Body Size Technical Report

Measurements and classifications in the 2006/07 New Zealand Health Survey

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Executive Summary

The purpose of this report is to provide technical information on anthropometric measurements and classifications used in the 2006/07 New Zealand Health Survey, and to outline some important changes to anthropometric analyses.

Anthropometry

Anthropometry is the most universally applicable, inexpensive and non-invasive method available to assess the size, proportions and composition of the human body.

The 2006/07 New Zealand Health Survey includes three common anthropometric measurements: height, weight and waist circumference. Height and weight measurements are used to calculate body mass index (BMI).

BMI is often used as an indirect measure of body fatness. Although BMI is correlated with total body fat, this relationship varies according to age, gender, ethnicity and other factors such as body build. This variation occurs primarily because BMI does not differentiate between lean and fat mass, nor does it provide information on body fat distribution.

BMI is commonly used to classify people into body size categories, such as underweight, overweight and obese. BMI categories are intended to highlight people or populations with an increased risk of health conditions associated with increasing BMI, not to measure body fatness *per se*.

Waist circumference is the simplest and most convenient indicator of abdominal obesity, and provides useful complementary information to BMI. Excess fat in the abdominal compartment is more metabolically active and more strongly linked to disease risk than total fat mass.

BMI classification

The World Health Organization principal BMI cut-off points were used to classify underweight (< 18.5 kg/m^2), overweight (25.0−29.9 kg/m^2) and obesity (≥ 30 kg/m^2) in adults aged 18 years and over.

The International Obesity Taskforce (IOTF) BMI reference values were used to classify thinness, overweight and obesity in children and adolescents. The IOTF cut-off points are gender and age-specific and designed to coincide with the adult BMI cut-off points at age 18 years.

Measurements

A new anthropometry protocol was developed for the 2006/07 New Zealand Health Survey, as this was the first survey to include measurements in both adults and children. Participants were asked to remove shoes and heavy outer clothing, so measurements could be made in light clothing. Of eligible participants, 96 percent of adults and 97 percent of children agreed to be measured.

Changes to anthropometric analyses

There have been some important changes to anthropometric analyses in the 2006/07 New Zealand Health Survey. The key changes relate to adjustment for clothing weight and BMI classification. These changes were necessary to comply with current international standards and ensure consistency between adults and children.

Adjustments for clothing weight in population surveys have varied over time and between adults and children, ranging from no adjustment to a 1.2 kg adjustment in adults. A review of national surveys in other countries and consultation with experts indicates current practice is for anthropometric measurements to be made in light clothing, without an adjustment for clothing weight. As measurements in the 2006/07 New Zealand Health Survey were made in light clothing, no adjustment for clothing weight was made. When a 1.2 kg clothing weight adjustment is not made in adults, mean BMI is 0.4 kg/m^2 higher and the proportion of adults classified as obese is approximately 2 percentage points higher.

A recent World Health Organization Expert Consultation recommended that international BMI cut-off points be retained as the international classification for all adults, regardless of ethnicity. In past surveys higher BMI cut-off points were used to classify Māori and Pacific adults as overweight (26.0−31.9 kg/m^2) and obese (≥ 32 kg/m^2). When international BMI cut-off points are adopted for all adults, the proportion of Māori and Pacific adults classified as obese is approximately 11 percentage points higher, and the proportion of all adults classified as obese is 2 percentage points higher.

Interpretation of results

Anthropometric results from the New Zealand Health Survey can be considered very reliable because the results are based on actual measurements rather than self-report. Furthermore, the response rate to measurements was very high, and measurements were made by trained interviewers using standardised protocols and professional anthropometric equipment.

Although changes to indicators in population surveys should be avoided where possible, the changes related to clothing weight adjustment and BMI cut-off points were necessary to comply with current international standards and ensure consistency between adults and children. The changes do affect the absolute values for body weight, BMI and BMI categories in adults, however they do not affect the more important time trends because past surveys were reanalysed using the new definitions.

Changes to BMI cut-off points for population monitoring do not necessarily have an impact on other uses of BMI. For public health action, the World Health Organization recommends the use of the full range of BMI cut-off points: 18.5, 23, 25, 27.5, 30, 32.5, 37.5 and 40 kg/m^2. For individuals, BMI should not be relied on as the sole indicator of body fatness or disease risk; factors such as body fat distribution and other risk factors or co-morbidities should also be taken into account.

Introduction

Anthropometry is the most universally applicable, inexpensive and non-invasive method available to assess the size, proportions and composition of the human body (World Health Organization 1995). Anthropometric indices can be compared to reference standards to assess growth and body dimensions, past or present nutritional status and the future risk of health outcomes.

The 2006/07 New Zealand Health Survey includes three common anthropometric measurements: height, weight and waist circumference. Height and weight measurements are used to calculate body mass index (BMI).

The purpose of this report is to provide technical information on anthropometric measurements and classifications in *A Portrait of Health: Key results of the 2006/07 New Zealand Health Survey* (Ministry of Health 2008a) and the online data tables.[1] This report includes an overview of anthropometric measurements and methods, as well as details of some important changes to anthropometric analyses and implications for interpreting results.

[1] www.moh.govt.nz/moh.nsf/indexmh/portrait-of-health

Anthropometric Measurements

The 2006/07 New Zealand Health Survey includes three common anthropometric measurements: height, weight and waist circumference. This section provides a brief overview of these measurements.

Height

Height is the perpendicular distance between the top of the head and the bottom of the feet. In countries where food is widely available during childhood and adolescence, most individuals reach their genetically predetermined height. Adult height is usually reached by age 25 years and remains relatively stable until middle age.

Weight

Weight is the force the matter in the body exerts when standing in a gravitational field. Body weight reflects both body dimensions (especially height) and body composition. Major components of total body mass are fat mass (ie, adipose tissue) and lean body mass (ie, muscle, bone and water).

