



**ITC New Zealand**

**Wave 1**

**Technical Report**

**August 2008**

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## **Method Summary**

This report summarises various methods issues that relate to the New Zealand arm of the International Tobacco Control (ITC) Policy Evaluation Survey (the ITC Project). It provides additional depth on the primary sampling frame for this survey (which is the 2006/07 New Zealand Health Survey) and on the subsequent ITC Project telephone survey of smokers. For further information not detailed in this report please contact Dr Nick Wilson (principal investigator) at: [nick.wilson@otago.ac.nz](mailto:nick.wilson@otago.ac.nz).

## **1 Introduction**

This report outlines in more detail the methods of this survey which is part of an international collaboration – the International Tobacco Control (ITC) Policy Evaluation Survey. The overall objective of the ITC Project is to “apply rigorous research methods to evaluate the psychosocial and behavioural effects of national-level tobacco control policies”. The ITC Project uses multiple country controls, longitudinal designs, and theory-driven mediational models that allow tests of hypotheses about the anticipated effects of given policies [Thompson et al., 2006]. The ITC Project began in 2002 as a prospective cohort study tracking and comparing the impact of national level tobacco policies among representative samples of adult smokers in four countries: the United States, Canada, the United Kingdom, and Australia. Since then the number of countries involved has expanded to 14 [ITC Project, 2008]. A conceptual framework [Fong et al., 2006a] and methods paper [Thompson et al., 2006], on the ITC Project have been published along with many published outputs in the scientific literature [Fong et al., 2006b] (see also a list of publications in the “key findings” section of the ITC Project website for a list of these: [ITC Project, 2008]). This output has included a whole supplement of the international journal *Tobacco Control* (in 2006: volume 15, Supplement III).

## **2 Background to the NZ arm of the ITC Project**

Development of this arm was stimulated by a visit to New Zealand of Dr Mike Cummings (PI for the USA arm) in 2005 (a visit funded by New Zealand's National Heart Foundation). An application to the Health Research Council of New Zealand for funding was submitted later in this year – with funding successfully obtained in late 2006. The New Zealand Ministry of Health provided critical support through its willingness to allow the New Zealand Health Survey to be the sampling frame.

### 3 The Primary sampling frame

In most of the other ITC Project countries with high telephone penetration, recruitment involves random digit dialling methods. However for New Zealand the sampling frame was based on a national survey, the 2006/07 New Zealand Health Survey (NZ Health Survey). For full details of the methods of this survey see the report on the key results [Ministry of Health, 2008b] and a very detailed methodology report [Ministry of Health, 2008a]. However, key features are as follows:

“The 2006/07 NZ Health Survey was carried out from October 2006 to November 2007, collecting information on over 17,000 New Zealanders (4921 children aged from birth to 14 years and 12,488 adults aged 15 years and over)... The adult sample included 3160 Māori, 1033 Pacific, 1513 Asian and 8593 European/Other adults”.

“The NZ Health Survey measures self-reported physical and mental health status (including doctor-diagnosed health conditions), risk and protective behaviours for health outcomes, and the use of health care services, among the usually resident New Zealand population living in private dwellings.”

“Like earlier NZ Health Surveys, the 2006/07 NZ Health Survey used a multi-stage, stratified, probability proportionate to size (PPS) sample design, with increased sampling of some ethnic groups, primarily through a ‘screened’ sample. The sample design was developed by the Centre for Statistical and Survey Methodology, University of Wollongong, New South Wales, Australia.”

“The survey only included the usually resident population who live in private dwellings, that is, approximately 94% of the usually resident population. People living in institutions (hospitals, intellectually disabled homes, rest homes, prisons, boarding schools), the homeless, short-term visitors and tourists were not included.”

“Small geographic areas (meshblocks) were randomly chosen throughout New Zealand, with larger areas and those with relatively higher population proportions of Māori having a slightly increased chance of selection. These areas were randomly allocated to the four seasons of the year to minimise seasonality bias. Interviewers began at a random point in each area and selected every kth house as the ‘core’ sample households. In core households, one adult aged 15 years and over, and one child aged from birth to 14 years old, if any, were randomly selected for the survey.

Interviewers then selected every jth house in each area as the ‘screened’ sample households, to boost Māori, Pacific and Asian sample sizes. 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 participant refused, was not contactable or was unavailable.”

