Microdata User Guide

Households and the Environment Survey

2011

Statistics Canada Statistique Canada

Canada

How to obtain more information

Specific inquiries about this product and related statistics or services should be directed to:

Environment Accounts and Statistics Division
Telephone: 613-951-0297
Fax: 613-951-0634
E-mail: environ@statcan.gc.ca

Accessing and ordering information

The 2011 Households and the Environment Survey (HES) produces three types of microdata files: master files, share files and public use microdata files (PUMF).

Master files

The master files contain all variables and all records from the survey collected during a collection period. These files are accessible at Statistics Canada for internal use and in Statistics Canada's Research Data Centres (RDC), and are also subject to custom tabulation requests.

Research Data Centre

The RDC Program enables researchers to use the survey data in the master files in a secure environment in several universities across Canada. Researchers must submit research proposals that, once approved, give them access to the RDC. For more information, please consult the following web page: http://www.statcan.gc.ca/rdc-cdr/index-eng.htm

Custom tabulations

Another way to access the master files is to offer all users the option of having staff in Environment Accounts and Statistics Division prepare custom tabulations. This service is offered on a cost-recovery basis. It allows users who do not possess knowledge of tabulation software products to get custom results. The results are screened for confidentiality and reliability concerns before release. For more information, please contact Environment Accounts and Statistics Division.

Share files

The share files contain all variables and all records of the HES respondents who agreed to share their data with Statistics Canada's partners. The share file is released only to these partner organizations. Personal identifiers are removed from the share files to respect respondent confidentiality. Users of these files must first certify that they will not disclose, at any time, any information that might identify a survey respondent.

Public use microdata files

The public use microdata files are developed from the master files using a technique that balances the need to ensure respondent confidentiality with the need to produce the most useful data possible. The PUMF must meet stringent security and confidentiality standards required by the *Statistics Act* before they are released for public access. To ensure that these standards have been achieved, each PUMF goes through a formal review and approval process by an executive committee of Statistics Canada. Variables most likely to lead to identification of an individual are deleted from the data file or are collapsed to broader categories.

A Microdata Licence Agreement is signed before releasing the file(s). This requires the name of the person who will be responsible for the data file and their contact information. To obtain a copy of the PUMF contact Environment Accounts and Statistics Division.

The Data Liberation Initiative

The Data Liberation Initiative (DLI) Program enables students and researchers to use the public use microdata files in several universities across Canada. For more information, please consult the following web page: http://www.statcan.gc.ca/dli-ild/dli-idd-eng.htm

Table of Contents

1.0 Introduction

The Households and the Environment Survey (HES) was conducted by Statistics Canada in October and November 2011. This guide has been produced to facilitate the manipulation of the microdata file of the survey results.

Any question about the data set or its use should be directed to:

Statistics Canada

Environment Accounts and Statistics Division
Telephone: 613-951-0297
Fax: 613-951-0634
E-mail: environ@statcan.gc.ca

2.0 Background

The Households and the Environment Survey (HES) was conducted in October and November 2011 as a supplement to the Canadian Community Health Survey. The survey was designed to specifically address the needs of its funding source the Canadian Environmental Sustainability Indicators (CESI) project, a joint venture between Statistics Canada, Environment Canada and Health Canada. The CESI project reports annually on air quality, water quality and greenhouse gas (GHG) emissions in Canada using indicators to identify areas of importance to Canadians and monitor progress.

The HES was first conducted in 1991, 1994 and more recently in 2006, 2007 and 2009. The 2011 survey offers an expanded view on household behaviours that relate to the environment but allows for comparisons with the 1994 survey for some indicators and most of the indicators from the 2006, 2007 and 2009 surveys.

The target population consisted of households in Canada, excluding households located in the Yukon, Northwest Territories and Nunavut, households located on Indian reserves or Crown lands, and households consisting entirely of full-time members of the Canadian Armed Forces. Institutions and households of certain remote regions were also excluded.

3.0 Objectives

The objective of the Households and the Environment Survey (HES) is to measure the behaviours and practices of households that relate to the environment in terms of their impact on the quality of the air, water and soils as well as contributions to greenhouse gas emissions. Specifically, the following topics were addressed in the 2011 HES:

- Energy use and home heating and cooling
- Consumption and conservation of water
- Water quality concerns of households
- Pesticide and fertilizer use on lawns and gardens
- Composting
- Recycling
- Indoor environment
- Recreational vehicles and gasoline powered equipment
- Disposal of hazardous waste and electronic waste
- Importance of nature
- Impacts of air and water quality on households
- Purchasing decisions

4.0 Concepts and definitions

This chapter outlines concepts and definitions of interest to the users. The concepts and definitions used in the Canadian Community Health Survey (CCHS) are described in Section 4.1 while those specific to the Households and the Environment Survey (HES) are given in Section 4.2.

4.1 Canadian Community Health Survey concepts and definitions

Dwelling
A dwelling is defined as any set of living quarters that is structurally separate and has a private entrance outside the building or from a common hall or stairway inside the building.

Types of dwellings

- **Single detached** – A structure with one dwelling only, separated by open space from all other structures except its own garage or shed.
- **Double** – A dwelling joined to only one other dwelling, separated from it by a wall extending from ground to roof.
- **Row or terrace** – A dwelling unit in a row of three or more dwellings, sharing common walls extending from ground to roof in which there are no other dwellings either above or below.
- **Duplex** – Two dwellings situated one above the other, not attached to any other structure and surrounded on all sides by open space.
- **Low-rise apartment** – Dwellings within triplexes, quadruplexes, and apartment buildings of fewer than five stories.
- **High-rise apartment** – Separate dwellings within a residential structure of five or more stories.
- **Mobile homes** – A movable dwelling designed and constructed to be transported (by road) on its own chassis to a site, and placed on a temporary foundation such as block posts or a prepared pad.

Household
A household is defined as any person or a group of persons living in a dwelling. A household may consist of any combination of: one person living alone, one or more families, a group of people who are not related but who share the same dwelling.

4.2 Households and the Environment Survey concepts and definitions

Consumption and conservation of water
"Canadians are concerned about how the environment affects their health, thus about the quality of the water they drink".[1] Since public perception, as a determining factor driving public policy, can be as persuasive as empirically-based evidence, it is important to understand how Canadians perceive the quality of their drinking water supply and the behaviours they are exhibiting that may reflect their concerns.

[1] *Sharing Environmental Decisions: Executive Summary and Recommendations.* Final report of the Task Force on a Canadian Information System for the Environment. October 2001, Ottawa.

These behaviours are measured in the HES through the purchases of bottled water or the use of water filters, and the reasons for making these purchases – for example, concerns about bacterial contamination. Analysis can be carried out to gain insight into the household characteristics of those that do and do not exhibit behaviours that may indicate uncertainties about the quality of their drinkable water.

Aside from drinking water issues, another important theme involves the water conservation practices of households. Water scarcity is an emerging issue for many Canadians and this concern may be exacerbated by climatic changes. Many regions of Canada have experienced drought or near-drought conditions which has led to regulatory responses by municipal authorities (e.g., water use restrictions) and/or the voluntary adoption of water conservation measures by households.

The HES provides reliable information on household practices such as lawn watering and the use of low-flow showerheads and low-volume toilets, which can be used to determine levels of public participation in water conservation.

Metals and minerals can include any of the following: iron, sulphur, cadmium, zinc, manganese, lead, mercury, arsenic.

Bacteria can include any of the following: E. coli, other coliforms, fecal matter, giardia, cryptosporidium, parasites, protozoa, shigellosis.

Chemicals or other pollutants can include any of the following: chlorine, bromine, pesticides, oil, gasoline, diesel fuel, heating oil, fluoride, nitrate, trichloroethylene (TCE), polycyclic aromatic hydrocarbons (PAH), fire retardants.

Holding tanks are septic tanks that do not have a weeping tile system and which must be pumped out on a regular basis.

A **communal septic system** is a private or public septic system that serves more than one household but is not a part of a municipal sewer system. These are common in places like trailer parks or neighbourhoods where there is not a high enough housing density to warrant full sewage services.

Low flow showerheads are used to regulate the flow of water.

Low volume toilets use a lower volume of water than regular toilets. Usually these toilets use 6 litres as opposed to 12 litres of water per flush.

A **rain barrel** is a container used to collect and store rainwater. It is usually placed below the downspout of a roof gutter. The collected water is usually used to water the landscape.

A **cistern** is an artificial reservoir for storing liquids; especially an underground tank for storing rainwater.

Energy use and home heating

The choices regarding what kind of energy a household uses to heat a home, whether the temperature is regulated and if any energy efficient electrical devices are used within the home are all decisions that affect the household's contributions to greenhouse gas (GHG) emissions.

Indirectly, the decisions also indicate to what degree the household has bought into the concept and need for energy conservation. The HES measures not only the types of energy used but those behaviours that indicate whether Canadian households are behaving in a sustainable way regarding energy use.

A **forced air natural gas furnace** is a heating system using a system of ducts and vents to circulate air heated by the combustion of natural gas.

