)
By NZDep2006 quintile					
Males	1	957 (882–1032)	0.2 (0.0–0.8)	29.2 (24.8–33.7)	0.1 (0.0–0.4)
	2	890 (838–943)	0.3 (0.1–1.0)	26.2 (23.1–29.3)	1.6 (0.2–5.2)
	3	983 (887–1078)	0.4 (0.1–1.2)	27.5 (24.6–30.3)	0.8 (0.0–1.5)
	4	863 (802–924)	1.0 (0.1–1.9)	25.7 (23.0–28.4)	2.3 (0.4–7.0)
	5	794 (733–856)	7.6 (2.5–12.6)	24.6 (21.9–27.4)	4.3 (1.0–7.5)
Females	1	957 (867–1048)	3.5 (0.8–9.1)	36.0 (30.5–41.5)	1.2 (0.0–5.7)
	2	954 (897–1011)	0.2 (0.0–0.9)	34.7 (30.6–38.8)	0.7 (0.1–2.1)
	3	914 (831–998)	4.6 (1.1–8.1)	31.7 (28.0–35.4)	1.7 (0.3–5.1)
	4	831 (780–881)	2.8 (0.5–5.2)	27.3 (24.9–29.7)	1.4 (0.4–2.3)
	5	846 (792–900)	1.9 (0.7–3.1)	26.0 (23.5–28.5)	2.9 (0.7–5.1)

1 < 317 nmol/L (Senti and Pilch 1985).

2 < 68 nmol/L (Senti and Pilch 1985).

3 Results not reported due to small sample size.

8.6 Diabetes and HbA1c

Diabetes is a metabolic condition which results in raised blood glucose. It is an important cause of morbidity and mortality in New Zealand. The presence of diabetes can lead to cardiovascular disease, blindness, kidney disease and vascular insufficiency. These vascular problems may lead to nerve damage in the feet, or amputation of the lower leg (Powers 2005).

Measurement of glycated haemoglobin (HbA1c) is the standard method for assessing long-term glycaemic (blood glucose level) control (over the previous 6–8 weeks) in people with diabetes (Powers 2005). It is the primary predictor of long-term complications of diabetes, with an HbA1c < 7.0% being the target for most people with diabetes (Powers 2011). HbA1c can also be used as a diagnostic test for diabetes, with the diagnosis of diabetes made if HbA1c ≥ 6.5% (International Expert Committee 2009; World Health Organization 2011).

In the 2008/09 NZANS participants were asked if they had ever been told by a doctor that they have diabetes (other than during pregnancy) and HbA1c levels were measured in blood.

Mean HbA1c

The mean HbA1c level was 5.57%, with similar levels for males (5.62%) and females (5.52%) (Table 8.8). Males and females aged 71+ years (6.01% and 5.52% respectively) had the highest levels of HbA1c, and there was a consistent upward trend from 19–30 years through to 71+ years for both males and females.

Mean HbA1c levels were highest in those aged 51+ years for Māori and Pacific males and females. There was a marked upward trend in HbA1c in both Māori and Pacific males and in females from 19–30 years to 51+ years.

Females living in NZDep2006 quintile 5 had higher mean levels of HbA1c than females living in NZDep2006 quintile 1. Overall, mean HbA1c levels increased with increasing neighbourhood deprivation, after adjusting for age, sex and ethnic group.

Prevalence of diabetes

The prevalence of total diabetes has been calculated by combining the prevalence of diabetes diagnosed by a doctor and the prevalence of undiagnosed diabetes (not diagnosed by a doctor and HbA1c ≥ 6.5%). The denominator for diagnosed diabetes includes all participants, whereas the denominator for undiagnosed diabetes only includes participants who reported they had not been diagnosed with diabetes and provided a blood sample. Therefore, total diabetes is not equal to the sum of diagnosed and undiagnosed because the denominators differ.

The survey revealed that 4.9% of the population 15 years and over had doctor-diagnosed diabetes (excluding diabetes during pregnancy) (males 6.0%; females 4.0%) (Table 8.8). Among the population not diagnosed with diabetes and who provided a blood sample, 2.0% had HbA1c levels ≥ 6.5%, which is indicative of undiagnosed diabetes (males 2.4%; females 1.6%). The total prevalence of diabetes in the

population 15 years and over (both doctor-diagnosed and undiagnosed) was 7.1% (males 8.4%; females 5.9%).

