

**Methodology Report  
for the 2009 New Zealand  
Oral Health Survey**

## Authors

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# 1 Introduction

The 2009 New Zealand Oral Health Survey (NZOHS) is the first nationwide survey to collect information on the oral health status of New Zealand adults and children in 21 years. There have been two previous national oral health surveys in New Zealand: the 1976 Survey of Adult Oral Health and Attitudes to Dentistry (Cutress et al 1979) and the 1988 Study of Oral Health Outcomes (the New Zealand section of the World Health Organization Second International Collaborative Study) (Hunter et al 1992).

The Ministry of Health commissioned the 2009 NZOHS to gather up-to-date information about the oral health of New Zealand adults and children and the oral health services they use. The 2009 NZOHS is valuable because it collected information on New Zealanders' oral health that is not available through other means, such as analysis of health system records. For most of the topics, the 2009 NZOHS is the best source of information on the current oral health status of the New Zealand population.

The 2009 NZOHS consisted of face-to-face interviews and dental examinations, and was carried out from February to December 2009 as a follow-up to the 2006/07 New Zealand Health Survey (NZHS). It is the first nationwide survey of oral health that has collected information on the oral health of New Zealand children aged two years and over. Findings from the 2009 NZOHS are available in the report *Our Oral Health: Key findings of the 2009 New Zealand Oral Health Survey* (Ministry of Health 2010).

This methodology report details the procedures and protocols followed to ensure the 2009 NZOHS produced the high-quality and robust data expected of official statistics. A methodology report for the 2006/07 NZHS (Ministry of Health 2008) is also available, which provides more information on the design of that survey.

## 2 Background

The 2009 NZOHS was carried out from February to December 2009, and collected information on the oral health of 4906 New Zealanders (adults and children), as well as including dental examinations for 3196 New Zealanders. It was a follow-up to the 2006/07 NZHS. The sampling frame for the 2009 NZOHS included the 2006/07 NZHS households that had given permission to be re-contacted for future health-related surveys.

The 2009 NZOHS was made up of two components: a computer-assisted face-to-face interview and a dental examination. The questionnaire measured self-reported oral health status, risk and protective factors for oral health outcomes and the use of oral health care services, among the usually resident New Zealand population living in private dwellings. Information on oral disease (particularly dental decay and periodontal disease) was recorded during clinical examinations of the teeth and periodontal tissue conducted by dental examiners.

The survey was a collaborative project involving the Ministry of Health, Defence Dental Services of the New Zealand Defence Force, the New Zealand Dental Association and the Accident Compensation Corporation (ACC). Health and Disability Intelligence in the Ministry of Health developed the objectives and content of the 2009 NZOHS, in consultation with stakeholders and an external technical advisory group. The data collection was carried out by a specialist survey company, CBG Health Research Ltd, which undertook the interviewing and prepared the data sets. Qualified and registered dentists specially trained for the survey carried out the dental examinations.

All results presented in the report *Our Oral Health* (Ministry of Health 2010) were weighted in order to be representative of New Zealand's estimated resident population living in permanent private dwellings at 30 June 2007 (the reference date for the NZHS survey).

### 2.1 Objectives of the 2009 New Zealand Oral Health Survey

The objectives of the 2009 NZOHS were to collect information to:

1. describe the oral health of New Zealand children and adults, and the prevalence and severity of selected oral conditions, including dental injury
2. estimate the prevalence of risk and protective factors associated with these oral health conditions
3. examine the relationship between general health and oral health
4. examine the relationship between adult oral health and child oral health within households
5. describe the use of oral health services, including the nature of barriers to accessing oral health services and the extent of any unmet need
6. examine inequalities between population subgroups (as defined by age, sex, ethnicity, rurality and socioeconomic position)

7. examine changes in the oral health of New Zealanders that have occurred since previous national surveys
8. provide policy makers with information that can be used to improve oral health and the oral health care system and services.

## **2.2 Ethical approval**

The New Zealand Health and Disability Multi-region Ethics Committee granted approval for the 2009 NZOHS (MEC/07/11/149), confirming that the study met the following ethical principles:

- validity of research
- minimisation of harm
- privacy and confidentiality
- informed consent
- cultural and social responsibility.

The Ethics Committee approved the wording of all public materials from the survey, including the invitation letter, information brochures, consent forms, medical history forms, the questionnaires, the report given to participants at the end of the dental examination, and the provision of a voucher to cover travel expenses incurred by participants in attending a dental facility for the dental examination.

## 3 Population and Frame

This section discusses the target population, the survey population and the sample frame for the 2009 NZOHS.

The **target population** is the population the survey aims to represent. All statistics for the survey refer to the target population. The **survey population** is the population covered by the survey. The **sample frame** is the list of areas, and the lists of dwellings and people within areas, that were used to select the sample from the survey population.

### 3.1 2006/07 New Zealand Health Survey

Because the 2009 NZOHS was a follow-up to the 2006/07 NZHS, the target population, survey population and sample frame mainly refer to those of the 2006/07 NZHS, as outlined below.

#### 3.1.1 Target population

The target population for the 2006/07 NZHS was the usually resident civilian population of all ages living in permanent private dwellings in New Zealand. The target population was approximately 4.0 million people (of all ages), according to the 2006 New Zealand Census of Population and Dwellings.

The target population is defined to include only permanent private dwellings, so temporary private dwellings are excluded, including caravans, cabins and tents in a motor camp, and boats. The target population also excludes non-private dwellings (institutions). Examples of this type of dwelling are: hotels, motels, guest houses, boarding houses, homes for the elderly, hostels, motor camps, hospitals, barracks and prisons.

Table 1 presents the proportion of people in each age group who were in institutions or non-private dwellings, as measured by the 2006 Census. Once non-permanent and non-private dwellings were excluded, the target population contained 94% of the total usually resident population.

**Table 1:** Proportion (%) of people in each age group in institutions or non-private dwellings, 2006 Census

Age group (years)	Proportion of people not in private occupied dwellings (%)
0-4	2.5
5-9	2.4
10-14	5.9
15-24	7.4
25-34	5.2
35-44	4.6
45-54	4.9
55-64	5.6
65-74	6.8
75+	30.6
Total	6.0

People were eligible to be interviewed at their usual residence only. If they were temporarily visiting a household that was selected into the NZHS, they were not eligible to be selected as part of that household. This criterion ensured that no one had a double chance of being selected in the survey.

People were in the scope for the survey if they were usually resident in a private dwelling in New Zealand, even if they were temporarily overseas for some of the survey period. In the great majority of cases, these individuals had a chance of being selected in the survey, as the survey provider made repeated call-backs to non-contacted households in the sample over the survey period. The benchmarks used in weighting the survey also included usual residents temporarily overseas.

People aged 15 years or over were in the target population for the adult survey, and those aged from birth to 14 years were in the target population for the child survey.

It should be noted that the survey only included the usually resident population living in private dwellings. People living in institutions (hospitals, IHC and rest homes, prisons, boarding schools), the homeless, short-term visitors and tourists were not included.

### **3.1.2 Survey population**

For various reasons (discussed below), there was a small proportion of people who could not be covered by the survey. As a result, the survey population is slightly smaller than the target population. The sample weights are designed to reflect the target population.

A total of 98.9% of New Zealand's 1.4 million permanent private dwellings (households) were eligible for participation in the 2006/07 NZHS. For practical reasons a small number of households that were part of the defined target population were excluded from the survey population, but these have been accounted for in the final estimates via the survey weights. Households not included were those in meshblocks with fewer than nine occupied dwellings (according to the 2001 New Zealand Census of Population and Dwellings), and those located off the main islands of New Zealand (North, South and Waiheke), such as those on other sparsely inhabited off-shore islands, on-shore islands, waterways and inlets. Due to the small number of households omitted, any possible bias is likely to be extremely small.

### **3.1.3 Sample frame**

An area-based frame of Statistics New Zealand's meshblocks was used, based on New Zealand 2001 Census meshblocks (which contains 32,173 meshblocks).

A sample of 1385 meshblocks was selected from this frame. Interviewers listed all the addresses in each of these areas. These lists of dwellings were then used as a frame from which a sample of dwellings was selected from each meshblock. One eligible adult (if any) and one eligible child (if any) were then selected from each selected dwelling. The sample design is described in more detail in Section 4.

## **3.2 2009 New Zealand Oral Health Survey**

The sample frame for the 2009 NZOHS included the 2006/07 NZHS households that had provided permission to be re-contacted for future health-related surveys.

## 4 Sample Design

Because the 2009 NZOHS was a follow-up to the 2006/07 NZHS, it essentially had the same sample design as the 2006/07 NZHS. This section provides an outline of the 2006/07 NZHS methodology along with a description of aspects of the design specific to the 2009 NZOHS. A full methodology report for the 2006/07 NZHS is available online at <http://www.moh.govt.nz/dataandstatistics>.

### 4.1 2006/07 New Zealand Health Survey

The 2006/07 NZHS, like other national health surveys run by the Ministry of Health, used a multi-stage, stratified, probability-proportional-to-size (PPS) sample design, with increased sampling of some ethnic groups, primarily through a 'screened' sample. This sample design was developed by the Centre for Statistical and Survey Methodology, University of Wollongong, New South Wales, Australia.

About 1385 small geographic areas (meshblocks) were randomly chosen throughout New Zealand, with larger areas having an increased chance of selection into the 2006/07 NZHS. Areas with higher proportions of Māori, Pacific or Asian peoples were also given a slightly higher chance of selection. The selected areas were randomly allocated to the four seasons of the year to minimise seasonality bias.

Interviewers selected households into the 'core' sample using a systematic procedure of beginning at a random point pre-allocated in the meshblock, and knocking on the door of every  $k$ th house. Households in the screened sample were selected by knocking on every  $j$ th house, excluding the core households in the same meshblock. The values of  $k$  were chosen so as to select on average 9.5 core households per meshblock. The values of  $j$  were chosen so as to select on average 12 screened households per meshblock in the 10 District Health Board (DHB) areas with a high concentration of Māori, and on average 15 screened households per meshblock in other DHB areas. In screened households, adults and children were only eligible if the participants identified with a Māori, Pacific or Asian ethnicity (determined using the Census ethnicity question and Statistics New Zealand Ethnicity Classification Level 4). There was no substitution of households or participants if the selected household or individual refused to take part, was not contactable or was unavailable.

This sample design ensured that:

- robust national estimates for key oral health behaviours and outcomes could be produced
- all population groups of interest, in particular Māori, Pacific and Asian populations, were included in sufficient numbers to enable estimates that are accurate for all groups
- interviewer travel costs were reduced because the sample was geographically clustered or 'clumped'.

A total of 12,874 households from throughout New Zealand participated in the 2006/07 NZHS, resulting in interviews with 12,488 adults (aged 15 years and over) and the parent or caregiver of 4921 children (aged from birth to 14 years).

More than four out of five households (84%) who took part in the NZHS agreed to be re-contacted for future health surveys, and formed the re-contact database from which the sample for the 2009 NZOHS was selected.

## **4.2 2009 New Zealand Oral Health Survey**

All Pacific, Asian and Māori participants in the 2006/07 NZHS re-contact database were selected for the 2009 NZOHS. This process maximised the sample sizes for these key sub-populations in the 2009 NZOHS. Four in ten European/Other participants in the 2006/07 NZHS re-contact database were selected for the 2009 NZOHS.

Where an adult 2006/07 NZHS participant was sub-selected for the 2009 NZOHS, and a child in that household had also been interviewed for the 2006/07 NZHS, that particular child was also selected for the 2009 NZOHS (regardless of their age at the time of the 2009 NZOHS). The primary caregiver of each selected child participant (ie, the person with the day-to-day responsibility for the care of the child) was invited to answer the child questionnaire on behalf of the child.