“The data collection was carried out by a specialist survey company, National Research Bureau Ltd (NRB), which undertook the interviewing and prepared the data sets.”

“Interviews were conducted in participants’ homes, at a time to suit participants. Interviewers typed responses directly into a laptop computer, and show cards with predetermined response categories were used to assist the participant, where appropriate. The height, weight and waist measurements were taken following protocols developed specifically for the survey, using professional weighing scales, a portable stadiometer, and a standard anthropometric measuring tape. Adult interviews were approximately 60 minutes long and child interviews (with the primary caregiver) were approximately 40 minutes long.”

“The New Zealand Health and Disability Multi-Region Ethics Committee granted approval for the 2006/07 NZ Health Survey (MEC/06/02/004).”

#### 4 Response to the NZ Health Survey

The response rates obtained were similar to previous NZ Health Surveys, but were markedly better than those achieved in some recent telephone surveys in New Zealand study (eg, only 21.4% in a recent New Zealand study [Adlam et al., 2007]).

**Table 1: Final adult weighted response rates (percentage), by ethnic group and gender (Table 7 from the NZ Health Survey Methodology Report)**

Ethnic group (total response)	Response rate (%)				
	Māori	Pacific	Asian	European/ Other	Total
Males	62.6	65.6	79.5	66.4	66.1
Females	70.9	74.3	79.6	68.9	69.9
Total	67.5	70.2	79.6	67.8	67.9

The coverage rate is an alternative measure related to survey response. This “rate” is the ratio of the sum of the selection weights for the survey to the known external population size. These coverage rates reflect the discrepancy between the sample weighted by selection weight and the population by age, gender and ethnicity.

**Table 2: Sample sizes and coverage rates (Table 11 from the NZ Health Survey Methodology Report)**

Population	Sample size	Population benchmark	Sum of selection weights	Coverage rate
All adults	12,488	3,120,706	1,844,371	59.1%
Māori adults	3,160	355,364	249,666	70.3%
Pacific adults	1,033	164,618	110,062	66.9%

## 5 Limitations of the NZ Health Survey

The NZ Health Survey is widely considered to be a very valuable instrument using state-of-the-art survey methods. Nevertheless, as detailed above, the sampling frame of the NZHS was somewhat constrained (eg, no institutionalised populations) and the response rate was less than optimal (though still very good for a national New Zealand survey). Although many quality control and other measures were taken (see Table 1.5, “Summary of actions taken to prevent non-sample error” in the NZHS Report p18 [Ministry of Health, 2008b]) there still remain various limitations with this approach to information collection. These include:

- The assumption that participants can accurately recall previous events (such as if a doctor has ever told them they had angina) and that they have a sufficient level of literacy to understand health-related terms.
- The assumption that self-reported smoking status provided in the NZHS is accurate since there was no biochemical validation of this status (eg, salivary cotinine).
- The unquantifiable effect of social desirability bias with regard to smoking behaviours (given the changes in socially cued smoking with the recent expansion of smokefree laws in New Zealand [Edwards et al., 2008]). The same societal trend towards the denormalisation of smoking may also make it easier for respondents to admit to such behaviours as “calling the Quitline” or utilising other smoking cessation services.

## 6 Secondary sampling frame

From the NZHS sample we had an additional sampling frame of adult smokers who had all of the following characteristics:

- Aged 18 years or older
- Smoked more than 100 cigarettes in their lifetime
- Smoked at least once a month
- Were willing to participate in further research (85.2% (2441/2866) of adult smokers in the NZ Health Survey agreed “they would be happy to be contacted again about the possibility of answering further health questions of importance to the Ministry of Health” when asked this at the end of the NZHS interview).
- Did not require language assistance for interviewing, did not have any cognitive impairment, and provided some name and address details (these conditions only excluded three potential respondents).

Out of 2,438 potential respondents who met these criteria, a total of 1376 completed the NZ ITC Project Wave 1 questionnaire giving a response rate of 56.4%. If however, the smokers who were unwilling to participate are considered in the denominator then this response rate is 48.0% (1376/2866). Furthermore, if the response rate is considered in terms of the NZ Health Survey overall response rate as well it is reduced to 32.6% (ie, 48.0% x 67.9%). However all three response rate estimates are probably slight underestimates, since they do not reflect that some people may have moved from in-scope to out-of-scope of ITC between the NZ Health Survey interview and the ITC interview. We suspect however, that these movements are not a substantive issue.

