Adjustments for Mode Effect Bias for the Canadian Community Health Survey

Andrew Quigley
Statistics Canada, Ottawa, Ontario, Canada

Abstract

The Canadian Community Health Survey is a cross-sectional survey designed to produce nationally comparable estimates of health risk factors, health status and health care services. Annually, data from 65,000 respondents are collected using a combination of an area frame and a telephone frame. To increase the precision of estimates, provinces can provide extra funds to increase the sample size for their regions. Almost all of these 'buy-in' units use the more cost-effective telephone frame option, thus leading to a larger than average ratio of telephone to personal interviews. For variables affected by the mode of collection, this larger ratio may lead to problems when comparing a region with past results or results from other regions. This paper identifies the presence of a mode effect for some variables due to the addition of buy-in units and suggests a method to control the problem using a weighting technique.

Key Words: Mode effect, Canadian Community Health Survey, weighting

1. Background

1.1 The Canadian Community Health Survey

The Canadian Community Health Survey (CCHS) is a cross-sectional survey designed to produce comparable estimates of health risk factors, health status and health care services for more than 120 Health Regions (HR) across Canada. It has a complex, multi-stage, dual frame design with an annual sample of approximately 65,000 respondents. The survey uses an area frame to account for approximately half of the sample and a telephone frame to account for the remaining half. For the telephone frame, all interviews are conducted by telephone. For the area frame, the majority of interviews are conducted face-to-face but it is possible to conduct the interview over the telephone.

1.2 Composite estimator

With the use of two modes of collection and with each expected to provide approximately half of the sample for most of the HRs, a final estimate from an HR that uses both modes can be calculated with the following composite estimator:

$$\hat{Y} = \alpha\hat{Y}_T + (1-\alpha)\hat{Y}_P$$

Where:
$\hat{Y}$ = the final composite estimator
$\hat{Y}_T$ = the estimate from telephone interviews
$\hat{Y}_P$ = the estimate from personal interviews
α = the proportion of interviews performed over the telephone

The unweighted value of α at the design stage, call it α_u, is approximately 0.5 for most HRs, where it is expected that all area frame units will be collected through personal interviews. When the survey weights were applied to the original 2005 CCHS sample, the expected weighted values of α for the HRs, call it α_w, ranged from 0.40 to 0.71. The national average for α_w was 0.54. During collection, the values of α_w can increase due to area frame units having their interviews conducted over the telephone. The percentage of interviews from area frame units that are conducted by telephone fluctuates over time and across HRs and it is generally accepted that this will cause a small amount of variability in the estimates. For the original 2005 CCHS sample, the values of α_w using the actual mode of collection for the HRs ranged from 0.45 to 0.83. The national average for α_w was 0.64. Note that all of the subsequent information in this report is based on data obtained after collection, unless otherwise stated.

1.3 Buy-in units

While the CCHS is initially designed to produce estimates at the HR level, provinces are given the option to provide more funds to increase the sample size of the HRs in order to produce more reliable estimates at the more detailed sub-HR level. This extra sample, referred to as buy-in units, can dramatically affect the ratio of telephone interviews to personal interviews because the buy-in units are almost exclusively selected from the more cost-efficient telephone frame. With the increase in the telephone to personal interview ratio, any potential mode effect bias will be amplified if the estimate coming from the telephone interviews for a given variable ($\hat{Y}_T$) differs from the estimate coming from the personal interviews ($\hat{Y}_P$). This can create comparability issues between HRs when dealing with an HR with buy-in units. A previous study on the effect of the mode of collection on some key variables from the 2003 CCHS (St-Pierre & Béland, 2004) demonstrated that there were some variables where the estimate based on the telephone interviews was significantly different from the estimates based on the personal interviews. For the 2005 CCHS, three HRs in the province of Quebec purchased additional sample: Bas-Saint-Laurent, Montréal-Centre and Laval. The unweighted distribution of the original sample and the buy-in units is shown in Figure 1. The original sample ratios from the telephone frame (orange vertical stripes) and the area frame (green horizontal stripes) were roughly a one-to-one ratio. With the addition of the buy-in sample (blue hash marks), this ratio was severely increased.
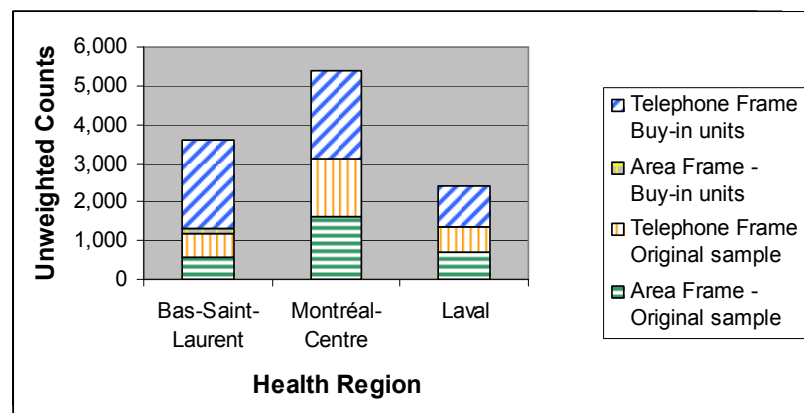

