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Prevalence of diagnosed and undiagnosed diabetes and prediabetes in New Zealand: findings from the 2008/09 Adult Nutrition Survey

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Abstract

Aim To describe the prevalence of diagnosed and undiagnosed diabetes and prediabetes for New Zealand adults.

Methods The 2008/09 New Zealand Adult Nutrition Survey was a nationally representative, cross-sectional survey of 4,721 New Zealanders aged 15 years and above. Self-reported diabetes and the 2010 American Diabetes Association cutoffs for HbA1c were used to define diagnosed diabetes, undiagnosed diabetes and prediabetes. Prevalence rates were calculated and age-specific diagnosed diabetes rates were compared with those from the Virtual Diabetes Register.

Results Overall, prevalence of diabetes was 7.0%, and prevalence of prediabetes 25.5%. Prevalence of diabetes was higher in men (8.3%, 95% CI: 6.4, 10.1) than in women (5.8%, 95% CI: 4.7, 7.0), and was higher among the obese (14.2%, 95% CI: 11.6, 16.9) compared with the normal weight group (2.5%, 95% CI: 1.4, 3.6). Prevalence of undiagnosed diabetes was highest among Pacific people (6.4%, 95% CI: 3.8, 9.1) compared with Māori (2.2%, 95% CI: 1.2, 3.1) and New Zealand European and Others (1.5%, 95% CI: 0.9, 2.1).

Conclusion The high prevalence of prediabetes indicates the prevalence of diabetes will continue to increase in New Zealand. Implementation of effective evidence-based prevention strategies is required to reduce the increasing costs of the diabetes epidemic.

Diabetes is a common chronic disease with significant morbidity, mortality and cost, and the prevalence continues to increase rapidly worldwide.[1,2] Estimates of the prevalence of diabetes in New Zealand have limitations. The four national health surveys, undertaken in 1992/93, 1996/97, 2002/03 and 2006/07, examined self-reports of doctor-diagnosed diabetes only.[3-6]

New Zealand's Virtual Diabetes Registry (VDR), established by the Ministry of Health over the past 10 years, counts known diabetes cases as follows: individuals with diabetes are identified using the National Health Index from six databases with information about hospital admissions, attendance at diabetes outpatients or retinal screening, diabetes-specific medication prescriptions, laboratory HbA1c testing and mortality.[7]

As national diabetes prevalence estimates have not included undiagnosed diabetes cases, the actual burden of disease has been underestimated. A number of local or workplace-based prevalence surveys conducted since 1967 have reported both

diagnosed and undiagnosed diabetes,[8-22] but the study populations were not necessarily representative of New Zealand's population.

National and international reports of diabetes prevalence in New Zealand have involved assumptions and modelling rather than direct measurements.[23,24]

The 2008/09 New Zealand Adult Nutrition Survey (2008/09 NZANS) enquired about doctor diagnosed diabetes and a blood sample was taken for the measurement of glycated haemoglobin (HbA1c). Thus the 2008/09 NZANS has provided an opportunity to report the national prevalence of diabetes and prediabetes in adult New Zealanders using American Diabetes Association (ADA) criteria.[25]

We also compared the prevalence of diagnosed diabetes in the 2008/09 NZANS with that obtained from New Zealand's national VDR.

Methods

The 2008/09 NZANS was a nationally representative, cross-sectional survey of 4,721 New Zealanders aged 15 years and above.[26] Ethical approval to undertake the survey was obtained from the New Zealand Health and Disability Multi-Region Ethics Committee (MEC/08/04/049).

The survey methods are described in detail elsewhere.[27] In brief, an area-based sampling frame was used based on 32,173 small geographic areas (meshblocks). 607 meshblocks were selected using probability-proportional-to-size design.

Within each selected meshblock private dwelling households in both urban and rural areas were randomly selected, then a single individual within each household was randomly selected. To ensure adequate samples for analysis, increased sampling occurred for the following groups: Māori, Pacific and the age groups, 15-18 years and 71+ years. The survey was conducted from 13 October 2008 to 4 October 2009. Informed written consent was obtained from the participant. The response rate for the survey was 61%.[26,27]

Data—Data were obtained at participants' homes by trained interviewers using computer-assisted personal interview software. All measurements were taken by trained interviewers using calibrated instruments. Data collected included: demographics, tobacco use, alcohol consumption, medical history including a specific question about diabetes. Ethnicity was self-reported, with the option to choose up to nine different groups using the Statistics New Zealand standard ethnicity question.[27]

Standing height was measured to the nearest 0.1 cm using a stadiometer (Seca 214) and weight was measured to the nearest 0.1 kg using electronic scales (Tanita HD-351, maximum weight 200kg). Height and weight were both measured twice, then if each duplicate measurement differed by more than 1%, a third measurement was taken. The mean of the two closest measurements was calculated and used in analyses.

A blood sample was obtained from 3,348 participants (71% of the survey respondents). Participants attended a local health clinic, where a non-fasting blood sample was collected in EDTA-treated vacutainers. These were kept at 4°C, until transported to Canterbury Health Laboratories. $HbA1_c$ was determined in whole blood using an ion-exchange high performance liquid chromatography method (Bio-rad Variant II). Samples were not collected from pregnant women, as pregnancy alters biochemical indices.

Definitions—For this study 'diagnosed diabetes' was defined as self-reported doctor-diagnosed diabetes. To allow international comparisons we used the 2010 ADA cutoffs for HbA1c to define 'undiagnosed diabetes' and 'prediabetes'.[25] Undiagnosed diabetes included those who had an HbA1c ≥ 6.5% (48mmol/mol), but did not self-report doctor-diagnosed diabetes.