Suboptimal response rates are inherent with surveys in New Zealand – even when respondents are thanked and acknowledged for their time as in this ITC Project survey (though acknowledgement for doing the NZ Health Survey was very modest). The current situation in New Zealand with households regularly approached by survey companies and marketing companies is likely to be impeding response rates to health surveys. Of note is that the suboptimal response rate issue is largely addressed by the use of weighting procedures (see below).

**The survey company:** The survey company (Roy Morgan Research) was selected for the NZ arm on the basis of this company having been used for multiple survey waves in the four main ITC Project countries (US, UK, Canada and the Australia). Furthermore, this company had an Auckland office and had Auckland-based staff with experience with the ITC Project questionnaire. All calling specifications and the formatting of the final questionnaires (as per the CATI format) were done as a collaborative exercise between the survey company and the ITC Project research team.

**Contact and interviewing protocol:** Potential respondents were sent an invitation letter (with an information sheet) approximately four to six months after the NZ Health Survey interview, followed by a phone call from Roy Morgan Research. If they agreed to participate they were given the opportunity to participate in the full survey immediately – or else called back at a more convenient time. In the event that a respondent did not keep a main survey appointment, up to 25 attempts to follow-up were made at varying times of day (as per standard ITC Project approaches). In addition, respondents could complete the main survey during two or more calls if requested.

The study protocol was approved by the Multi-Region Ethics Committee in New Zealand (MEC/06/07/071) and by the Office of Research Ethics, University of Waterloo, Waterloo, Canada (ORE #13547).

**Thanking participants:** After the interview in Wave 1, a thank you letter was mailed along with a \$NZ20 voucher for a popular retail store. This type of response has been shown in randomised experiments on incentives to increase response rates [Edwards et al., 2005]. For the Wave 2 survey, prior respondents were sent a letter with the compensation approximately one week before being re-contacted to do the interview. For the latter, we included as an additional gift a chocolate bar that was high (70%+) in cocoa solids. This additional gift was also approved by both the Ethics Committees overseeing this study.

**Questionnaire development:** The New Zealand questionnaire was adapted from the ITC-four country questionnaire used for Wave 4. The latter was developed by the ITC Project's team of experts on tobacco control (whose varied backgrounds covered: psychology, public health, economics, community medicine, marketing, sociology and statistics/biostatistics). This team also conducted a pilot survey just before Wave 1 to test the questionnaire and the study protocol, as well as further refining the survey measures (n=approximately 125 participants in each country completing the survey). Modifications to wording and question framing were made as a result of this pre-testing. The questionnaire has been revised at each subsequent wave since this time, but the core of the instrument has remained essentially the same to facilitate comparisons and modelling over time.

Adaptations for New Zealand included minor variations in wording to account for national differences in colloquial speech (for example, bar/pub) and the names of local services and smoking cessation products. A number of additional policy-related questions of particular New Zealand relevance were added to the questionnaire with these being pre-tested on a convenience sample of smokers. But to keep the questionnaire length short we also deleted some of the 4-country Wave 4 questions (in lower-priority tobacco control areas for New Zealand).

**Timeframe – NZ arm:** The interviews were conducted between 19 March 2007 and 8 February 2008 with the median interview date being 7 September 2007. In

total, 89% of interviews were conducted in the 2007 calendar year. These telephone interviews were several months after participants had participated in the face-to-face NZHS. The surveying was done in four batches during this period with subsequent weeks spent following up potential respondents who were difficult to contact. Also during 2007 we undertook a range of reviews and background studies to inform subsequent ITC Project work. These publications and presentations are detailed on the New Zealand ITC Project website (<http://www.wnmeds.ac.nz/itcproject.html>).

**Representativeness of the sample:** Survey weights have been used to account and adjust for uneven representation of the final sample (due to the sampling process of the NZHS and also to the non-response rates). A separate report on the weighting process has been prepared and is available online [Clark, 2008]. Of note is that if non-contact and non-response occur randomly, no bias is introduced and the validity of the estimates is unaffected (ie, low response rates lead to biased estimates only to the extent that non-respondents differ from respondents on the characteristics of interest). Other studies report that large differences in response rates have tended to show only minor effects on key estimates (as discussed in: [Thompson et al., 2006]).