Figure 1: Unweighted distribution by HR and frame of the original and buy-in samples

A summary of the actual mode of collection for the three buy-in HRs and the rest of Quebec from the 2005 CCHS is shown in Table 1. All results are unweighted. The unweighted percentage of telephone interviews in the rest of Quebec (56.5%) was quite different from the three buy-in regions (ranging from 75.9%-78.7%). Before including the buy-in units, α_w for the composite estimator for the three buy-in HRs ranged from 0.59 to 0.65. With the inclusion of the buy-in units, the range for α_w increased to 0.78 to 0.84, thus the addition of the buy-in units increased the potential for bias in the composite estimator $\hat{Y}$. With this 2.5- to 3-fold increase in the telephone to personal interview ratio, the comparisons with variables that may be affected by the mode of collection can be even more problematic when one of the regions being compared contains buy-in units. This includes comparisons between HRs, between provinces and

Mode of collection	Bas-Saint-Laurent		Montréal-Centre		Laval		Rest of Quebec	
	n	%	n	%	n	%	n	%
Telephone	2,768	78.7%	4,090	75.9%	1,910	78.5%	10,481	56.5%
Personal	680	19.3%	1,266	23.5%	500	20.6%	7,914	42.7%
Both *	40	1.1%	21	0.4%	8	0.3%	56	0.3%
Not stated *	30	0.9%	13	0.2%	14	0.6%	100	0.5%
Total	3,518	100.0%	5,390	100.0%	2,432	100.0%	18,551	100.0%
Telephone: Personal ratio	4.07:1		3.23:1		3.82:1		1.32:1	

Table 1: Unweighted mode of collection summary for the buy-in HRs and the rest of Quebec for 2005

* These 2 categories were ignored for all analyses in this paper

also from one cycle to another.   By modifying the value of α_w, the contributions from the two modes of collection could be controlled and thus create a more comparable final estimate $\hat{Y}$. This is the motivation for this study. While the results of this report are based on the mode of collection differences due to the inclusion of the buy-in units, any potential results could also be applied to non-buy-in HRs to help control for the HR-to-HR variability in area frame units that had an interview conducted over the telephone.   The 2 major goals of this paper are:

1. To identify if there was a mode effect bias for certain variables due to the addition of the buy-in units for the 2005 CCHS – i.e. that $\hat{Y}_{i \text{ (including the buy-in units)}} \neq \hat{Y}_{i \text{ (excluding the buy-in units)}}$ for a given variable i
2. To implement a new weighting strategy to help control for any mode effect bias due to the buy-in units such that $\hat{Y}_{i \text{ (including the buy-in units)}} = \hat{Y}_{i \text{ (excluding the buy-in units)}}$ for a given variable i

2. Identification of a mode effect due to the buy-in units

2.1 Method to identify a mode effect due to the buy-in units

The identification of a mode effect bias due to the buy-in units is a 3-step process. In the first step, point estimates and coefficients of variation (CV) are calculated for the three buy-in HRs for some key health indicators using the data file that was released to the public in 2006 and therefore contained the buy-in units. Many of these key health indicators were previously analyzed in the CCHS mode effect study (St-Pierre & Béland, 2004). A total of 37 variables are analyzed. Two of these variables (physical activity and self-perceived weight) are broken down into multiple response categories. The estimates are calculated using Bootvar, a software program designed by Statistics Canada for analyzing data from complex surveys using bootstrapping.

