Data Sources and Methods

The surveys

Four nationally representative nutrition or health surveys have been conducted in New Zealand, in which BMI was measured. These four surveys are summarised in Table 2 and described in more detail below. Although there was some variation in survey design and response rates, as well as in weight and height measurement methods (eg, number of measurements, adjustment for clothing and season), these surveys are considered to be reasonably comparable.[2]

Table 2: Nationally representative surveys with measured BMI

Survey	Year	Age (years)	Sample size (for BMI)		Socioeconomic position	Smoking data
			Total	Māori		
National Diet Survey	1977	20–64	1,761	106	Ellie–Irving Scale	No
Life in New Zealand	1989	15–74*	2,924	202	Household income	Yes
National Nutrition Survey	1997	15–74*	4,100	638	Household income, NZDep96 quartile	Yes
New Zealand Health Survey	2003**	15–74*	10,813*	3,648	Household income, NZDep2001 quintile	Yes

* Subset of the data set, excluding the 75+ years age group.

** Actually 2002/03, but referred to as 2003 throughout this report.

Unfortunately, serial data on child and adolescent BMI distributions are not available from national surveys, so this study had to be restricted to the adult population. Results of the first national survey of children, the 2002 National Children's Nutrition Survey, are reported elsewhere (Ministry of Health 2003b).

Despite oversampling of selected ethnic groups in the more recent surveys (ie, 1997 and 2003), once stratified by age and gender there were too few Māori respondents to allow age-specific analysis of BMI distributions for this ethnic group. In analysing the changes in BMI distribution for Māori we have pooled all age groups. There were too few Pacific or Asian respondents in any but the most recent survey (ie, 2003) to allow separate analysis of BMI distributional shifts for these ethnic groups.

Ethnicity was self-identified in all four surveys, although the precise wording of the ethnicity item did vary slightly between surveys. Social constructs of ethnicity, in particular the tendency to identify with more than one ethnic group, may also have varied over time. This additional source of bias should be borne in mind when interpreting the results reported here for Māori for the 1989–2003 period.

[2] The comparability of the four surveys is considered in more detail in the 'Discussion' section.

1977 National Diet Survey

The target population for the 1977 National Diet Survey was non-institutionalised adults aged 20–64 years residing in permanent private dwellings. A stratified, multi-stage sampling design was used to select participants. Approximately 1900 adults responded to the survey. Further details about the survey design are reported in *New Zealanders and Their Diet* (Birkbeck 1979).

1989 Life in New Zealand Survey

The 1989 Life in New Zealand Survey used a stratified sampling process to select adult persons aged 15 years and over. The majority of respondents were selected from the 1988 general electoral rolls. As young people (under 18) are not on the electoral roll, a snowball technique was used to generate the sample for this group. Approximately 8000 adults responded to phase one of the survey, which involved completing two of the following four postal questionnaires, which were randomly selected and mailed to the respondent: 'Your Health', 'Changes in Your Life', 'Your Eating Habits', and 'Leisure'. Over 3100 adults responded to phase two of the survey, a health check. Further details about the survey design are reported in *Life in New Zealand Survey: Executive overview* (Russell and Wilson 1991).

1997 National Nutrition Survey

The 1997 National Nutrition Survey was undertaken in a subset of the 1996/97 New Zealand Health Survey respondents. The target population for the 1996/97 New Zealand Health Survey was the total usually resident, non-institutionalised civilian population of all ages, residing in permanent private dwellings. A stratified multi-stage cluster sampling process was undertaken to select a sample from this population. Māori and Pacific peoples were over-sampled. Approximately 7900 adults (aged 15 years and over) responded to the 1996/97 New Zealand Health Survey, and approximately 4600 adults responded to the 1997 National Nutrition Survey. Further details about the survey design are reported in *Taking the Pulse: The 1996/97 New Zealand Health Survey* (Ministry of Health 1999) and *NZ Food NZ People: Key results of the 1997 National Nutrition Survey* (Russell et al 1999).

2002/03 New Zealand Health Survey

The target population for the 2002/03 New Zealand Health Survey was the total usually resident civilian adult population (aged 15 years and over) residing in permanent private dwellings. A stratified multi-stage cluster sampling process was undertaken to select a sample from this population. Māori and Pacific peoples were over-sampled. Approximately 12,900 adults responded to the survey. The survey also included a survey of institutions, but these results are not included in this analysis. Further details about the survey design are reported in *A Portrait of Health: Key results of the 2002/03 New Zealand Health Survey* (Ministry of Health 2004).

Methods

BMI data from the four surveys were extracted by 10-year age groups and by gender, then smoothed using a sample-weighted Gaussian kernel density estimator (Buskirk 1998). All estimates reported here, including BMI percentiles and means and overweight and obesity prevalences, are based on the weighted survey data.