**Mediation models:** As noted by other ITC Project investigators [Fong et al., 2006a], it is of importance to test whether the effects of policies on downstream distal variables (*psychosocial mediators*) and behavioural end-points (for example, quit attempts) are *mediated* by the proximal variables (*policy-specific variables*). There are analytic methods for conducting such mediational analyses which are well-described in the psychosocial literature [MacKinnon et al., 2002]. However, such methods need to be considered in the context of the complex survey design of the NZ ITC Project.

**Ethnic group analyses:** As detailed in the NZHS “ethnicity is a self-defined concept” and participants in the 2006/07 NZHS were able to report affiliation with multiple ethnicities, using the Statistics New Zealand standard ethnicity question and Level 4 response categories. Only three adult participants (0.02%) refused the ethnicity question in the NZHS. In all our analyses participants’ ethnicity was detailed according to the following ethnic groups: European/Other, Māori, Pacific, and Asian. The ‘Other’ ethnic group (only n=5 individuals) has been combined with ‘European’ to avoid small number problems. The small number of participants who reported ‘New Zealander’ as their ethnicity (0.9% of adults in the NZHS) or refused the ethnicity question (noted above) have also been included in the European/Other group.

In most analyses we prioritised ethnicity in the following way:

- “Māori” was for all those who reported being “Māori” or having multiple affiliations that included “Māori”.

- “Pacific” was for all those who reported being “Pacific” or having multiple affiliations that included “Pacific” (unless Māori affiliation was also reported).
- “Asian” was for all those who reported being “Asian” or having multiple affiliations that included “Asian” (unless Māori or Pacific affiliation was also reported).
- “European” was for all those who reported being “European” or “New Zealander” or who reported another (non-Māori, non-Pacific) ethnic affiliation (n=5).

But we have also in our ITC Project studies described the sample in terms of the “total response” (ie, where participants were counted in each of the four output ethnic groups, and so the sum of the ethnic group populations exceeds the total New Zealand population) (Table 3). This approach is referred to as ‘total response standard output’ by Statistics New Zealand and was used in reporting the NZHS results [Ministry of Health, 2008b].

**Table 3: Ethnicity of the ITC Project respondents (Wave 1, n=1376) using the “prioritised” and “total response” approaches to ethnicity classification**

	<b>Prioritised (%)*</b>	<b>Total response (%)*</b>
European/other**	45.1	65.6
Māori	44.1	44.1
Pacific	6.5	7.8
Asian	4.3	4.4
<b>Total</b>	<b>100.0</b>	<b>121.9</b>

\* See the text for details on these different approaches.

\*\* Other was small (n=5 respondents). This “European” category also included a few respondents who described themselves as “New Zealander”.

**Neighbourhood deprivation analyses:** Data in our analyses has been presented by quintile of the 2006 version of the New Zealand Index of Deprivation (NZDep2006) as a proxy measure of socioeconomic position (SEP). NZDep2006 is an area-based index of deprivation that measures the level of socioeconomic deprivation for each neighbourhood (meshblock) according to a combination of the following 2006 Census variables: income, benefit receipt, transport (access to car), household crowding, home ownership, employment status, qualifications, support (sole-parent families), and access to a telephone [Salmond et al., 2007].

This index has been used in many published articles and reports and the predecessors of NZDep2006 (NZDep91, NZDep96 and NZDep2001) have been extensively validated (see [White et al., 2008] for further details). A full Atlas of

Socioeconomic Deprivation in New Zealand (3<sup>rd</sup> edition) that uses this index has recently been published by the Ministry of Health [White et al., 2008].

***Heaviness of Smoking Index (HSI)***: This index has been developed by others and we used the “alternative version” (HIS-AV) utilised by Borland et al [Borland et al., 2004].

This is calculated as the square root of the daily cigarette consumption minus the natural logarithm of time to first cigarette of the day. The specific equations are:

For daily smokers:

$$\text{HIS-AV} = \text{SQRT}(\text{daily cigarette consumption}) - \ln(\text{time to first cigarette}) + 1.$$

(Note: A value of 1 is added to the above computation to adjust the addiction measure to have a score of zero or more based on 10 or more cigarettes smoked per day and smoked within the first hour of waking up. Also, the value of time to first cigarette has to be at least 1 for the log).