The prevalence of diabetes may be underestimated as undiagnosed diabetes could not be determined for participants who did not provide a blood sample.

Diabetes management

Measurement of glycated haemoglobin (HbA1c) is the standard method for assessing long-term glycaemic (blood glucose level) control (over the previous 6–8 weeks) in people with diabetes. Just under half (48.5%) of the total population 15 years and over had HbA1c levels < 7.0%, indicating good control of blood glucose levels (males 48.1%; females 48.9%) (Table 8.8).

Table 8.8: HbA1c, by age group, ethnic group, NZDep2006 and sex

		HbA1c (%)	Prevalence of diabetes			Diabetes management
		Mean (95% CI)	Diagnosed by a doctor	Undiagnosed diabetes (not diagnosed by a doctor and HbA1c ≥ 6.5%)	Total[1]	Good management among those diagnosed with diabetes (HbA1c < 7.0%)
Total population		5.57 (5.54–5.60)	4.9 (4.2–5.7)	2.0 (1.4–2.6)	7.1 (6.0–8.1)	48.5 (39.9–57.0)
By age group (years)						
Males	15–18	5.28 (5.22–5.33)	0.2 #	0.4 (0.0–2.3)	0.7 (0.1–2.5)	[1]
	19–30	5.28 (5.21–5.36)	0.1#	1.1 (0.0–7.1)	1.6 (0.0–8.6)	[1]
	31–50	5.60 (5.49–5.71)	2.4 (0.9–3.8)	2.4 (0.9–5.2))	5.6 (2.9–8.4)	38.2 (2.1–90.6)
	51–70	5.87 (5.76–5.97)	12.8 (8.3–17.2)	3.1 (1.2–6.5)	14.3 (9.6–18.9)	41.9 (14.1–74.2)
	71+	6.01 (5.93–6.09)	18.0 (13.1–22.9)	6.1 (3.4–10.0)	23.7 (18.4–29.1)	63.2 (49.5–76.9)
	Total	5.62 (5.57–5.68)	6.0 (4.6–7.3)	2.4 (1.4–3.5)	8.4 (6.5–10.2)	48.1 (35.2–61.0)
Females	15–18	5.22 (5.17–5.27)	0.0	0.0	0.0	[1]
	19–30	5.22 (5.17–5.27)	0.1#	0.2 (0.0–1.2)	0.5 (0.1–1.4)	[1]
	31–50	5.44 (5.38–5.50)	2.4 (1.3–4.1)	1.6 (0.8–3.0)	4.5 (2.7–6.4)	51.6 (0.1–99.9)
	51–70	5.76 (5.69–5.83)	7.0 (4.5–9.5)	2.0 (1.1–3.5)	8.9 (5.9–11.9)	49.8 (26.6–73.0)
	71+	5.97 (5.89–6.05)	12.1 (8.6–15.5)	4.7 (2.6–7.7)	16.8 (12.5–21.1)	45.7 (28.9–62.6)
	Total	5.52 (5.48–5.56)	4.0 (3.1–4.8)	1.6 (1.1–2.1)	5.9 (4.8–6.9)	48.9 (35.9–61.9
Māori						
Male	15–18	5.32 (5.20–5.45)	0.0	0.0	0.0	[1]
	19–30	5.45 (5.37–5.53)	0.0	0.0	0.0	[1]
	31–50	6.18 (5.67–6.69)	6.1 (1.7–14.8)	2.7 (0.6–7.4)	10.7 (4.6–20.3)	[1]
	51+	6.50 (5.91–7.09)	20.9 (12.3– 32.0)	5.3 (0.7–17.3)	26.8 (15.6–40.5)	[1]
	Total	5.93 (5.70–6.16)	6.8 (4.3–9.3)	2.0 (0.7–4.4)	9.7 (6.0–13.5)	25.7 (8.8–50.6)
Female	15–18	5.29 (5.13–5.46)	0.0	0.0	0.0	[1]
	19–30	5.38 (5.28–5.48)	0.4 #	1.3 (0.0–7.5)	2.2 (0.2–8.1)	[1]
	31–50	5.59 (5.49–5.69)	5.0 (0.7–15.6)	3.4 (1.3–7.1)	8.0 (3.9–14.1)	[1]
	51+	6.27 (6.00–6.53)	23.8 (15.1– 32.5)	5.1 (1.5–12.1)	28.4 (16.9–40.0)	42.6 (13.7–75.8)
	Total	5.64 (5.55–5.73)	7.1 (4.7–9.5)	2.7 (1.4–4.6)	9.8 (6.5–13.1)	44.0 (19.2–71.3)