Prediabetes included those who had an HbA1c result between 5.7% (39mmol/mol) and 6.4% (46mmol/mol) inclusive, but did not self-report doctor diagnosed diabetes. The 2010 ADA criteria differ from the recently revised 2012 New Zealand criteria, which coincided with a change in HbA1c units from % to mmol/mol. The New Zealand cutoffs are - diabetes: HbA1c ≥50mmol/mol (6.7%) and prediabetes: HbA1c 41-49 mmol/mol (5.8% - <6.7%).[28]

Statistical analysis—Survey weights[27] were used in all analyses so that no group was under- or over-represented. The weights reflect the probabilities of selection of each respondent, and correct for any discrepancies between the survey sample distribution and the population with respect to age, sex and ethnicity. For this survey the estimated resident population aged 15 years and over living in private dwellings in New Zealand at 30 June 2007 was used.[26,27]

Age-specific rates of self-reported diabetes, undiagnosed diabetes, total diabetes and prediabetes were calculated for men and women by 10 year age groups (15-24, 25-34, 35-44, 45-54, 55-64, 65-74, ≥75 years). Data were extracted from the VDR as at 31 December 2010. Age-specific diabetes rates were calculated for men and women by 10-year age groups as specified above. The 10-year age-specific self-reported diabetes rates using the 2008/09 NZANS data were compared with those obtained from the VDR and the 2006/07 New Zealand Health Survey.[5]

450 participants reported more than one ethnic group.[26,27] We used prioritised ethnicity,[4] and categorised participants into three ethnic groups: Māori, Pacific, and New Zealand European and Other (NZEO), where 'Other' includes mainly Asian, Middle-Eastern, Latin-American and African ethnic groups. Because of small numbers in some age groups within each ethnic group, broader age groups were used when calculating the ethnic-specific rates (15-24, 25-44, 45-64, 65-74, ≥75 years).

Body mass index (BMI) was calculated as weight (kg) / [height (m)].[2] The World Health Organization BMI cutoff points were used to define the following categories for participants aged 19 years and over: normal weight (BMI 18.50–24.99 kg/m^2), overweight (BMI 25.00–29.99 kg/m^2), obese (BMI≥30.00 kg/m^2). [29] For participants aged 15–18 years, the Cole gender and age-specific BMI cutoff points were used.[30,31] Diabetes and prediabetes rates were calculated for men and women for each of the three body weight categories.

Previous diabetes prevalence surveys—A literature search was undertaken to identify all published diabetes prevalence studies undertaken at a regional or national level in New Zealand. The methods and results for each study were summarised and tabulated.

Results

Overall the prevalence of diabetes was 7.0% (95% CI: 6.0, 8.0). Diabetes was more common among men (8.3%; 95% CI: 6.4, 10.1) compared with women (5.8%; 95% CI: 4.7, 7.0). The prevalence of diagnosed diabetes was 6.0% (95% CI: 4.5, 7.5) among men and 4.0% (95% CI: 3.1, 4.8) among women, and the prevalence of undiagnosed diabetes was 2.1% (95% CI: 1.2, 3.0) among men and 1.5% (95% CI: 1.0, 2.0) among women.

Table 1 shows the age-specific rates for diagnosed diabetes, undiagnosed diabetes, total diabetes and prediabetes for men and women aged 15 years and over. For both men and women, the prevalence of diagnosed diabetes and total diabetes increased with increasing age, notably from the 35–44 year age group, for whom the prevalence of total diabetes was 5%.

The age-specific undiagnosed diabetes rates varied among the age groups. Among men aged <45 years with diabetes, a high proportion had undiagnosed diabetes, particularly men aged 25-34 years for whom the ratio of diagnosed diabetes to undiagnosed diabetes was 1:15. Prediabetes increased with increasing age, and was higher than diabetes in all age groups.

Diabetes and prediabetes were prevalent among Māori and Pacific peoples, and particularly high among Pacific peoples (Table 2). One-third or more of Pacific people aged 45 years and over had diabetes and more than one-third had prediabetes. Age-specific rates of undiagnosed diabetes were highest among Pacific peoples, for whom the ratio of diagnosed to undiagnosed diabetes was 5:4 compared with 10:3 for Māori and 10:1 for NZEO.

Table 1. The age-specific rates for self-reported doctor diagnosed diabetes, undiagnosed diabetes, total diabetes and prediabetes by 10-year age groups for men and women aged 15 years and over