For non-daily smokers:

$$\text{HIS-AV} = \text{SQRT}(\text{daily cigarette consumption}) - \ln((\text{time to first cigarette} + 900)/2) + 1$$

(Note: The computation of time to first cigarette for non-daily smokers is adjusted by taking the average of the time to first cigarette on days the respondent smoked plus a dummy amount for days they don't smoke. As we did not have data on number of days smoked, we assume these are equal to days not-smoked. The dummy time for non-smoking days is set to 900 minutes (a time lag of 15 hours), which is higher than the longest period reported of 14 hours).

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## Summary of Method for Calculating Estimation Weights for Wave 1

### 1 Introduction

To ensure that no group is under- or over-represented in estimates from a survey, a method of calculating estimates which reflects the sample design must be used. This is usually achieved by assigning a weight for every respondent in the survey unit record file; these weights can then be used in calculating estimates of population totals, averages, counts and proportions, or in statistical modelling. Survey weights are designed to meet a number of objectives:

- Weights should reflect the sampling process, for example groups who had a smaller chance of selection in the sampling design should be assigned a higher weight.
- Weights should adjust for non-response as far as this is possible using the information available. Groups who had a lower rate of response to the survey should be assigned a higher weight.
- Weights should make use of external benchmark information to reduce standard errors of weighted estimates.

This report describes the creation of estimation weights for the ITC unit record dataset.

The 2007 ITC sample was obtained by a complex sampling and response process. The first phase of sampling was the selection of the 2006/2007 New Zealand Health Survey (NZHS) sample using an unequal probability, multi-stage sampling design. NZHS respondents satisfying an eligibility requirement (essentially that the respondent is a regular smoker), were asked if they were available to be recontacted for the ITC. Those who agreed were subsequently approached for the ITC, and complete responses were obtained from a subset of this group.

Calibrated weighting was used to achieve the above objectives for the ITC. In some surveys, calibrated weights are calculated using population benchmarks, for example the NZHS weights were calculated using population benchmarks from Statistics New Zealand which were based on the 2006 Census. The ITC had a restricted scope (regular smokers only) and was a subsample of the NZHS sample. Because of this, ITC weights were based on benchmarks calculated from the NZHS. Benchmarks based on a survey are sometimes called pseudo-benchmarks. This type of calibrated weighting is sometimes called two-phase calibrated weighting.

Section 2 of this note briefly describes how survey weights are used. Section 3 summarises the weighting method used in the NZHS, as this was the starting

point for the calculation of the ITC weights. Section 4 describes the calculation of ITC weights and the characteristics of the weights. Section 5 describes an alternative weighting approach where the 2006 Census smoking question was used in weighting. This method was not implemented for a number of reasons, the main one being that the NZHS and ITC smoking information may be superior in some ways to the Census data, because while the Census is free from sampling variability, the surveys were based on personal interviewing rather than a self-completion form. Section 6 contains response rate and Section 7 comments on the weighting for future waves of ITC.

## 2 Survey Weights

The estimation weight (usually abbreviated to "the weight") is sometimes thought of as the number of population members represented by a given respondent.

Weights are designed to do two things:

- a) reflect the probabilities of selection of each respondent; and
- b) make use of external population benchmarks (typically obtained from a population census) to correct for any discrepancies between the sample in the population. This improves the precision of estimates and reduces bias due to non-response.

Aim (a) can be achieved by setting weights equal to one divided by the probability of selection for the respondent. This method is called inverse probability weighting. A better method is calibrated weighting, which can achieve both (a) and (b).

Section 2 of this note will describe this process in more detail.

Once weights have been calculated for all respondents, estimates of means, totals, counts and proportions can be calculated as follows:

### *Totals*

Estimates of totals are given by the sum over the respondents of the weight multiplied by the variable of interest. For example, estimate of total number of bicycles owned by the whole population would be given by the sum over all respondents of (#bicycles owned by respondent)\*weight.

### *Averages*

Estimate of the population average are calculated by

- the sum over all respondents of the weight multiplied by the variable of interest, divided by
- the sum of the weights.