There was a 16-month period between the end of data collection for the 2006/07 NZHS and the start of the 2009 NZOHS. All participants were interviewed using the questionnaire or examination protocol (adult or child) appropriate for their age at the time of the NZOHS interview or examination. Some participants who were interviewed as children in the 2006/07 NZHS were, at the time of interview for the 2009 NZOHS, aged 15 or 16 years, and hence were interviewed and examined as adults in the 2009 NZOHS.

A total of 6318 households (8938 people, including 6318 people aged 15 years and over and 2620 children aged 2–14 years) were selected to participate in the 2009 NZOHS. More details on the sample sizes and response rates are provided in Sections 7 and 8.

## **4.3 Rationale for the follow-up survey**

The oral health survey was conducted as a follow-up to the 2006/07 NZHS, in order to link oral health data for participants with comprehensive and relatively recent information about their general health from the NZHS. The overall response rate was lower than it would have been if the survey had been conducted as a stand-alone project. However, there is extra value in linking such a comprehensive general health survey to each participant, which will mean that relationships between oral health and general health can be examined with much more authority and detail. In addition, because the 2006/07 NZHS had some oral health content, it was possible to assess (and possibly adjust for) any non-response bias that arose from the lower overall response rate.



## **5 Data Collection Instruments**

The 2009 NZOHS was made up of two components: a computer-assisted, face-to-face interview and a dental examination. The 2009 NZOHS questionnaire measured self-reported oral health status, risk and protective factors for oral health outcomes and the use of oral health care services among the usually resident New Zealand population living in private dwellings. Information on oral disease (particularly dental decay and periodontal disease) was recorded during dental examinations of the teeth and periodontal tissue conducted by dental examiners.

This section outlines the information that was collected in the face-to-face interviews and dental examinations. Further information about the data collection process and procedures is provided in the next section.

### **5.1 Face-to-face interview**

The child and adult oral health questionnaires for the 2009 NZOHS were developed by Health and Disability Intelligence of the Ministry of Health. Topics for inclusion were based on gaps in current child and adult oral health data collection, following a content consultation with stakeholders and the external technical advisory group. The questionnaire was constructed using validated questions from existing surveys where possible, and new questions were tested in the pilot study (see Section 6.1.4).

#### **5.1.1 Adult questionnaire**

The adult questionnaire for the 2009 NZOHS contained 129 questions specific to oral health, organised into five broad topic areas (Table 2). Additional questions were included to update the sociodemographic information previously collected for each participant in the 2006/07 NZHS. NZOHS participants aged 15 years and over were invited to answer the adult questionnaire.

**Table 2:** Summarised content of the 2009 New Zealand Oral Health Survey adult questionnaire (answered by adults aged 15 years and over)

<b>Module</b>	<b>Topics</b>
Self-reported oral health status	<p>Self-reported number of natural teeth</p> <p>History of tooth loss</p> <p>Presence of dentures, bridges, implants</p> <p>Appearance of teeth</p> <p>Assessment of general oral health status</p> <p>Orofacial pain/symptoms</p> <p>Oral health-related quality of life</p> <p>Lost work/school days due to dental problems</p> <p>Self-perceived need for dental care</p> <p>ACC knowledge of cover for dental trauma</p>
Risk and protective behaviours	<p>Preventive care (toothbrushing, cleaning between the teeth)</p> <p>Use of fluoridated toothpaste</p> <p>Use of mouth rinses</p> <p>Wearing of mouth guards</p> <p>Current smoking status</p>
Utilisation of oral health services	<p>Dental visits in last 12 months, including reason for visit and reasons for not visiting</p> <p>Tooth extraction in last 12 months</p> <p>Last visit (reason, type of dental provider, dental services by type, choice of dental professional, time taken to get there)</p> <p>Cost of dental care</p> <p>Usual provider of dental care</p> <p>Regular dental check-ups</p> <p>Enrolment of adolescents (aged 15–18 years) in dental care</p> <p>Insurance cover for dental expenses</p> <p>Dental anxiety</p>
Orofacial trauma	<p>History of orofacial trauma</p> <p>History of dental trauma</p> <p>Dental care following dental trauma, including reasons for not seeking care</p> <p>Function, appearance and maintenance of teeth repaired following dental trauma</p> <p>Uptake of ACC contribution to dental treatment</p>
Attitudes to and knowledge and opinions about oral health	<p>Perceived importance of oral health (children, adults, general wellbeing, government spend on oral health)</p> <p>Opinions about dental care for adults</p> <p>Opinions about fluoridation of water supplies</p>
Sociodemographic update	<p>Age, ethnic group, education, employment, income support, income, household income, household composition</p>

### 5.1.2 Child questionnaire

The child questionnaire for the 2009 NZOHS contained 74 questions about the oral health of the child, organised into three main topic areas (Table 3). Questions to update the sociodemographic information collected about the child in the 2006/07 NZHS were also included.

The primary caregiver of each selected child participant (ie, the person with the day-to-day responsibility for the care of the child) answered the child questionnaire on behalf of the child. In households where the primary caregiver of the child was not the adult participant in the 2006/07 NZHS and 2009 NZOHS, a section containing six questions about the oral health of the primary caregiver was included to enable further research into oral health within households.

The questionnaire included a specific child response module, which children aged 9–14 years were able to answer if they were willing and their primary caregiver gave permission. Otherwise, the primary caregiver answered the child response module.

**Table 3:** Summarised content of the 2009 New Zealand Oral Health Survey child questionnaire (answered by the primary caregiver for children aged from 2–14 years)

Module	Topics
Proxy-reported oral health	<ul style="list-style-type: none"> <li>Assessment of general oral health status</li> <li>Appearance of teeth</li> <li>Placement of dental fillings and history of dental extractions</li> <li>Orofacial pain/symptoms</li> <li>Lost work/school days or activity change by caregivers and children due to dental problems</li> </ul>
Risk and protective behaviours	<ul style="list-style-type: none"> <li>Oral hygiene history of child</li> <li>Current oral hygiene practices of child (frequency of toothbrushing, toothpaste use)</li> <li>Use of fluoride drops, tablets or mouth rinses</li> <li>Infancy – drinks at nap or bedtime</li> <li>Frequency of between meal eating</li> <li>Drinks at night (frequency, type of drink, drinking vessel, addition of sugar)</li> <li>Eating at bedtime</li> <li>Wearing of dental mouth guards when playing contact sport</li> </ul>
Utilisation of oral health care services, nature of barriers to accessing services, and extent of unmet need	<ul style="list-style-type: none"> <li>First dental visit</li> <li>Time since last dental visit</li> <li>Last visit – type of dental facility</li> <li>Enrolment in School Dental Service</li> <li>Preferred facility for child/teenager's dental care</li> <li>Treatment for orofacial trauma</li> <li>ACC – knowledge of cover for dental trauma</li> </ul>

<b>Module</b>	<b>Topics</b>
Questions on oral health of caregiver if primary caregiver was not the NZOHS adult participant	Presence of any natural teeth Self-reported oral health Time since last dental visit Tooth extraction in last 12 months
Sociodemographic update of child	Ethnicity
Child response module (answered by children aged 9–14 years if they were willing and their caregiver gave permission; otherwise answered by the primary caregiver)	Toothbrushing (frequency of toothbrushing, toothpaste use) Eating between meals Drinks at night (frequency, type of drink, drinking vessel, addition of sugar) Eating in bed at night (frequency, type of food) Wearing of mouth guard when playing contact sport

### **5.1.3 Testing of the questionnaires**

New questions in the 2009 NZOHS (ie, those questions that had not been used in previous oral health surveys) were tested in the pilot study (discussed in Section 6.1.4), to ensure the questions were easily understood by participants and able to produce high-quality data. Where questions appeared to be unclear, survey instructions were included in the body of the questionnaire to standardise explanations.

## **5.2 Dental examination**

Adults and children who completed the face-to-face interview for the 2009 NZOHS were asked whether they would participate in a clinical dental examination. For adults, examinations were limited to people who reported having at least one of their own natural teeth at the time of the interview (ie, dentate adults).

Dental examiners followed a standardised protocol to record information about the clinical oral status of the survey participant. Information was collected on the levels of tooth loss, dental decay experience, dental fluorosis, dental trauma, oral mucosal lesions, oral debris and, for adult participants with no medical contraindications to periodontal probing, signs of periodontal disease. Information about the use of dentures worn to the examination was also collected for adults. In addition, clinical photographs of the teeth were taken.

Survey participants were examined in a supine (lying on their back) position in standard dental chairs, with illumination provided by the chair's overhead dental light. Dental examiners used an intra-oral mirror that additionally had its own battery-powered light source. A periodontal probe with 2 mm markings was used to remove debris and to record distances (eg, when assessing periodontal destruction). Sharp explorers were not used, and no X-rays were taken. This section outlines the key measures included in the dental examination.

The examination protocols followed those used in the Australian National Survey of Adult Oral Health 2004–06. The full examination protocol is provided online ([www.moh.govt.nz/dataandstatistics](http://www.moh.govt.nz/dataandstatistics)).

## **5.2.1 Tooth loss**

### **5.2.1.1 Adults**

For adults younger than 45 years, dental examiners distinguished between missing teeth that had been extracted due to decay or periodontal disease, and teeth that were absent for any other reason (ie, congenitally missing, unerupted or extracted for orthodontics, trauma or impaction). For adults aged 45 years or older, no such distinction was made, so that an extracted or otherwise absent tooth was recorded as missing. Dental implants, root fragments and primary teeth were coded separately and not counted as missing or absent teeth.

### **5.2.1.2 Children and adolescents aged 2–14 years**

For children and adolescents aged 2–14 years, examiners distinguished between missing teeth that had been extracted due to decay and teeth that were absent for any other reason (ie, congenitally missing, unerupted or extracted for orthodontics, trauma or impaction). Missing teeth extracted due to decay were not differentiated as being either primary or permanent teeth.

For analyses presented in *Our Oral Health* (Ministry of Health 2010), assumptions were made on how to classify missing teeth due to decay in children and adolescents, based on advice from the 2009 NZOHS External Technical Advisory Group and the protocol used in Australian child oral health surveys. Teeth recorded as missing due to dental decay were classified into one of three groups – (1) primary teeth missing due to decay; (2) permanent teeth missing due to decay; or (3) unerupted permanent teeth – based on the specific tooth, the average age at which that tooth erupts (as cited in Beaglehole et al 2009) and the age of the child.

If the child was at or older than the average age of eruption of the permanent tooth, the tooth was assumed to be a missing permanent tooth. If the child was younger than the average age of eruption of the permanent tooth, but within two years of the average age, the permanent tooth was assumed to be unerupted. If the child was more than two years younger than the average age of eruption of the permanent tooth, the tooth was assumed to be a missing primary tooth (except for first and second permanent molars, which do not have a primary tooth preceding them). For children aged 2–14 years, the dental examination did not include third molars as the average age for eruption of these teeth is between 17 and 21 years. Table 4 summarises the assumptions used in the analyses.

**Table 4:** Assumptions used to determine nature of missing teeth for children and adolescents aged 2–14 years in the 2009 NZOHS

Teeth	Tooth type (permanent)	Average age of eruption of permanent tooth (years)	Age of child (years)		
			Tooth assumed to be missing primary tooth	Tooth assumed to be unerupted permanent tooth	Tooth assumed to be missing permanent tooth
Teeth in upper jaw	Central incisor	7–8	2–4	5–6	7+
	Lateral incisor	8–9	2–5	6–7	8+
	Canine	11–12	2–8	9–10	11+
	1st premolar	10–11	2–7	8–9	10+
	2nd premolar	10–12	2–7	8–9	10+
	1st molar	6–7	NA	4–5	6+
	2nd molar	12–13	NA	10–11	12+
Teeth in lower jaw	Central incisor	6–7	2–3	4–5	6+
	Lateral incisor	7–8	2–4	5–6	7+
	Canine	9–10	2–6	7–8	9+
	1st premolar	10–12	2–7	8–9	10+
	2nd premolar	11–12	2–8	9–10	11+
	1st molar	6–7	NA	4–5	6+
	2nd molar	11–13	NA	9–10	11+

### 5.2.2 Replacement teeth

For adults aged 15 years and over, all lost teeth were further classified as replaced or not replaced by a fixed bridge or a removable denture that was worn to the examination.