		HbA1c (%)	Prevalence of diabetes			Diabetes management
		Mean (95% CI)	Diagnosed by a doctor	Undiagnosed diabetes (not diagnosed by a doctor and HbA1c ≥ 6.5%)	Total[1]	Good management among those diagnosed with diabetes (HbA1c < 7.0%)
Pacific						
Males	15–18	[2]	0.0	0.0	0.0	[2]
	19–30	5.52 (5.35–5.69)	1.2[#]	9.1 (0.6–34.0)	12.1 (1.8–35.6)	[2]
	31–50	6.00 (5.72–6.29)	8.4 (3.9–15.1)	4.9 (1.8–10.3)	11.6 (5.7–20.2)	[2]
	51+	6.76 (6.22–7.30)	22.7 (12.8–35.6)	18.2 (4.2–43.4)	38.3 (23.4–54.9)	[2]
	Total	5.83 (5.66–6.00)	7.8 (5.4–10.2)	7.9 (2.6–17.6)	14.8 (7.0–22.6)	[2]
Females	15–18	[2]	0.0	0.0	0.0	[2]
	19–30	5.41 (5.30–5.52)	0.7 [#]	0.0	1.3 (0.0–7.6)	[2]
	31–50	6.17 (5.82–6.53)	9.2 (4.3–16.8)	8.8 (3.7–16.8)	18.6 (10.9–28.8)	[2]
	51+	6.35 (6.04–6.66)	21.4 (12.7–32.5)	17.6 (6.7–34.5)	37.3 (22.9–53.5)	[2]
	Total	5.87 (5.70–6.04)	8.0 (5.5–10.4)	6.2 (3.5–10.2)	14.9 (10.7–19.2)	[2]
NZEO						
Males	15–18	5.29 (5.23–5.34)	0.2[#]	0.5 (0.0–2.8)	0.8 (0.1–3.0)[#]	[2]
	19–30	5.23 (5.14–5.32)	0.0	0.0	0.0	[2]
	31–50	5.50 (5.40–5.60)	1.5 (0.0–46.8)	2.1 (0.6–5.5)	4.4 (1.9–8.6)	[2]
	51+	5.85 (5.77–5.93)	13.3 (9.5–17.2)	3.2 (1.5–5.9)	15.3 (11.3–19.3)	51.1 (36.0–66.2)
	Total	5.57 (5.51–5.62)	5.6 (4.0–7.2)	2.0 (1.0–3.0)	7.5 (5.6–9.3)	50.8 (34.9–66.6)
Females	15–18	5.22 (5.17–5.26)	0.0	0.0	0.0	[2]
	19–30	5.19 (5.13–5.25)	0.1[#]	0.0	0.2 (0.0–0.9)	[2]
	31–50	5.38 (5.32–5.43)	1.5 (0.1–6.9)	1.0 (0.2–2.8)	3.1 (1.4–5.9)	[2]
	51+	5.77 (5.71–5.82)	7.1 (4.8–9.4)	2.2 (1.3–3.6)	9.3 (6.6–11.9)	51.9 (34.3–69.5)
	Total	5.48 (5.44–5.52)	3.3 (2.4–4.2)	1.2 (0.7–1.8)	4.7 (3.5–5.9)	52.3 (35.5–69.2)
By NZDep2006 quintile						
Males	1	5.57 (5.49–5.66)	5.7 (2.2–11.8)	1.5 (0.2–5.2)	8.3 (3.6–12.9)	[2]
	2	5.50 (5.38–5.63)	4.2 (1.2–10.4)	2.4 (0.5–7.0)	7.4 (3.2–14.3)	[2]
	3	5.64 (5.50–5.78)	5.5 (2.2–10.9)	2.9 (0.7–8.0)	8.7 (4.3–13.1)	[2]
	4	5.63 (5.51–5.74)	6.2 (3.6–8.9)	3.0 (1.0–6.7)	8.7 (5.0–12.3)	40.2 (11.9–74.5)
	5	5.77 (5.62–5.92)	8.5 (4.9–12.1)	2.5 (1.3–4.3)	8.9 (5.2–12.6)	40.8 (11.3–76.4)
Females	1	5.48 (5.39–5.57)	2.6 (0.7–6.3)	0.5 (0.1–2.0)	3.5 (1.5–7.0)	[2]
	2	5.47 (5.41–5.52)	2.1 (1.1–3.8)	1.1 (0.4–2.5))	3.4 (1.7–5.1)	[2]
	3	5.45 (5.38–5.52)	3.4 (1.7–6.0)	0.5 (0.1–1.3)	4.8 (2.0–7.6)	[2]
	4	5.54 (5.46–5.62)	4.3 (2.2–6.4)	2.8 (1.4–5.0)	6.9 (4.6–9.2)	47.1 (8.8–88.3)
	5	5.68 (5.58–5.77)	7.8 (5.3–10.2)	3.2 (1.7–5.6)	10.9 (7.6–14.2)	44.7 (23.0–68.0)