### *Averages within Groups*

Sometimes the average within a group is of interest, for example the average number of bicycles owned by males. The estimate is given by:

the sum over respondents in the group of the weight multiplied by the variable of interest;  
divided by  
the sum of the weights of respondents in the group.

#### *Counts*

The number of people in a group (for example the number of people with diabetes) is estimated by the sum of the weights of the respondents in the group.

#### *Proportions*

The proportion of the population who belong to a particular group (for example the proportion of the population who have diabetes) is estimated by the sum of the weights for the respondents in the group, divided by the sum of the weights of all respondents.

#### *Proportions within a Group*

The proportion of people in a group who belong to a subgroup (for example the proportion of Māori who have diabetes) is estimated by the sum of the weights for the respondents in the subgroup, divided by the sum of the weights for the respondents in the group.

#### *Weighted Regression and Other Statistical Models*

Weights can be used in regression and other analyses, to ensure that different groups in the population are represented proportionately in analyses. Almost all statistical packages allow for the use of weights in analysis, however in some cases the associated standard errors will not be correct for weighted data. The statistical packages SAS, R, STATA, SUDAAN and SPSS all have specialist procedures which correctly implement survey weighting in regression modelling.

### **3 Calibrated Weighting in the 2006/2007 NZ Health Survey**

The most commonly used methodology for survey weighting is calibrated weighting. Calibrated weights are calculated using some population benchmark information obtained externally from the survey. The aim in calibrated weighting is for the sum of the weights in the sample, broken down by variables of interest, to exactly agree with external population counts. This means that discrepancies between the responding sample and the population are corrected for in weighted estimates, at least with respect to the variables used in weighting.

In the case of the 2006/2007 NZ Health Survey, the external population counts were based on the 2006 Census broken down by

Age (0-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-74, 75+)

by

Sex (male, female)

by  
Total Response Ethnic Group (Statistics New Zealand Level 1  
classification: Māori, Pacific, Asian, Other)  
and also broken down by  
District Health Board (DHB) area;  
by  
Child (0-14) vs Adult (15+).

Standard errors are a measure of the precision of an estimate. Replicate weights are a method for obtaining standard errors for any weighted estimate. In the NZHS, 100 replicate weights were produced for every unit in the sample. For any weighted estimator, 100 "replicate estimators" can be calculated using these replicate weights. The standard error of the estimate is then estimated based on the variation across these 100 replicate estimators. This process can be done automatically in a number of statistical packages, including SUDAAN, STATA and R.

For full details, see the Methodology Report for the 2006/2007 New Zealand Health s

- they smoked at least once a month at the time of the NZHS interview (A3\_21 equal to 2, 3 or 4);

All inscope NZHS respondents who agreed to be recontacted (AR\_4=1) were selected in the ITC sample.

All eligible NZHS respondents who met the eligibility requirement were selected in the ITC sample. Of the 12,488 NZHS respondents, 2869 were in scope for ITC. Of these, 2441 agreed to be recontacted, and of these 1376 people responded fully to ITC.

If all 2869 in-scope NZHS respondents had responded to ITC, the NZHS weight for these people could have been used as the weight on the ITC file also. This is because the probability of selection in ITC is the same as the probability of selection in NZHS, for eligible persons. However, only 1376 of the potential respondents actually responded fully to ITC. Weights are therefore needed to reflect the fact that the responding ITC sample is a subsample from the eligible component of the NZHS sample.

The ITC sample is said to be a two-phase sample, where the first phase consists of the NZHS sample and the second phase sample is the subset of this sample who also responded to ITC. The aim is to produce ITC weights which reflect both the first phase sampling process (i.e. the NZHS sample design), and the fact that the ITC responding sample may differ from the eligible NZHS sample.

Two-phase calibrated weighting was used. This means that

the sum of the ITC weight over the ITC sample in a category (for example Māori people in a region) was equal to the sum of the NZHS weight over in-scope NZHS respondents in the category.

Subject to this constraint, the ITC weights were required to be as close as possible to the NZHS weights, according to a distance measure. This method of weighting is called two-phase calibrated weighting and is the most common approach used in weighting surveys of this type. A number of distance measures are in common use. We used the chi-square distance function, which corresponds to generalized regression estimation (see case 1 in Deville and Sarndal, 1992, p.378).