During the second step, a data file is created that did not contain the buy-in units and the point estimates and CVs are recalculated using this new file.

The final step is to compare the estimates calculated during the first and second steps to identify the variables that are affected by the mode of collection due to the buy-in units. Any variable with estimates that are significantly different from one another at the 5% level is considered to be affected by the mode of collection due to the buy-in units. By focusing on the final value for the estimates (i.e. $\hat{Y}$ from the composite estimator), it would be more difficult to label a variable as being affected by the mode of collection due to the buy-in units.

2.2 Results of the identification of a mode effect due to the buy-in units

Highlights of the results for the identification of a mode effect for the 3 HRs can be found in Table 2. Out of the 37 variables compared using the data files including and excluding the buy-in units, 13 were found to be significantly different at the 5% level in at least one of the HRs. Four of these variables were found to be significantly different in multiple HRs: physical activity and injury treated in an emergency room were different in all three HRs while sexual intercourse and consulted other medical practitioner were different in two of the three HRs.   Other variables, such as self-perceived weight (overweight) and life stress (quite a lot), showed a difference of more than 1.5% in multiple HRs though they were not found to be significantly different at the 5% level. It is interesting to note that the youth and adult BMI-related variables, which are based on self-reported height and weight and therefore likely to be affected by how the interview was conducted, were found to not be affected by the buy-in units. The overall conclusion from the first part of the analysis was that there is a mode effect bias present due to the addition of the buy-in units for some variables. The next step is to identify a method to control for this bias.

3. Controlling for the mode effect due to the buy-in units – Part I

3.1 Method to control for the mode effect using a national level adjustment

For the second part of the analysis, a re-weighting strategy is proposed in order to control for the mode effect bias due to the buy-in units. The goal is to create a process that will minimize the differences between estimates that include and exclude the buy-in units for the variables that are affected by the mode. The variables unaffected by the mode of collection should remain relatively unchanged. Similar to Section 2, controlling for the mode effect is a 3-step process. In the first step, the weighted ratio of telephone to personal interviews is determined at the national level, excluding the

HR	Variable	Incl. buy-in units		Excl. buy-in units		Change	Significantly different?
		Prop.	CV %	Prop.	CV %		
Bas-Saint-Laurent	Physically very active	0.25	4.16	0.22	7.65	-0.03	Yes
	Physically inactive	0.47	2.51	0.52	3.97	0.05	Yes
	Self-perceived overweight	0.27	4.03	0.29	5.97	0.02	No
	Injury treated in emergency room	0.47	8.21	0.59	10.72	0.12	Yes
Montréal-Centre	Physically inactive	0.50	1.76	0.54	2.12	0.04	Yes
	Sexual intercourse	0.86	0.95	0.88	1.06	0.02	Yes
	Had an influenza vaccine	0.38	2.09	0.36	2.81	-0.02	Yes
	Smoking banned in the home	0.86	0.99	0.88	1.20	0.02	Yes
Laval	Physically very active	0.21	4.64	0.17	6.96	-0.04	Yes
	Injury treated in emergency room	0.30	13.15	0.39	16.08	0.09	Yes
	Consulted other medical practitioner	0.32	3.82	0.35	4.77	0.03	Yes
	Self-perceived overweight	0.34	3.42	0.36	4.32	0.02	No

Table 2: Highlights for the identification of a mode effect due to the buy-in units

three buy-in HRs. This ratio will be used as the target for telephone to personal interviews in the three buy-in HRs. The rationale for determining this ratio is that by mimicking the ratio of telephone to personal interviews in the rest of Canada, the buy-in HRs will be more similar to the other HRs in terms of the mode of collection and thus comparability will be less of an issue. Targeting the ratio of telephone to personal interviews would have the same effect as modifying the value of α_w in the composite estimator.