1 Total diabetes is not equal to the sum of diagnosed and undiagnosed because the denominators differ.

2 Results not reported due to small sample size.

Confidence interval could not be calculated. Estimate should be interpreted with caution.

8.7 Iodine status

Iodine is an essential component of thyroid hormones, which play a critical role in maintaining the body's metabolic rate and normal growth and mental development. There is a wide spectrum of iodine deficiency disorders (IDDs) affecting all life-cycle groups, from the foetus to adult. Mild to moderate iodine deficiency causes a range of disorders, including goitre (enlarged thyroid gland) and hypothyroidism. Severe iodine deficiency during foetal development impairs mental development (Mann and Truswell 2007).

More than 90% of iodine is excreted in the urine, so urinary iodine is a good indicator of recent iodine status. The following International Council for the Control of Iodine Deficiency Disorders (WHO 2007) cut-offs for iodine deficiencies were used to assess iodine deficiency. Where urinary iodine concentration was measured as 0–10 µg/L, it was replaced with the value 10 µg/L, which is the lowest detectable limit of the assay (ICCIDD 2000):

- mild iodine deficiency: median urinary iodine concentration 50–99 µg/L
- moderate iodine deficiency: median urinary iodine concentration 20–49 µg/L.

Median urinary iodine concentration

The median urinary iodine concentration (MUIC) of the New Zealand population aged 15 years and over was 53 µg/L (males 55 µg/L; females 50 µg/L), which indicates mild iodine deficiency. MUICs were similar across all age groups (Table 8.9).

The MUIC was 55 µg/L for Māori males and 57 µg/L for Māori females; 74 µg/L for Pacific males and 72 µg/L for Pacific females.

In the general population 47% had urinary iodine concentrations < 50 µg/L and 79% had concentrations < 100 µg/L. The ICCIDD suggests that no more than 20% of a population should have urinary iodine concentration below 50 µg/L (moderate deficiency).

The proportion of the population with an MUIC < 50 and < 100 µg/L was similar for males and females in all three ethnic groups. The proportion of the population with an MUIC < 50 and < 100 µg/L was also similar across all NZDep2006 quintiles. Overall, there was no gradient in median urinary iodine concentration across NZDep2006 quintiles after adjusting for age, sex and ethnic group.