Unlike height, which is relatively stable during adulthood, weight varies with age. In countries where food is widely available, adults tend to gain weight until about age 60 years. Adult weight gain is usually caused by an excess of energy intake (food and drink) over energy expenditure (physical activity), with most weight gained during adulthood being adipose tissue.

Body mass index

BMI is an index of weight adjusted for height, and is calculated by dividing weight in kilograms by height in metres squared (kg/m^2). BMI is often used as an indirect measure of body fatness because it is relatively simple to measure and is correlated with total body fat. However, it is important to remember that BMI is not a direct measure of body fat. More direct assessments of body fat include underwater weighing and dual x-ray absorptiometry, but as these measures are complex and expensive they are not feasible for population surveys or large epidemiological studies.

Although BMI is correlated with total body fat, this relationship varies according to age, gender, ethnicity, and other factors such as body build. This variation occurs primarily because BMI does not differentiate between lean and fat mass, nor does it provide information on the distribution of body fat. Although BMI is a reasonable indicator of body fatness in populations and most individuals, it is not a reliable indicator for all individuals. When interpreting BMI measurements for individuals, a range of other factors should be taken into account, such as age, ethnicity, body fat distribution, and other risk factors and co-morbidities.

BMI cut-off points are commonly used to classify people into body size categories, such as underweight, overweight and obese. BMI classifications are intended to highlight people or populations with an increased risk of health conditions associated with increasing BMI, not to measure body fatness *per se*. Like most biological risk factors,

BMI is a continuous variable and the relationship between BMI and health outcomes is continuous, with no threshold at which the risk of disease suddenly increases. Therefore, the use of specific cut-off points to define BMI categories is somewhat arbitrary – as is evident in the 'tidy' cut-off points of 25 and 30 kg/m^2 used to define overweight and obesity in adults. As with BMI itself, other factors should be taken into account when interpreting BMI categories for individuals.

Waist circumference

The waist is the circumference of the abdomen midway between the lower costal (10th rib) border and the top of the iliac crest, perpendicular to the long axis of the trunk. Waist circumference is the simplest and most convenient indicator of abdominal obesity. There is good evidence that excess fat in the abdominal (visceral) compartment is more metabolically active and more strongly linked to diabetes and cardiovascular disease risk than total fat mass. Therefore, waist circumference provides useful complementary information to BMI.

The ratio of waist to hip circumference was previously considered a more useful index than waist circumference alone, but more recent evidence suggests hip circumference does not add much value to waist circumference alone. Also, hip circumference is more invasive and difficult to measure than waist circumference. For these reasons, hip circumference is not included in the New Zealand Health Survey.

Waist circumference cut-off points are commonly used to classify adults into abdominal obesity categories. As with BMI, waist circumference cut-off points are somewhat arbitrary, and are intended to identify adults at increased risk of metabolic complications associated with abdominal obesity; they are not intended to measure abdominal obesity.

Anthropometric Methods

This section outlines the methods for making anthropometric measurements in the 2006/07 New Zealand Health Survey. Standardised equipment and techniques for making anthropometric measurements are required to minimise measurement error.

Anthropometry protocol

A new anthropometry protocol was developed for the 2006/07 New Zealand Health Survey (Ministry of Health 2008b), as this was the first survey to include measurements in both adults and children. The protocol was developed by Public Health Intelligence (PHI) in consultation with Professor Mike Marfell-Jones, an ISAK (International Standards for Anthropometric Assessment) accredited anthropometrist (Level 4, the most senior level). The protocol specifies equipment and measurement techniques for height, weight and waist circumference measurements.

The anthropometry protocol was developed specifically for the New Zealand Health Monitor (Ministry of Health 2005) population surveys, which are household surveys. As a result, the equipment and techniques specified in the protocol may not be appropriate for other data collection settings. For example, portable anthropometry equipment is not required for a clinical setting, and multiple measurements are not always necessary.

Interviewer training

Interviewers for the 2006/07 New Zealand Health Survey underwent comprehensive training on the correct techniques for making anthropometric measurements. An anthropometry instruction video was loaded onto the interviewers' laptops, and they were encouraged to review this regularly to remind them of the correct technique.

Anthropometric measurements were taken in the following order: height, weight, waist, then height, weight, waist again. If the two readings differed by more than 1 percent, the computer prompted the interviewer to take a third measurement. This method takes slightly longer, but improves accuracy.

If an anthropometric measurement was unusual, interviewers were able to enter a text comment about the measurement. Further checks were undertaken during data processing, with interviewers phoned to check any measurements below the 1st percentile or above the 99th percentile of height/weight/waist measurements in previous surveys.

Measurements

Adult participants in the 2006/06 New Zealand Health Survey were eligible for anthropometric measurements unless they were in pain, wheelchair bound, or pregnant. Overall, 98 percent of adults were eligible for anthropometric measurements. Of eligible adult participants, 96 percent agreed to height, weight and waist measurements.

Child participants in the 2006/07 New Zealand Health Survey were eligible for anthropometric measurements unless they were in pain, wheelchair bound, or below a

certain age (less than two years for height and weight, and less than five years for waist circumference). Overall, 87 percent of children were eligible for height and weight measurements, and 67 percent were eligible for waist measurements. Of eligible child participants, 97 percent agreed to height, weight and waist measurements.

Weight and waist circumference measurements can vary by season. To minimise any impact of seasonal variation on anthropometric measurements (and other indicators), the 2006/07 New Zealand Health Survey was in the field for one year, from October 2006 to November 2007. Information on survey coverage by month is presented in the *Methodology Report for the 2006/07 New Zealand Health Survey* (Ministry of Health 2008c).

It is standard practice for measurements to be made in light clothing, so participants were asked to remove shoes and heavy outer clothing before the anthropometry module of the survey.