Sex	Age groups (years)	Diagnosed Diabetes† % (95% CI)		Undiagnosed Diabetes‡ % (95% CI)		Total Diabetes‡ % (95% CI)		Prediabetes‡ % (95% CI)	
All	15–24	0.07	(0, 0.1)	0.1	(0, 0.3)	0.1	(0, 0.4)	8.4	(5.6, 11.2)
	25–34	0.8	(0, 1.6)	1.3	(0.1, 2.6)	2.4	(0.7, 4.1)	15.8	(11.2, 20.4)
	35–44	1.9	(0.9, 2.9)	2.1	(0.7, 3.5)	4.8	(2.6, 6.9)	21.7	(16.6, 26.7)
	45–54	4.0	(2.1, 5.9)	1.9	(0.4, 3.4)	6.0	(3.2, 8.7)	26.2	(20.7, 31.7)
	55–64	11.0	(7.2, 14.7)	2.9	(1.3, 4.6)	13.4	(9.3, 17.4)	40.7	(34.6, 46.9)
	65–74	12.8	(9.2, 16.4)	1.8	(0.8, 2.8)	14.7	(10.9, 18.6)	45.1	(39.3, 51.0)
	75+	15.4	(11.6, 19.2)	4.6	(2.8, 6.4)	21.3	(17.0, 25.6)	43.8	(39.1, 48.4)
	Total	4.9	(4.1, 5.8)	1.8	(1.3, 2.3)	7.0	(6.0, 8.0)	25.5	(23.5, 27.6)
Men	15–24	0.1	(0, 0.2)	0.2	(0, 0.5)	0.3	(0, 0.7)	10.2	(5.4, 15.0)
	25–34	0.1	(0, 0.3)	1.5	(0, 3.6)	1.8	(0, 3.9)	19.5	(12.0, 27.0)
	35–44	2.0	(0.4, 3.6)	2.2	(0, 4.6)	5.0	(1.4, 8.6)	25.2	(17.3, 33.0)
	45–54	4.6	(1.2, 7.9)	2.7	(0, 5.6)	7.1	(2.5, 11.8)	25.9	(17.5, 34.3)
	55–64	15.2	(8.2, 22.2)	3.5	(0.5, 6.6)	17.7	(10.2, 25.3)	43.8	(33.0, 54.5)
	65–74	16.4	(10.4, 22.3)	1.9	(0.5, 3.3)	18.7	(12.4, 25.1)	39.0	(30.5, 47.6)
	75+	19.4	(12.5, 26.3)	4.8	(2.1, 7.5)	25.4	(18.2, 32.6)	40.0	(33.0, 47.0)
	Total	6.0	(4.5, 7.5)	2.1	(1.2, 3.0)	8.3	(6.4, 10.1)	26.4	(23.2, 29.5)
Women	15–24	–*		–*		–*		6.7	(3.8, 9.6)
	25–34	1.5	(0, 3.0)	1.1	(0, 2.7)	3.0	(0.3, 5.7)	12.2	(7.1, 17.4)
	35–44	1.8	(0.5, 3.2)	2.0	(0.6, 3.4)	4.6	(2.1, 7.1)	18.6	(12.3, 24.9)
	45–54	3.4	(1.3, 5.6)	1.1	(0.1, 2.1)	4.8	(1.9, 7.7)	26.5	(19.0, 33.9)
	55–64	7.3	(3.7, 11.0)	2.4	(0.8, 4.0)	9.8	(5.5, 14.0)	38.2	(30.5, 45.9)
	65–74	9.6	(5.5, 13.6)	1.7	(0.3, 3.1)	11.1	(6.5, 15.7)	50.6	(42.9, 58.3)
	75+	12.0	(8.6, 15.5)	4.4	(1.9, 6.9)	17.6	(13.0, 22.2)	47.1	(40.8, 53.5)
	Total	4.0	(3.1, 4.8)	1.5	(1.0, 2.0)	5.8	(4.7, 7.0)	24.8	(22.0, 27.5)

† Total number completing the survey = 4721; ‡ Total number providing a sample for blood analysis = 3348; * Insufficient data to calculate rate.

Table 2. The age-specific rates for self-reported doctor diagnosed diabetes, undiagnosed diabetes and prediabetes by age group for Māori, Pacific and New Zealand European and Other (NZEO) ethnic groups

Ethnic Group	Age groups (years)	Diagnosed Diabetes† % (95% CI)		Undiagnosed' Diabetes‡ % (95% CI)		Total Diabetes‡ % (95% CI)		Prediabetes‡ % (95% CI)	
All	15-24	0.04	(0, 0.1)	0.1	(0, 0.3)	0.1	(0, 0.4)	8.4	(5.6, 11.2)
	25-44	1.4	(0.7, 2.1)	1.7	(0.8, 2.6)	3.7	(2.3, 5.0)	18.9	(15.4, 22.4)
	45-64	7.0	(5.0, 9.0)	2.3	(1.2, 3.5)	9.2	(6.8, 11.6)	32.5	(28.4, 36.5)
	65-74	12.8	(9.2, 16.4)	1.8	(0.8, 2.8)	14.7	(10.9, 18.6)	45.1	(39.3, 51.0)
	75+	15.4	(11.6, 19.2)	4.6	(2.8, 6.4)	21.3	(17.0, 25.6)	43.8	(39.1, 48.4)
	Total	4.9	(4.1, 5.8)	1.8	(1.3, 2.3)	7.0	(6.0, 8.0)	25.5	(23.5, 27.6)
Māori	15-24		-*		-*		-*	12.9	(5.7, 20.1)
	25-44	2.3	(0.8, 3.9)	2.3	(0.8, 3.8)	5.5	(2.8, 8.2)	31.0	(23.7, 38.3)
	45-64	16.4	(10.6, 22.1)	4.4	(1.6, 7.1)	20.8	(13.7, 27.9)	42.4	(33.1, 51.7)
	65-74	28.8	(15.0, 42.6)	1.1	(0, 3.2)	34.7	(18.3, 51.0)	51.0	(34.6, 67.4)
	75+	36.5	(15.6, 57.5)		-	40.1	(15.3, 64.9)	44.4	(16.8, 71.9)
	Total	7.0	(5.2, 8.9)	2.2	(1.2, 3.1)	9.8	(7.4, 12.2)	30.4	(25.8, 35.0)
Pacific	15-24		-*		-*		-*	13.6	(4.2, 23.1)
	25-44	4.5	(2.3, 6.7)	6.0	(1.8, 10.3)	10.7	(5.7, 15.7)	29.6	(22.4, 36.8)
	45-64	18.0	(11.9, 24.2)	12.7	(5.7, 19.7)	32.9	(21.7, 44.2)	38.7	(27.7, 49.7)
	65-74	27.6	(13.4, 41.9)	10.7	(0, 22.4)	34.2	(16.6, 51.8)	56.9	(37.8, 76.0)
	75+	39.0	(6.3, 71.7)		-*	55.8	(14.6, 96.9)		-*
	Total	8.1	(6.0, 10.3)	6.4	(3.8, 9.1)	15.4	(11.5, 19.4)	29.8	(24.8, 34.7)
NZEO	15-24	0.05	(0, 0.1)	0.1	(0, 0.3)	0.2	(0, 0.5)	7.0	(3.9, 10.2)
	25-44	1.0	(0.2, 1.8)	1.3	(0.2, 2.4)	2.8	(1.2, 4.4)	16.0	(11.9, 20.0)
	45-64	5.5	(3.3, 7.7)	1.7	(0.5, 2.9)	6.9	(4.3, 9.4)	31.1	(26.7, 35.6)
	65-74	11.6	(7.9, 15.3)	1.6	(0.5, 2.6)	13.2	(9.2, 17.2)	44.5	(38.3, 50.7)
	75+	14.5	(10.6, 18.4)	4.8	(2.9, 6.7)	20.3	(15.9, 24.6)	43.9	(39.1, 48.6)
	Total	4.5	(3.5, 5.4)	1.5	(0.9, 2.1)	6.1	(5.0, 7.3)	24.6	(22.4, 26.9)