The second step is to create a new weight adjustment that will force the weights of the three buy-in HRs to mimic the national ratio of telephone to personal interviews. To meet the target ratio determined in the first step, the weights of the telephone respondents are decreased and the weights of the personal interview respondents are increased. After this new mode of collection adjustment, the weights are post-stratified using a standard weight adjustment to match population estimates at the HR by age group by sex level. Due to of the post-stratification, the final ratio of telephone to personal interviews in the three buy-in HRs would only be approximately equal to the national ratio.

The final step is to compare the estimates calculated with the mode-adjusted weights with the estimates from the weights that excluded the buy-in units. The estimates that excluded the buy-in units are used as the standard since these are the estimates that would have been obtained had there been no buy-in. To demonstrate the successful control for the mode effect, the difference in estimates between the mode-adjusted and excluding the buy-in unit methods should no longer be statistically significant.

3.2 Results of controlling for the mode effect using a national level adjustment

The weighted results for the actual mode of collection were calculated for the 3 buy-in HRs and the rest of Canada and are presented in Table 3. The weighted ratio for the rest of Canada (1.97:1) was used as the standard for the mode of collection adjustment step during the weighting process. This equated to a weighted value $\alpha_w=0.66$ for the composite estimator. The new target ratio was applied at the sub-HR level since the rationale for including additional sample was to produce estimates at this level. Finally, the weights were post-stratified and then estimates were calculated.

Region	Telephone Interviews	Personal Interviews	Total	Telephone : personal interview ratio
Bas-Saint-Laurent	135,200	26,606	161,806	5.08:1
Montréal-Centre	1,217,578	345,172	1,562,750	3.53:1
Laval	252,489	61,289	313,778	4.12:1
Rest of Canada	14,784,200	7,501,136	22,285,336	1.97:1
Canada Total	16,389,466	7,934,203	24,323,670	2.07:1

Table 3: Weighted number of telephone and personal interviews for the buy-in HRs and the rest of Canada

Highlights of the results after controlling for the mode of collection are presented in Table 4. Note that without the mode adjustment, the only estimate shown in Table 4 that was not significantly different from the estimate excluding the buy-in units was for self-perceived overweight. After the mode adjustment, many of the variables that had previously been shown to be significantly affected by the mode were no longer different compared to the estimates when excluding the buy-in units. For example, the mode-adjusted estimate for physically very active in Bas-Saint-Laurent (0.24) moved closer to the estimate from excluding the buy-in units (0.22), compared to the estimate from including the buy-in units (0.25) and this difference was no longer significantly different. Overall, 7 of the 13 variables found to be affected by the mode of collection in Section 2 were no longer showing significant differences after the new adjustment. For variables that were not affected by the mode (such as self-perceived overweight in Table 4), the mode adjustment only had a minimal effect on the estimates. However, the majority of the mode-adjusted estimates did tend to move closer towards the estimates that excluded the buy-in units. In Montréal-Centre, many of the variables identified as being affected by the mode of collection in Section 2 were not controlled after the Canada level mode adjustment. Two factors to help explain this outcome were sample size and the inherent differences between the buy-in units that responded by telephone and the original sample units that responded by telephone. First, Montréal-Centre has a large sample size and therefore has many estimates with very low CVs. This made it easier to identify significant differences and therefore more difficult to modify the estimates enough to make them non-significant. Second, any inherent differences between the estimates from the telephone buy-in units and the original sampled units that responded over the telephone would be more difficult to control through any type of weighting adjustment. For example, for the variable physically very active with the full data file (not shown in Table 4), the estimate for the telephone buy-in units was 30.0% and the estimate for the original units that responded by telephone was 25.3%. The estimate for the units that responded by personal interview was 17.2%. In this example, the assumption that there would be no difference between the telephone buy-in units and the originally sampled units that responded by telephone did not hold. This added some extra noise in the composite estimate and made it more difficult to control with the new weight adjustment.