The categories used for weighting should:

- reflect important output classifications;
- include factors related to people's propensity to respond to the survey; or
- be related to variables of interest collected in ITC.

Categories should not be too extensive, and should not be so finely classified that there are small sample counts in some cells. Otherwise the resulting weights will be more variable, and will result in increased standard errors for some or all weighted statistics produced from ITC.

The categories selected were:

- Region (4 regions were used, consisting of the following DHBs:  
Northern Region: Northland, Auckland, Waitemata, Counties-Manakau;  
Midland Region: Bay of Plenty, Lakes, Tairāwhiti, Taranaki, Waikato;  
Lower North Island: Hawkes Bay, Midcentral, Wanganui, Wairarapa,  
Capital & Coast, Hutt Valley;  
South Island: Nelson-Marlborough, Canterbury, West Coast,  
South Canterbury, Otago, Southland.
- Region by Māori (total response ethnic group output);
- Gender by Age (6 categories: 18-24, 25-34, 35-44, 45-54, 55-64, 65 and over);
- Gender by Age (5 categories: 18-24, 25-34, 35-44, 45-54, 55 and over) by Māori;

- Age (5 categories: 18-24, 25-34, 35-44, 45-54, 55 and over) by Pacific;
- Gender by Pacific;
- 2006 NZ Deprivation index decile (10 categories);
- How often does the respondent now smoke (item A3\_21 from the NZHS: 3 categories);
- Quitting Intention (item A3\_25 from the NZHS: 4 categories).

Table 1 shows the properties of the initial weight, given by the inverse of the probability of selection in the NZHS sample, and the final calibrated weight. Some observations on this table:

- The mean calibrated weight is roughly double the mean of the initial weights. This is because about half of the in-scope respondents identified in the NZHS resulted in a complete ITC interview.
- The coefficients of variation of the initial and final weights are 84.9% and 89.9%, respectively. The latter is higher because including more benchmarks in weighting generally results in more variable weights. If too many benchmarks are used, the final weights can be unacceptably variable, but this has not occurred in the ITC weights.
- The final weights were constrained to be less than or equal to 2500. In 6 records the weights were set to this value.
- The distribution of the final weights looks to be reasonable, without excessive variability, or too many weights set to the maximum value.

**Table 1: Properties of Initial Inverse Selection Probability Weights and Final Calibrated Weights for ITC**

	<b>Initial Weights</b>	<b>Final Calibrated Weights</b>
Mean Weight	214.2	428.2
Coefficient of Variation (%) of Weights	84.9	89.9
Minimum Weight	13.7	26.6
First Quartile of Weights	84.9	165.3
Median Weight	160.0	311.4
Upper Quartile of Weights	295.5	569.6
95 <sup>th</sup> Percentile of Weights	545.6	1162.8
Maximum Allowed Weight	not applicable	2500
Number of Weights equal to the Maximum Allowed Weight	not applicable	6

## 5 The Use of the Census Smoking Question in Weighting

The 2006 NZ Census included two questions on smoking, allowing classification of respondents as follows:

**Table 2: Census Results (Aged 15 years and over) (source: [www.stats.govt.nz](http://www.stats.govt.nz))**

Smoking Status	Population Count
Regular Smoker	597,792
Ex-Smoker	637,293
Never Smoked Regularly	1,653,924
Response Unidentifiable	106,347
Not Stated	165,015
Total	3,160,371

The category “regular smoker” should be roughly equivalent to variable A3\_21 on the NZHS (and ITC) file being equal to 2. We could calculate calibrated ITC weights such that the sum of the weights of the regular smokers in ITC would equal the census number of regular smokers. This would have the effect of reducing standard errors of ITC estimates of numbers of regular smokers, although it would have little effect on the standard errors of breakdowns within the smoking population.

The major difficulty with this is that there was significant non-response to the census question. Approximately 8.6% of the population had missing values for the smoking question (the last two categories in Table 2). A sensible estimate of the proportion of regular smokers can be calculated by taking the proportion of regular smokers out of the first three rows of Table 2, giving a smoking rate of 20.7%. (This is somewhat higher than the estimated rate of 18.2% based on the NZHS dataset using variable A3\_21.)