† Total number completing the survey = 4721. ‡ Total number providing a sample for blood analysis = 3348; * Insufficient data to calculate the rate.

Table 3 shows prevalence rates for normal weight, overweight and obese groups. The rates of self-reported doctor diagnosed diabetes, undiagnosed diabetes and prediabetes were all higher among those categorised as obese compared with the overweight and normal weight groups.

Among the obese 14.2% (95% CI: 11.6, 16.9) had diabetes and 32.2% (95% CI: 28.3, 36.2) had prediabetes. Similar patterns were observed in both men and women.

Table 3. The age-specific rates for self-reported doctor diagnosed diabetes, undiagnosed diabetes and prediabetes by body weight category (normal weight, overweight and obesity)

Sex	Body Weight Category	Diagnosed Diabetes†		Undiagnosed Diabetes‡		Total Diabetes‡		Prediabetes‡	
		%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)
All	Normal weight	1.4	(0.6, 2.2)	0.7	(0.2, 1.3)	2.5	(1.4, 3.6)	19.5	(16.1, 22.9)
	Overweight	4.6	(3.2, 5.9)	1.3	(0.5, 2.0)	5.9	(4.3, 7.5)	26.9	(23.5, 30.2)
	Obese	9.8	(7.5, 12.0)	4.0	(2.7, 5.3)	14.2	(11.6, 16.9)	32.2	(28.3, 36.2)
Men	Normal weight	2.0	(0.3, 3.7)	1.0	(0, 2.2)	3.5	(1.1, 6.0)	19.1	(13.2, 24.9)
	Overweight	5.2	(3.2, 7.2)	1.8	(0.4, 3.2)	6.7	(4.3, 9.1)	25.9	(21.3, 30.4)
	Obese	11.4	(7.5, 15.3)	3.9	(1.8, 6.0)	15.9	(11.2, 20.5)	35.8	(29.4, 42.2)
Women	Normal weight	0.9	(0.4, 1.5)	0.5	(0.1, 1.0)	1.7	(0.8, 2.5)	19.8	(15.4, 24.2)
	Overweight	3.8	(2.1, 5.6)	0.6	(0.2, 1.1)	4.8	(2.8, 6.9)	28.1	(23.2, 32.9)
	Obese	8.2	(5.9, 10.5)	4.1	(2.4, 5.8)	12.7	(9.6, 15.7)	29.0	(23.7, 34.2)

† Total number completing the survey = 4721; ‡ Total number providing a sample for blood analysis = 3348.

Figures 1 and 2 compare the 10-year age-specific diagnosed diabetes rates between three sources of national diabetes prevalence data.

Overall, for men the age-specific rates are similar for most age groups. For women the age-specific diabetes rates using the VDR dataset are higher for women aged 55 years and over.

Tables 4–6 summarise and compare regional and national diabetes prevalence surveys undertaken in New Zealand since the late 1960s.

Figure 1. The 2006/07 New Zealand Health Survey, 2008/09 New Zealand Adult Nutrition Survey and the Virtual Diabetes Register age-specific diagnosed diabetes rates, by 10-year age groups for men aged 15 years and over

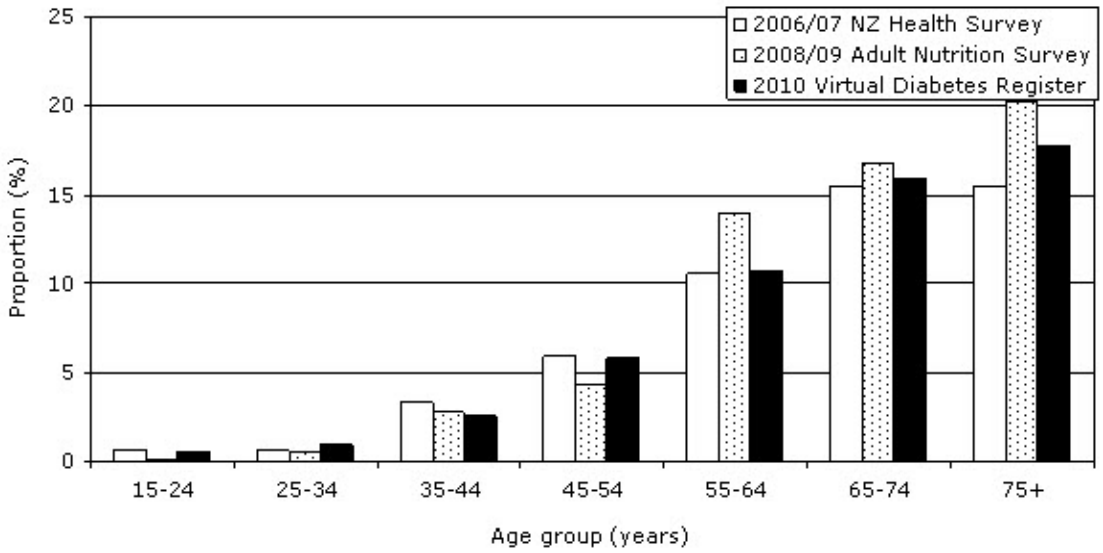

Figure 2. The 2006/07 New Zealand Health Survey, 2008/09 New Zealand Adult Nutrition Survey and the Virtual Diabetes Register age-specific diagnosed diabetes rates, by 10-year age groups for women aged 15 years and over.