Table 4: Highlights for controlling for the mode effect due to the buy-in units using the national average

HR	Variable	Including buy-ins		Excluding buy-ins		Mode adjusted: National level		Difference between excluding & mode adjusted?
		Prop.	CV %	Prop.	CV %	Prop.	CV %	
Bas-Saint-Laurent	Physically very active	0.25	4.16	0.22	7.65	0.24	4.25	No
	Physically inactive	0.47	2.51	0.52	3.97	0.49	2.33	No
	Self-perceived overweight	0.27	4.03	0.29	5.97	0.28	4.23	No
	Injury treated in emergency room	0.47	8.21	0.59	10.72	0.51	7.45	No
Montréal-Centre	Physically inactive	0.50	1.76	0.54	2.12	0.52	1.73	Yes
	Sexual intercourse	0.86	0.95	0.88	1.06	0.86	0.89	Yes
	Had an influenza vaccine	0.38	2.09	0.36	2.81	0.38	2.11	Yes
	Smoking banned in the home	0.86	0.99	0.88	1.20	0.87	1.00	No
Laval	Physically very active	0.21	4.64	0.17	6.96	0.20	4.60	Yes
	Injury treated in emergency room	0.30	13.15	0.39	16.08	0.32	12.57	No
	Consulted other medical practitioner	0.32	3.82	0.35	4.77	0.33	3.76	No
	Self-perceived overweight	0.34	3.42	0.36	4.32	0.35	3.41	No

It was feared that the introduction of a new weighting adjustment step would create extra variability in the estimates and would therefore increase the CVs. When compared with the CVs from the estimates including the buy-in units, the CVs from the Canada level mode adjusted estimates were very similar. This can in part be due to the fact that the weights were post-stratified after the mode adjustment, thus stabilizing any potential effect on the CVs. These two sets of estimates contained the same number of observations. The CVs from each of the three sets of estimates presented in Table 4 are representative of all of the results not presented in this paper. There were no major changes in the CVs and therefore it was concluded that this extra weight adjustment step does not have a detrimental effect on the variability of the estimates.

By implementing an adjustment to mimic the ratio of telephone to personal interviews at the Canada level, estimates would be more comparable between HRs due to controlling for the mode of collection. However, the results would still not compare to the results obtained after excluding the buy-in units because of the HR-to-HR variability in the number of area frame units responding over the telephone. The goal of Part II for controlling for the mode effect will be to mimic a more detailed ratio of telephone to personal interviews to further decrease the difference between estimates obtained when excluding the buy-in units and the mode-adjusted estimates that included the buy-in units.

4. Controlling for the mode effect due to the buy-in units – Part II

4.1 Control for the mode effect using an HR level adjustment

In Part I for controlling for the mode effect, the national ratio (excluding the buy-in HRs) of telephone to personal interviews was used as the standard to be applied to the three buy-in HRs. The overall result was an improvement in estimates as the difference between the mode-adjusted estimates and the excluding buy-in units estimates decreased. When using a Canada level ratio, the results would also be more comparable among the HRs by fixing the interview ratio for all HRs and therefore fixing the value of α_w in the composite estimator. For Part II, a more detailed telephone to personal interview ratio is used in place of a national value. For each of the three HRs, the weighted ratio of telephone to personal interviews is determined at the HR level after excluding the buy-in units. These HR level ratios would take into account the region-to-region variability in the number of respondents that were selected from the area frame but who responded over the telephone. The new ratios can be seen in Table 5. All three HRs had ratios that were smaller than the national average of 1.97:1 that was used in Part I for controlling for the mode effect. These new ratios are the target during the mode adjustment weighting step. Note that the number of interviews in Table 5 were calculated using weights that did not include the buy-in units, thus the totals are much smaller than those in Table 3. These would be the numbers available at this stage of the weighting process.