### 5.2.3 Decay experience of coronal tooth surfaces

For adults and children, all teeth present were divided into five tooth surfaces: mesial, buccal, distal, lingual, and either occlusal (for premolars and molars) or incisal (for incisors and canines). Each coronal surface was dried with compressed air, assessed and categorised using visual criteria (no explorer was used) and one of the following codes was assigned:

- decay: cavitation of enamel or dentinal involvement or both present
- recurrent caries: visible caries that is contiguous with a restoration
- filled unsatisfactorily: a filling placed for any reason in a surface that requires replacement but has none of the above conditions
- filling to treat decay: a filling placed to treat decay in a surface that has none of the above conditions
- filling placed for reasons other than decay: a filling placed in a surface that has none of the above conditions (incisors and canines only)

- fissure sealant and where none of the above conditions was found
- sound: where none of the above conditions was found.

#### **5.2.4 Decay experience of tooth root surfaces**

For adults aged 15 years and over, all teeth present were subdivided into four root surfaces: mesial, buccal, distal and lingual. Each root surface was assessed visually and, if necessary, using the periodontal probe. One of the following codes was assigned:

- decay: a discrete, well-defined or discoloured lesion on the root surface that is soft to exploration using the periodontal probe
- recurrent caries: detectable caries that is contiguous with a restoration
- filled unsatisfactorily: a filling placed for any reason in a surface that has unacceptable defects but none of the above conditions was found
- filled root surface: one or more permanent restorations placed for any reason but none of the above conditions was found
- wear of 2 mm or more: recorded only on buccal surfaces with none of the above conditions
- sound root surface: where none of the above conditions was found
- no visible root surface.

#### **5.2.5 Periodontal tissue destruction**

As part of the adult dental examination, the dental examiners examined periodontal tissue for destruction (pocket depth and recession). The assessment of periodontal tissue destruction followed the protocol used in the Australian National Survey of Adult Oral Health 2004–06, which was based on the methods used in the United States National Health and Nutrition Examination Survey (NHANES).

Assessments were made of probing pocket depth and gingival recession, recorded in millimetres using a periodontal probe with 2 mm markings. Measurements were made at the mesio-buccal, mid-buccal and disto-lingual aspects of all teeth present, except for third molars. All fractional millimetre measurements were rounded down to the lowest whole millimetre before calling the number. For recession, the cemento-enamel junction (CEJ) was identified or its position estimated (eg, if a filling obscured its position), and the distance from the CEJ to the free gingival margin was recorded in millimetres. When the CEJ was subgingival, the number called was negative; otherwise it was positive. For probing pocket depth, the distance from the free gingival margin to the bottom of the periodontal crevice/pocket was called.

Dental examiners did not measure clinical attachment loss directly; instead, it was computed during data analysis.

At least 10 seconds after each tooth was probed, dental examiners recorded whether there was bleeding present at any of the three probing sites for each tooth.

It should be noted that the periodontal component of the dental examination was only carried out for adult participants who did not have any medical conditions that excluded them from this part of the examination (such as heart disease; see Table 5 in Section 6 for more details).

### **5.2.6 Dental trauma**

If present, the upper six anterior permanent teeth (upper right canine to upper left canine) were assessed for dental trauma. Dental examiners asked survey participants about any history of trauma to the upper front teeth and then assessed the teeth for visual signs of trauma. One of the following codes was assigned to each tooth:

- no trauma
- treated trauma: any size or involvement (usually with composite)
- trauma limited to enamel and not treated
- trauma involving at least dentine (treatment required but not yet treated)
- tooth discoloured after trauma (verified by participant)
- avulsed, luxated because of trauma (verified by participant)
- not able to be scored (primary tooth, unerupted tooth, tooth missing for reasons other than trauma).

### **5.2.7 Dental fluorosis**

The appearance of the upper front permanent teeth has the greatest impact on aesthetics for individuals over their lifetime. The eight upper front permanent teeth of children and adults aged 8–30 years (inclusive) were assessed for fluorosis in this survey. For teeth to be assessed for fluorosis, the teeth must be fully erupted into the mouth. By the age of 8 years, the upper central incisor teeth will be fully erupted in most children and therefore can be assessed for fluorosis. Data on fluorosis in adolescents and young adults up to the age of 30 years were collected to enable assessment of the prevalence of fluorosis in the child and young adult population within New Zealand, and to identify whether further research into fluorosis is needed. The teeth of adults older than 30 years were excluded from the fluorosis assessment, on the grounds that it becomes more difficult to assess fluorosis because the tooth enamel matures, people have dental procedures undertaken, or some teeth become restored with dental fillings or crowns.

For survey participants aged 8–30 years, the buccal surfaces of eight upper anterior teeth (upper right first premolar to upper left first premolar), if present, were assessed for dental fluorosis using the six categories of Dean's Index of Fluorosis (Dean 1934) as described in the World Health Organization (WHO) publication *Oral Health Surveys* (WHO 1997). The categories used were:

1. normal: the enamel surface is smooth, glossy and usually a pale creamy-white colour
2. questionable: the enamel shows slight aberrations from the translucency of normal enamel, which may range from a few white flecks to occasional spots

3. very mild: small opaque, paper-white areas scattered irregularly over the tooth but involving less than 25% of the labial tooth surface
4. mild: the white opacity of the enamel of the teeth is more extensive than for category 2, but covers less than 50% of the tooth surface
5. moderate: the enamel surfaces of the teeth show marked wear and brown stain is frequently a disfiguring feature
6. severe: the enamel surfaces are badly affected and hypoplasia is so marked that the general form of the tooth may be affected. There are pitted or worn areas and brown stains are widespread; the teeth often have a corroded appearance
7. not able to be scored (restoration on buccal surface, previous or present orthodontic treatment, tooth not fully erupted).

To assist dental examiners in distinguishing whether the condition observed on a tooth was due to fluorosis or was a developmental defect of enamel, Russell's differential criteria were used as a sieve (Russell 1962).

### **5.2.8 Simplified Debris Index**

The Simplified Debris Index (DI-S) of the Simplified Oral Hygiene Index (Green and Vermillion 1964) was used to assess the level of food deposits and plaque on six index teeth (if present) as follows:

- the buccal surface of the upper right permanent or primary incisor, and the lower left permanent or primary incisor
- the buccal surface of the most anterior permanent molar, or the most distal primary molar
- the lingual surface of the most anterior permanent molar, or the most distal primary molar.

The surface area of tooth covered by debris was assessed visually or by running the side of the periodontal probe along the tooth surface being examined. One of the following codes was assigned:

- no debris or stain present
- soft debris covering not more than one-third of the tooth surface being examined, or the presence of extrinsic stains without debris (regardless of surface area covered)
- soft debris covering more than one-third but no more than two-thirds of the exposed tooth surface
- soft debris covering more than two-thirds of the exposed tooth surface
- unable to be scored (tooth not fully erupted, tooth with orthodontic band cemented, crowned tooth, tooth reduced in height by caries or trauma).

### **5.2.9 Oral mucosal tissues**

Dental examiners examined the lips and intra-oral mucosa of each participant for any of the following:

- suspected malignant tumours (oral cancer)
- ulcerated lesions (aphthous, herpetic, traumatic)
- any other oral mucosal lesions (including tongue piercings and lip piercings)
- none of the above (eg, healthy oral mucosa).

If the dental examiner discovered a suspected malignancy, the participant was referred for further investigation to the relevant DHB.

### **5.2.10 Clinical photography**

With the participants' consent, examiners took three clinical photographs of participants' teeth using standardised equipment developed for the survey. A Nikon digital camera set for close-up photography was attached to a lighting rig containing six neon lights that ensured consistency of light output. A jig attached to the lighting rig standardised the focal length of the camera to the participant's chin. Three views of the teeth were taken, based on the methods of Wong et al (2005): a frontal view perpendicular to the four incisors, and two lateral views, each showing the lateral incisors and canines on each side of the arch.

## **6 Data Collection and Quality Control**

### **6.1 Face-to-face interview**

The 2009 NZOHS interview team consisted of approximately 39 interviewers from CBG Health Research Ltd (CBG). Interviews were conducted in participants' homes, at a time to suit participants. The survey was carried out using a face-to-face computer-assisted personal interview (CAPI). Interviewers typed responses directly into a laptop computer, and show cards with predetermined response categories were used to assist the participant where appropriate.

Participation in the 2009 NZOHS was voluntary, relying on the goodwill of participants, and consent was obtained without coercion or inducement. Adults within households selected for the survey were sent an invitation letter from the Ministry of Health prior to the start of the survey. Interviewers from CBG contacted the households, explained about the NZOHS and asked if they were willing to take part in the survey. If they agreed to take part, the CBG interviewer made an appointment to visit the participant at their home (or another venue if requested by the participant) and, on their arrival, gave the participant an information brochure, available in eight languages. Participants were then asked to sign an electronic consent form which included a request for an interpreter, if required.

Adult interviews were an average of 31 minutes long, with a median of 30 minutes and a range of 10–70 minutes. The child interviews (with the primary caregiver) had a mean of 14 minutes, a median of 13 minutes and a range of 4–54 minutes.

#### **6.1.1 Interviewer training**

CBG interviewers received specialised training on how to conduct the 2009 NZOHS. There were five training days. All interviewers received a copy of the 2009 NZOHS manual, and received training on how to use it. Interviewers also completed general survey training, online training modules about public policy surveying techniques, and a one-on-one oral examination for each survey module to test each interviewer's comprehension of the survey.

#### **6.1.2 Call pattern**

The 'call' refers to one attempt to contact on one day during a particular time band. CBG conducted up to nine call-backs. Where an address was available, these call-backs included one to three home visits at different times of the day; home visits were not undertaken when a household address was not available. Interviewers were required to try to make contact with participants using all the following possible contact modes: landline, mobile, email, alternate contact person, white pages and home visits.

### **6.1.3 Language assistance**

Professional language interpreters assisted with 25 interviews and/or examinations, and two telephone introductions. A further 13 interviews were conducted with language assistance provided by a friend or family member of the participant.

### **6.1.4 Pilot study**

A pilot study was carried out in March 2008, to test the survey interview and dental examination. One hundred participants from the NZHS re-contact database were randomly selected from Capital and Coast DHB for contact, which resulted in 49 surveys and examinations completed within the time period. The pilot study tested both the interview and the dental examination. As a result of the pilot study, scripting problems in the survey were identified and fixed, and processes were developed for scheduling the survey interviews and examinations. The 100 participants were not eligible to be selected in the subsequent full survey.

### **6.1.5 Dress rehearsal**

A dress rehearsal was undertaken over two weeks, starting 16 February 2009, by CBG. Its purpose was to test the sample design, method of contacting potential participants, and the interviews and dental examinations, and therefore to refine the instruments, operations and processes. The dress rehearsal showed that the information technology (IT) system worked well, and identified some questions in the questionnaire that needed further clarification.

The dress rehearsal was carried out in 12 randomly selected meshblocks in Northland DHB, with participants randomly selected from the NZHS database of participants who were willing to be re-contacted. This selection process resulted in 24 interviews in the dress rehearsal. The interview and examination data from the dress rehearsal were included in the full survey data set, because the timing of the dress rehearsal was so close to the full survey, and no major issues were found with the data collected in the dress rehearsal.

### **6.1.6 Field dates**

Interviews for the 2009 NZOHS were conducted between 16 February and 20 December 2009.