A **forced air oil furnace** is a heating system using a system of ducts and vents to circulate air that has been heated by the combustion of oil.

A **forced air electric furnace** is a heating system using a system of ducts and vents to circulate air that has been heated by electrical current.

A **forced air hot water system** is a heating system using a system of ducts and vents to circulate air that has been heated by hot water.

Hot water radiators are metal structures or pieces of equipment used to heat a room by emitting heat from hot water or steam that circulates through it.

Electric baseboards are heating systems attached to the wall near the floor where elements heat up through use of electrical current. Electric baseboards are usually controlled by individual thermostats on each unit or in some cases one thermostat per room.

Other electric heating is heat produced through electrical current that is delivered through an appliance or other means excluding forced air or baseboards.

A **heating stove** typically uses firewood or wood pellets as a fuel source. A chimney is used for ventilation of smoke and excess heat.

A **central air conditioning system** is part of the home's central heating system and distributes cool air through the home's ductwork as opposed to stand alone air conditioning units that are usually seen in windows and are used to cool a specific part of the home.

Lawn care equipment

Many pieces of lawn care equipment, such as lawnmowers, use internal combustion engines, as do many boats and snowmobiles. Internal combustion engines emit greenhouse gases (GHGs), which are believed to be a main contributor to climate change. By measuring the extent of the use of these devices, we are establishing a baseline that can be compared to future data to see if the use of these devices are increasing or decreasing.

A **grass trimmer (weed eater)** is a device that trims grass and weeds through the use of a rapidly spinning plastic cord or circular saw.

A **leaf blower** is a device that emits a strong air current that is intended to blow leaves off of one's lawn.

Pesticide and fertilizer use

The usage of fertilizers and pesticides by households is measured in the 2011 HES. By analysing these data with selected household characteristics, policymakers can then use this information to better inform targeted public awareness and information campaigns.

Chemical fertilizers are chemicals given to plants with the intention of promoting growth. They are usually applied either directly to the soil or by spraying.

Herbicides, insecticides, and fungicides are a substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any weeds, insects or fungi, respectively.

Hazardous waste
The need for better data on household practices regarding how households deal with their hazardous waste is an issue that arose through contacts with provincial officials and has been on the agenda at the Federal level.[2] Concerns about the levels of toxic substances (e.g., lead, mercury and dioxins) that can be found in these wastes are heightening as policymakers examine methods to mitigate the impact of these materials on the environment. The HES measures whether households are disposing of hazardous waste in proper disposal facilities or whether they are including it in the "regular" garbage or are perhaps simply unaware of what to do with these materials and are storing them in basements and garages.

Electronic waste
Electronic devices, such as cell phones, televisions and computers, often include components that contain hazardous materials such as mercury, lead and other heavy metals, meaning that they cannot be disposed of in traditional landfills. As well, some of these materials have enough value that it is economically viable to recover them. The HES measures which types of electronic products were disposed of and how they were disposed.

Composting practices
Usage by households of backyard composters and/or curb side organic pick-up containers represents another data gap in waste statistics. There is a high level of interest from all levels of government and NGOs (non-government organizations) regarding household usage of backyard composters and the socio-economic characteristics of users and non-users of backyard composters and centralized composting programs. Composting involves the separation of kitchen waste (includes food scraps, coffee grinds, eggshells, etc.) and/or yard waste (includes leaves, plants or grass clippings) from the rest of your household garbage. The separated materials can be:

- put in a compost bin, compost pile or garden
- picked up by the city, town, municipality or a private company; or
- taken to a depot or drop off centre

Participation in recycling initiatives
Governments are finding it difficult to gauge the level of participation in various waste diversion initiatives concerning certain materials such as plastics, paper, glass and metal. Scores of such initiatives are underway across Canada and there is a perception that the level of success for these programs is high. As in 1991, 1994, 2006, and 2007, the 2011 HES asked questions on access to and use of recycling programs.

Air and water quality
The quality of the air and the bodies of water (lakes, rivers) used for recreational purposes may influence how Canadians behave in their day to day activities. A failure to alter our behaviour can impact the quality of life and health for all Canadians. The HES measures, for example, how smog advisories or swimming restrictions have influenced people's activities.

> **Smog** is the most visible form of air pollution. It is a brownish-yellow haze caused when heat and sunlight react with various pollutants in the air. Smog is a year-round problem but most smog watches and alerts occur from April to September, especially on hot days.
>
> An **air quality advisory** is an advisory that is issued for smoke, smog or poor air quality. Alerts are based on the air quality index.

[2] *Information Technology (IT) and Telecommunication Waste in Canada.* EnvirosRIS. Prepared for Environment Canada, National Office of Pollution Prevention. October 2000, Ottawa.

Importance of nature
Canadians interact with nature in a variety of ways almost every day, and a recent study has found a link between lower death rates and the residential levels of green space. The use of parks and greenspaces and other ways in which Canadians interact with nature are measured in the 2011 Households and the Environment Survey.

5.0 Survey methodology

The Households and the Environment Survey (HES) was administered from October to November 2011 to a sub-sample of the dwellings that were part of the Canadian Community Health Survey (CCHS) that was conducted between January 1st and June 30th, 2011. Therefore its sample design is closely tied to that of the CCHS. The CCHS design is briefly described in Sections 5.1 and 5.2.

5.1 Canadian Community Health Survey population coverage

The CCHS data is collected from people aged 12 years and over living in private dwellings within the 10 provinces and three territories. Specifically excluded from the survey's coverage are residents of Indian reserves and Crown lands, full-time members of the Canadian Armed Forces, inmates of institutions and residents of isolated areas. The CCHS represents approximately 98% of the Canadian population aged 12 years and over.

5.2 Canadian Community Health Survey sample design

To provide reliable estimates to the 115 Health Regions (HR), and given the budget allocated to the 2011 CCHS, a sample of 63,500 respondents was desired. The sample allocation strategy consisting of three steps, gave relatively equal importance to the HRs and the provinces. In the first two steps, the sample was allocated among the provinces according to their respective populations and the number of HRs they contain. In the third step, each province's sample was allocated among its HRs proportionally to the square root of the estimated population in each HR.

The CCHS used three sampling frames to select the sample of households: 40.5% of the sample of households came from an area frame, 58.5% came from a list frame of telephone numbers and the remaining 1% came from a Random Digit Dialling (RDD) sampling frame. For most of the health regions, 41% of the sample was selected from the area frame and 59% from the list frame of telephone numbers.

The CCHS used the area frame designed for the Canadian Labour Force Survey (LFS) as its primary frame. The sampling plan of the LFS is a multistage stratified cluster design in which the dwelling is the final sampling unit. In the first stage, homogeneous strata were formed and independent samples of clusters were drawn from each stratum. In the second stage, dwelling lists were prepared for each cluster and dwellings, or households, were selected from the lists.

For the purpose of the plan, each province is divided into three types of regions: major urban centres, cities and rural regions. Geographic or socio-economic strata are created within each major urban centre. Within the strata, dwellings are grouped together to create clusters. Some urban centres have separate strata for apartments or for census Dissemination Areas (DA) in which the average household income is high. In each stratum, six clusters or residential buildings (sometimes 12 or 18 apartments) are chosen by a random sampling method with a probability proportional to size (PPS), the size of which corresponds to the number of households. The number six was used throughout the sample design to allow a one-sixth rotation of the sample every month for the LFS.

The other cities and rural regions of each province are stratified first on a geographical basis, then according to socio-economic characteristics. In the majority of strata, six clusters (usually census DAs) are selected using the PPS method. Where there is low population density, a three-

step plan is used whereby two or three primary sampling units (PSU), which normally correspond to groups of DAs, are selected and divided into clusters, six of which are sampled. The final sample is obtained using a systematic sampling of dwellings.

5.3 Sample size by province for the Households and the Environment Survey

The following table shows the number of dwellings that were selected for the 2011 HES. This table excludes dwellings which were non-respondents to the CCHS.

Province	Sample Size - Number of dwellings
Newfoundland and Labrador	835
Prince Edward Island	373
Nova Scotia	963
New Brunswick	994
Quebec	3,490
Ontario	6,637
Manitoba	1,332
Saskatchewan	1,074
Alberta	1,928
British Columbia	2,374
Canada	**20,000**

6.0 Data collection

An introductory letter was mailed to respondents approximately one week before data collection began. Collection for the Households and the Environment Survey (HES) was carried out in October and November 2011 using a computer-assisted telephone interviewing (CATI) system.

The CATI system has a number of generic modules which can be quickly adapted to most types of surveys. A front-end module contains a set of standard response codes for dealing with all possible call outcomes, as well as the associated scripts to be read by the interviewers. A standard approach set up for introducing the agency, the name and purpose of the survey, the survey sponsors, how the survey results will be used, and the duration of the interview was used. We explained to respondents how they were selected for the survey, that their participation in the survey is voluntary, and that their information will remain strictly confidential. Help screens were provided to the interviewers to assist them in answering questions that are commonly asked by respondents.