Table 5: Telephone to personal interview weighted ratios for the HRs after excluding the buy-in units				
Health Region	Telephone interviews	Personal interviews	Total interviews	Telephone : Personal interview ratio
Bas-Saint-Laurent	31,172	21,914	53,086	1.42:1
Montréal-Centre	531,633	345,172	876,805	1.54:1
Laval	113,087	61,289	174,376	1.85:1

4.2 Results of controlling for the mode effect using an HR level adjustment

For the analyses on controlling for the mode effect at the HR level, 16 variables were analyzed. These included all of the variables that were affected by the mode in at least two of the HRs (physical activity, injury treated in an emergency room, sexual activity and consulted other medical practitioner). Two of the variables (physical activity and self-perceived weight) were again broken down into multiple response categories. Highlights of the results after controlling at the HR level are shown in Table 6. A couple of the mode affected variables that were not controlled with the Canada level telephone to personal interview ratio in Part I (sexual intercourse in Bas-Saint-Laurent and physically inactive in Montréal) were now controlled with the HR level ratio. The majority of the other variables saw some further small improvements as their estimates moved towards the estimates from excluding the buy-in units.

In terms of CVs, there was a small increase in the variability when mimicking the HR level ratio. This was expected as the weighted telephone to personal interview ratios for all three HRs were smaller than the national ratio and therefore required larger weight adjustments to reach the targets.

4.3 Further analyses at the sub-HR level

To get an idea of how the HR level mode adjustment affected the estimates at the sub-HR level, analyses were performed for all of the sub-HRs (8 in Bas-Saint-Laurent, 12 in Montréal-Centre and 2 in Laval) for a total of 17 variables. An overall summary of the results are presented in Table 7. Note that with the smaller domain sizes, it was more difficult to find significant differences between the estimates excluding the buy-in units and the HR level mode adjusted estimates. Overall, 62% (21/34) of the cells that were found to be significantly different at the 5% level were no longer significant after the HR level mode adjustment. The cells that remained significantly different after the

HR	Variable	Including buy-ins		Excluding buy-ins		Mode adjusted: HR level		Difference between excluding & mode adjusted?
		Prop.	CV %	Prop.	CV %	Prop.	CV %	
Bas-Saint-Laurent	Physically very active	0.25	4.16	0.22	7.65	0.23	4.87	No
	Sexual intercourse	0.88	1.22	0.91	1.67	0.89	1.16	No
	Self-perceived overweight	0.27	4.03	0.29	5.97	0.29	4.60	No
	Injury treated in emergency room	0.47	8.21	0.59	10.72	0.53	7.59	No
Montréal-Centre	Physically very active	0.26	3.00	0.22	4.14	0.24	3.16	Yes
	Physically inactive	0.50	1.76	0.54	2.12	0.53	1.75	No
	Sexual intercourse	0.86	0.95	0.88	1.06	0.87	0.89	Yes
	Had an influenza vaccine	0.38	2.09	0.36	2.81	0.38	2.18	Yes
Laval	Physically very active	0.21	4.64	0.17	6.96	0.19	4.80	Yes
	Injury treated in emergency room	0.30	13.15	0.39	16.08	0.32	12.81	No
	Consulted other medical practitioner	0.32	3.82	0.35	4.77	0.33	3.84	No
	Self-perceived overweight	0.34	3.42	0.36	4.32	0.36	3.52	No

Table 6: Highlights for controlling for the mode effect due to the buy-in units using the HR level ratio adjustment

adjustment were examined and found that there were once again some inherent differences between the buy-in units that responded by telephone and the original sample units that responded by telephone. This was the case in 9 of the 13 cases that remained significantly different after the adjustment and in all 3 cases that went from being insignificant to significant.

Table 7: Summary of the results of analyses of the 17 variables at the sub-HR level using the HR level ratio adjustment

HR	Total Cells	# Significant before adjustment (5%)	After adjustment	
			Significant to insignificant	Insignificant to significant
Bas-Saint-Laurent	136	11	5	2
Montréal-Centre	204	18	12	1
Laval	34	5	4	0
Totals	374	34	21	3

The CVs from the sub-HR analyses were also examined to see if the HR level adjustment would increase the variability at the more-detailed sub-HR level compared to the estimates that included the buy-in units but did not adjust for the mode of collection. The differences between the CVs were calculated and averaged over all cells for each HR and are presented in Table 8. The average increase in CV was 0.25 percentage points.