### **6.1.7 Quality control**

As part of the survey, CBG audited a random sample of 18% of completed interviews, to confirm that the interviews had been completed. Satisfaction ratings showed that, on a scale from 1 (not at all satisfied) to 5 (extremely satisfied), 84% of these participants rated the way the interviewer approached and conducted the survey with them as the top rating (5), while 16% rated it as 4, and 0% rated it as 3 or lower.

## **6.2 Dental examinations**

At the end of the survey interview, adult participants who reported having at least one of their own teeth, and child participants (through their primary caregiver) were invited to take part in the dental examination. Those who agreed were given an information sheet that explained in more detail about the adult or child dental examination. Participants who, after reading the information sheet, were still willing to take part in the dental examination were encouraged to attend a local dental facility, as first preference, for their dental examination. They were given a selection of appointment times at a private dental practice, a DHB, School Dental Service clinic or iwi-provider clinic close to their home or work. Where a participant could not physically travel to a clinic-based appointment, an in-home examination was offered.

Dental examinations were never completed on the same day as the interview. About 84% of clinic-based dental examinations were completed within six weeks of the interview. For clinic-based examinations, the mean time between the survey and dental examination was 26 days, and the median time was 17 days. There were 16 in-home examinations carried out at the end of the survey, with the longest gap of 242 days between survey and dental examination.

CBG forwarded the appointment schedules to examination teams and to the dental facility prior to each clinic day, and the examination team kept records of attendance. Any non-attendance of a scheduled appointment was noted, and the participant concerned was contacted again by the interviewer or appointment co-ordinator in an attempt to establish another suitable time slot. About 90% of participants who did not attend the first appointment completed the dental examination on the second appointment. Participants who did not attend the second appointment were not followed up further. Most examinations were conducted during work hours on weekdays, although some examinations were completed after regular working hours or during weekends, if dental practices or DHBs offered clinics at these times.

### **6.2.1 Training of dental examiners**

The 2009 NZOHS clinical team comprised a lead examiner and 22 dental examiners, including a gold standard examiner. All dentists (including the lead examiner and gold standard examiner) were fully qualified and registered, and held current Annual Practising Certificates.

The lead examiner was Associate Professor Kaye Roberts-Thomson, an international expert in examiner training for population-based oral health surveys, from the Australian Research Centre for Population Oral Health, University of Adelaide, Australia. Associate Professor Roberts-Thomson was lead examiner for the Australian National Survey of Adult Oral Health 2004–2006. The gold standard examiner was Dr Robyn Haisman from the Ministry of Health. Her role was to conduct replicate examinations for about six survey participants per examiner, to ensure consistency among the dental examiners. In addition, 21 other dental examiners were selected to be involved in the survey.

All dental examiners undertook a two-and-a-half-day training and calibration course led by the lead examiner. Four training sessions were held at the Auckland University of Technology (January, February, April and July 2009), and an additional training session was held in June 2009 in Wellington at the Ministry of Health and the Wellington Dental Practice. The training courses were timed to precede the start of major roll-out phases, as the survey was implemented regionally within DHBs. The training courses also coincided with the availability of the lead examiner and with clinical facilities that had at least six dental units available for three consecutive days.

The gold standard examiner took part in all five training sessions, completing hands-on examiner training in four of the training sessions and assisting Associate Professor Roberts-Thomson with the training and calibration of examiners during the April training session.

In total, the dental examiners completed 3196 examinations. The majority of examiners undertook 50 to 200 examinations each, with the median being 117. (One examiner undertook only three examinations, while the most prolific examiner undertook 675 examinations.) One examiner withdrew part way through the survey, having completed 152 examinations. The gold standard examiner from the Ministry of Health completed 10 examinations in addition to the replicate examinations.

#### **6.2.1.1 Dental recorders**

Along with the dental examiners, dental recorders were present at the clinical examinations to record the information provided by the dental examiners during the examinations. CBG interviewers were trained as dental recorders for the purposes of the 2009 NZOHS. The dental recorders attended the training course, received instruction on oral epidemiology and the anatomy of the mouth, and were trained in and provided with a manual about the use of the computer system for collecting data.

#### **6.2.2 Locations of survey dental examinations**

Appointments for dental examinations were made primarily at private dental practices within or near the area (meshblock) in which people were sampled. If the participant preferred, appointments were made at private dental practices located close to their work.

Dental examinations were also undertaken in DHB School Dental Service clinics and DHB oral health clinics, iwi-provider clinics, privately owned commercial mobile medical clinics and, in a few cases, in the participant's home.

##### **6.2.2.1 In-home dental examinations**

In-home dental examinations were offered as an alternative to clinic-based examinations for participants who were physically unable to travel to a local dental facility. In-home examinations were completed for 16 participants, comprising 10 adults and 6 children, and representing about 0.5% of the total number of dental examinations.

Due to the logistics involved in organising them, in-home examinations were organised and completed at the end of the survey. To maintain consistency in examining conditions between clinic-based and in-home examinations, portable dental equipment, including a reclining dental chair and an overhead focusing beam examining light, was used where possible. Compressed air was not used to dry the teeth during in-home examinations; cotton rolls and gauze were used instead. Participants in wheelchairs were examined in their wheelchairs. Delaying the in-home examinations until the end of the survey meant that the time interval between interview and dental examination could be up to several months. In-home dental examinations were completed by one dental examiner and dental recorder in mid-December 2009.

### 6.2.3 Procedures prior to the examination

On arrival at the clinic, the dental examiner or dental recorder checked that the participant understood the procedures and, if necessary, gave them another information sheet and explanation. The adult survey participant, or the caregiver accompanying child survey participants, was then asked to read and sign a consent form and complete a medical history form. Children aged 6–14 years could complete a voluntary written consent form for themselves. Children were examined only if both they and their caregiver agreed. Adults and children were advised that they could stop the examination at any time. For the majority of participants, the CBG interviewer was also their dental recorder.

The adult medical history questionnaire asked about conditions that, if present, would preclude a periodontal examination (Table 5), and included general medical questions in case of a medical emergency. The medical history was then checked by the dental examiner and, if any of the relevant medical conditions were confirmed, the periodontal component of the examination was excluded. The child medical history form asked about general medical conditions in case of medical emergency.

**Table 5:** Questions asked to assess fitness for periodontal examination (adults)

1.	Has a doctor ever told you that you must ALWAYS take antibiotics (eg, penicillin) before you get a dental check-up or care?
2.	Has a doctor ever told you that you have a heart problem?
3.	Was your heart problem due to one of these conditions: <ul style="list-style-type: none"> <li>(a) Congenital or acquired heart murmur</li> <li>(b) Heart valve problems</li> <li>(c) Congenital heart disease</li> <li>(d) Bacterial endocarditis</li> <li>(e) Congestive heart failure</li> <li>(f) Heart attack (myocardial infarction or coronary)</li> </ul>
4.	Have you ever had rheumatic fever?
5.	Do you have a joint replacement (hip or knee) that has been inserted in the last six months?

- |  |
|--|
| 6. Are you immuno-suppressed or are you on immuno-suppressant therapy (for example, chemotherapy)? |
|--|

Note: Adults who answered 'yes' to one or more questions were excluded from the periodontal component of the examination, except for adults who answered positively only to 3(f).

## **6.2.4 Procedures following the examination**

At the end of the examination, survey participants were given a written report completed by the dental examiner describing the main clinical findings. The report included general advice about regular dental check-ups and dental treatment. If the dental examiner had discovered a suspected malignancy, the gold standard examiner referred the participant for further investigation at the relevant DHB.

Adult participants who completed the dental examination were sent a thank you letter from the Ministry of Health and a \$50 travel voucher to cover travel expenses incurred in attending a dental examining facility. Children who completed the dental examination were given a toothbrush and fluoride toothpaste. In the majority of cases, adults and children from the same household attended the dental examination together.

## **6.2.5 Ensuring consistency among dental examiners**

Whenever there are multiple examiners, there is the potential for variation among examiners in their diagnostic criteria and recording of oral health indices. To minimise this variation, the following strategies were adopted.

- All examiners were given an 83-page manual describing the examination protocols, with simple and clear codes for each component of the examination.
- All examiners attended a two-and-a-half-day training and calibration course run by the lead examiner.
- When there was a delay between training and starting in the field, the gold standard examiner worked with and recalibrated the dentist on their first day of dental examinations.

To measure the consistency among dental examiners, the gold standard examiner conducted replicate examinations for about six survey participants per examiner, in order to check that dental examiners had consistent results.

### **6.2.5.1 Replicate examinations**

The gold standard examiner visited each examiner on a day when they were examining survey participants. The purpose of her visit was to conduct 'masked replicate' examinations of survey participants. Survey participants were examined twice (once by the dental examiner and once by the gold standard examiner), and the gold standard examiner recorded her findings without being aware of the findings recorded by the dental examiner. Replicate examinations were conducted with all but the one examiner who only completed three examinations.

The replicate examination included assessments of tooth presence, periodontal assessment of teeth in one jaw, dental trauma, dental fluorosis, debris index, and an assessment of caries experience in both crowns and roots of teeth. The gold standard examiner assessed fluorosis and debris at the same time as the dental examiner examined the participant, and made her assessments independent of the dental examiner's call.

#### **6.2.5.2 Calculating dental examiner reliability**

The reliability of each dental examiner, relative to the gold standard examiner, was measured by calculating the intra-class correlation coefficient (ICC). The ICC is a measure of how well the dental examiner's results match the gold standard examiner's results. Guidelines for interpreting the resulting kappa statistic propose that values of 0.8–1.0 represent 'almost perfect' agreement, 0.6–0.8 show 'substantial' agreement, 0.4–0.6 show 'moderate' agreement, and 0.2–0.4 show 'fair' agreement (Landis and Koch 1977).

Replicate pairs of examinations were conducted with 107 survey participants to assess the reliability of 19 of the 21 original examiners; excluded were the one examiner who did only three examinations in total, and another whose set of replication records was inadvertently lost. The number of replicate pairs of examinations ranged from three to seven per examiner, depending on the number of participants who arrived and consented to be re-examined on the scheduled day. Reliability of most aspects of the examination was based on person-level summary indicators (such as the number of missing teeth). Additionally, reliability was measured for coding of decayed, missing or filled status of 2376 teeth, and for periodontal measures recorded at 2498 sites.

The highest levels of agreement were found for the following indicators: number of teeth present, number of teeth missing due to pathology, and number of decayed, missing and filled teeth, per person (Table 6). There was almost perfect agreement for all indicators measured (ICC 0.78 or greater). These levels of examiner reliability are comparable with those reported for other surveys (such as the Australian National Survey of Adult Oral Health 2004–06, and the 1998 Adult Dental Health Survey in the United Kingdom). Overall, these results showed high levels of agreement between the examiner team and the gold standard examiner.

Also presented in Table 6 are the differences in means between the examiner team and the gold standard examiner. If the examiner team was biased (eg, tended to under-report issues of dental concern) then the differences would be large and would tend to be either all positive or all negative. Instead, differences in mean show that on some measures (periodontal and root decay/fillings) the team picked up marginally more dental issues and on other measures (coronal decay and fillings) marginally less. In all cases the differences were small, indicating that the examination team was not over- or under-reporting to any great extent compared with the gold standard examiner.

Table 6 also reports the percentage of cases where the pairs matched exactly, and where the pairs were close (within 1 of each other). These results identified that the measures with lower levels of matching included filled teeth, clinical attachment loss

and probing pocket depth. However, the mismatches were generally small, with over 85% exact or close matches on all measures and over 90% on all but two (decayed, missing or filled teeth; and filled coronal surfaces).

These results show that the most difficult measures to get very high levels of inter-examiner reliability were those related to the periodontal examination and those related to relatively rare counts of teeth (such as number of decayed teeth). Overall, the results show that the dental examiners' results closely matched those of the gold standard examiner.