Height

Height was measured using a SECA 214 portable stadiometer with a base plate, two wall stabilisers, a sliding head plate and four connecting rods with a metric measuring scale. The stadiometer was placed on a hard, flat surface, close to a wall. Participants were asked to stand upright with their feet together and their heels touching the bottom of the stadiometer.

Two height measurements were made to the nearest 0.1 cm, with the head positioned in the Frankfurt plane. If the two measurements differed by more than 1 percent, a third measurement was made (this occurred in 1.1 percent of adults and 2.2 percent of children). The final height measurement for each participant was calculated by averaging the two closest measurements. For the small proportion of participants that had only one height measurement (0.1 percent), this value was used as the final height measurement.

Weight

Weight was measured using Tanita HD-351 electronic weighing scales with a digital display (maximum 200 kg). Scales were placed on a hard, flat surface, and participants were asked to stand in the centre of the scales with their arms loosely by their sides and weight distributed on both feet.

Two weight measurements were made to the nearest 0.1 kg. If the two measurements differed by more than 1 percent, a third measurement was made (this occurred in 1.2 percent of adults and 2.4 percent of children). No participants weighed more than 200 kg.

The final weight measurement for each participant was calculated by averaging the two closest measurements. For the small proportion of participants that had only one weight measurement (0.1 percent), this value was used as the final weight measurement.

No adjustment was made for clothing weight as participants were weighed in light clothing without shoes.

Waist

Waist circumference was measured using a Lufkin W606PM anthropometric measuring tape. Since the measurement is made over light clothing, participants were asked to identify their waist (the narrowest point between the lower costal margin and the top of the iliac crest).

Two waist measurements were made to the nearest 0.1 cm at the end of normal expiration. If the two measurements differed by more than 1 percent, a third measurement was made (this occurred in 19.4 percent of adults and 21.3 percent of children). The final waist circumference measurement for each participant was calculated by averaging the two closest waist measurements. For the small proportion of participants that had only one waist measurement (0.1 percent), this value was used as the final waist measurement.

Anthropometric Classifications

This section outlines the BMI and waist circumference cut-off points used in the 2006/07 New Zealand Health Survey to classify adults and children into body size categories associated with risk of health conditions.

BMI classification – adults

The World Health Organization (WHO) BMI cut-off points were used to classify underweight, normal range, overweight and obesity (three classes) in adults aged 18 years and over (Table 1).

Table 1: Principal BMI cut-off points for adults aged 18 years and over

New Zealand classification	BMI value (kg/m^2)	Risk of health conditions*
Underweight	< 18.50	Low risk
Normal range	18.50–24.99	Average risk
Overweight	25.00–29.99	Increased risk
Obese	≥ 30.00	Substantially increased risk
Obese (class I)	30.00–34.99	Moderate risk
Obese (class II)	35.00–39.99	Severe risk
Obese (class III)	≥ 40.00	Very severe risk

Source: Adapted from: World Health Organization 2000.

* Only health conditions associated with increasing BMI.

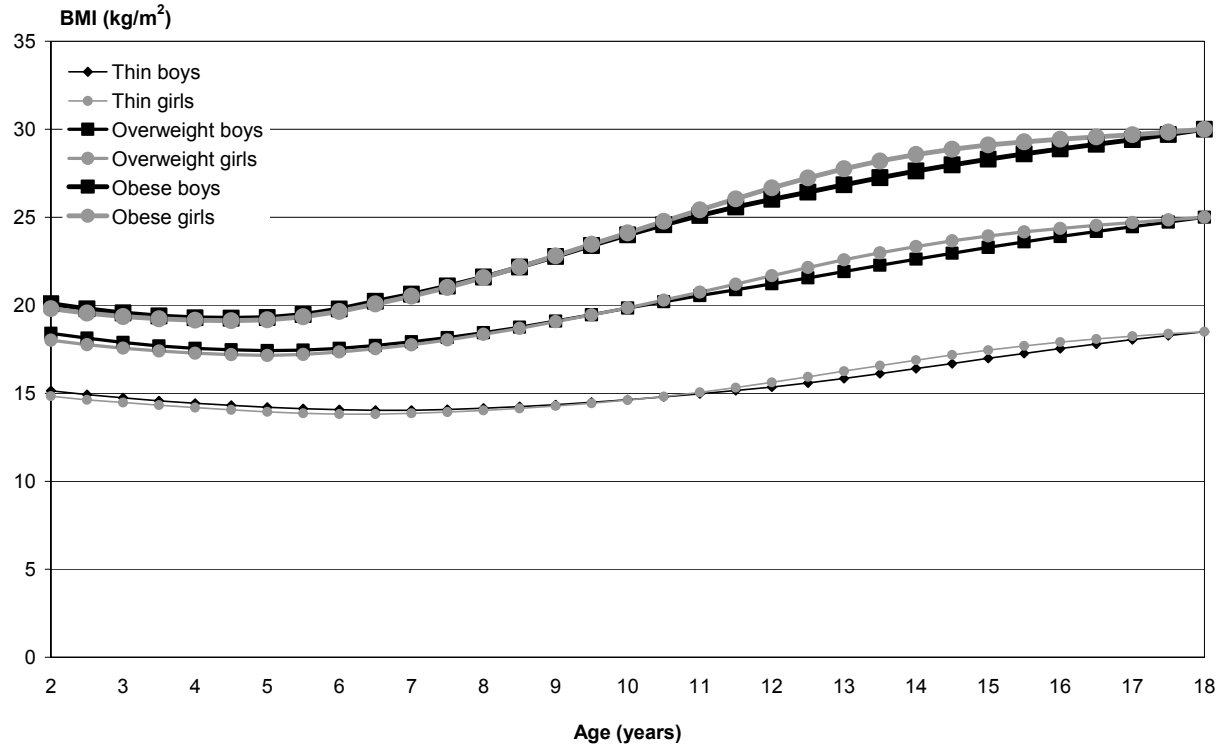
The WHO BMI cut-off points have been developed and revised by a series of expert working groups or consultations (World Health Organization 1995, World Health Organization 2000, World Health Organization Expert Consultation 2004) and are widely used internationally. The WHO BMI cut-off points are intended to identify people or populations at increased risk of health conditions associated with increasing BMI, not to measure percent body fat.