The CATI application ensured that only valid question responses were entered and that all the correct flows were followed. Edits were built into the application to check the consistency of responses, identify and correct outliers, and to control who gets asked specific questions. This meant that the data was already quite “clean” at the end of the collection process.

The survey manager met with senior staff responsible for collection to discuss issues and questions before the start of the training session. A description of the background and objectives as well as a detailed description of the concepts and definitions particular to the 2011 HES was provided for interviewers in their Interviewer Manual. A glossary of terms and a set of questions and answers were also included.

Interviewers were trained on the survey content through a classroom training session. In addition, the interviewers completed a series of mock interviews to become familiar with the survey, its concepts, definitions and the CATI application itself. Question and answer documentation was provided to the interviewers to assist them in answering questions that are commonly asked by respondents.

The data collection was conducted by specialized staff at Statistics Canada offices in Edmonton, Sturgeon Falls, Halifax, Winnipeg and Sherbrooke. The workload and interviewing staff within each office was managed by a project manager. The automated scheduler used by the CATI system ensured that cases were assigned randomly to interviewers and that cases were called at different times of the day and different days of the week to maximize the probability of contact. There were a maximum of 25 call attempts per case; once the maximum was reached, the case was reviewed by a senior interviewer who determined if additional calls would be made.

The average interview time was estimated to be 20 minutes. However, the length of the interviews varied depending on the circumstances of the responding households. For example, the average interview time was slightly higher for respondents residing in a single family household as opposed to respondents living in an apartment.

The team of interviewers was under the supervision of senior interviewers responsible for ensuring that everyone was familiar with the concepts and procedures of the survey. Periodical monitoring of interviewers and the review of completed documents was done in accordance with collection protocol.

7.0 Data processing

The main output of the Households and the Environment Survey (HES) is a “clean” microdata file. This chapter presents a brief summary of the processing steps involved in producing this file.

The microdata file contains data from the following sections:

- HH Household demographics
- DC Dwelling characteristics
- EH Energy use and home heating
- WA Water
- FP Fertilizer and pesticide use
- GP Recreational vehicles/Outdoor equipment
- CP Composting
- RC Recycling
- IE Indoor environment
- AQ Air quality
- HW Hazardous waste
- NN Importance of nature
- PD Purchasing decisions
- HD Income

7.1 Data capture

Responses to survey questions are captured directly by the interviewer at the time of the interview using a computerized questionnaire. The computerized questionnaire reduces processing time and costs associated with data entry, transcription errors and data transmission. The response data are encrypted to ensure confidentiality and were transferred over a secure network for further processing.

Some editing is done directly at the time of the interview. Where the information entered is out of range (too large or small) of expected values, or inconsistent with the previous entries, the interviewer is prompted, through message screens on the computer, to modify the information. However, for some questions, interviewers have the option of bypassing the edits and of skipping questions if the respondent does not know the answer or refuses to answer. Therefore, the response data are subjected to further edits once they arrive in head office.

7.2 Editing

The first stage of survey processing undertaken at head office was the replacement of any "out-of-range" values on the data file with blanks. This process was designed to make further editing easier.

The first type of error treated was errors in questionnaire flow, where questions that did not apply to the respondent (and should therefore not have been answered) were found to contain answers. In this case a computer edit automatically eliminated superfluous data by following the flow of the questionnaire implied by answers to previous, and in some cases, subsequent questions.

The second type of error treated involved a lack of information in questions that should have been answered. For this type of error, a non-response or "not-stated" code was assigned to the item.

This was followed by a series of edits to ensure consistency in the responses for a household.

7.3 Coding of open-ended questions

A few data items on the questionnaire were recorded by interviewers in an open-ended format. These questions required coding for inclusion on the HES data file.

The second type of coding performed was for questions which allow for numeric values to be entered. These numeric values were first reviewed for outliers and then grouped into ranges. An example of a question which allows for numeric values would be total household income from all sources.

7.4 Creation of derived variables

A number of data items on the microdata file have been derived by combining items on the questionnaire in order to facilitate data analysis. The following is a list of the derived variables for the HES.

HES derived variables

WAD04	Indication if any treatment is applied to the drinking water in the household
WADREDUC	Indication if any of the noted devices are used by the household to conserve or reduce consumption of water
EHD11	During the winter season, at what temperature is the dwelling usually kept when you are there and awake? (Celsius)
EHD12	During the winter season, at what temperature is the dwelling usually kept when you are asleep? (Celsius)
EHD13	During the summer season, at what temperature is the dwelling usually kept when you are there and awake? (Celsius)
EHD14	During the summer season, at what temperature is the dwelling usually kept when you are asleep? (Celsius)

EHD15	During the summer season, at what temperature is the dwelling usually kept when you are not at home? (Celsius)
EHD12A	Temperature settings during winter while asleep
EHD14A	Temperature settings during summer while asleep
GPDEQUIP	Usage of snow blower, lawn mower, weed eater, or leaf blower
CMA	Census Metropolitan Area (CMA) - 2006 Census Code
HHEDUCLV HHGEDUC	Highest level of education ever completed by any member of the household
HHAG0005	Number of persons aged 0 to 5 in the household (Master and Share file)
HHAG0612	Number of persons aged 6 to 12 in the household (Master and Share file)
HHAG1315	Number of persons aged 13 to 15 in the household (Master and Share file)
HHAG1617	Number of persons aged 16 to 17 in the household (Master and Share file)
HHAG1819	Number of persons aged 18 to 19 in the household (Master and Share file)
HHAG2024	Number of persons aged 20 to 24 in the household (Master and Share file)
HHAG2534	Number of persons aged 25 to 34 in the household (Master and Share file)
HHAG3544	Number of persons aged 35 to 44 in the household (Master and Share file)
HHAG4554	Number of persons aged 45 to 54 in the household (Master and Share file)
HHAG5564	Number of persons aged 55 to 64 in the household (Master and Share file)
HHAG65PL HHGAG65P	Number of persons aged 65 and over in the household
HHSIZE HHGSIZE	Number of people in the household
HHTYPE	Type of household, based on age composition (Master and Share file)
THID01 THI_G01	Household income

7.5 Weighting

The principle behind estimation in a probability sample such as the HES is that each unit in the sample "represents", besides itself, several other units not in the sample. For example, in a simple random 2% sample of the population, each unit in the sample represents 50 units in the population.

The weighting phase is a step which calculates, for each record, what this number is. This weight appears on the microdata file, and **must** be used to derive meaningful estimates from the survey. For example if the number of households that treat their drinking water is to be estimated, it is done by selecting the records referring to those households in the sample with that characteristic and summing the weights entered on those records.

Details of the method used to calculate these weights are presented in Chapter 9.0.

7.6 Suppression of confidential information

It should be noted that the "Public Use" Microdata Files (PUMF) may differ from the survey "master" files held by Statistics Canada. These differences usually are the result of actions taken to protect the anonymity of individual survey respondents. The most common actions are the suppression of file variables, grouping values into wider categories, and coding specific values into the "not stated" category. Users requiring access to information excluded from the microdata files may purchase custom tabulations. Estimates generated will be released to the user, subject to meeting the guidelines for analysis and release outlined in Chapter 10.0 of this document.

8.0 Data quality

8.1 Response rates

The following table summarizes the response rates to the Canadian Community Health Survey (CCHS) and to the Households and the Environment Survey (HES).

Province	CCHS Selected Households	CCHS Response Rate (%) *	HES Selected Households	HES Responding Households	HES Response Rate (%)**
Newfoundland and Labrador	1,225	81.3	835	612	73.3
Prince Edward Island	612	80.7	373	257	68.9
Nova Scotia	1,568	83.4	963	738	76.6
New Brunswick	1,500	80.9	994	782	78.7
Quebec	8,300	79.6	3,490	2,598	74.4
Ontario	15 ,067	79.6	6,637	4,952	74.6
Manitoba	2,197	79.9	1,332	990	74.3
Saskatchewan	2,413	80.2	1,074	779	72.5
Alberta	3,826	76.3	1,928	1,464	75.9
British Columbia	5,442	78.1	2,374	1,690	71.2
Canada	**42,150**	**79.4**	**20,000**	**14,862**	**74.3**

* The CCHS response rate is the number of CCHS responding households as a percentage of the number of CCHS selected households for the January 1st to June 30th, 2011 period.

** The HES response rate is the number of HES responding households as a percentage of the number of HES selected households.

8.2 Survey errors

The estimates derived from this survey are based on a sample of households. Somewhat different estimates might have been obtained if a complete census had been taken using the same questionnaire, interviewers, supervisors, processing methods, etc. as those actually used in the survey. The difference between the estimates obtained from the sample and those resulting from a complete count taken under similar conditions, is called the sampling error of the estimate.

Errors which are not related to sampling may occur at almost every phase of a survey operation. Interviewers may misunderstand instructions, respondents may make errors in answering questions, the answers may be incorrectly entered on the questionnaire and errors may be introduced in the processing and tabulation of the data. These are all examples of non-sampling errors.