**Table 6:** Summary of findings from assessment of inter-examiner reliability, 2009 NZOHS

Index	Number of examiners evaluated	Number of replicate pairs evaluated	Median reliability of the examiners	Overall team reliability score	% of pairs where exact match with gold standard examiner	% of pairs where difference <= 1	Difference in pair means	Relative difference (as % of gold standard mean)
Number of teeth present per person	18	107 people	1.00	1.00	96%	96%	-0.09	-0.3
Number of missing teeth due to pathology per person	18	107 people	1.00	1.00	90%	95%	-0.01	-0.3
Number of filled coronal surfaces per person	18	107 people	0.99	0.98	54%	87%	0.17	2.4
Number of decayed, missing or filled teeth per person	18	107 people	1.00	0.99	63%	85%	-0.04	-0.3
Number of decayed coronal surfaces per person	17	107 people	0.82	0.89	71%	90%	-0.20	-16.0
Number of decayed root surfaces per person	15	62 people	1.00	0.98	91%	93%	0.02	4.7
Number of filled root surfaces per person	15	62 people	1.00	0.78	86%	100%	0.04	11.3
Millimetres of clinical attachment loss per site	17	2498 sites	0.92	0.93	46%	90%	0.15	9.1
Millimetres of probing pocket depth per site	17	2498 sites	0.86	0.86	51%	94%	0.12	7.2
Decayed, missing or filled status of teeth	19	2376 teeth	0.93 <sup>a</sup>	0.94 <sup>a</sup>	96%	–	–	–

a Reliability refers to intra-class correlation coefficients (ICC), except for decayed, missing and filled status, where the kappa statistic is presented.

## 7 Sample Size

A total of 4906 New Zealanders participated in the 2009 NZOHS, and 3196 participants had a dental examination (Table 7) (see Section 8 for response rates).

**Table 7:** Sample sizes for various stages of sample selection, 2009 NZOHS

<b>Sample</b>	<b>Number of participants (adults and children)</b>
Participated in the 2006/07 NZHS	17,409
Selected to participate in the 2009 NZOHS	8938
Able to be re-contacted	6173
<b>Participated in the interview</b>	<b>4906</b>
Agreed to participate in the dental examination	4241
<b>Had a dental examination</b>	<b>3196</b>

Table 8 provides further information about the sample sizes and population counts for the groups referred to in this report, for children and adolescents aged 2–17 years. Overall, there were interviews for 1431 children and adolescents aged 2–17 years. A parent or caregiver completed the interview for the 1210 child and adolescent participants aged 2–14 years.

Using total response ethnicity, the sample included 694 Māori, 269 Pacific, 237 Asian and 817 European/Other children and adolescents aged 2–17 years.

**Table 8:** Sample size numbers and design effects for children and adolescents aged 2–17 years, for the 2009 NZOHS, by demographic group

Children and adolescents (2–17 years)	Population size	Number interviewed	Number dentally examined	Example design effects (DEFFs)		
				Fair or poor oral health status	Brush teeth twice daily with adult strength fluoride toothpaste	DMFT
All	900,000	1431	987	3.4	3.4	2.4
Females	430,000	693	474	2.9	2.4	1.8
Males	470,000	738	513	3.0	3.2	2.8
2–4 years	150,000	280	195	0.9	2.8	2.0
5–11 years	390,000	642	438	3.3	3.4	2.5
12–17 years	360,000	509	354	2.8	3.2	2.3
Māori	200,000	694	461	1.6	1.5	1.6
Pacific	100,000	269	184	1.8	1.6	2.1
Asian	70,000	237	171	4.0	3.7	1.7
European/Other	700,000	817	570	2.6	3.1	2.4
NZDep2006 quintile 1	180,000	182	118	2.9	2.5	2.6
NZDep2006 quintile 2	180,000	225	167	2.1	3.0	2.4
NZDep2006 quintile 3	190,000	266	187	3.2	3.1	3.3
NZDep2006 quintile 4	160,000	323	217	3.6	3.3	2.5
NZDep2006 quintile 5	180,000	435	298	2.0	1.7	1.6

Note: Total response ethnic groups have been used.

Key: DMFT = dental, missing and filled teeth; NZDep2006 = New Zealand Index of Deprivation 2006

Table 9 provides sample sizes and population counts for the groups referred to in this report, for adults aged 18 years and over. Overall, there were interviews for 3475 adults aged 18 years and over. This total includes 1267 Māori, 353 Pacific, 518 Asian and 2125 European/Other adults (using total response ethnicity).

**Table 9:** Sample size numbers and design effects for adults aged 18 years and over, for the 2009 NZOHS, by demographic group

Adults (18+ years)	Population size	Number interviewed	Number dentally examined	Number periodontally examined	Example design effects (DEFFs)		
					Fair or poor oral health status	Usually visit dentist for check up	DMFT
All	2,930,000	3,475	2,209	2,048	2.0	2.1	0.8
Females	1,530,000	2,110	1,355	1,265	1.7	1.8	0.9
Males	1,400,000	1,365	854	783	2.2	2.3	0.7
18–24 years	360,000	268	168	163	2.2	3.2	2.1
25–34 years	460,000	549	364	352	1.8	2.8	2.0
35–44 years	570,000	783	578	560	2.2	2.2	2.4
45–54 years	550,000	687	464	433	2.1	2.3	2.1
55–64 years	440,000	510	303	269	2.0	1.7	1.5
65–74 years	290,000	375	202	176	1.7	1.2	1.1
75+ years	240,000	303	130	95	1.6	1.6	1.6
Māori	330,000	1,267	781	723	2.1	2.0	1.5
Pacific	150,000	353	219	209	1.4	1.9	1.3
Asian	250,000	518	380	363	2.6	3.3	2.2
European/Other	2,430,000	2,125	1,353	1,248	1.8	1.5	1.1
NZDep2006 quintile 1	610,000	519	340	316	1.8	1.9	2.5
NZDep2006 quintile 2	600,000	599	418	389	1.8	2.0	2.1
NZDep2006 quintile 3	570,000	639	415	396	2.0	2.7	2.4
NZDep2006 quintile 4	590,000	787	483	446	1.9	2.5	2.7
NZDep2006 quintile 5	570,000	931	553	501	2.6	3.1	2.7

Note: Total response ethnic groups have been used.

Key: DMFT = dental, missing and filled teeth; NZDep2006 = New Zealand Index of Deprivation 2006

Tables 8 and 9 also provide measures of the design effect (DEFF). The DEFF is a measure of the net effect of a complex survey design. It is the ratio of the variance (a measure of precision) of an estimate achieved by a complex design, relative to the variance of the same estimate that would be achieved by a simple random sample of the same size. The closer the DEFF is to 1, the closer the design is to simple random sampling. Design effects of between 2 and 4 are typical in population health studies, which mean the variance is larger than would have been obtained using a simple random sample. Even though the DEFF is greater than 1, it does not mean that a simple random sample should be used, as this design would be prohibitively expensive. A complex design like that used in the NZHS is less precise than a simple random sample with the same sample size, but is much more precise than could be achieved by a simple random sample with the same budget.

Nevertheless, DEFFs should not be too large. In particular, it is appropriate for weights to vary across the sample, for example to increase the chance of selecting Māori, Pacific and Asian peoples in the sample. However, if the variation in weights is too extreme, the DEFF will be very large, which would be counter-productive for all statistics (even for Māori and other sub-population groups). The best statistical methods available for sampling sub-populations were used to ensure that the designs of the 2006/07 NZHS and 2009 NZOHS were appropriate for achieving adequate precision for national population estimates within the survey budget.

## 8 Response Rates

The main measure used to assess the overall quality of a survey is the final weighted response rate. The response rate is a measure of how many people who were selected to take part in the survey actually participated. A high response rate means that the survey results are more representative of the New Zealand population.

The weighted response rate for the interview was 70% for adults (aged 18 years and over) and 69% for children (among 2006/07 NZHS participants selected to participate in the 2009 NZOHS). Of the 4906 participants who completed an interview, 3196 completed the dental examination (including 2209 aged 18 years and over, and 987 aged 2–17 years). The weighted response rate for the dental examination was 84% for adults and 80% for children (of those who completed the NZOHS interview).

It was also necessary to take into account that the survey followed on from the 2006/07 NZHS, which itself had a response rate of 68% for adults and 71% for children. This means that, when combined, the overall response rate to the 2009 NZOHS was 49% for the face-to-face interview and 41% for the dental examination. The response rates at each stage of the survey were quite reasonable, but the combined effect of each stage of drop-out means that the response rate is lower than the standard aimed at for other New Zealand health surveys (70%). However, these lower rates are fairly typical of response rates for surveys of this type internationally.

It is also important to note that, as this survey was a follow-up to the 2006/07 NZHS, it was possible to examine potential non-response bias quite thoroughly, and much more so than in other large national surveys. The 2006/07 NZHS contained several questions related to oral health, which made it possible to examine whether participants with better oral health outcomes and/or more frequent use of oral health services were more or less likely to have participated in the 2009 NZOHS survey and dental examination. The results of this analysis show that non-response was not related to the oral health variables collected in the 2006/07 NZHS (see the appendix for more information).

Hence, although the response rate is relatively low, there is no evidence to suggest it was related to the key variables of interest in this survey. This finding should give readers confidence that the results presented in the report *Our Oral Health* (Ministry of Health 2010) are indeed generalisable to the New Zealand population as a whole, despite the relatively low response rate.

Table 10 presents the response rates for the 2009 NZOHS, by demographic group. Overall, these rates show that there was no strong evidence of bias in the survey response rate by population group.

**Table 10:** Response rates for the 2009 NZOHS, by demographic group

Variable	Group	Survey response rate	Survey refusal rate	Survey non-contact rate	Exam co-operation rate	Exam refusal rate	Exam 'no show' rate	Exam response rate (overall)
All		70%	20%	10%	83%	8%	9%	56%
<i>Adjusting for NZHS response rate</i>		<i>49%</i>			<i>83%</i>			<i>41%</i>
Demographic group	Adults	70%	20%	10%	84%	8%	8%	57%
	Children	69%	19%	12%	80%	9%	12%	55%
Sex	Males	70%	20%	10%	82%	9%	9%	56%
	Females	70%	20%	10%	84%	8%	9%	57%
Age group	0–4 years	79%	14%	7%	74%	13%	13%	58%
	5–9 years	81%	12%	6%	75%	8%	17%	61%
	10–14 years	67%	21%	12%	77%	11%	12%	52%
	15–17 years	70%	18%	12%	83%	10%	7%	58%
	18–24 years	61%	17%	22%	83%	4%	13%	48%
	25–44 years	68%	21%	12%	83%	8%	9%	56%
	45–64 years	75%	20%	6%	85%	8%	7%	61%
65 years and over	76%	22%	3%	84%	14%	2%	56%	
Ethnic group	Māori	64%	18%	18%	78%	5%	17%	47%
	Pacific	63%	15%	21%	77%	5%	19%	47%
	Asian	62%	24%	15%	85%	8%	7%	51%
	European/Other	72%	20%	8%	84%	9%	8%	59%
NZDep2006 quintile	1 (least deprived)	74%	19%	7%	80%	13%	7%	58%
	2	72%	21%	8%	87%	5%	8%	61%
	3	72%	19%	9%	84%	8%	7%	59%
	4	67%	22%	11%	84%	7%	9%	54%
	5 (most deprived)	64%	20%	16%	80%	6%	14%	48%

Note: The survey response rate, survey refusal rate, survey non-contact rate and examination response rate (overall) are among NZHS re-contactable participants who were selected into the 2009 NZOHS. The examination co-operation rate, examination refusal rate and examination 'no show' rate are among NZOHS survey participants. The row in italics provides the overall response rates for the NZOHS, taking into account the response rate for the NZHS as well.

Key: NZDep2006 = New Zealand Index of Deprivation 2006

## **9 Data Processing**

This section outlines the processes used to collect, check and output the data for the NZOHS.