Note that one minor change has been made to terminology: our overweight category is equivalent to the WHO pre-obese category. The WHO defines overweight as BMI ≥ 25.00, and pre-obese as BMI 25.00−29.99. Obese class III is sometimes referred to as extreme or morbid obesity.

BMI classification – children and adolescents

The International Obesity Taskforce (IOTF) BMI references values were used to classify overweight and obesity in children and adolescents (Cole et al 2000). The same group has recently developed BMI cut-off points to classify thinness in children and adolescents (Cole et al 2007). The IOTF cut-off points are gender- and age-specific and designed to coincide with the WHO principal BMI cut-off points for adults for underweight, overweight and obesity at age 18 years (BMI 18.5, 25 and 30, respectively) (Figure 1). See the appendix for actual BMI cut-off points for children and adolescents.

Figure 1: IOTF BMI cut-off points for children and adolescents



Source: Adapted from: Cole et al 2000 and Cole et al 2007.

A useful Excel Add-in that automatically assigns six BMI categories (thinness grades 1−3, normal, overweight, obese) (Pan and Cole 2007) was used for descriptive analyses in the 2006/07 New Zealand Health Survey and the reanalysis of data from the 2002 National Children's Nutrition Survey. The Excel Add-in avoids lengthy and complicated analytical code and can assign categories according to exact age, which is more accurate than using age rounded to the nearest six months.

Waist circumference classification – adults

The following waist circumference cut-off points were used to identify adults at increased risk of metabolic complications associated with abdominal obesity in the 2006/07 New Zealand Health Survey (Table 2). These waist circumference cut-off points were suggested by the World Health Organization (2000) and are used by a number of other countries, but have not been adopted internationally.

Table 2: Waist circumference cut-off points for adults aged 18 years and over

Risk of metabolic complications	Men	Women
Average risk	< 94 cm	< 80 cm
Increased risk	94−101 cm	80−87 cm
Substantially increased risk	≥ 102 cm	≥ 88 cm

Note that waist circumference results were not reported in *A Portrait of Health* (Ministry of Health 2008a) due to space limitations, but are presented in the online data tables.

Changes to Anthropometric Analyses

There have been some important changes to the anthropometric analyses in the 2006/07 New Zealand Health Survey. The changes were necessary to comply with current international practice and to ensure consistency between adults and children.

The key changes include:

- no clothing weight adjustment for adults
- adopting the latest international BMI classifications for adults and children.

Data from the 2006/07 New Zealand Health Survey were used to illustrate the impact of changes to anthropometric analyses, but results presented in this technical report are not final results and should not be cited. Please refer to Ministry of Health 2008a and the online data tables for final results and age-adjusted time trends based on a reanalysis of data from past surveys using the new anthropometric definitions.

Clothing weight adjustment

Previous surveys

Protocols for anthropometric measurements in population surveys have varied over time, particularly in relation to adjustment for clothing weight. In the 1977 National Diet Survey participants (adults aged 20–64 years) were weighed in light indoor clothing without footwear, and no clothing weight adjustment was made (Birkbeck 1979).

In the 1989 Life in New Zealand Survey, participants (adults aged 15+ years) were weighed in light clothing without shoes. A 0.5 kg allowance for clothing weight was subtracted from measured weight (Mann et al 1991).

In the 1997 National Nutrition Survey, participants (adults aged 15+ years) were asked to remove their shoes, and anthropometric measurements were made in light clothing (Russell et al 1999). A 1.2 kg adjustment for clothing weight was made to final weight measurements (Russell et al 1999).

In the 2002/03 New Zealand Health Survey, the anthropometry protocol was similar to that used in the 1997 National Nutrition Survey. Participants (adults aged 15+ years) were weighed in light clothing without shoes, and a clothing weight adjustment of 1.2 kg was made to final weight measurements.

In the 2002 National Children's Nutrition Survey, participants (children aged 5–14 years) were weighed in light clothing without shoes at school (Ministry of Health 2003). No adjustment for clothing weight was made in this survey, as there was no precedent for this in children.