Over a large number of observations, randomly occurring errors will have little effect on estimates derived from the survey. However, errors occurring systematically will contribute to biases in the survey estimates. Considerable time and effort were taken to reduce non-sampling errors in the survey. Quality assurance measures were implemented at each step of the data collection and processing cycle to monitor the quality of the data. These measures include the use of highly skilled interviewers, extensive training of interviewers with respect to the survey procedures and questionnaire, observation of interviewers to detect problems of questionnaire design or misunderstanding of instructions, procedures to ensure that data capture errors were minimized, and coding and edit quality checks to verify the processing logic.

8.2.1 The frame

Because the 2011 HES was a supplement to the 2011 CCHS, the sampling frame used was the CCHS frame. The CCHS frame was based on both the Labour Force Survey (LFS) area frame and a telephone frame including a random digit dialling component. The CCHS survey coverage was very good (98% of all households in Canada). It is unlikely that the 2% exclusion introduces any significant bias into the survey data.

8.2.2 Data collection

Interviewer training consisted of reading the HES Procedures Manual and Interviewer's Manual, practicing with the HES training cases on the computer and discussing any questions with senior interviewers before the start of the survey. A description of the background and objectives of the survey was provided, as well as a glossary of terms and a set of questions and answers. Interviewers collected the HES information after the CCHS information was collected. The interviews were conducted in October and November 2011.

8.2.3 Data processing

Data processing of the HES was done in a number of steps including verification, coding, editing, estimation, etc. At each step a "picture" of the output files is taken and an easy verification can be made comparing files at the current and previous step.

8.2.4 Non-response

A major source of non-sampling errors in surveys is the effect of non-response on the survey results. The extent of non-response varies from partial non-response (failure to answer just one or some questions) to total non-response. Total non-response occurred because the interviewer was either unable to contact the respondent, no member of the household was able to provide the information, or the respondent refused to participate in the survey. Total non-response was handled by adjusting the weight of households that responded to the survey to compensate for those that did not respond.

In most cases, item non-response to the survey occurred when the respondent did not understand or misinterpreted a question, refused to answer a question, or could not recall the requested information. Values were not imputed when these were missing. They were coded to "not-stated".

Partial non-response occurs when the interview is started but not completed for various reasons. In the case of the HES, less than 1% of interviews were started but not completed and the missed questions were treated as multiple item non-response and coded to “not-stated”.

8.2.5 Measurement of sampling error

Since it is an unavoidable fact that estimates from a sample survey are subject to sampling error, sound statistical practice calls for researchers to provide users with some indication of the magnitude of this sampling error. This section of the documentation outlines the measures of sampling error which Statistics Canada commonly uses and which it urges users producing estimates from this microdata file to use also.

The basis for measuring the potential size of sampling errors is the standard error of the estimates derived from survey results.

However, because of the large variety of estimates that can be produced from a survey, the standard error of an estimate is usually expressed relative to the estimate to which it pertains. This resulting measure, known as the coefficient of variation (CV) of an estimate, is obtained by dividing the standard error of the estimate by the estimate itself and is expressed as a percentage of the estimate.

For example, suppose that, based upon the 2006 HES results, one estimates that 34.9% of households had a lawn and used chemical fertilizers in 2005 and this estimate is found to have a standard error of 0.0051. Then the coefficient of variation of the estimate is calculated as:

$$\left(\frac{0.0051}{0.349}\right) X\ 100\,\% = 1.46\,\%$$

There is more information on the calculation of coefficients of variation in Chapter 10.0, Appendix A and Appendix B.

9.0 Weighting

Since the Households and the Environment Survey (HES) used a sub-sample of the Canadian Community Health Survey (CCHS) sample, the derivation of weights for the survey records is clearly tied to the weighting procedure used for the CCHS. The CCHS weighting procedure is briefly described below.

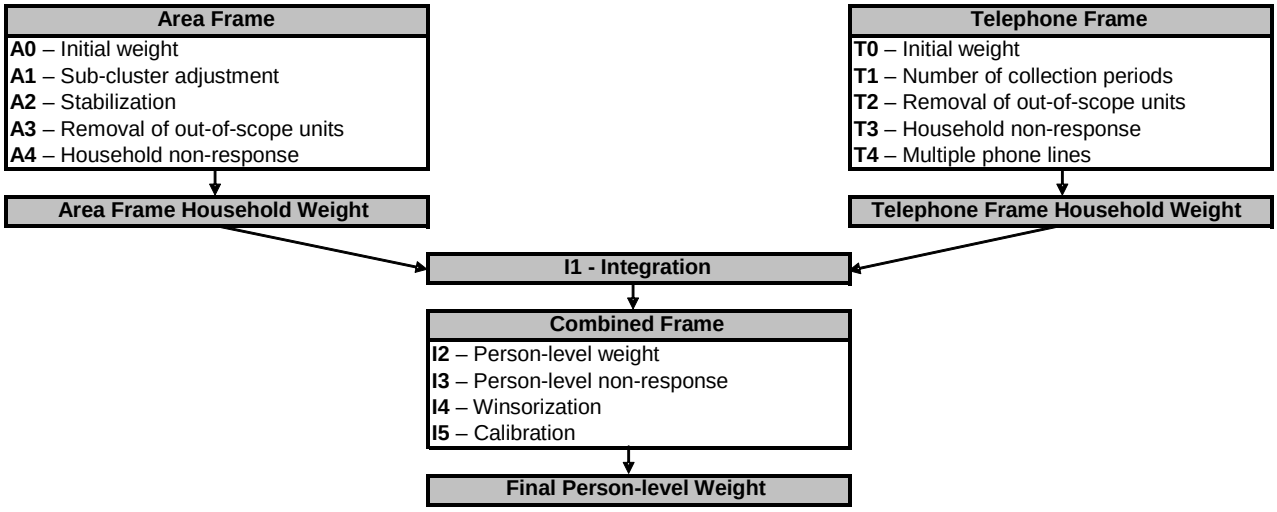
9.1 Weighting procedures for the Canadian Community Health Survey

The CCHS has recourse to three sampling frames for its sample selection: an area frame acting as the primary frame and two frames formed of telephone numbers complementing the area frame. Since only minor differences differentiate the two telephone frames in terms of weighting, they are treated as one and referred to as being part of the telephone frame.

The weighting strategy was developed by treating both the area and telephone frames independently. Household-level weights resulting from these two frames are then combined into a single set of household weights through a step called "*integration*". After applying person-level weights and some further adjustments, this integrated weight becomes the final weight.

Note: The CCHS household subweight (after the **I1 - Integration** step) corresponds to the initial HES weight.

Diagram A: Canadian Community Health Survey Weighting Strategy Overview



The CCHS household subweight (required for the HES weighting) is available once steps **A0** to **A4** (for the area frame), **T0** to **T4** (for the telephone frame) and **I1** (integration) are completed. Each CCHS weighting step is described below.

Weighting of the area frame sample

A0 – Initial weight
The weighting on the area frame sample begins with a weight provided by the Labour Force Survey (LFS). The initial weight **A0** is based on the LFS design since the CCHS sample is derived from the LFS. The LFS design consists of a sample of dwellings within the selected clusters of the LFS strata.

A1 – Sub-cluster adjustment
In clusters that experience significant growth, a sub-sampling methodology is used to ensure that the workload of the interviewers is kept at a reasonable level. This can consist of sub-sampling from the selected dwellings, dividing the cluster into sub-clusters, or reclassifying the cluster as a stratum and creating new clusters within the stratum. In all these cases, a sub-sample adjustment is calculated and applied to the CCHS weight. This adjustment is applied to weight **A0** to produce weight **A1**.

A2 – Stabilization
In some Health Regions (HR), the increase of the sample size results in a significantly larger sample than necessary. Stabilization is used to bring the sample size back down to the desired level. The stabilization process consists of randomly sub-sampling dwellings at the HR level from the dwellings originally obtained within each cluster. An adjustment factor representing the effect of this stabilization is calculated in order to adjust the probability of selection appropriately. This factor, multiplied by weight **A1**, produces weight **A2**.

A3 – Removal of out-of-scope units
Among all dwellings sampled, a certain proportion is identified during collection as being out-of-scope. Dwellings that are demolished or under construction, vacant, seasonal or secondary, and institutions are examples of out-of-scope cases for the CCHS. These dwellings and their associated weight are simply removed from the sample. This leaves a

sample that consists of, and is representative of, in-scope dwellings. These remaining dwellings maintain the same weight as in the previous step, which is now called **A3**.

A4 – Household non-response
During collection, a certain proportion of sampled households inevitably result in non-response. Weights of the non-responding households are redistributed to responding households within response homogeneity groups (RHG). In order to create the response groups, a scoring method based on logistic regression models is used to determine the propensity to respond and these response probabilities are used to divide the sample into groups with similar response properties. The information available for non-respondents is limited so the regression model uses characteristics such as the collection period and geographic information, as well as paradata, which includes the number of contact attempts, the time/day of attempt, and whether the household was called on a weekend or weekday. An adjustment factor is calculated within each class as follows:

$$\frac{\textit{Sum of weights A3 for all households}}{\textit{Sum of weights A3 for all responding households}}$$

Weight **A3** is multiplied by this factor to produce weight **A4** for the responding households. Non-responding households are dropped from the process at this point.