### **9.1 Capture**

The NZOHS questionnaire was provided to CBG Health Research Ltd as a Word document, and was turned into a series of web pages using CBG's survey software, based on modified output from the 'The Survey System' package. Each tablet personal computer provided to the interviewers had a web server installed, and the survey was administered as a series of web pages linked to a survey database unique to each tablet personal computer.

The date of completion of the survey and survey timing data were recorded automatically in the survey database, as was the duration of the time spent answering each survey question.

### **9.2 Coding**

Most of the questions used single-response options. However, some questions allowed for multiple responses. For these questions all responses were retained, with each response shown as a separate variable on the data file.

In the dental examinations, codes were called by the dental examiner and were recorded by the dental recorder.

### **9.3 Security of information**

Any information collected in the survey that could be used to identify individuals has been treated as strictly confidential. Data were transferred from each interviewer's tablet personal computer to head office at CBG by a secure Internet upload facility. Data were transported to Health and Disability Intelligence at the Ministry of Health on CD-Rom by signed courier.

Names and addresses of people and households who participated in the survey have not been stored with response data. Unit record data were stored in a secure area and were only accessible on a restricted ('need to know') basis.

### **9.4 Checking and editing**

CBG undertook routine checking and editing of the data throughout the field period of the NZOHS. In addition, the final unit record data sets provided to Health and Disability Intelligence have been edited for range and logic.

## **9.5 Imputation**

No explicit unit record or item imputation was used in the survey to deal with either unit record or item non-response.

Non-response was adjusted for in the calculation of weights, to the extent that such an adjustment was possible using the weighting variables available.

## **9.6 Creation of derived variables**

A number of derived variables have been created on the NZOHS data set. Where possible, standard definitions have been used and all derivations were thoroughly checked.

For more information on the derived variables in the NZOHS, refer to the confidentialised unit record file (CURF) documentation, which will be available in 2011.

## 10 Weighting

Survey 'weights' are used in analyses so that estimates of population totals, averages and proportions can be said to be representative of the total usually resident population of New Zealand (excluding institutionalised groups and the homeless). Survey weights can be thought of as the number of population members represented by each survey participant. Using weights in analyses ensures that no population group is under- or over-represented in estimates from the survey.

All results presented in the report *Our Oral Health* (Ministry of Health 2010) were weighted in order to be representative of New Zealand's estimated resident population living in permanent private dwellings at 30 June 2007 (the reference date for the 2006/07 NZHS).

### 10.1 Weighting procedure

The procedure to calculate the survey weights for the 2009 NZOHS had three main stages. These stages are described in more detail below.

#### 10.1.1 Selection probabilities

First, the 2006/07 NZHS weights for the participants to the 2009 NZOHS questionnaire were adjusted to account for the probability that an NZOHS participant was selected into the NZOHS sample. These selection probabilities were based on the participant's ethnicity (Māori, Pacific and Asian participants had a probability of selection into the NZOHS of 1, whereas European/Other participants were given a 4 in 10 chance of being selected into the NZOHS).

#### 10.1.2 Calibration for interview data

Second, these weights were calibrated so that they matched a set of population benchmarks. The benchmarks were estimates of the New Zealand resident non-institutionalised population (as at 30 June 2007) broken down by age group, sex, ethnicity and whether they had visited a dental professional in the past 12 months, as follows:

- benchmark 1: sex by age group (0–4, 5–11, 12–17, 18–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75+ years)
- benchmark 2: sex by Māori/non-Māori by age group (0–4, 5–9, 10–14, 15–17, 18–24, 25–44, 45–64, 65+ years)
- benchmark 3: sex by Pacific/non-Pacific by age group (0–4, 5–9, 10–14, 15–17, 18–24, 25–44, 45–64, 65+ years)
- benchmark 4: visited a dental professional in past year (yes or no) by ethnicity (Māori or Pacific/non-Māori and non-Pacific) by age group (0–4, 5–9, 10–14, 15–17, 18–24, 25–44, 45–64, 65+ years).

The first three benchmarks were derived from Statistics New Zealand 2006 Census data, population growth factors (from Statistics New Zealand population estimates), and Census undercount factors from the Census post-enumeration survey. A full description can be found in the 2006/07 NZHS methodology report (Ministry of Health 2008).

The fourth set of benchmarks (using whether participants had visited a dental professional in the past year as a benchmark variable) was derived from the 2006/07 NZHS data, which included this information on visiting a dental professional.

The resulting weights from this second stage of calibration were those used to analyse the self-reported data from the 2009 NZOHS questionnaire.

### **10.1.3 Calibration for dental examination data**

A third calibration stage produced weights used when analysing the dental examination data.

In this calibration stage, all the examination participants' weights from the previous stage (ie, their NZOHS survey weights) were re-calibrated back to the same set of benchmarks as in stage two. However, this time, the benchmarks were estimates from the NZOHS pertaining to the dentate population (ie, all participants with no natural teeth were removed, before the benchmarks were re-estimated using the stage two NZOHS survey weights).

## **10.2 Selection of calibration variables**

The calibration variables included in the weighting process (age, sex, ethnicity and whether the participant had visited a dental professional in last year) were chosen because they are related to many oral health conditions and to non-response. By using these variables in the calibration, the weighting corrects for the discrepancy if the sample differed from the population according to any of these categories.

For example, if young men are under-represented in the sample relative to the Census counts (as can often be the case due to non-response), the survey weights for young male participants are increased so that this group is correctly represented in estimates.

The variable of 'visit to a dental professional in past year' was only weakly related to non-response, but was still included in the calibration to remove any very small differences in the rate of visiting a dental professional between the population as a whole and the sample of NZOHS participants. It was important to ensure the 2009 NZOHS accurately represented dental visiting patterns in the population, as regular visits to a dental professional are a critical factor relating to all the oral health outcomes analysed in the report.

## 11 Sampling and Non-sampling Errors

As a signatory to the Protocols of Official Statistics (Statistics New Zealand 2007), Health and Disability Intelligence has used best-practice survey techniques throughout the 2009 NZOHS. Many steps have been taken to ensure the data collected are of high quality and robust to the greatest extent possible. One of these steps was to establish an advisory group to direct questionnaire and dental examination content. External peer review of the sample design of the survey and this report has also contributed to the high quality of the survey.

However, readers should be aware that errors can arise due to sampling (selection of only some people in a population) and for other reasons (referred to as non-sampling errors). The quantification of sampling errors and the prevention of non-sampling errors are discussed below.

### 11.1 Sampling error

Sampling error results from selecting a sample to represent the entire population, and is influenced by the complex design of the survey (with the result that some people have a higher chance of selection than others). That is, the estimates in this survey may differ from those results that would have been produced if all the information had been obtained for all people in the population.

The most common measure of sampling error is the standard error, which can be interpreted as an estimate of the typical absolute error of estimates. Standard errors for survey estimates from this survey were calculated using a replicate method, called the delete-a-group jack-knife method (Kott 1998). This method correctly reflected both the complex sample design and the use of calibrated weights, including the benchmarks based on NZHS sample data.

#### 11.1.1 95% confidence intervals and statistical significance

If multiple survey samples were obtained, even at the same time, they would provide results that differed. The 95% confidence interval is the interval that would be expected to contain the true population value 95% of the time if many samples were taken.

The difference between two estimates is said to be statistically significant at the 0.05 level if the difference is of a magnitude that would be unlikely to occur by chance (5% probability or less). When the confidence intervals of two groups do not overlap, the difference in rates between the groups is statistically significant at the 5% level ( $p$ -value < 0.05). Any differences between two variables where the confidence intervals overlap were tested using a  $t$ -test.

It should be noted that the confidence interval is influenced by the sample size of the group: when the sample size is small, the confidence interval becomes wider.

The Korn and Graubard (1998) method was used to calculate 95% confidence intervals of prevalence estimates when only a small number of participants (fewer than 30) answered 'yes' to a question, or when the original confidence interval included prevalences outside the range 0–100%.

## **11.2 Non-sampling errors**

Non-sampling errors may occur in any enumeration, regardless of whether it is a sample or a full enumeration. Possible non-sampling errors include coverage errors, response bias and measurement errors. Although these elements cannot be measured, it is useful to be aware of them when interpreting the results of the survey. Significant effort has been made to reduce non-sampling errors by carefully designing and testing the survey, questionnaire and processes, and ensuring quality control of procedures and data.

Response bias may have occurred if there was differential non-response; that is, if the survey was less likely to be answered by certain people, such as a certain population group (eg, young males) or people who are not often home. The interview introduction was an important part of trying to ensure that all people who were selected took part in the survey. The use of calibrated weighting, described in Section 10, also tends to reduce response bias, to the extent that response is related to the benchmark variables such as age, sex and ethnicity.

Measurement errors might also have occurred in this survey. Some of the analyses in this report used self-reported information, which may be inaccurate. Measurement errors include recall error (eg, mistakes made when participants recall how often they have done something over the last 12 months), under- and over-reporting (which may be influenced by the participant's perception of what is socially desirable) and item non-response (if the participant does not answer certain questions). Many of the survey results are based on the assumption that participants could accurately recall previous events and that they provided correct information.

A range of steps were taken to try to minimise recall and other reporting errors, including testing, and use of questions that had been validated elsewhere.

As discussed in Section 6, the inter-examiner reliability in the 2009 NZOHS was shown to be sufficient, and therefore there is unlikely to be a large amount of measurement bias in the clinical analyses.

## **11.3 Small sample sizes**

Small sample sizes can affect both reliability and confidentiality of results. Problems with reliability generally arise when the denominator (the number of people in the sample for a population group) is small, and consequently random variation is high, resulting in estimates that might change substantially if the survey was repeated. Problems with confidentiality can occur when it becomes possible to identify an individual, usually someone in a sub-group of the population within a small geographical area.

To ensure that the survey data presented were reliable and to protect the confidentiality of the participants, data were only presented when the sample size in the denominator of a rate was at least 30. In most cases this meant presenting the data in a sufficiently aggregated form and, in a small number of cases, this meant suppressing results for some cells in a table presented. Care was taken to ensure that no participant can be identified in the results.

## 12 Analysis and Interpretation

The report *Our Oral Health* (Ministry of Health 2010) presents key findings from the 2009 NZOHS. This section outlines some of the techniques used to analyse the survey data for *Our Oral Health*, and also provides some notes that may be of use to readers when interpreting the findings.

### 12.1 Prevalences and means

Many key findings in the report *Our Oral Health* are presented as prevalences and means. Prevalence estimates provide estimates of the proportion of people with a defined outcome, within a defined population. Additionally, means are generally presented as the mean number per person (eg, the mean number of decayed teeth per person).

Prevalence and mean estimates are provided for the total population, for each age group, and for other population groups, including ethnic groups and neighbourhood socioeconomic deprivation (New Zealand Index of Deprivation 2006 or NZDep2006) quintiles. These unadjusted prevalences and means give an indication of the burden of oral health outcomes in these population groups.

When interpreting findings in the *Our Oral Health* report, it is important to note the denominator – that is, the population for which the indicator is presented. For example, in the report, dental examination results were only reported for adults who had at least one natural tooth (ie, dentate adults). Adults who reported in the interview that they had no natural teeth were not asked to have a dental examination. Additionally, periodontal results were estimated only for adults who were periodontally examined. Therefore, these results do not represent people with existing health conditions, including people who must always take antibiotics before they visit a dentist, people who have ever been told they have a heart problem (excluding a heart attack), people who have ever had rheumatic fever, people who have had a hip or knee replacement in the previous six months, and people who are immuno-suppressed or who are on immuno-suppressant therapy.