Rationale for change

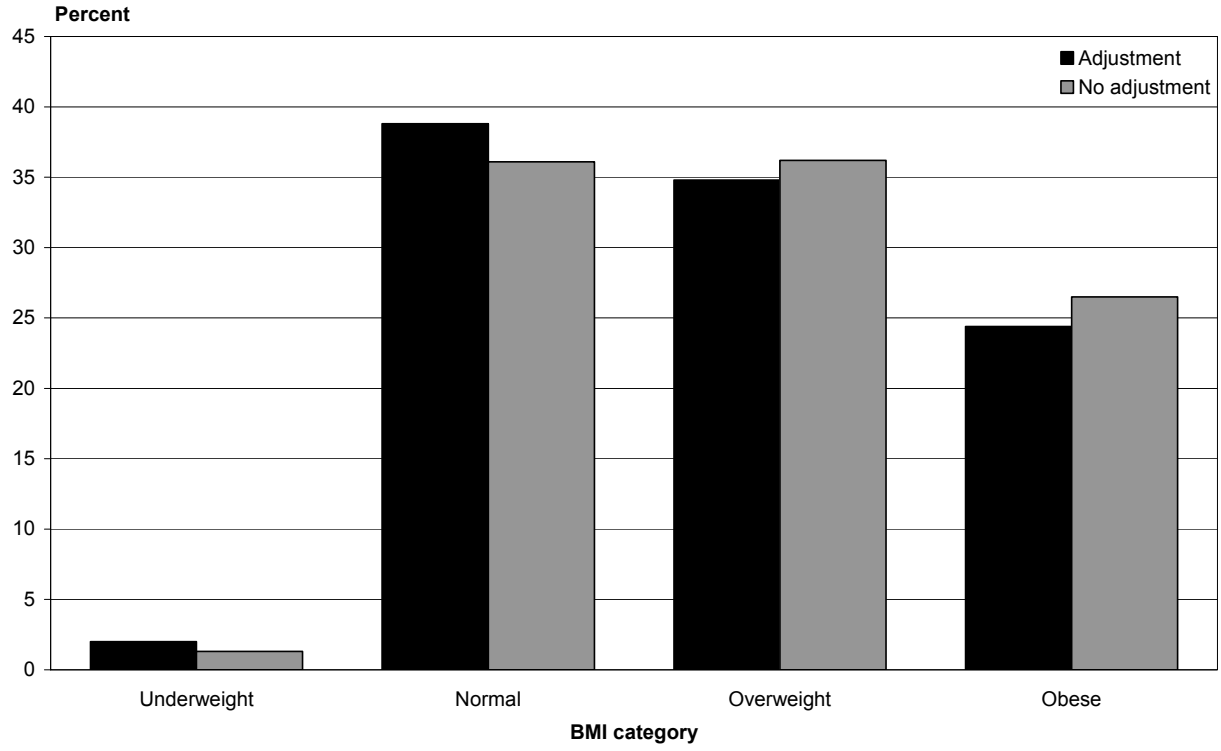
The 2006/07 New Zealand Health Survey includes both adults and children, and it would be inconsistent to have a clothing weight adjustment for adults and not children. A review of anthropometry protocols for national health surveys in other countries and consultation with experts indicates it is standard practice for anthropometric measurements to be made in light clothing, without an adjustment for clothing weight.

Therefore, no adjustment for clothing weight was made in the 2006/07 New Zealand Health Survey, as measurements were made in light clothing. For an analysis of time trends in adults, the 1.2 kg clothing weight adjustment made in the 1997 National Nutrition Survey and 2002/03 New Zealand Health Survey was reversed.

Impact of change

When the 1.2 kg adjustment for clothing weight in adults is no longer applied, mean BMI is 0.4 kg/m^2 higher overall. The increase in BMI affects all adults, and causes the BMI distribution to shift slightly to the right. As shown in Figure 2, this causes a slight decrease in the proportion of adults in the underweight and normal range categories, and an increase in the proportion of adults classified as overweight and obese (1.4 and 2.1 percentage points, respectively). The magnitude of the change depends on the initial BMI distribution, although variation across gender and ethnic groups is relatively minor.

Figure 2: Proportion of adults in major BMI categories calculated with and without a 1.2 kg adjustment for clothing weight



Source: 2006/07 New Zealand Health Survey (results are indicative only).

Note: IOTF BMI cut-off points for ages 15−17 years and WHO BMI cut-off points for 18+ years.

BMI classification – adults

Previous surveys

In the 1997 National Nutrition Survey and the 2002/03 New Zealand Health Survey, the World Health Organization (WHO) BMI cut-off points were used to classify overweight and obesity (25 and 30 respectively) in European/Other and Asian adults (Table 3). Higher BMI cut-off points were used to classify Māori and Pacific adults as overweight and obese (26 and 32 respectively), based on evidence that at an equivalent BMI, Māori and Pacific adults had a lower percentage of body fat than European adults (Swinburn 1998).

Table 3: New Zealand ethnic-specific BMI cut-off points for adults

New Zealand classification	European/Other and Asian	Māori and Pacific
Underweight	< 18.50	< 18.50
Normal range	18.50–24.99	18.50–25.99
Overweight	25.00–29.99	26.00–31.99
Obese	≥ 30.00	≥ 32.00

Rationale for the change

The issue of whether different BMI cut-off points are needed for different ethnic groups has been debated for many years, with much of the international debate focused on BMI cut-off points for Asian populations. The basis of the argument for ethnic-specific BMI cut-off points is that the association between BMI, percent body fat and body fat distribution differs across ethnic groups.

However, the WHO BMI cut-off points are intended to identify people or populations at increased risk of health conditions associated with increasing BMI, not to estimate percent body fat *per se*. Furthermore, the associations between BMI, percent body fat and body fat distribution differ by factors other than ethnicity, such as gender and age. The differences are primarily due to the fact that BMI does not distinguish between weight associated with muscle and weight associated with fat; nor does BMI provide information on the distribution of body fat (World Health Organization 2000).

Although the WHO BMI cut-off points were developed primarily using data from populations of European origin, the health risks associated with increasing BMI are continuous and graded and begin at a BMI below 25 in all population groups. Therefore, the most recent WHO Expert Consultation recommended that principal BMI cut-off points should be retained as the international classification for all adults (World Health Organization 2006).

The most recent WHO Expert Consultation (World Health Organization 2006) also recommended that additional BMI cut-off points be added as points for public health action. This is in recognition of the fact that the risk of disease increases as BMI increases, even within the 'normal' range (Table 4). It is recommended that all countries use these additional BMI cut-off points for reporting purposes with a view to facilitating international comparisons.