If we were to make a different assumption about the missing data in Table 2, the census smoking rates would change substantially:

- if all missing cases were assumed to be non-smokers, the smoking rate would drop to 18.9%;
- if all missing cases were assumed to be smokers, the smoking rate would increase to 27.5%.

These are extreme cases and it is unlikely that non-respondents to the census smoking question differ from the respondents to this extent. However, the census is a self-completion form, and the missing data in Table 2 is specifically missing for the smoking question. Therefore it seems likely that respondents' decision to specifically omit the smoking question in the census is correlated to some degree with their smoking behaviour.

In contrast, there was virtually no item non-response for variable A3\_21 in the NZHS (<1%, apart from those who had already indicated that they had smoked less than 100 cigarettes to date). There was approximately 30% non-response to the NZHS, but this was non-response to the whole survey, and in almost all cases of non-response the interview did not even commence. It therefore seems that non-response would be less related to smoking behaviour in the NZHS than in the Census. Moreover reporting errors would be expected to be less in a face-to-face interviewer survey than in a self-completion surveys. Also, the use of computer-assisted interviewing in the NZHS means that any inconsistencies in the series of questions about smoking would be instantly identified and queried with the respondent, further reducing the possibility of reporting error.

Based on this, the NZHS and ITC measures of regular smoking would be expected to be superior to the Census measure in some although not all respects. Therefore it is recommended that the NZHS and ITC should produce an independent measure of smoking rate, which is not forced to agree exactly with the census measure.

Other issues affecting the decision whether to use the census smoking question include:

- The census benchmark can be broken down by other classifications as it is not subject to sampling error. Using this benchmark in weighting would greatly reduce the standard errors of ITC estimates of the number of regular

smokers broken down by other classifications. However there would be no benefit for the standard errors of breakdowns within the smoking population.

- The census and survey scopes are not identical.
- Census counts of regular smokers have not been adjusted for undercount. Births, deaths and migration between the Census and the survey have also not been adjusted for. A crude adjustment could be made by assuming that the smoking rate is unchanged by these adjustments. A more sophisticated calculation of benchmarks would disaggregate the smoking rate by age and sex and make use of Statistics New Zealand population estimates by age and sex for the relevant time period.
- The proposed ITC weighting method means that ITC weighted counts will be identical to NZHS counts for key classifications including Māori and Pacific, age and sex, region, smoking frequency and quitting intentions. This consistency would be lost if ITC weights were based on the census smoking question.

## 6 Response Rates

Three definitions of the response rate capture different dimensions of response to ITC:

- 1) In evaluating ITC operations specifically, the response rate conditional on agreeing to be recontacted for the ITC is the appropriate measure. This can be estimated by dividing 1376 into 2441, giving 56.4%.
- 2) A second measure of response rate is the response rate conditional on being an NZHS respondent who is in-scope for ITC. A crude estimate of this response rate of 48.0% is given by dividing 1376 into 2866 (there were 3 smokers in the NZHS sample who were excluded from the denominator for various reasons eg, they required language assistance for interviewing, or did not provide name and address details).
- 3) The most relevant measure in considering the quality of ITC statistics is perhaps the combined ITC response rate, i.e. the proportion of in-scope people selected for the NZHS who provide complete data to the ITC. This can be estimated by the response rate of ITC conditional on responding to the NZHS, multiplied by the NZHS response rate. This gives a combined response rate of 32.6% (obtained by multiplying 48.0% by 67.9%).

All three response rate estimates are underestimates, because they do not reflect that some people may have moved from in-scope to out-of-scope of ITC

between the NZHS interview and the ITC interview. However this is not thought to be a substantial issue.

Several NZHS variables (smoking frequency and quitting intention), and NZ deprivation decile, were used to weight the ITC back to the NZHS. Age, sex, region and ethnicity benchmarks were also used. The use of weighting would be expected to reduce bias due to ITC non-response to some extent.

## **7 Weighting of Future Waves of ITC**

There will be subsequent waves of the ITC using the same sample as Wave 1. There is expected to be attrition and non-response for future waves, so that a new set of weights will be required for each wave. In each case the target population for weighting will be the in-scope population at the time of the NZ Health Survey. The weighting method used will be similar to the method used for Wave 1.

## **References**

Deville JC, Särndal CE. 1992. Calibration Estimators in Survey Sampling. *Journal of the American Statistical Association*. 87: 376-382.

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