### 12.2 Comparative measures

To help answer comparative questions such as, ‘Do men have a higher prevalence of untreated decay than women?’, two types of measures were presented in *Our Oral Health*: rate ratios and rate differences (and the equivalent measures for means, ie, ratios of means and differences of means). **Rate ratios** give a measure of relative difference in burden for the group of interest, while **rate differences** give a measure of the absolute difference in burden. These measures were adjusted for possible confounding factors.

Rate ratios and rate differences complement each other and give different perspectives on the difference between the two groups with respect to the outcome measure. For example, a 20% rate difference (eg, men = 40%, women = 20%, difference = 40% – 20% = 20%) can be interpreted as placing a much higher burden on men than a 1% rate difference (eg, men = 2%, women = 1%, difference = 1%), even though in both examples the risk is twice as high for men as it is for women (ie, the same rate ratio of 2).

### 12.2.1 Rate ratios and ratios of means

A rate ratio is a ratio of the prevalence estimates between two population groups. Similarly, the **ratio of means** is the ratio of the means of two population groups.

Rate ratio	= $\frac{\text{prevalence in group of interest}}{\text{prevalence in reference group}}$
Ratio of means	= $\frac{\text{mean in group of interest}}{\text{mean in reference group}}$

All the comparisons in this report refer to a ‘group of interest’ compared with a ‘reference group’. For example, men are compared with women, and Māori are compared with non-Māori.

Rate ratios (and ratios of means) can be interpreted in the following ways:

- a value of 1 shows that there is no difference between the group of interest (eg, men) and the reference group (eg, women)
- a value higher than 1 means that the result is higher for the group of interest than for the reference group
- a value lower than 1 means that the result is lower for the group of interest than for the reference group.

### 12.2.2 Rate differences and differences in means

The rate difference is a measure of the difference in prevalence estimates between the group of interest and the reference group. It can be referred to as the **percentage point difference**.

Similarly, the **difference in means** is a measure of the difference in estimates of the means for two groups.

Rate difference	= (prevalence in group of interest) – (prevalence in reference group)
Difference in means	= (mean in group of interest) – (mean in reference group)

It should be noted that in a few cases the rate difference is statistically significant (noted with an asterisk \*), while the rate ratio is not, for a particular comparison. This situation may arise when both the rate difference and rate ratio are close to the cut-off of statistical significance (ie, close to a  $p$ -value of 0.05).

### 12.2.3 Adjustment

A further consideration is the selection of possible confounding factors to adjust for in comparisons. Confounding can occur when two population groups have different distributions of other factors (such as age) which are themselves related to the health outcome but are not on the causal pathway. Adjusting for potential confounding factors makes comparisons more accurate and meaningful, as the adjustment removes the effect of these confounding factors.

Confounding factors include age and sex, which are important and fundamental determinants of health. Populations with different age structures (such as men and women, whose age structure differs because women have a longer life expectancy) may have differences in rates simply because of their age differences. Hence, when comparing population groups such as men and women, it is useful to remove (or adjust for) the effect of age, to be able to see if the differences between men and women go beyond what can be explained by age effects. Similarly, the Māori population is generally younger than the total New Zealand population, and therefore it is important to adjust for age when comparing Māori and non-Māori.

Both comparative measures in this report are based on adjusted prevalences (or means) for the group of interest and reference group. They are a form of direct adjustment, which is calculated in two steps as follows.

1. A model is fitted to the data (a logistic model for indicator variables, and a log-linear regression model for count variables, such as the counts of teeth).
2. The parameters of the model are used to estimate a prevalence (or mean) for a population that matches the New Zealand population with respect to the other adjustment factors in the model (eg, age), except that everyone belongs to the group of interest (eg, everyone is male).

Once the adjusted prevalences (for the group of interest and the reference group) are estimated, the ratio or difference between them is calculated to provide the comparative measures. When these are presented in the report, the adjustment factors that have been used in the model are always listed.

In the report *Our Oral Health*, in terms of the comparison presented of men and women (which is adjusted for age), the resulting rate ratio is essentially an age-standardised rate ratio (SRR). The rate ratios are presented in this more general framework so that it is easy to adjust for more than one factor at a time.

## 12.2.4 Choice of adjustment factors

The comparisons and adjustment factors used in this report are presented in Table 11.

**Table 11:** Adjustment factors used in analyses

Comparisons	Adjustment factors
Males and females	Age group
Māori and non-Māori	Age group and sex
Pacific peoples and non-Pacific peoples	Age group and sex
Asian and non-Asian	Age group and sex
Neighbourhood socioeconomic deprivation (NZDep2006)	Age group, sex and ethnic group
All other comparisons	Age group, sex, ethnic group and neighbourhood socioeconomic deprivation

The choices of adjustment factors used in the comparative analysis in this report are relatively consistent with standard practice for the descriptive analysis of national health-related surveys. However, it is noted that a variety of possible approaches to the selection of adjustment factors could be taken; the availability of the survey unit record dataset for researchers means that other approaches can always be explored in subsequent projects.

The selection of adjustment factors used in this report is based on the following logic.

- Results generally adjust for age group and sex, because these are such fundamental determinants related to most health outcomes.
- When assessing the impact of neighbourhood socioeconomic deprivation (using NZDep2006), results are also adjusted for ethnic group. Generally, the strength of the association between ethnicity and NZDep2006 means that ethnicity will act as a confounding factor when assessing the effect of NZDep2006 on health outcomes. Hence, to compare low and high socioeconomic deprivation, results are adjusted for age group, sex and ethnic group. Although ethnic groups based on total response were used as the basis for reporting ethnicity in the report, a prioritised ethnic group variable was used as an adjustment variable in models because it was simpler to include in the regression model, and is a very good approximation of using a full set of total response ethnic group indicators as adjustment factors in a regression model.
- For all other groups compared in this report, results were adjusted for age, sex, ethnicity and NZDep2006. These variables were assumed to account for the main sociodemographic factors that will otherwise confound the differences found between groups.

### 12.2.5 Why adjust socioeconomic deprivation analyses for ethnicity, but not ethnic analyses for socioeconomic deprivation?

Ethnicity confounds the relationship between socioeconomic deprivation and oral health outcomes. That is, ethnicity is associated with neighbourhood socioeconomic deprivation (different NZDep quintiles have differing ethnic compositions) and is independently and causally linked to oral health outcomes. If socioeconomic deprivation analyses are not adjusted for ethnicity (as well as age) then the effects found will not reflect the independent effect of socioeconomic deprivation, but instead will be a mix of socioeconomic deprivation and ethnic effects.

By contrast, socioeconomic deprivation is a mediator, not a confounder, of the association between ethnicity and oral health. That is, socioeconomic deprivation is on the pathway that links ethnicity to oral health – it is one of the mechanisms (indeed, a major one) whereby ethnicity exerts its influence on oral health. So if ethnic analyses were adjusted for socioeconomic deprivation, the analyses would not be estimating the full, independent effect of ethnicity, but only that portion of the ethnic effect that is not mediated by socioeconomic position. The purpose of the analysis is to estimate the full effect of ethnicity (rather than exploring the relative magnitude of the different pathways or mechanisms whereby ethnicity impacts on oral health), and therefore the ethnic analyses do not adjust for socioeconomic deprivation.

Note that when estimating the independent effect of other variables, such as reason for visiting the dentist (dental problem or check-up) or residence in areas with or without a fluoridated reticulated water supply, it is appropriate to adjust for both ethnicity and socioeconomic deprivation (as well as age group and sex), as both of these variables may be confounders (but not mediators) in this situation.

### 12.2.6 Inequality measures for NZDep2006

For NZDep2006 comparisons, the method used to calculate the rate ratio (or mean ratio) was slightly different from that used for other comparisons. Instead of simply comparing the most socioeconomically deprived quintile (NZDep2006 quintile 5) with the least deprived quintile (quintile 1), the data from all quintiles (1–5) were used to calculate a line of best fit (regression line), adjusted for age group, sex and ethnic group.

This method provided adjusted estimates for the minimum socioeconomically deprived (slightly 'less deprived' than quintile 1) and the maximum socioeconomically deprived (slightly 'more deprived' than quintile 5), which were then used to calculate the **relative index of inequality** (RII) in a similar way to a standardised rate ratio (Hayes and Berry 2002). This method had the advantage of using all data from all NZDep2006 quintiles to give an overall test for trend (gradient pattern) by neighbourhood socioeconomic deprivation, rather than only using data from quintiles 1 and 5. It also overcame problems with small numbers for some conditions in some NZDep2006 quintiles.

Similarly, for the NZDep2006 analyses, the rate difference was calculated as the difference between the estimated rate for the minimum socioeconomically deprived (slightly 'less deprived' than quintile 1) and the maximum socioeconomically deprived (slightly 'more deprived' than quintile 5), using the regression technique described in Section 12.2.3 above. This is the **slope index of inequality (SII)**. The same technique was used to calculate the difference in means (using means instead of rates).

Despite differences in how these measures have been derived, the results can be interpreted in a similar way to the rate ratios and rate differences derived for sex and ethnic comparisons.

### **12.2.7 Interpretation of comparative analyses**

The 2009 NZOHS is a sample survey at one point in time, and can be used to examine associations between oral health and sociodemographic characteristics. However, readers of this report need to be aware that associations do not necessarily imply causality. For example, if the survey finds that a particular behaviour is more common in people living in more socioeconomically deprived areas, an association has been identified. Such an association does not mean the behaviour is caused by living in a socioeconomically deprived area.

## 13 Comparability of 2009 NZOHS Data with Other Survey Data

Where possible, key findings from the 2009 NZOHS have been compared with data from the previous two New Zealand national surveys of oral health: the 1976 Survey of Adult Oral Health (SAOH) and the 1988 Survey of Oral Health Outcomes (SOHO). However, there are a number of differences between the 1976, 1988 and 2009 surveys, which limit the comparisons between them that may be made.

Caution is recommended when comparing results of different surveys as there are differences in sample sizes, response rates, questions and methodology. These aspects should be taken into account before making any such comparisons.

### 13.1 Time trend comparisons

#### 13.1.1 1976 Survey of Adult Oral Health

The 1976 SAOH had a multi-stage, systematic sampling design, and surveyed people aged 15 years and over living in permanent private dwellings in the North and South Islands (Cutress et al 1979). A total of 3231 participants completed the face-to-face interview (a response rate of 84%). Dental examinations were carried out for 3117 of these participants.

#### 13.1.2 1988 Survey of Oral Health Outcomes

For the 1988 SOHO, the adult sample was drawn nationally using a complex survey design, and included people living in private dwellings in the North and South Islands (Hunter et al 1992). The adult sample had 295 participants aged 20–24 years, 692 participants aged 35–44 years, and 483 participants aged 65–74 years (who both answered the questionnaire and had a clinical dental examination). The response rate varied from 54% to 61% for the three adult age groups. The sample of children aged 12–13 years was drawn from schools, with the result that 1024 children underwent dental examinations and completed questionnaires, a response rate of 96%.

#### 13.1.3 Comparability of surveys

The most notable difference between the surveys concerned the age groups sampled. The 1976 survey included adults in all age groups from 15 years of age. No children were included in the 1976 survey. In the 1988 survey, there were more limited age groups: 12–13 years for children and 20–24, 35–44 and 65–74 years for adults. The 2009 NZOHS included adults and children aged 2 years and over.

Furthermore, the questionnaires for the three surveys were very different, and as a result, very few direct comparisons for self-reported indicators were able to be made. Comparisons made over time included the prevalence of tooth loss and experience of dental decay. The long-term and widespread use of the DMFT index (measuring the number of decayed, missing and filled teeth) to report experience of dental decay enabled the time trends of this indicator to be established. However, it should be noted that the criteria used to determine dental caries have become more sensitive over time.

In the 2009 NZOHS, data on dental decay experience were recorded at surface level and for coronal surfaces and root surfaces. However, to enable these DMFT data to be compared with previous surveys, coronal and root surfaces were combined to a whole-tooth measure, and surface level data were aggregated to tooth-level data. For periodontal pocketing and loss of attachment it was difficult to make comparisons.