Table 4: International classification of adult underweight, normal range, overweight and obesity according to BMI

Classification	BMI (kg/m^2)	
	Principal cut-off points	**Additional cut-off points**
Underweight	< 18.50	< 18.50
Severe thinness	< 16.00	< 16.00
Moderate thinness	16.00−16.99	16.00−16.99
Mild thinness	17.00−18.49	17.00−18.49
Normal range	18.50−24.99	18.50−22.99 23.00−24.99
Overweight	≥ 25.00	≥ 25.00
Pre-obese	25.00−25.99	25.00−27.49 27.50−29.99
Obese	≥ 30.00	≥ 30.00
Obese class I	30.00−34.99	30.00−32.49 32.50−34.99
Obese class II	35.00−39.99	35.00−37.49 37.50−39.99
Obese class III	≥ 40.00	≥ 40.00

Source: World Health Organization 2006.

In addition to complying with international standards, there are two other important reasons for ceasing to use ethnic-specific BMI cut-off points in adults. Firstly, it is to ensure consistency between adults and children. There are no ethnic-specific BMI cut-off points for children, and they would be extremely difficult to develop because cut-off points are gender- and age-specific (see the appendix).

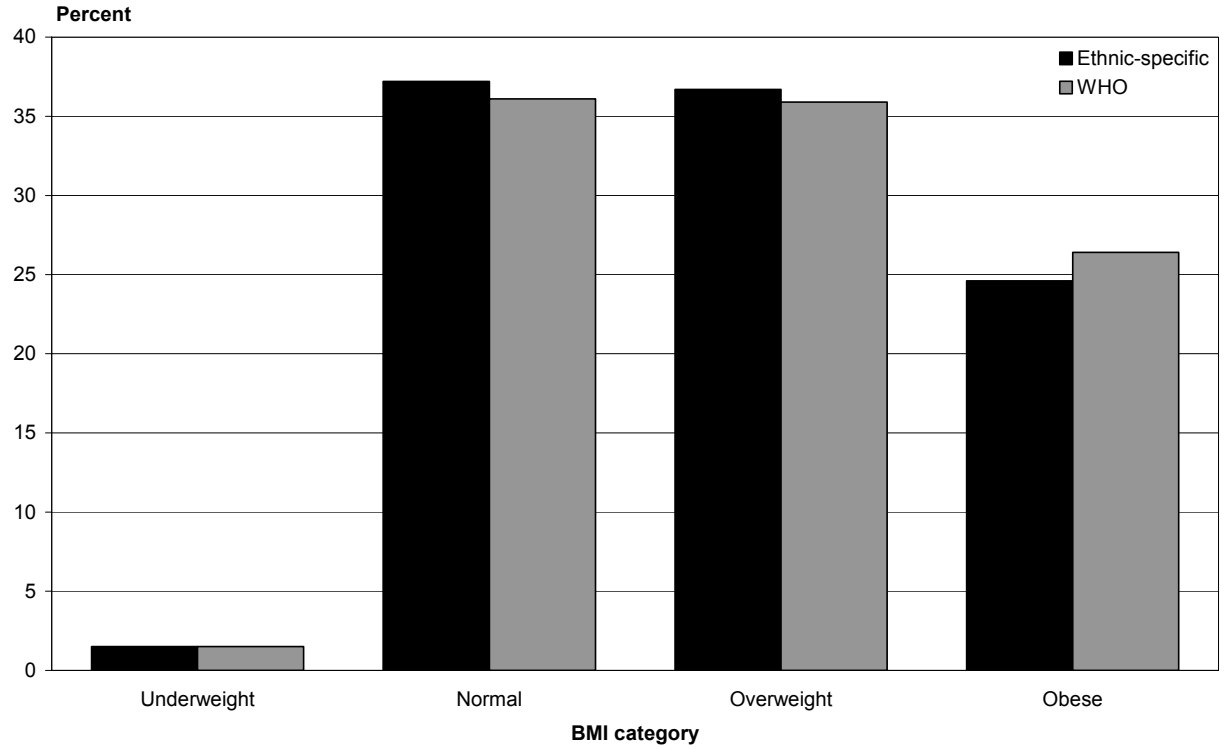
Secondly, an increasing proportion of the population identify with multiple ethnic groups, and it is unclear which BMI cut-off points should be used for people identifying with two ethnic groups with different BMI cut-off points (eg, Māori and European). Without ethnic-specific BMI cut-off points for multi-ethnic groups it would be necessary to prioritise ethnicity before classifying BMI categories. This approach would be inconsistent with the move to reporting by 'total response standard output' for ethnic groups, whereby participants are counted in each of the ethnic groups they self-report. For more detailed information on total response standard output, please refer to the online methodology report for the 2006/07 New Zealand Health Survey (Ministry of Health 2008c) and a separate technical report (Ministry of Health 2008d).

Impact of the change

Adopting international BMI cut-off points for all adults affects Māori and Pacific adults, but not European/Other or Asian adults. This change results in a decrease in the proportion of Māori and Pacific adults in the normal and overweight categories, and an approximately 11 percentage point increase in the proportion of Māori and Pacific adults classified as obese.

For adults overall, this change has no impact on the proportion of adults classified as underweight, causes a slight decrease in the proportion of adults in the normal and overweight categories, and increases the proportion of adults classified as obese by approximately 2 percentage points (Figure 3).

Figure 3: Proportion of adults in major BMI categories calculated using WHO and New Zealand ethnic-specific BMI cut-off points



Source: 2006/07 New Zealand Health Survey (results are indicative only).

BMI classification – children and adolescents

Previous surveys

In the 2002 National Children's Nutrition Survey, published gender- and age-specific (nearest six months) IOTF BMI cut-off points (Cole et al 2000) were used to classify overweight and obesity in children aged 5–14 years. BMI cut-off points to define thinness (Cole et al 2007) were not available at the time this survey was undertaken.

In the 1997 National Nutrition Survey and the 2002/03 New Zealand Health Survey, adult BMI cut-off points were used to classify underweight, overweight and obesity in adolescents aged 15–17 years (ie, WHO BMI cut-off points for European/Other and Asian, and ethnic-specific BMI cut-off points for Māori and Pacific peoples).