Weighting of the telephone frame sample

T0 – Initial weight
The initial weight **T0** for the units on the telephone frames is defined as the inverse of the probability of selection and is computed separately for the random digit dialling (RDD) and list frame samples since the method of selection differs between these two frames.

T1 – Number of collection periods
On the area frame, the entire sample is selected at the beginning of the year. This is in contrast to the telephone frame, where samples are drawn every two months. Each of these samples comes with an initial weight that allows each sample to be representative at the HR level. To ensure that the total sample represents the population only once, an adjustment factor is applied to reduce the weights of each two-month sample. The adjustment factor applied to each two-month sample is equal to the inverse of the number of samples being combined (i.e. the number of collection periods). Following this adjustment, the entire list frame sample corresponds to the average over the entire combined collection period. The initial weights are multiplied by this adjustment factor to produce weight **T1**.

T2 – Removal of out-of-scope numbers
Telephone numbers associated with businesses, institutions or other out-of-scope dwellings, as well as numbers not in service or any other non-working numbers are all examples of out-of-scope cases for the telephone frame. Similar to the methods used on the area frame, these cases are simply removed from the process, leaving only in-scope dwellings in the sample. These in-scope dwellings keep the same weight as in the previous step, now called weight **T2**.

T3 – Household non-response
The adjustment applied here to compensate for the effect of household non-response is identical to the one applied for the area frame (adjustment **A4**) although the paradata used does differ because of the differences in collection applications for personal and telephone interviews. The adjustment factor calculated within each class was obtained as follows:

$$\frac{\textit{Sum of weights } T2 \textit{ for all households}}{\textit{Sum of weights } T2 \textit{ for all responding households}}$$

The weight **T2** of responding households is multiplied by this factor to produce the weight **T3**. Non-responding households are removed from the process at this point.

T4 – Multiple phone lines
Some households can possess more than one residential telephone line. This has an impact on the weighting as these households have a higher probability of being selected so the weights for these households need to be adjusted for the number of residential telephone lines within the household. The adjustment factor represents the inverse of the number of lines in the household. The weight **T4** is obtained by multiplying this factor by the weight **T3**.

9.2 Weighting procedures for the Households and the Environment Survey

The principles behind the calculation of the weights for the HES are identical to those for the CCHS. However, further adjustments are made to the CCHS household subweight in order to derive a final weight for the records on the HES microdata file.

Diagram B: Households and the Environment Survey Weighting Strategy Overview

Weighting steps
H0 - CCHS subweight
H1 - HES initial weight
H2 - HES non-response adjustment
H3 - Calibration

H0 – CCHS subweight
The CCHS subweight is obtained once the **I1** step of the CCHS weighting process is completed. The CCHS **I1** step consists of integrating the weights for households common to the area and telephone frames into a single weight by applying a method of integration. The integration factor can be calculated as follows:

$$\alpha = n_A / (n_A + n_T)$$

where n_A and n_T represent the area and telephone frames sample sizes respectively. The weight of the area frame units is multiplied by this factor α, while the weight of the telephone frame units is multiplied by $1-\alpha$. The product between the factor derived here and the final household weight calculated earlier (**A4** or **T4**, depending on which frame the unit belongs to), gives the integrated household weight **I1**, also called the CCHS subweight.

H1 – HES initial weight
The HES sample is a stratified simple random sample of the CCHS respondents. The probability of being selected in the HES sample is first calculated. For each household selected for the HES, an adjustment factor is defined as the inverse of its probability of selection. This factor, multiplied by weight **H0**, produces weight **H1**.

H2 – HES non-response adjustment
The weights of the non-responding HES households are redistributed to responding households within response homogeneity groups (RHG). In order to create the RHGs, a scoring method based on a logistic regression model is used to determine the propensity to respond. The logistic

regression model is used to predict the probabilities of being a respondent. These probabilities are then used to divide the sample into groups with similar response properties (RHG). An adjustment factor is calculated within each class (RHG) as follows:

$$\frac{\textit{Sum of weights } H1 \textit{ for all HES households}}{\textit{Sum of weights } H1 \textit{ for all HES responding households}}$$

The weight **H1** of responding households is multiplied by this factor to produce the weight **H2**. The HES non-responding households are removed from the process at this point.

H3 – Calibration
The last step necessary to obtain the final HES weight, **H3**, is calibration. Calibration is done to ensure that the sum of the final weights corresponds to the Census projections defined at the province and household size (one person, two persons or three persons and more) levels. Calibration is also done to ensure that the estimate of the number of persons in the age groups "0 to 19", "20 to 44" and "45 and over" corresponds to the Census projections for each province and for each sex. The weight **H3**, produced at this step, is the final weight, WTHM, on the Master microdata file.

10.0 Guidelines for tabulation, analysis and release

This chapter of the documentation outlines the guidelines to be adhered to by users tabulating, analyzing, publishing or otherwise releasing any data derived from the survey microdata files. With the aid of these guidelines, users of microdata should be able to produce the same figures as those produced by Statistics Canada and, at the same time, will be able to develop currently unpublished figures in a manner consistent with these established guidelines.

10.1 Rounding guidelines

In order that estimates for publication or other release derived from these microdata files correspond to those produced by Statistics Canada, users are urged to adhere to the following guidelines regarding the rounding of such estimates:

a) Estimates in the main body of a statistical table are to be rounded to the nearest hundred units using the normal rounding technique. In normal rounding, if the first or only digit to be dropped is 0 to 4, the last digit to be retained is not changed. If the first or only digit to be dropped is 5 to 9, the last digit to be retained is raised by one. For example, in normal rounding to the nearest 100, if the last two digits are between 00 and 49, they are changed to 00 and the preceding digit (the hundreds digit) is left unchanged. If the last digits are between 50 and 99 they are changed to 00 and the preceding digit is incremented by 1.

b) Marginal sub-totals and totals in statistical tables are to be derived from their corresponding unrounded components and then are to be rounded themselves to the nearest 100 units using normal rounding.

c) Averages, rates and percentages are to be computed from unrounded components (i.e. numerators and/or denominators) and then are to be rounded themselves to one decimal using normal rounding. In normal rounding to a single digit, if the final or only digit to be dropped is 0 to 4, the last digit to be retained is not changed. If the first or only digit to be dropped is 5 to 9, the last digit to be retained is increased by 1. Proportions and ratios are to be computed from unrounded components and then are to be rounded themselves to three decimals using normal rounding.

d) Sums and differences of aggregates are to be derived from their corresponding unrounded components and then are to be rounded themselves to the nearest 100 units (or the nearest one decimal). Sums and differences of percentages (or ratios) are to be derived from their corresponding unrounded components and then are to be rounded themselves to the nearest one decimal (or three decimals) using normal rounding.

e) In instances where, due to technical or other limitations, a rounding technique other than normal rounding is used resulting in estimates to be published or otherwise released which differ from corresponding estimates published by Statistics Canada, users are urged to note the reason for such differences in the publication or release document(s).

f) Under no circumstances are unrounded estimates to be published or otherwise released by users. Unrounded estimates imply greater precision than actually exists.

10.2 Sample weighting guidelines for tabulation

The sample design used for the HES 2011 was not self-weighting. When producing simple estimates including the production of ordinary statistical tables, users **must** apply the proper survey weights.

If proper weights are not used, the estimates derived from the microdata files cannot be considered to be representative of the survey population, and will not correspond to those produced by Statistics Canada.

Users should also note that some software packages may not allow the generation of estimates that exactly match those available from Statistics Canada, because of their treatment of the survey weight field.

10.3 Guidelines for statistical analysis

The HES is based upon a complex sample design, with stratification, multiple stages of selection, and unequal probabilities of selection of respondents. Using data from such complex surveys presents problems to analysts because the survey design and the selection probabilities affect the estimation and variance calculation procedures that should be used. In order for survey estimates and analyses to be free from bias, the survey weights must be used.

While many analysis procedures found in statistical packages allow weights to be used, the meaning or definition of the weight in these procedures may differ from that which is appropriate in a sample survey framework, with the result that while in many cases the estimates produced by the packages are correct, the variances that are calculated are poor.

For other analysis techniques (for example linear regression, logistic regression and analysis of variance), a method exists which can make the variances calculated by the standard packages more meaningful, by incorporating the unequal probabilities of selection. The method rescales the weights so that there is an average weight of 1.

For example, suppose that analysis of all Quebec households is required. The steps to rescale the weights are as follows:

1. select all households from the file that reported PROV = 24, Quebec;
2. calculate the AVERAGE weight for these records by summing the original household weights from the microdata file for these records and then dividing by the number of households that reported PROV = 24;

3. for each of these records, calculate a RESCALED weight equal to the original household weight divided by the AVERAGE weight;
4. perform the analysis for these households using the RESCALED weight.

However, because the stratification and clustering of the sample's design are still not taken into account, the variance estimates calculated in this way are likely to be under-estimates.