It should also be noted that in the 2009 survey, any missing teeth in people aged 45 years and over were assumed to be missing due to pathology; in the 1988 survey, the age at which missing teeth were assumed to be missing due to pathology was younger, at 30 years.

#### **13.1.4 Time trend comparisons**

In the report *Our Oral Health* (Ministry of Health 2010), the prevalence and severity of selected oral conditions from the 2009 NZOHS were compared with data from the 1976 SAOH and the 1988 SOHO. Due to the limited age groups for which data were collected in the SOHO, comparisons were only made for the following age groups: 12–13, 20–24, 35–44 and 65–74 years.

Estimates for oral conditions were produced directly from the SAOH and SOHO survey data sets, and therefore may differ from those presented in previously published reports. Using the original survey data sets has enabled other indicators that were not in the original reports to be included in analyses, in particular prevalence estimates. The methodology for the current analyses and the likely cause(s) of the differences are presented in the relevant sections.

Several points need to be considered when interpreting time trends. First, the change in the age structure of the dentate population may affect the overall results. As people keep their teeth for longer, the age distribution of the dentate population has changed, with a resulting increase in the proportion of older people represented.

Furthermore, the assessment criteria used to determine dental caries have become more sensitive over time. These changes are likely to have resulted in a higher mean number of decayed teeth identified in the 2009 NZOHS.

Additionally, the report *Our Oral Health* only presented data on decayed, missing and filled teeth for dentate adults. These results may differ from previously published results from the 1976 SAOH and 1988 SOHO reports, where results were reported for all adults.

### 13.1.5 Comparative measures for the time trends

Time trend analyses were only carried out for the age groups covered in the 1988 SOHO; that is, people aged 12–13, 20–24, 35–44 and 65–74 years. Overall measures of change (using standardised rate (or mean) ratios) also examined only people in these age groups.

For crude prevalence rates, estimates were weighted for the population at the time. For the adult comparisons, the 1976, 1988 and 2009 survey results were standardised for age using the WHO world standard population to take the differing age structures of the populations into account (Ahmad et al 2000).

Overall comparisons across years have been presented as standardised rate ratios (SRRs) and standardised ratios of means (SRMs). These are presented for the 2009 value, compared with the previous survey. An SRR of less than 1 means that the prevalence (or mean) in 2009 was lower than in the comparison year (either 1976 or 1988). Ninety-five percent confidence intervals have been presented in brackets and as error bars on the graphs.

One of the difficulties in making comparisons over time was that the 1988 SOHO did not cover all age groups. To go beyond comparing each age group separately, and to assess whether any of the oral health outcome measures had changed significantly across age groups, a standardised rate ratio (SRR) was constructed:

$$SRR(1998,2009) = \frac{\sum_{AGE=1}^3 N_{2009,AGE} \cdot P_{2009,AGE}}{\sum_{AGE=1}^3 N_{2009,AGE} \cdot P_{1988,AGE}}$$

where *AGE* refers to the three adult age groupings used in 1988 (20–24, 35–44 and 65–74 years),  $P_{2009,AGE}$  refers to a prevalence or mean from the 2009 NZOHS for a particular age grouping, and  $P_{1988,AGE}$  is a similar figure from the 1988 SOHO.

This SRR is a ratio of:

1. a weighted combination of the 2009 prevalences (or means) across the 1988 age groupings, with weights based on the 2009 NZOHS population numbers ( $N_{2009,age}$ )
2. a weighted combination of the 1988 prevalences (or means) across the 1988 age groupings, with weights based on the 2009 NZOHS population numbers ( $N_{2009,age}$ ).

For the small number of comparisons that were able to be made with the 1976 results, similar ratios were constructed for SRR (1976, 2009).

The above standardised rate ratios could have been constructed to allow standardisation across other factors such as sex and ethnicity (as was done for the

main comparative analysis of the 2009 data). However, the sample sizes were insufficient to allow for this level of adjustment in the comparisons over time.

## **13.2 International comparisons**

The National Survey of Adult Oral Health 2004–06 was a national survey carried out in Australia to measure the oral health status of adults (Slade et al 2007). Telephone interviews collected information about oral health status, behaviours and perceptions, and a dental examination was also carried out to assess clinical oral health status. The survey covered the adult population aged 15 years and over and included 14,123 interviews and 5505 dental examinations.

It was possible to include comparisons between New Zealand and Australia in *Our Oral Health* (Ministry of Health 2010), as the 2009 NZOHS and the Australian National Survey of Adult Oral Health 2004–06 were very similar. The 2009 NZOHS clinical dental examination closely followed the protocol for the Australian oral health survey.

Comparisons between New Zealand and Australia were made for the adult population aged 15 years and over. Age-adjusted ratios of rates and means were presented in order to show a direct comparison between the countries, and age-specific (unadjusted) rates were also presented to show differences by age group. In the case of these international comparisons, the WHO standard population was used as the standard population (Ahmad et al 2000).

## 14 Dissemination of Data

There are several ways to access the results and data from the 2009 NZOHS:

- publications
- online data tables
- confidential unit record files
- contacting Health and Disability Intelligence.

This section details how each of these sources can be accessed. Further information is available on the Ministry of Health website: [www.moh.govt.nz/dataandstatistics](http://www.moh.govt.nz/dataandstatistics).

### 14.1 Publications

Reports and technical papers about the 2009 NZOHS are available on the Ministry of Health website at: [www.moh.govt.nz/moh.nsf/indexmh/portrait-of-health](http://www.moh.govt.nz/moh.nsf/indexmh/portrait-of-health).

The first publication on the 2009 NZOHS was released in December 2010. *Our Oral Health* (Ministry of Health 2010) presented the key findings of the 2009 NZOHS by sex, age group, ethnic group and neighbourhood socioeconomic deprivation. Results were compared with earlier surveys, where possible, for the total population and by age group.

In addition to this methodology report, several other technical reports and papers related to the 2006/07 NZHS and the 2009 NZOHS have been published, and are available online.

### 14.2 Online data tables

Data for all key descriptive analyses (some of which are presented in *Our Oral Health*), are presented in online data tables in Excel format (see [www.moh.govt.nz/dataandstatistics](http://www.moh.govt.nz/dataandstatistics)).

### 14.3 Access to confidential unit record files

The analyses presented in this report are only a small proportion of those that could be undertaken, and in many ways pose more questions than they answer. Health and Disability Intelligence in the Ministry of Health encourages researchers to use 2009 NZOHS data sets to explore topics of interest.

Confidentialised unit record files (CURFs) of survey data are potentially available for statistical purposes to bona fide public good researchers working within academic institutions, government agencies and the wider health sector, subject to certain conditions. CURFs have had all identifying information about individuals removed, and have been modified to protect individual information.

The 2009 NZOHS adult and child CURFs, with accompanying documentation and user guides, will be available in 2011. These CURFs will be able to be linked to the CURFs for the 2006/07 NZHS. Approval is subject to certain criteria, terms and conditions, and the researcher's organisation must sign a microdata access agreement with Health and Disability Intelligence. For more information on accessing CURFs, and to download an application form, please go to <http://www.moh.govt.nz/dataandstatistics>.

#### **14.4 Contacting Health and Disability Intelligence**

If you have a question about the survey or a data request, you can contact Health and Disability Intelligence:

Health and Disability Intelligence  
Ministry of Health  
PO Box 5013  
Wellington  
New Zealand

Tel: +64 (4) 816 2000

Fax: +64 (4) 816 2340

Email: [hdi@moh.govt.nz](mailto:hdi@moh.govt.nz)

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## Appendix: Bias Analyses

Tables A1 and A2 compare oral health indicators for different groups of participants, to examine whether the sample selections (from the 2006/07 NZHS into the 2009 NZOHS interview, and from the NZOHS interview into the NZOHS dental examination) were biased. Overall, these tables show that generally there were no large biases.

**Table A1:** Differences between 2006/07 NZHS and 2009 NZOHS interview results for NZOHS interview participants

Indicator	Age group (years)	All adults			Māori adults			Pacific adults		
		NZHS	OHS	Difference	NZHS	OHS	Difference	NZHS	OHS	Difference
Visited dentist in past year	15–19	64%	64%	0%	51%	62%	11%	55%	59%	3%
	20–24	34%	32%	-2%	29%	24%	-5%	21%	20%	0%
	25–44	45%	47%	2%	38%	41%	3%	32%	34%	2%
	45–69	59%	60%	2%	35%	39%	4%	34%	37%	3%
	70+	54%	64%	11%	34%	52%	18%	37%	60%	23%
Never visited dentist	15–19	2%	1%	-1%	1%	0%	-1%	8%	12%	4%
	20–24	3%	2%	-2%	1%	1%	0%	6%	9%	3%
	25–44	2%	1%	-1%	1%	0%	-1%	7%	6%	-1%
	45–69	2%	1%	0%	4%	6%	2%	7%	5%	-3%
	70+	4%	1%	-3%	14%	6%	-8%	0%	0%	0%
Had teeth extracted because of decay or disease	15–19	11%	12%	1%	13%	13%	0%	19%	10%	-8%
	20–24	15%	11%	-4%	25%	26%	2%	29%	26%	-3%
	25–44	37%	38%	1%	52%	48%	-5%	54%	63%	9%
	45–69	66%	66%	0%	78%	78%	0%	74%	77%	3%
	70+	86%	87%	1%	90%	91%	1%	94%	85%	-9%
Unmet need for dentist	15–19	8%	11%	3%	11%	9%	-1%	10%	4%	-6%
	20–24	14%	10%	-4%	22%	20%	-2%	21%	13%	-9%
	25–44	13%	14%	1%	21%	18%	-3%	15%	17%	2%
	45–69	7%	6%	-1%	16%	14%	-2%	11%	14%	3%
	70+	3%	4%	1%	2%	0%	-2%	6%	0%	-6%

**Table A2:** Differences between 2009 NZOHS interview participants and NZOHS examination participants

Indicator	Age group (years)	All adults			Māori adults			Pacific adults		
		Interview	Exam	Difference	Interview	Exam	Difference	Interview	Exam	Difference
Visited dentist in past year	15–19	65%	61%	-4%	60%	61%	1%	60%	52%	-8%
	20–24	30%	37%	7%	25%	30%	5%	21%	22%	1%
	25–44	44%	47%	2%	40%	43%	4%	35%	38%	3%
	45–69	59%	64%	5%	44%	41%	-3%	36%	45%	10%
	70+	68%	74%	5%	57%	70%	13%	57%	64%	7%
Never visited dentist	15–19	2%	1%	-1%	0%	0%	0%	12%	0%	-12%
	20–24	3%	1%	-2%	1%	1%	-1%	9%	6%	-4%
	25–44	3%	2%	-1%	1%	1%	0%	6%	7%	1%
	45–69	1%	1%	0%	2%	2%	0%	5%	6%	1%
	70+	0%	0%	0%	0%	0%	0%	0%	0%	0%
Had teeth extracted because of decay or disease	15–19	11%	12%	1%	14%	13%	-1%	11%	0%	-11%
	20–24	16%	13%	-4%	26%	28%	2%	28%	24%	-4%
	25–44	40%	36%	-4%	48%	45%	-4%	61%	60%	-1%
	45–69	65%	62%	-3%	76%	76%	-1%	78%	73%	-5%
	70+	84%	82%	-2%	94%	93%	-1%	78%	75%	-3%
Unmet need for dentist	15–19	9%	7%	-1%	9%	7%	-2%	4%	4%	0%
	20–24	11%	8%	-3%	21%	20%	-1%	13%	14%	0%
	25–44	14%	14%	0%	19%	17%	-2%	18%	17%	0%
	45–69	8%	6%	-2%	15%	15%	0%	15%	10%	-5%
	70+	4%	4%	0%	0%	0%	0%	0%	0%	0%