Rationale for the change

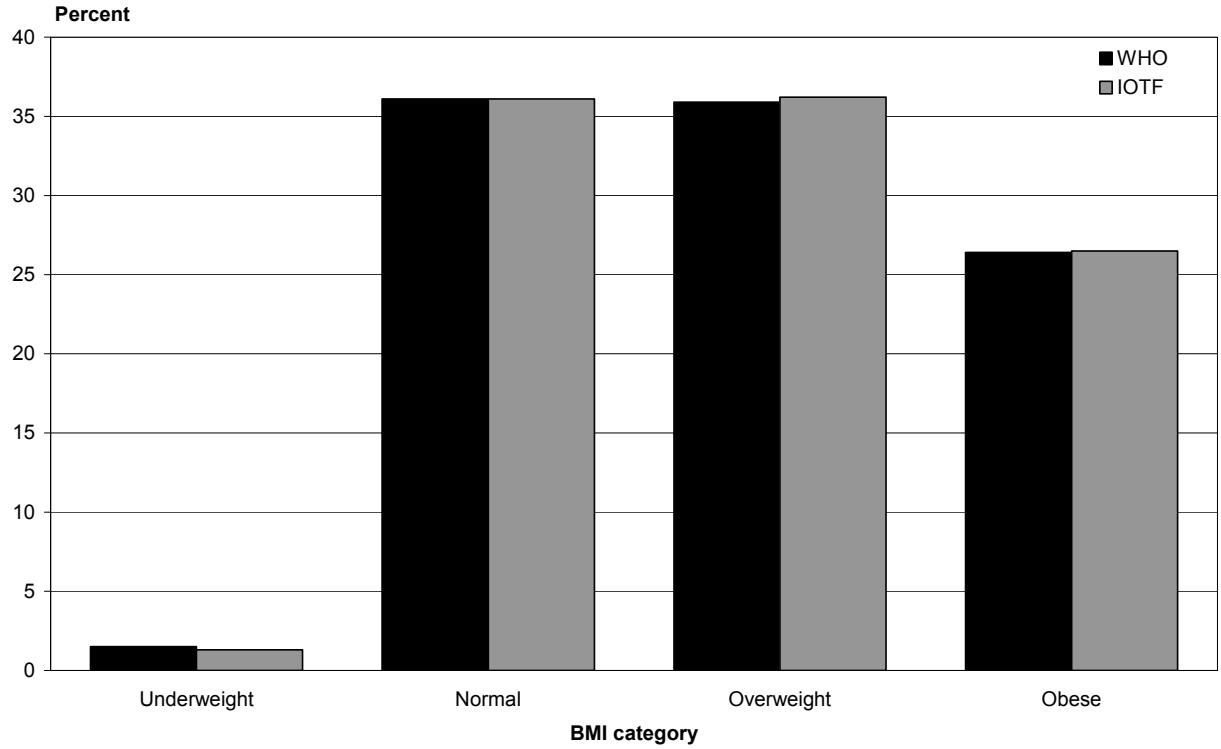
IOTF BMI cut-off points are more appropriate for adolescents aged 15–17 years because adult body size is unlikely to have been reached at this age. The WHO BMI cut-off points (intended for adults aged 18+ years) had previously been used for 15+

years because international BMI cut-off points for children and adolescents were not available. Moving from the six-month to the exact-age IOTF BMI cut-off points further improves accuracy.

Impact of the change

Figure 4 shows that using the IOTF BMI cut-off points rather than the WHO cut-off points for participants aged 15–17 years makes little or no difference to the overall proportion of adults classified as underweight, normal range, overweight or obese.

Figure 4: Proportion of adults in major BMI categories calculated using WHO vs IOTF BMI cut-off points for the 15–17 years age group



Source: 2006/07 New Zealand Health Survey (results are indicative only).

Discussion

Anthropometric results from the New Zealand Health Survey can be considered very reliable for several reasons. Firstly, results are based on actual measurements rather than self-report. National health surveys in some countries, such as Australia and Canada, rely on self-reported height and weight to calculate BMI, which systematically underestimates the prevalence of obesity by approximately 50 percent (Starky 2005). Secondly, the response rate to measurements was very high, with over 96 percent of eligible participants agreeing to be measured. Thirdly, measurements were made by trained interviewers using professional anthropometric equipment and standardised protocols, including at least two measurements at each site.

Changes to anthropometric definitions have not affected time trends presented in *A Portrait of Health: Key results of the 2006/07 New Zealand Health Survey* (Ministry of Health 2008a) and the online data tables because all data have been analysed using the same definitions. This involved the reanalysis of anthropometric data from the 1997 National Nutrition Survey, 2002 National Children's Nutrition Survey and the 2002/03 New Zealand Health Survey using the new definitions. Therefore, time trends in anthropometric measurements presented in *A Portrait of Health* and the online data tables can be interpreted as real changes over time.

If anthropometric time trends of interest are not presented in either *A Portrait of Health* or the online data tables, please contact PHI rather than making comparisons with previous publications. There are a number of reasons why comparisons with previous publications may not be appropriate, including changes to anthropometric definitions, changes to reporting by ethnic group (total response standard output vs prioritised), and differences in the use of age standardisation.

As would be expected, changes in anthropometric definitions for adults do affect the absolute values for body weight, BMI and BMI categories. When there is no adjustment for clothing weight in adults, mean body weight is 1.2 kg higher, mean BMI is 0.4 kg/m^2 higher, and the proportion of adults classified as obese is approximately 2 percentage points higher. Adopting international BMI cut-off points for all adults regardless of ethnicity has no effect on mean body weight and BMI, but increases the proportion of Māori and Pacific adults classified as obese by approximately 11 percentage points, and increases the proportion of all adults classified as obese by approximately 2 percentage points.