The calculation of more precise variance estimates requires detailed knowledge of the design of the survey. Such detail cannot be given in this microdata file because of confidentiality. Variances that take the complete sample design into account can be calculated by Statistics Canada on a cost-recovery basis

10.4 Coefficient of variation release guidelines

Before releasing and/or publishing any estimates from the HES 2011, users should first determine the quality level of the estimate. The quality levels are *acceptable, marginal* and *unacceptable.* Data quality is affected by both sampling and non-sampling errors as discussed in Chapter 8.0. However for this purpose, the quality level of an estimate will be determined only on the basis of sampling error as reflected by the coefficient of variation (CV) as shown below. Nonetheless users should be sure to read Chapter 8.0 to be more fully aware of the quality characteristics of these data.

First, the number of respondents that contribute to the calculation of the estimate should be determined. If this number is less than 30, the weighted estimate should be considered to be of unacceptable quality.

For weighted estimates based on sample sizes of 30 or more, users should determine the coefficient of variation of the estimate and follow the guidelines below. These quality level guidelines should be applied to rounded weighted estimates.

All estimates can be considered releasable. However, those of marginal or unacceptable quality level must be accompanied by a warning to caution subsequent users.

Quality level guidelines

Category 1 - Acceptable

The estimates have low coefficients of variation in the range of 0.0% to 16.5%. No release restrictions: data are of sufficient accuracy that no special warnings to users or other restrictions are required.

Category 2 - Marginal
The estimates have high coefficients of variation in the range of 16.6% to 33.3%. Release with caveats: data are potentially useful for some purposes but should be accompanied by a warning to users regarding their accuracy.

Estimates should be flagged with the letter E (or some similar identifier).

Category 3 - Unacceptable
The estimates have very high coefficients of variation in excess of 33.3%. Not recommended for release: data contain a level of error that makes them so potentially misleading that they should not be released in most circumstances. If users insist on inclusion of Category 3 data in a non-standard product, even after being advised of their accuracy, the data should be accompanied by a disclaimer. The user should acknowledge the warnings given and undertake not to disseminate, present or report the data, directly or indirectly, without this disclaimer.

Estimates should be flagged with the letter F (or some similar identifier) and the following warning should accompany the estimates:

“Please be warned that these estimates [flagged with the letter F] do not meet Statistics Canada’s quality standards. Conclusions based on these data will be unreliable, and most likely invalid.”

Appendix A – Variance estimation for master and share files

In order to determine the quality of the estimate and to calculate the CV, the standard deviation must be calculated. Confidence intervals also require the standard deviation of the estimate. The HES uses a multi-stage survey design and calibration, which means that there is no simple formula that can be used to calculate variance estimates. Therefore, an approximate method was needed, the bootstrap method. With the use of the bootstrap weights and the BOOTVAR program, discussed in the next section, CVs and other variance estimates can be derived with accuracy.

Bootstrap method for variance estimation

Independently, in each stratum, a simple random sample of $(n-1)$ of the n units in the sample is selected with replacement. Note that since the selection is with replacement, a unit may be chosen more than once. This step is repeated R times to form R bootstrap samples. An average initial bootstrap weight based on the R samples is calculated for each sample unit in the stratum. The entire process (selecting simple random samples, recalculating weights for each stratum) is repeated B times, where B is large, yielding B different initial bootstrap weights.

These weights are then adjusted according to the same weighting process as the regular weights: non-response adjustment, calibration and so on. The end result is B final mean bootstrap weights for each unit in the sample. The variation among the B possible estimates based on the B bootstrap weights are related to the variance of the estimator based on the regular weights and can be used to estimate it.

Statistical packages for variance estimation

Bootvar

Users should note that bootstrap weights are provided and should be used for variance estimation. BOOTVAR is a macro program that can be used to do the variance calculation using the bootstrap weights. The Bootvar program is available in SAS or SPSS format. It is made up of macros that compute variances for totals, ratios, differences between ratios and for linear and logistic regression.

Bootvar may be downloaded from Statistics Canada's Research Data Centre (RDC) website. Users must accept the Bootvar Click-Wrap License before they can read the files. There is a document on the site explaining how to adapt the system to meet users' needs.

SAS: http://www.statcan.gc.ca/rdc-cdr/bootvar_sas-eng.htm
SPSS: http://www.statcan.gc.ca/rdc-cdr/bootvar_spss-eng.htm

Other packages

Other than Bootvar, there are different commercial software packages that can carry out some design-based analysis for variance estimation; Stata 9 or 10, SUDAAN and WesVar.

These methods can be adapted for the HES from a paper by Owen Phillips "*Using bootstrap weights with Wes Var and SUDAAN*" (Catalogue no. 12-002-X20040027032) in *The Research Data Centres Information and Technical Bulletin, Chronological index*, Fall 2004, vol.1 no. 2 Statistics Canada, Catalogue no. 12-002-XIE.

Appendix B – Variance estimation for public use microdata files

Approximate sampling variability tables

In order to supply coefficients of variation (CV) which would be applicable to a wide variety of categorical estimates produced from this microdata file and which could be readily accessed by the user, a set of Approximate Sampling Variability Tables has been produced. These CV tables allow the user to obtain an approximate coefficient of variation based on the size of the estimate calculated from the survey data.

How to Use the Coefficient of Variation Tables for Categorical Estimates

The following rules should enable the user to determine the approximate coefficients of variation from the Approximate Sampling Variability Tables for estimates of the number, proportion or percentage of the surveyed population possessing a certain characteristic and for ratios and differences between such estimates.

Rule 1: Estimates of Numbers of Households Possessing a Characteristic (Aggregates)

The coefficient of variation depends only on the size of the estimate itself. On the Approximate Sampling Variability Table for the appropriate geographic area, locate the estimated number in the left-most column of the table (headed "Numerator of Percentage") and follow the asterisks (if any) across to the first figure encountered. This figure is the approximate coefficient of variation.

Rule 2: Estimates of Proportions or Percentages of Households Possessing a Characteristic

The coefficient of variation of an estimated proportion or percentage depends on both the size of the proportion or percentage and the size of the total upon which the proportion or percentage is based. Estimated proportions or percentages are relatively more reliable than the corresponding estimates of the numerator of the proportion or percentage, when the proportion or percentage is based upon a sub-group of the population. (Note that in the tables the coefficients of variation decline in value when reading from left to right).

When the proportion or percentage is based upon the total population of the geographic area covered by the table, the CV of the proportion or percentage is the same as the CV of the numerator of the proportion or percentage. In this case, Rule 1 can be used.

When the proportion or percentage is based upon a subset of the total population (e.g. those in a particular sex or age group), reference should be made to the proportion or percentage (across the top of the table) and to the numerator of the proportion or percentage (down the left side of the table). The intersection of the appropriate row and column gives the coefficient of variation.

Rule 3: Estimates of Differences Between Aggregates or Percentages

The standard error of a difference between two estimates is approximately equal to the square root of the sum of squares of each standard error considered separately. That is, the standard error of a difference $\left(\hat{d} = \hat{X}_1 - \hat{X}_2\right)$ is:

$$\sigma_{\hat{d}} = \sqrt{\left(\hat{X}_1\alpha_1\right)^2 + \left(\hat{X}_2\alpha_2\right)^2}$$

where $\hat{X}_1$ is estimate 1, $\hat{X}_2$ is estimate 2, and α_1 and α_2 are the coefficients of variation of $\hat{X}_1$ and $\hat{X}_2$ respectively. The coefficient of variation of $\hat{d}$ is given by $\sigma_{\hat{d}} / \hat{d}$. This formula is accurate for the difference between separate and uncorrelated characteristics, but is only approximate otherwise.

Rule 4: Estimates of Ratios
In the case where the numerator is a subset of the denominator, the ratio should be converted to a percentage and Rule 2 applied.

In the case where the numerator is not a subset of the denominator, the standard error of the ratio of the estimates is approximately equal to the square root of the sum of squares of each coefficient of variation considered separately multiplied by $\hat{R}$. That is, the standard error of a ratio $\left(\hat{R} = \hat{X}_1 / \hat{X}_2\right)$ is:

$$\sigma_{\hat{R}} = \hat{R}\sqrt{\alpha_1^{\,2} + \alpha_2^{\,2}}$$

where α_1 and α_2 are the coefficients of variation of $\hat{X}_1$ and $\hat{X}_2$ respectively. The coefficient of variation of $\hat{R}$ is given by $\sigma_{\hat{R}} / \hat{R}$. The formula will tend to overstate the error if $\hat{X}_1$ and $\hat{X}_2$ are positively correlated and understate the error if $\hat{X}_1$ and $\hat{X}_2$ are negatively correlated.

Rule 5: Estimates of Differences of Ratios
In this case, Rules 3 and 4 are combined. The CVs for the two ratios are first determined using Rule 4, and then the CV of their difference is found using Rule 3.

Examples of Using the Coefficient of Variation Tables for Categorical Estimates
The following examples based on the 2002 Canadian Tobacco Use Monitoring Survey Annual data are included to assist users in applying the foregoing rules. Please note that the data for these examples are different than the results obtained from the current survey and are only to be used as a guide.