Table 8.9: Urinary iodine, by age group, ethnic group, NZDep2006 and sex

		Median (µg/L) [1]	% <50 µg/L [2]	%<100 µg/L [2]
Total population		53 (50–56)	47 (44–50)	79 (77–81)
By age group (years)				
Males	15–18	52 (45–58)	46 (37–56)	80 (71–87)
	19–30	57 (51–66)	39 (30–49)	79 (70–86)
	31–50	52 (47–60)	47 (40–54)	81 (75–85)
	51–70	58 (49–68)	44 (38–51)	76 (70–81)
	71+	66 (59–75)	38 (31–45)	71 (65–76)
	Total	55 (52–61)	44 (40–48)	78 (75–81)
Females	15–18	53 (49–61)	45 (38–52)	78 (70–84)
	19–30	48 (42–55)	51 (42–60)	82 (75–87)
	31–50	46 (42–55)	53 (46–59)	82 (77–86)
	51–70	53 (45–60)	48 (41–54)	80 (75–85)
	71+	56 (49–64)	45 (39–51)	73 (67–79)
	Total	50 (47–55)	50 (46–54)	80 (78–83)
Māori				
Male	15–18	43 (30–76)	52 (28–75)	83 (55–95)
	19–30	53 (39–74)	45 (28–64)	79 (57–92)
	31–50	54 (41–67)	42 (30–55)	84 (73–91)
	51+	64 (46–86)	38 (23–55)	68 (55–78)
	Total	55 (47–65)	43 (35–53)	79 (70–86)
Female	15–18	49 (43–65)	49 (29–69)	80 (59–92)
	19–30	54 (42–64)	42 (29–57)	89 (81–94)
	31–50	56 (42–67)	46 (36–56)	79 (68–86)
	51+	63 (50–77)	39 (29–51)	70 (55–81)
	Total	57 (50–63)	44 (37–51)	80 (74–85)
Pacific				
Males	15–18	[3]	[3]	[3]
	19–30	68 (49–89)	34 (18–55)	73 (55–86)
	31–50	80 (67–92)	30 (20–44)	70 (55–82)
	51+	96 (73–123)	24 (13–39)	54 (39–68)
	Total	74 (64–91)	30 (21–42)	68 (58–76)
Females	15–18	[3]	[3]	[3]
	19–30	66 (45–95)	39 (25–55)	68 (50–82)
	31–50	78 (65–94)	24 (16–35)	63 (51–75)
	51+	72 (56–90)	28 (17–43)	65 (50–78)
	Total	72 (64–90)	30 (23–38)	65 (55–73)

		Median (µg/L) [1]	% <50 µg/L [2]	%<100 µg/L [2]
NZEO				
Males	15–18	53 (46–57)	46 (37–56)	80 (71–87)
	19–30	56 (51–67)	37 (27–49)	79 (68–87)
	31–50	51 (45–58)	48 (40–57)	81 (74–87)
	51+	58 (50–66)	44 (38–50)	76 (71–81)
	Total	55 (51–60)	44 (40–49)	79 (75–82)
Females	15–18	50 (47–56)	49 (41–56)	80 (73–86)
	19–30	47 (39–54)	53 (42–64)	83 (75–89)
	31–50	45 (41–52)	55 (48–62)	84 (78–88)
	51+	52 (47–59)	48 (43–53)	79 (75–83)
	Total	48 (45–53)	51 (47–56)	82 (79–84)
By NZDep2006 quintile				
Males	1	55 (47–64)	45 (36–53)	78 (70–84)
	2	51 (45–63)	48 (38–57)	81 (73–88)
	3	56 (47–64)	46 (37–55)	84 (76–89)
	4	55 (48–61)	44 (36–52)	78 (69–85)
	5	66 (54–81)	36 (29–44)	69 (62–75)
Females	1	51 (44–57)	49 (42–56)	83 (76–88)
	2	45 (38–57)	54 (45–62)	80 (73–85)
	3	48 (42–61)	51 (43–59)	86 (80–90)
	4	48 (43–56)	52 (45–59)	77 (70–83)
	5	56 (50–63)	42 (36–49)	76 (71–81)

1 Mild iodine deficiency: median urinary iodine concentration 50–99 µg/L; moderate iodine deficiency: median urinary iodine concentration 20–49 µg/L; severe iodine deficiency: median urinary iodine concentration < 20 µg/L.

2 WHO/UNICEF/ICCIDD recommend that no more than 50% of the population have a MUIC < 100 ug/L, and no more than 20% have a MUIC < 50 ug/L.

3 Results not reported due to small sample size.