Table 8: Average changes in CV for the 17 analyzed variables at the sub-HR level using the HR level ratio adjustment

HR	Total Cells	Average change in CV
Bas-Saint-Laurent	136	+ 0.68
Montréal-Centre	204	+ 0.36
Laval	34	+ 0.10
Totals	374	+ 0.25

5. Conclusions and future work

With the ability to increase sample sizes to produce estimates at a more detailed level, provinces can create comparability issues when trying to compare HRs that contain buy-in units with HRs that do not. This is due to some

variables being affected by the mode of collection and to the fact that the interviews for the buy-in units are almost exclusively telephone interviews. In this paper, a total of 13 out of the 37 variables analyzed were shown to have estimates that differed significantly when including and excluding the buy-in units in at least one of the three buy-in HRs. To help control the bias that was introduced due to the buy-in units, a new weighting adjustment step was introduced. In Part I for controlling for the mode effect, a national-level average for the ratio of telephone to personal interviews was calculated and then applied to the three HRs that had buy-in units for the 2005 CCHS. The adjustment helped control for the mode effect due to the buy-in units for many of the affected variables while having minimal effects on the CVs. Using the national level average ratio as a target was explored in this paper for buy-in regions but could also be extended to all HRs and would allow the comparability of all HRs across Canada by having each HR have approximately the same ratio. One limitation is that this method ignored the variability amongst HRs in terms of the number of area frame interviews that were conducted over the telephone. Another limitation is that these methods do not assume one mode provides a truer response than another for a given variable. They are driven by ensuring comparability, not reducing or correcting a particular mode effect, if any.

In Part II for controlling for the mode effect, a more detailed HR level ratio of telephone to personal interviews was calculated and then applied to each of the buy-in HRs. This method controlled for the mode of collection within each HR and accounted for the HR-to-HR variability in the number of area frame interviews that were conducted over the telephone in the HR ratios. The HR level ratio adjustments resulted in the controlling of two additional variables that were previously shown to be affected by the mode of collection due to the buy-in units. Most of the other variables affected by the mode of collection continued to show small decreases in the differences between the mode-adjusted estimates compared to the estimates that excluded the buy-in units. Since the target HR level ratios were smaller than the Canada level ratios, the weight adjustments required to match the target ratios were larger and therefore the CVs were slightly more variable. The HR level ratio also helped to control for the mode of collection at the sub-HR level. This was accompanied by a slightly larger increase in the CVs, which was expected due to the small domain size of the sub-HRs.

Both variations of the mode-adjustment method used in this paper diminished the effects of the mode of collection due to the buy-in units on the final estimates at the HR levels, therefore $\hat{Y}_{\text{(including the buy-in units)}} = \hat{Y}_{\text{(excluding the buy-in units)}}$ for many of the variables analyzed. Even with the mode adjustment, some estimates still remained significantly different from what would have been obtained had there not been a buy-in. This was shown to be partly caused by an inherent difference between the contributions to the final estimates from the buy-in units that responded by telephone and the original sampled units that responded by telephone. Part of this difference may be explained by the idea that the people that were selected from the area frame but responded to the interview over the telephone may have been different from the telephone frame units that responded by telephone. This unique group of respondents requires further study as they could be treated as a third mode of collection. The results from this paper were obtained using the buy-in HRs but the implications that the fluctuations in mode of collection can cause comparability issues can be extrapolated to all HRs. The next step is to determine if a form of the method will be put into production for the 2008 CCHS and this involves further analyses and discussions with the clients of the survey. Any future adjustments could be for just the buy-in HRs, since the 2008 CCHS contains buy-in units in two different HRs in Quebec, or for all HRs in order to completely control for the mode of collection. It could then be applied over time to avoid comparability issues that can arise when there is a shift in the mode of collection between cycles.

Acknowledgements

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