Example 1: Estimates of Numbers of Persons Possessing a Characteristic (Aggregates)

Suppose that a user estimates that during the reference period 5,414,335 persons were current smokers (DVSST1 = 1) in Canada. How does the user determine the coefficient of variation of this estimate?

1) Refer to the Person coefficient of variation table for CANADA – All Ages.

Canadian Tobacco Use Monitoring Survey 2002 - February to December - Person File

Approximate Sampling Variability Tables for Canada - All Ages

NUMERATOR OF PERCENTAGE	ESTIMATED PERCENTAGE													
('000)	0.1%	1.0%	2.0%	5.0%	10.0%	15.0%	20.0%	25.0%	30.0%	35.0%	40.0%	50.0%	70.0%	90.0%
1	197.2	196.3	195.3	192.3	187.1	181.9	176.4	170.8	165.0	159.0	152.8	139.5	108.0	62.4
2	139.4	138.8	138.1	135.9	132.3	128.6	124.8	120.8	116.7	112.5	108.0	98.6	76.4	44.1
3	113.8	113.3	112.7	111.0	108.0	105.0	101.9	98.6	95.3	91.8	88.2	80.5	62.4	36.0
4	98.6	98.1	97.6	96.1	93.6	90.9	88.2	85.4	82.5	79.5	76.4	69.7	54.0	31.2
5	88.2	87.8	87.3	86.0	83.7	81.3	78.9	76.4	73.8	71.1	68.3	62.4	48.3	27.9
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
75	********	22.7	22.5	22.2	21.6	21.0	20.4	19.7	19.1	18.4	17.6	16.1	12.5	7.2
80	********	21.9	21.8	21.5	20.9	20.3	19.7	19.1	18.5	17.8	17.1	15.6	12.1	7.0
85	********	21.3	21.2	20.9	20.3	19.7	19.1	18.5	17.9	17.2	16.6	15.1	11.7	6.8
90	********	20.7	20.6	20.3	19.7	19.2	18.6	18.0	17.4	16.8	16.1	14.7	11.4	6.6
95	********	20.1	20.0	19.7	19.2	18.7	18.1	17.5	16.9	16.3	15.7	14.3	11.1	6.4
100	********	19.6	19.5	19.2	18.7	18.2	17.6	17.1	16.5	15.9	15.3	13.9	10.8	6.2
125	********	17.6	17.5	17.2	16.7	16.3	15.8	15.3	14.8	14.2	13.7	12.5	9.7	5.6
150	********	16.0	15.9	15.7	15.3	14.8	14.4	13.9	13.5	13.0	12.5	11.4	8.8	5.1
200	********	13.9	13.8	13.6	13.2	12.9	12.5	12.1	11.7	11.2	10.8	9.9	7.6	4.4
250	********	12.4	12.4	12.2	11.8	11.5	11.2	10.8	10.4	10.1	9.7	8.8	6.8	3.9
300	********	********	11.3	11.1	10.8	10.5	10.2	9.9	9.5	9.2	8.8	8.1	6.2	3.6
350	********	********	10.4	10.3	10.0	9.7	9.4	9.1	8.8	8.5	8.2	7.5	5.8	3.3
400	********	********	9.8	9.6	9.4	9.1	8.8	8.5	8.3	8.0	7.6	7.0	5.4	3.1
450	********	********	9.2	9.1	8.8	8.6	8.3	8.1	7.8	7.5	7.2	6.6	5.1	2.9
500	********	********	8.7	8.6	8.4	8.1	7.9	7.6	7.4	7.1	6.8	6.2	4.8	2.8
750	********	********	********	7.0	6.8	6.6	6.4	6.2	6.0	5.8	5.6	5.1	3.9	2.3
1000	********	********	********	6.1	5.9	5.8	5.6	5.4	5.2	5.0	4.8	4.4	3.4	2.0
1500	********	********	********	********	4.8	4.7	4.6	4.4	4.3	4.1	3.9	3.6	2.8	1.6
2000	********	********	********	********	4.2	4.1	3.9	3.8	3.7	3.6	3.4	3.1	2.4	1.4
3000	********	********	********	********	********	3.3	**3.2**	**3.1**	3.0	2.9	2.8	2.5	2.0	1.1
4000	********	********	********	********	********	********	2.8	2.7	2.6	2.5	2.4	2.2	1.7	1.0
5000	********	********	********	********	********	********	**2.5**	2.4	2.3	2.2	2.2	2.0	1.5	0.9
6000	********	********	********	********	********	********	********	2.2	2.1	2.1	2.0	1.8	1.4	0.8
7000	********	********	********	********	********	********	********	********	2.0	1.9	1.8	1.7	1.3	0.7
8000	********	********	********	********	********	********	********	********	********	1.8	1.7	1.6	1.2	0.7
9000	********	********	********	********	********	********	********	********	********	********	1.6	1.5	1.1	0.7
10000	********	********	********	********	********	********	********	********	********	********	1.5	1.4	1.1	0.6
12500	********	********	********	********	********	********	********	********	********	********	********	1.2	1.0	0.6
15000	********	********	********	********	********	********	********	********	********	********	********	********	0.9	0.5

NOTE: FOR CORRECT USAGE OF THESE TABLES PLEASE REFER TO MICRODATA DOCUMENTATION

2) The estimated aggregate (5,414,335) does not appear in the left-hand column (the "Numerator of Percentage" column), so it is necessary to use the figure closest to it, namely 5,000,000.

3) The coefficient of variation for an estimated aggregate is found by referring to the first non-asterisk entry on that row, namely, 2.5%.

4) So the approximate coefficient of variation of the estimate is 2.5%. The finding that there were 5,414,335 (to be rounded according to the rounding guidelines in Section 10.1) current smokers in the reference period is publishable with no qualifications.

Example 2: Estimates of Proportions or Percentages of Persons Possessing a Characteristic

Suppose that the user estimates that 2,865,929 / 12,436,728 = 23.0% of men currently smoke in Canada in the reference period. How does the user determine the coefficient of variation of this estimate?

1) Refer to the Person coefficient of variation table for CANADA (see above). The CANADA level table should be used because it is the smallest table that contains the domain of the estimate, all men in Canada.

2) Because the estimate is a percentage which is based on a subset of the total population (i.e. men), it is necessary to use both the percentage (23.0%) and the numerator portion of the percentage (2,865,929) in determining the coefficient of variation.

3) The numerator, 2,865,929, does not appear in the left-hand column (the "Numerator of Percentage" column) so it is necessary to use the figure closest to it, namely 3,000,000. Similarly, the percentage estimate does not appear as any of the column headings, so it is necessary to use the percentage closest to it, 25.0%.

4) The figure at the intersection of the row and column used, namely 3.1% is the coefficient of variation to be used.

5) So the approximate coefficient of variation of the estimate is 3.1%. The finding that 23.0% of men currently smoke can be published with no qualifications.

Example 3: Estimates of Differences Between Aggregates or Percentages

Suppose that a user estimates that 2,548,406 / 12,814,359 = 19.9% of women currently smoke in Canada, while 2,865,929 / 12,436,728 = 23.0% of men currently smoke in Canada. How does the user determine the coefficient of variation of the difference between these two estimates?

1) Using the Person CANADA coefficient of variation table (see above) in the same manner as described in Example 2 gives the CV of the estimate for women as 3.2%, and the CV of the estimate for men as 3.1%.

2) Using Rule 3, the standard error of a difference $\left(\hat{d} = \hat{X}_1 - \hat{X}_2\right)$ is:

$$\sigma_{\hat{d}} = \sqrt{\left(\hat{X}_1\alpha_1\right)^2 + \left(\hat{X}_2\alpha_2\right)^2}$$

where $\hat{X}_1$ is estimate 1 (men), $\hat{X}_2$ is estimate 2 (women), and α_1 and α_2 are the coefficients of variation of $\hat{X}_1$ and $\hat{X}_2$ respectively.

3) That is, the standard error of the difference $\hat{d}$ = 0.230 – 0.199 = 0.031 is:

$$\begin{aligned}\sigma_{\hat{d}} &= \sqrt{[(0.230)(0.031)]^2 + [(0.199)(0.032)]^2} \\ &= \sqrt{(0.00005) + (0.00004)} \\ &= 0.009\end{aligned}$$

The coefficient of variation of $\hat{d}$ is given by $\sigma_{\hat{d}} / \hat{d}$ = 0.009 / 0.031 = 0.290.

4) So the approximate coefficient of variation of the difference between the estimates is 29.0%. The difference between the estimates is considered marginal and Statistics Canada recommends this estimate not be released. However, should the user choose to do so, the estimate should be accompanied by a warning to caution subsequent users about the high levels of error associated with the estimate.