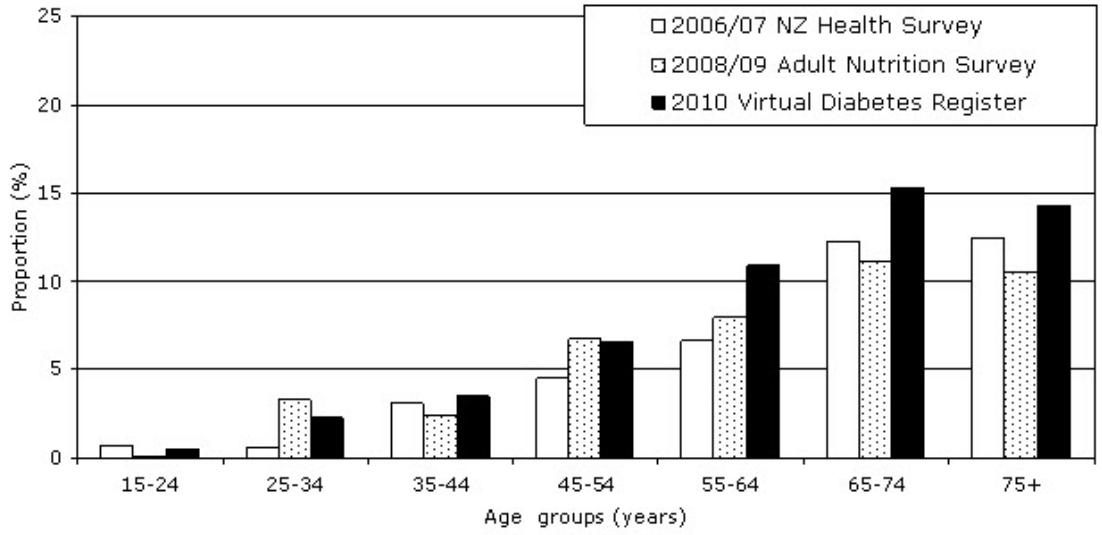

Table 4. Reported prevalence of diagnosed diabetes for different regional and national studies in New Zealand, 1967–2009

Place	Study period	Diabetes definition	Recruitment method	Number of participants	Response Rate	Age group (years)	Prevalence *diagnosed* diabetes (%)			
							European	Māori	Pacific	All ethnic groups
Rangiora community[14]	Apr 1967	Self-report		2,670	93%	>20	-	-	-	1.7
Single large multi-departmental workplace, Christchurch[10]	Dec 1982 to Feb 1983	Self-report	Workplace invitation	969	93%	≥ 15	-	-	-	1.6
41 worksites in Auckland and 5 work sites in Tokoroa[15]	May 1988 to April 1990	Self-report	Workplace invitation	5,677	67%	40-44	0.4	3.6	0.8	0.8
						45-49	0.8	4.0	4.8	1.5
						50-54	1.0	4.1	11.9	2.7
						≥ 55	2.4	10.5	5.4	3.4
						40-64	1.1	5.3	5.3	1.8
Dunedin general practice[9]	Dec 1989 to June 1990	Medical record documentation	-	-	-	Men	-	-	-	
						39-49				0.8
						50-69				7.0
						Women				
						39-49				1.9
						50-69				8.1
Large urban medical centre, Christchurch[13]	Not stated	Medical record documentation	Random selection from practice age/sex register	595	69.4%	Men	-	-	-	
						65-69				8.0
						70-74				7.7
						75-79				3.2
						80+				4.0
						Women				
						65-69				8.5
						70-74				3.3
						75-79				2.0
						80+				0
Otara, South Auckland[16]	Apr 1992 to Oct 1992	Self-report and local GP diabetes register checks.	All households in area visited.	22,651	92.7% of 4,707 households	<20	0.4	0.1	0.1	-
						20-39	0.8	1.5	0.7	
						40-59	2.9	10.8	7.2	
						≥ 60	9.3	16.5	10.1	
						≥ 20†	3.8	5.3	3.3	
Otara and Mangere,	Apr 1992 to	Self-report and	All households	55,518	91.2% of	20-29	0.3	0.4	0.2	-