Using the new anthropometric definitions, the unadjusted prevalence of obesity in 2006/07 was 42 percent for Māori adults and 64 percent for Pacific adults, compared to 26.5 percent for the total adult population (Ministry of Health 2008a). Some may argue that Māori and Pacific adults are not as obese as these results suggest. However, although Māori and Pacific adults tend to have a lower proportion of body fat than European adults at a given BMI, we have used BMI cut-off points to identify population subgroups at increased risk of health conditions associated with increasing BMI, not to measure body fatness *per se*.

Currently, there is no evidence that this lower level of body fatness in Māori and Pacific adults at a given BMI is associated with a lower risk of disease, and in fact it appears the opposite may be true. New Zealand research suggests that Māori and Pacific adults have a higher risk of diabetes even after adjusting for BMI (Rush et al 2002, Sundborn et al 2007). Other research shows that the risk of metabolic syndrome components and insulin resistance is significantly higher in Pacific adolescents classified as obese compared to their non-obese counterparts (Grant et al 2008). In the 2006/07 New Zealand Health Survey the age-adjusted prevalence of both obesity and diagnosed diabetes was approximately 1.5 times higher in Māori adults compared to the total adult population (Ministry of Health 2008a). A similar pattern was seen for Pacific adults, who were 2.5 to 3 times more likely to be obese and three times more likely to have been diagnosed with diabetes than the total adult population (Ministry of Health 2008a). Together, this information suggests that international BMI cut-off points for obesity are useful for identifying Māori and Pacific adults at increased risk of health problems associated with increasing BMI, particularly diabetes.

In contrast, results from the 2006/07 New Zealand Health Survey suggest that international BMI cut-off points for obesity may underestimate the risk of diabetes in Asian adults. After adjusting for age, Asian adults are 30 percent less likely to be obese but twice as likely as the total adult population to have been diagnosed with diabetes (Ministry of Health 2008a). Asian adults living in New Zealand have been shown to have a higher proportion of body fat than European adults with the same BMI (Rush et al 2004, Rush et al 2007), although this does not seem to fully explain differences in disease risk. Other factors thought to contribute to differences in disease risk for Asian populations include a tendency towards body fat accumulation in the more metabolically active abdominal compartment, and other metabolic changes resulting from foetal or early life nutrition exposures (World Cancer Research Fund and American Institute for Cancer Research 2007, World Health Organization Expert Consultation 2004).

Population surveys, such as the New Zealand Health Survey, are primarily used for monitoring. In this context, consistent definitions are more important than the actual definitions – hence the reanalysis of data from past nutrition and health surveys using the new definitions, and the intention to use the same definitions in future surveys, including the 2008/09 New Zealand Adult Nutrition Survey. When anthropometric data routinely provided to the WHO and Organisation for Economic Cooperation and Development (OECD) are next updated, data from current and past surveys will be analysed according to the new definitions.

Changes to BMI cut-off points for population monitoring do not necessarily have an effect on other uses of BMI. For public health action, the WHO recommends the use of the full range of BMI cut-off points: 18.5, 23, 25, 27.5, 30, 32.5, 37.5 and 40 kg/m^2 (World Health Organization 2006). For individuals, BMI should not be relied on as the sole indicator of body fatness or disease risk. If factors such as body fat distribution (eg, waist circumference) and other risk factors or co-morbidities are taken into account, then clinical judgements should not be influenced by changes in anthropometric definitions.

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Appendix

Table A1: IOTF BMI cut-off points for overweight and obesity in children and adolescents

Age	Thinness		Overweight		Obese	
	Males	Females	Males	Females	Males	Females
2	15.14	14.83	18.41	18.02	20.09	19.81
2.5	14.92	14.63	18.13	17.76	19.80	19.55
3	14.74	14.47	17.89	17.56	19.57	19.36
3.5	14.57	14.32	17.69	17.40	19.39	19.23
4	14.43	14.19	17.55	17.28	19.29	19.15
4.5	14.31	14.06	17.47	17.19	19.26	19.12
5	14.21	13.94	17.42	17.15	19.30	19.17
5.5	14.13	13.86	17.45	17.20	19.47	19.34
6	14.07	13.82	17.55	17.34	19.78	19.65
6.5	14.04	13.85	17.71	17.53	20.23	20.08
7	14.04	13.86	17.92	17.75	20.63	20.51
7.5	14.08	13.93	18.16	18.03	21.09	21.01
8	14.15	14.02	18.44	18.35	21.60	21.57
8.5	14.24	14.14	18.76	18.69	22.17	22.18
9	14.35	14.28	19.10	19.07	22.77	22.81
9.5	14.49	14.43	19.46	19.45	23.39	23.46
10	14.64	14.61	19.84	19.86	24.00	24.11
10.5	14.80	14.81	20.20	20.29	24.57	24.77
11	14.97	15.05	20.55	20.74	25.10	25.42
11.5	15.16	15.32	20.89	21.20	25.58	26.05
12	15.35	15.62	21.22	21.68	26.02	26.67
12.5	15.58	15.93	21.56	22.14	26.43	27.24
13	15.84	16.26	21.91	22.58	26.84	27.76
13.5	16.12	16.57	22.27	22.98	27.25	28.20
14	16.41	16.88	22.62	23.34	27.63	28.57
14.5	16.69	17.18	22.96	23.66	27.98	28.87
15	16.98	17.45	23.29	23.94	28.30	29.11
15.5	17.26	17.69	23.60	24.17	28.60	29.29
16	17.54	17.91	23.90	24.37	28.88	29.43
16.5	17.80	18.09	24.19	24.54	29.14	29.56
17	18.05	18.25	24.46	24.70	29.41	29.69
17.5	18.28	18.38	24.73	24.85	29.70	29.84
18	18.50	18.50	25.00	25.00	30.00	30.00