Canadian Tobacco Use Monitoring Survey 2002 - February to December - Person File

Approximate Sampling Variability Tables for Canada - 15-19

NUMERATOR OF PERCENTAGE ('000)	ESTIMATED PERCENTAGE													
	0.1%	1.0%	2.0%	5.0%	10.0%	15.0%	20.0%	25.0%	30.0%	35.0%	40.0%	50.0%	70.0%	90.0%
1	95.8	95.3	94.9	93.4	90.9	88.3	85.7	83.0	80.2	77.3	74.2	67.8	52.5	30.3
2	67.7	67.4	67.1	66.0	64.3	62.5	60.6	58.7	56.7	54.6	52.5	47.9	37.1	21.4
3	********	55.0	54.8	53.9	52.5	51.0	49.5	47.9	46.3	44.6	42.9	39.1	30.3	17.5
4	********	47.7	47.4	46.7	45.5	44.2	42.9	41.5	40.1	38.6	37.1	33.9	26.2	15.2
5	********	42.6	42.4	41.8	40.7	39.5	38.3	37.1	35.9	34.6	33.2	30.3	23.5	13.6
6	********	38.9	38.7	38.1	37.1	36.1	35.0	33.9	32.7	31.5	30.3	27.7	21.4	12.4
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
95	********	********	********	9.6	9.3	9.1	8.8	8.5	8.2	7.9	7.6	7.0	5.4	3.1
100	********	********	********	9.3	9.1	8.8	8.6	8.3	8.0	7.7	7.4	6.8	5.2	3.0
125	********	********	********	********	8.1	7.9	7.7	7.4	7.2	6.9	6.6	6.1	4.7	2.7
150	********	********	********	********	7.4	7.2	7.0	6.8	6.5	6.3	6.1	5.5	4.3	2.5
200	********	********	********	********	**6.4**	6.2	6.1	5.9	5.7	5.5	5.2	4.8	3.7	2.1
250	********	********	********	********	********	**5.6**	5.4	5.2	5.1	4.9	4.7	4.3	3.3	1.9
300	********	********	********	********	********	5.1	4.9	4.8	4.6	4.5	4.3	3.9	3.0	1.7
350	********	********	********	********	********	********	4.6	4.4	4.3	4.1	4.0	3.6	2.8	1.6
400	********	********	********	********	********	********	4.3	4.1	4.0	3.9	3.7	3.4	2.6	1.5
450	********	********	********	********	********	********	********	3.9	3.8	3.6	3.5	3.2	2.5	1.4
500	********	********	********	********	********	********	********	3.7	3.6	3.5	3.3	3.0	2.3	1.4
750	********	********	********	********	********	********	********	********	********	********	2.7	2.5	1.9	1.1
1000	********	********	********	********	********	********	********	********	********	********	********	2.1	1.7	1.0
1500	********	********	********	********	********	********	********	********	********	********	********	********	********	0.8

NOTE: FOR CORRECT USAGE OF THESE TABLES PLEASE REFER TO MICRODATA DOCUMENTATION

Example 4: Estimates of Ratios

Suppose that the user estimates that 237,261 women currently smoke in the age group 15 to 19, while 220,511 men currently smoke in the age group 15 to 19. The user is interested in comparing the estimate of women versus that of men in the form of a ratio. How does the user determine the coefficient of variation of this estimate?

1) First of all, this estimate is a ratio estimate, where the numerator of the estimate ($\hat{X}_1$) is the number of women currently smoking in the age group 15 to 19. The denominator of the estimate ($\hat{X}_2$) is the number of men currently smoking in the age group 15 to 19.

2) Refer to the Person coefficient of variation table for CANADA – 15 - 19.

3) The numerator of this ratio estimate is 237,261. The figure closest to it is 250,000. The coefficient of variation for this estimate is found by referring to the first non-asterisk entry on that row, namely, 5.6%

4) The denominator of this ratio estimate is 220,511. The figure closest to it is 200,000. The coefficient of variation for this estimate is found by referring to the first non-asterisk entry on that row, namely, 6.4%.

5) So the approximate coefficient of variation of the ratio estimate is given by Rule 4, which is:

$$\alpha_{\hat{R}} = \sqrt{\alpha_1^{\,2} + \alpha_2^{\,2}}$$

where α_1 and α_2 are the coefficients of variation of $\hat{X}_1$ and $\hat{X}_2$ respectively. That is:

$$\begin{aligned}\alpha_{\hat{R}} &= \sqrt{(0.056)^2 + (0.064)^2} \\ &= \sqrt{0.003136 + 0.004096} \\ &= 0.085\end{aligned}$$

6) The obtained ratio of women currently smoking in the age group 15 to 19 versus men currently smoking in the age group 15 to 19 is 237,261 / 220,511 which is 1.08 (to be rounded according to the rounding guidelines in Section 8.1). The coefficient of variation of this estimate is 8.5%, which makes the estimate releasable with no qualifications.

How to Use the Coefficient of Variation Tables to Obtain Confidence Limits

Although coefficients of variation are widely used, a more intuitively meaningful measure of sampling error is the confidence interval of an estimate. A confidence interval constitutes a statement on the level of confidence that the true value for the population lies within a specified range of values. For example a 95% confidence interval can be described as follows:

If sampling of the population is repeated indefinitely, each sample leading to a new confidence interval for an estimate, then in 95% of the samples the interval will cover the true population value.

Using the standard error of an estimate, confidence intervals for estimates may be obtained under the assumption that under repeated sampling of the population, the various estimates obtained for a population characteristic are normally distributed about the true population value. Under this assumption, the chances are about 68 out of 100 that the difference between a sample estimate and the true population value would be less than one standard error, about 95 out of 100 that the difference would be less than two standard errors, and about 99 out of 100 that the differences would be less than three standard errors. These different degrees of confidence are referred to as the confidence levels.

Confidence intervals for an estimate, $\hat{X}$, are generally expressed as two numbers, one below the estimate and one above the estimate, as $\left(\hat{X} - k,\ \hat{X} + k\right)$ where k is determined depending upon the level of confidence desired and the sampling error of the estimate.

Confidence intervals for an estimate can be calculated directly from the Approximate Sampling Variability Tables by first determining from the appropriate table the coefficient of variation of the estimate $\hat{X}$, and then using the following formula to convert to a confidence interval $(CI_{\hat{x}})$:

$$CI_{\hat{x}} = \left(\hat{X} - t\hat{X}\alpha_{\hat{x}},\ \hat{X} + t\hat{X}\alpha_{\hat{x}}\right)$$

where $\alpha_{\hat{x}}$ is the determined coefficient of variation of $\hat{X}$, and

t = 1 if a 68% confidence interval is desired;
t = 1.6 if a 90% confidence interval is desired;
t = 2 if a 95% confidence interval is desired;
t = 2.6 if a 99% confidence interval is desired.

Note: Release guidelines which apply to the estimate also apply to the confidence interval. For

example, if the estimate is not releasable, then the confidence interval is not releasable either.

Example of Using the Coefficient of Variation Tables to Obtain Confidence Limits
A 95% confidence interval for the estimated proportion of men who currently smoke (from Example 2) would be calculated as follows:

$\hat{X}$ = 23.0% (or expressed as a proportion 0.230)

t = 2

$\alpha_{\hat{x}}$ = 3.1% (0.031 expressed as a proportion) is the coefficient of variation of this estimate as determined from the tables.

$CI_{\hat{x}}$ = {0.230 - (2) (0.230) (0.031), 0.230 + (2) (0.230) (0.031)}

$CI_{\hat{x}}$ = {0.230 - 0.014, 0.230 + 0.014}

$CI_{\hat{x}}$ = {0.216, 0.244}

With 95% confidence it can be said that between 21.6% and 24.4% of men currently smoke.

How to Use the Coefficient of Variation Tables to Do a T-test
Standard errors may also be used to perform hypothesis testing, a procedure for distinguishing between population parameters using sample estimates. The sample estimates can be numbers, averages, percentages, ratios, etc. Tests may be performed at various levels of significance, where a level of significance is the probability of concluding that the characteristics are different when, in fact, they are identical.

Let $\hat{X}_1$ and $\hat{X}_2$ be sample estimates for two characteristics of interest. Let the standard error on the difference $\hat{X}_1 - \hat{X}_2$ be $\sigma_{\hat{d}}$.

If $t = \dfrac{\hat{X}_1 - \hat{X}_2}{\sigma_{\hat{d}}}$ is between -2 and 2, then no conclusion about the difference between the characteristics is justified at the 5% level of significance. If however, this ratio is smaller than -2 or larger than +2, the observed difference is significant at the 0.05 level. That is to say that the difference between the estimates is significant.

Example of Using the Coefficient of Variation Tables to Do a T-test
Let us suppose that the user wishes to test, at 5% level of significance, the hypothesis that there is no difference between the proportion of men who currently smoke and the proportion of women who currently smoke. From Example 3 the standard error of the difference between these two estimates was found to be 0.009. Hence,

$$t = \frac{\hat{X}_1 - \hat{X}_2}{\sigma_{\hat{d}}} = \frac{0.230 - 0.199}{0.009} = \frac{0.031}{0.009} = 3.44$$

Since t = 3.44 is greater than 2, it must be concluded that there is a significant difference between the two estimates at the 0.05 level of significance.