South Auckland[18]	Dec 1993	local GP diabetes register checks.	in area visited.		12,770 households	30-39 40-49 50-59 60-69 70+ ≥ 30†	0.7 2.0 4.5 7.5 8.5 4.2	2.6 7.7 14.5 16.7 11.5 7.9	1.0 5.0 12.0 13.1 10.0 5.5	
Three inner suburbs, South Auckland[19]	1991 to 1994	Self-report	Random selection all households with members aged 40-79 years	1,899	69.4%	40-59 60-79	4.4 8.7	11.7 16.2	13.1 22.0	-
1996/97 NZ Health Survey[3]	Oct 1996 to Oct 1997	Self-report	Stratified cluster sampling	7,862	73.8%	≥ 15*	3.1‡	8.3	8.1	3.7
2002/03 NZ Health Survey[4]	2002 - 2003	Self-report	Stratified cluster sampling	12,929	72%	Men ≥ 15§ Women ≥ 15§	 3.4‡ 2.4‡	 9.5 6.7	 8.1 11.9	 4.5 3.7
East Coast north of Gisborne[11,21]	May 2003 to Dec 2003	Self-report	Random selection local health provider age sex register	289	48.7%	25+	-	7.1**	-	8.4
Auckland region[20]	Jan 2002 to Dec 2003	Self-report	1. Cluster sample, and 2. Random sample from electoral roll	3,770	1. 61.3% 2. 65%	35-74*	3.9	12.0	19.5	-
East Coast north of Gisborne[11]	May 2006 to Jan 2007	Self-report	Random selection local health provider age sex register	235	47.7%	25+	-	-	-	7.6
2006/07 NZ Health Survey[5]	Oct 2006 to Nov 2007	Self-report	Multi-stage, stratified, probability proportionate to size sample design	12,488		≥ 15†	4.3‡	5.8	10.0	5.0
Rotorua General Practice Group[22]	1 July 2007	Validated diabetes cases identified in	Invitation of Rotorua General	45,500	10 of 15 (66.7%)	0-9 10-19	0.2 0.3	0.1 0.2	0.0 0.0	

		general practice	Practice Group practices		invited general practices	20-29 30-39 40-49 50-59 60-69 70-79 80+ All ages[β]	0.6 1.0 2.2 4.8 9.3 12.3 13.1 3.1	0.9 1.8 5.8 14.9 22.6 27.8 18.2 7.0	0.7 4.6 10.6 19.2 27.3 - - 8.9	
Wairoa Community Heart Study[12]	May 2007 to Dec 2007	Self-report	Random sample Māori electoral roll	252	57.6%	Men 20-64 Women 20-64	-	 11.8 10.7	-	-
2008/09 Adult Nutrition Survey (current study)	Oct 2008 to Oct 2009	Self-report	Multi-stage, stratified, probability proportionate to size sample design	4,721	61.0%	≥ 15	4.5[‡]	7.0	8.1	4.9

† Crude rate; ‡ Includes other (non-Māori and non-Pacific) ethnic groups; * Age and sex standardised; ** Age-standardised to the WHO world population; [§] Age standardised; [β] Age standardised to the 2006 NZ population

Table 5. Reported prevalence of new diabetes for different regional and national studies in New Zealand, 1967–2009

Place	Study period	Diabetes test	Diagnostic criteria	Recruitment method	Sample size, or total recruited	Response rate (%)	Age group (years)	Prevalence *undiagnosed* diabetes (%)			
								European	Māori	Pacific	All ethnic groups
Rangiora community[14]	April 1967	2 hr OGTT	Fasting blood sugar >110mg/100ml, or 1 hour > 200mg/100ml or 2 hour > 130mg/100ml or an increment of >40mg between fasting and 2hr value.		2670	93	>20	-	-	-	2.5
Single large multi-departmental workplace, Christchurch[10]	Dec 1982 to Feb 1983	Random capillary blood glucose. If level ≥ 7.8 mmol/l, 2hr 75g OGTT	1980 WHO criteria	Workplace invitation	969	93	≥ 15	-	-	-	1.6
41 worksites in Auckland and 5 work sites in Tokoroa[15]	May 1988 to April 1990	2 hr 75g OGTT	1985 WHO criteria	Workplace Invitation	5677	67	40-44 45-49 50-54 ≥ 55 40-64‡	0.4 1.0 1.0 1.0 0.8	2.1 7.3 3.1 6.6 4.6	3.6 1.0 3.7 6.8 3.6	1.0 1.4 1.6 2.3
Dunedin general practice[9]	Dec 1989 to June 1990	2hr 75g OGTT	1985 WHO criteria				Men 39-49 50-69 Women 39-49 50-69	- 	- 	- 	 0 3.3 0 0.8
Large urban	Not stated	Random	Diabetes if fasting	Random	595	69.4	Men	-	-	-	

medical centre, Christchurch[13]		plasma glucose and HbA1c. If glucose ≥ 7.8 mmol/l or HbA1c >50 mmol/l, then 2hr 75g OGTT	glucose ≥ 11.1 mmol/l at 2 hour post challenge, and at an intermediate time.	selection from practice age/sex register			65-69 70-74 75-79 80+ Women 65-69 70-74 75-79 80+				8.0 7.7 3.2 4.0 8.5 3.3 2.0 0
Three inner suburbs, South Auckland[19]	1991 to 1994	Non-diabetic people with random glucose ≥ 6.5 mmol/l within 2 hrs of a meal or ≥ 6 mmol/l 2 hrs or more after a meal, then 2 hr 75g OGTT. Also, 20% screen negative people randomly selected for 2 hr 75g OGTT	1998 WHO criteria	Random selection all households with members aged 40-79 years	1899	69.4	40-59* 60-79*	3.3 2.7	10.6 7.9	13.7 9.1	
East Coast north of Gisborne[11,21]	May 2003 to Dec 2003	OGTT if negative self-report		Random selection local health provider age sex register	289	48.7	25+	-	3.6**	-	4.2
Auckland region[20]	Jan 2002 to Dec 2003	OGTT if negative self-report	1998 WHO criteria	1. Cluster sample, and 2. Random	3,770	1. 61.32. 65	35-74†	1.8	3.8	4.0	-