Distributional changes from 1977 to 1989 ('first period'), from 1989 to 1997 ('second period'), and from 1997 to 2003 ('third period') were then analysed by age group and gender using kernel density plots, cumulative distribution plots and Tukey mean–difference plots as described in the 'Introduction'. Confidence intervals could not be calculated for Tukey mean–difference plots.

As well as BMI distributions, mean and median BMI and the prevalence of overweight, obesity and extreme obesity were also calculated for each age group/gender–period combination. Confidence intervals for mean BMI and prevalence of overweight and obesity for each age–gender group for 1989, 1997 and 2003 were estimated using replicated weights. Insufficient information about the 1977 survey design meant that we were unable to create replicated weights for this survey. Consequently, variances for the 1977 estimates were derived under a simple random sampling framework, and then multiplied by an assumed design effect of 2.

Socioeconomic inequalities in mean BMI and obesity prevalence, and trends in these inequalities, were examined using two markers of socioeconomic position:

- equivalised household income expressed in constant 2001 dollars and categorised into tertiles (a household level measure) was used for 1989, 1997 and 2003
- an index of small area (neighbourhood) deprivation (NZDep), based on principal components analysis of nine socioeconomic variables from the 1996 and 2001 censuses (the NZDep96 and NZDep2001 indexes), was used for 1997 and 2003.

The data were also stratified by smoking status (current, ex-smoker and never smoker) to investigate the impact of trends in smoking on the changes in the BMI distribution (see later for more detail of method).

As well as BMI, data on stature were analysed separately to assess whether a secular trend in stature persists in New Zealand (see later for more detail of the methods).

Presentation of results

BMI distributions

We first present the overall shift in the whole population BMI distribution over the 26-year study period (1977–2003), with all age groups pooled.

We then examine each period (1977–1989, 1989–1997 and 1997–2003) separately. Within each period, we examine the shift in BMI distribution for each age (and gender) group in turn. Note that by comparing age group x in period t with age group x+1 in period t+1, an approximation can also be gained of cohort as well as age and period effects.

Prevalence of overweight and obesity

Along with the BMI distributions, we also present summary charts of the prevalence of overweight and obesity using a similar approach to that above. Confidence intervals for these statistics, as well as tabulations of changes at key percentiles (10th, 25th, 50th, 75th and 90th), are provided in the Statistical Annexe to this report.

Epidemic growth rate

The growth rate of the epidemic is presented next. This statistic is measured by calculating the average annual percentage change (AAPC) separately for mean and median BMI, and for overweight and obesity prevalence.

The AAPC is estimated for the whole observation period, or each period of interest, assuming a constant rate of change over the period concerned (log linearity). A compound interest model is used whereby, given statistic y_1 at time t_1 and statistic y_2 at time t_2, the rate of change is calculated via:

$$\exp\left(\frac{\ln\left(y_2 / y_1\right)}{t_2 - t_1}\right) - 1 .$$

Confidence intervals could not be estimated for the AAPCs because this statistic involves two sets of replicate weights from two different surveys, and it is not clear how such weights should be incorporated into variance estimates.

Ethnic analysis

A separate analysis of trends in the BMI distribution of the Māori population is also presented. This could be done only for the three most recent surveys (ie, the second [1989–1997] and third [1997–2003] periods), and only for all adult age groups combined.

A similar analysis was done for non-Māori, and for the total population with ethnic mix standardised (ie, the proportions of Māori, Pacific and non-Māori non-Pacific ethnic groups were held constant over all time points at their 2001 levels). Results for both analyses did not differ substantially from the total population analysis, implying that changes in ethnic mix do not contribute substantively to the observed shifts in the total population's BMI distribution. Because of space limitations, only total population and Māori ethnic group results are presented in this report.

Socioeconomic position analysis

Analysis of inequalities in mean BMI and in the prevalence of obesity by tertiles of household income are presented for 1989–2003, for all age and ethnic groups combined. Corresponding analysis by NZDep is then presented for 1997–2003.

Smoking and stature

Data on BMI distributions stratified by smoking status, and on trends in stature, are then briefly summarised.

Age standardisation

The crude ages-pooled analysis (total population and Māori population) was repeated with the data age-standardised by the direct method to the WHO world population. This was done to separate the influence of changes in population age structure from other factors affecting BMI

distribution. Age-standardised results were similar to the crude results, and are briefly presented in relevant sections of the report.

Life cycle stages

Life cycle stages are defined as follows:

- youth (15–24 years)
- young adults (25–44 years)
- middle-aged adults (45–64 years)
- older people (65+ years).