				sample from electoral roll						
East Coast north of Gisborne[11]	May 2006 to Jan 2007	OGTT if negative self-report		Random selection local health provider age sex register	235	47.7	25+	-	-	-	3.0
Waikato District Health Board boundary, and the Ngati Tu Wharetoa tribal area[17]		*Fasting* – finger-prick glucose. If glucose ≥ 4.4mmol/l then 2hour 75g OGTT *Non-fasting* – random glucose and HbA1c	Screen negative if – fasting glucose ≥ 5.3mmol/l, or random glucose ≥ 5.3mmol/l, or HbA1c ≥ 5.3%. Diabetes, IFG and IGT diagnosed using 1998 WHO criteria	Invitations from local GPs with media releases	4,269	-	Men 28-29 30-39 40-49 50-59 60-69 70-79 80+ ≥28 Women 28-29 30-39 40-49 50-59 60-69 70-79 80+ ≥28	-	 2.3 2.3 7.7 8.4 11.2 12.4 0 6.5 2.2 2.4 3.8 5.0 8.5 7.0 0 4.2	-	-
2008/09 Adult Nutrition Survey (current study)	Oct 2008 to Oct 2009	HbA1c	American Diabetes Association criteria	Multi-stage, stratified, probability proportion-ate to size sample design	4,721	61.0	≥ 15	1.5	2.2	6.4	1.8

* Calculated by direct standardisation from the prevalence of diabetes within the screen-negative and screen-positive groups; ** Age-standardised to the WHO world population; † Age and sex standardised; ‡ Age standardised.

Table 6. Reported prevalence of *total* diabetes for different regional and national studies in New Zealand, 1967 – 2009

Place	Study period	Age group (years)	Prevalence total (*known and new*) diabetes (%)			
			European	Māori	Pacific	All ethnicities
Rangiora community[14]	Apr 1967	>20	-	-	-	2.5
41 worksites in Auckland and 5 work sites in Tokoroa[15]	May 1988 to Apr 1990	40-44	0.7	5.8	4.4	-
		45-49	1.7	11.3	5.8	
		50-54	2.0	7.1	15.7	
		55-64	3.4	17.1	12.2	
Dunedin general practice[9]	Dec 1989 to Jun 1990	Men	-	-	-	
		39-49				0.8
		50-69				7.8
		Women				
		39-49				1.9
		50-69				11.4
Large urban medical centre, Christchurch[13]	Not stated	Men	-	-	-	
		65-69				14.0
		70-74				28.2
		75-79				16.1
		80+				8.0
		Women				
		65-69				17.0
		70-74				8.2
		75-79				11.2
		80+				13.8
Three inner suburbs, South Auckland[19]	1991 to 1994	40-59	7.5	21.1	25.0	-
		60-79	11.2	22.8	29.1	
East Coast north of Gisborne[11,21]	May 2003 to Dec 2003	25+	-	10.6**	-	12.6
Auckland region[20]	Jan 2002 to Dec 2003	35-74*	5.7	15.8	23.5	-
East Coast north of Gisborne[11]	May 2006 to Jan 2007	25+	-	-	-	10.6
2008/09 Adult Nutrition Survey (current study)	Oct 2008 to Oct 2009	15+	6.1	9.8	15.4	7.0

* Age and sex standardized; ** Age-standardised to the WHO world population.

Discussion

The 2008/09 NZANS provides for the first time reliable estimates of diabetes and prediabetes prevalence in New Zealand. Overall, the prevalence of diabetes was 7.0%, and prediabetes was 25.5%. The prevalence of diabetes was higher in men (8.3%) than women (5.8%), and was markedly higher among the obese group (14.2%) compared with that of normal weight (2.5%).

The highest prevalence of diabetes was observed among Pacific peoples, with rates among Māori in between that observed for Pacific and the NZEO groups. Rates increased with age with the highest prevalence observed for those aged 75 years and over.

The prevalence of prediabetes was high in all groups leading to an alarmingly high prevalence of a glucose metabolism disorder (diabetes or prediabetes) in working age groups. More than one-quarter (27%) of those aged 35-44 years, almost one-third(32%) of those aged 45-54 years and more than half (55%) of those aged 55-64 years had a glucose metabolism disorder (data not presented).

Diabetes prevalence surveys in New Zealand have used different methods and involved different population groups; direct comparisons are therefore not possible.[3-5,8-21] However the data presented in Tables 4 to 6 together provide convincing evidence that the prevalence of diabetes has increased over time from the first measures in 1967 till today. This is consistent with observations world-wide.[1,2]

The high prevalence of prediabetes observed in the 2008/09 NZANS strongly suggests that the prevalence of diabetes is likely to continue to increase for the foreseeable future. Estimates of the future burden of disease suggest that worldwide the number with diabetes will increase by 50% between 2011 and 2030; an annual growth of 2.7%.[1]

The implications of increased diabetes-related morbidity, mortality and health care costs are considerable. In 2009 diabetes was the sixth leading cause of death for all New Zealanders (12.3 per 100,000 population) and the fourth leading cause of death for Māori (49.0 per 100,000 population).[32] However this is an underestimate of the impact of diabetes since the condition is likely to have contributed to the other leading causes of death including ischaemic heart disease, cerebrovascular disease and some cancers.

In the present study, self-report of doctor-diagnosed diabetes was used to define diagnosed diabetes without confirmation from medical records. This approach is typically used in epidemiological studies, and has been shown to be a reasonably accurate measure of diagnosed diabetes compared with medical records.[33,34] Furthermore, the age-specific diagnosed diabetes rates for men in the 2008/09 NZANS were reasonably consistent with those from the VDR. For women over 55 years the age-specific rates derived from the VDR were higher than those reported in the 2008/09 NZANS and the NZ Health Survey suggesting under-reporting in the NZANS of diagnosed diabetes by women in this age category.

Overall the proportion of diagnosed to undiagnosed diabetes cases was better than the previously often quoted 1:1 ratio.[35] Improved diabetes detection was also observed among Māori aged 25 years and over in the 2003 Ngati and Healthy diabetes prevalence survey (2:1 ratio)[21] and among all three ethnic groups aged 35-74 years in the 2003 Auckland Diabetes Heart and Healthy Survey (2:1 ratio for Europeans, 3:1 for Māori and 5:1 for Pacific).[20] This suggests there has been good uptake of recent diabetes screening guidelines and that testing for diabetes has become more widespread. However, unlike both the NZEO and Māori groups for whom the ratio of diagnosed to undiagnosed diabetes cases was better than 3:1, among the Pacific population the ratio was almost 1:1 with 6.4% identified as having undiagnosed diabetes.

Moreover among both men and women aged <45 years in all ethnic groups, the ratio of diagnosed to undiagnosed diabetes cases was also 1:1, which indicates that those at risk are not being tested.

The NZ Society for the Study of Diabetes recommends screening obese children and young adults if there is a family history of early onset T2DM, or if they are Māori, Pacific or Indo-Asian. The high rate of prediabetes (15.6%) among those aged <45 years (data not presented) also indicates the need for more systematic screening in this age group, particularly as lifestyle changes can halt or delay the progression to T2DM.[36,37]

We used the ADA criteria to define undiagnosed diabetes (HbA1c ≥6.5% (48mmol/mol)).[25] Using HbA1c only to detect undiagnosed diabetes is likely to have missed some cases, which would have been identified on the basis of fasting plasma glucose criteria or following oral glucose tolerance tests (OGTT).

Where an OGTT has also been done as part of the survey testing, additional cases are identified. For example in the US, the prevalence of undiagnosed diabetes among those aged ≥20 years was 2.25% using fasting plasma glucose, 1.58% using HbA1c, 4.52% using an OGTT and 5.41% if all three tests were used.[38]

Similarly in the French Nutrition and Health Survey 2006-2007, the prevalence of undiagnosed diabetes for 18-74 year olds was 1.0% using fasting plasma glucose, 0.8% using HbA1c and 1.4% if both tests were used.[39] Therefore, it is likely that the prevalence of diabetes in the present study is underestimated.

For this study the use of the ADA prediabetes criteria allows comparisons with other countries, and highlights differences in prediabetes prevalence can be due to different cutoff points. For example, among US adults aged ≥ 18 years the crude prevalence of prediabetes was 14.2% for the period 2005-2008,[38] whereas in France only 1.1% of adults aged 18-74 years were found to have prediabetes.[39]

In the national French survey different criteria were used (HbA1c ≥ 6% (42 mmol/l) and <6.5% (48 mmol/l)), but when both fasting plasma glucose (ADA criteria[25]) and HbA1c were used the prevalence of prediabetes in France was 15.8%.[39] In the US the prevalence of prediabetes was 32.2% when the two tests were used.[38]

The high rates of prediabetes, especially among those who are obese, is of particular concern since they herald a likelihood of continuing increases in rates of diabetes. Using the ADA HbA1c criteria for prediabetes, the 7.5 year probability of developing

type 2 diabetes is 41.3% and the 10 year probability of a cardiovascular event is 13.3%.[40]

The risks are even higher for those who are overweight or obese with concomitant high blood pressure or high cholesterol.[40] The identification of this at risk prediabetes group whether by HbA1c, fasting plasma glucose or oral glucose tolerance test is important.

The implementation and long term commitment to preventive high risk and public health programmes provides the only hope of reversing the diabetes epidemic. Clinically and statistically significant delays in the progression from impaired glucose tolerance (prediabetes) to diabetes through lifestyle (dietary and physical activity) changes have been convincingly demonstrated in clinical trials.[36, 37]

A local example, the Ngati and Healthy Prevent Diabetes project, which combined a high risk approach with a community wide approach, demonstrated a statistically significant reduction in the prevalence of insulin resistance from 38.2% to 25.6% among women aged 25-49 years over a 2-year period.[11] Women in this age group made more lifestyle changes than other community member groups.

The main strength of this study is that we were able to estimate the prevalence of undiagnosed diabetes and prediabetes in a nationally representative sample of New Zealand adults. The oversampling of both the Māori and Pacific populations enabled prevalence estimates to be calculated for these two ethnic groups, although small numbers in the younger age groups prevented the calculation of some age-specific rates.

While diabetes is common among Indo-Asian groups,[1] insufficient participants from this ethnic group prevented calculation of Indo-Asian-specific rates.

The relatively recent and now internationally accepted use of HbA1c as an alternative for the diagnosis of both diabetes and prediabetes has facilitated diabetes testing and screening on a large scale in the research and clinical setting without the requirement of a burdensome overnight 10-hour fast and 2-hour oral glucose tolerance test. However, as an oral glucose tolerance test was not done, it is conceivable that our reported rates of diabetes and prediabetes prevalence are underestimated. Although the prevalence of both type 1 diabetes and type 2 diabetes are increasing,[41,42] we were unable to distinguish between these two main types of diabetes.

The response rate of 61% for the 2008/09 NZANS (44% for blood and urine samples) may be considered to be less than ideal, but for a national nutrition survey with a high respondent burden it is good. As the results were weighted so that they were representative of New Zealand's population, our estimates of diabetes and prediabetes prevalence can be considered to reasonably reliable.

Conclusions

The prevalence of diabetes in New Zealand is increasing. The high frequency of prediabetes suggests diabetes is likely to become more common, particularly in high risk groups. Implementation of effective evidence-based diabetes prevention strategies are required to reduce the increasing health and economic costs of the diabetes epidemic.

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