

## **Comparing Sampling Methods for Hard-to-Reach Francophone Populations: Random, Advertisement and Respondent Driven Sampling**

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## ABSTRACT

**Background:** Francophones who live outside of French speaking province of Quebec, Canada risk being excluded from research due to lack of a sampling frame. The effectiveness of using random, advertising and respondent driven sampling (RDS) for recruiting Francophones in survey research was examined

**Methods:** Francophones residing in the city of Calgary, Alberta, Canada were recruited through advertising, followed by RDS. The generated samples were then compared with a random subsample of Calgary Francophones derived from the 2006 Canadian Community Health Survey (CCHS). Effectiveness of advertising and RDS was assessed based on how (dis)similar both samples were to the CCHS sample by comparing demographic characteristics, and selected items from the CCHS: self-reported general health status, perceived weight and having a family doctor.

**Results:** This study included 120 Francophones recruited through advertising, 145 recruited through RDS and 259 from the CCHS. The advertising and RDS samples differed from the CCHS, gold standard, in age (mean age: 37.6, 41.0 and 42.5, respectively), sex (male: 26.1%, 40.6% and 56.6%), education (college or higher: 43.0%, 54.2% and 59.1%), place of birth (immigrants: 43.0%, 54.2% and 3.7%) and having regular medical doctor (16.0%, 33.1% and 16.6%). Factors associated with having regular medical doctors in the samples generated from advertising, RDS, or both differed from the CCHS subsample.

**Interpretation:** The samples generated exclusively through advertising, RDS or both were not representative of the gold standard sample from the CCHS. The biased samples could generate misleading results.

**Keywords:** hard-to-reach, Francophone, sampling method, advertising, respondent driven sampling

Having a representative sample is imperative for generalizing study results. When lacking a sampling frame, researchers find it difficult to generate a random sample that is representative of the targeted population. In Canada, the term ‘minority Francophone’ refers to people residing in English speaking provinces of Canada who speak French as mother tongue or first official language.<sup>1</sup> Based on the 2006 census,<sup>2</sup> there are 6.8 million Francophones (22.1% of total population) in Canada. Of this number, 975,390 reside outside of Quebec, mostly in the provinces of New Brunswick, Ontario, British Columbia and Alberta. French is a national official language of Canada and Canada accepts immigrants with adequate knowledge of French. Thus, minority Francophones are from the province of Quebec and overseas. Health researchers need convenient and feasible mechanisms to recruit participants for studies involving hard-to-reach populations<sup>3-6</sup> such as minority Francophones in Canada. This population is hard-to-reach for survey purposes as there is no registry of Francophones and neither ethnicity (except for registered natives) or language are routinely collected as part of administrative health data.<sup>7</sup>

Advertising is one technique used to recruit study participants. Often, researchers will advertise the study to recruit participants in print media, online, through email distribution, and using posters or flyers. Snow-ball is another sampling technique that uses initial recruits (seeds) to name others in the population who may be interested in the study.<sup>3,8</sup> This system of chain referrals usually continues until the target sample size is obtained. Respondent driven sampling (RDS) is yet another technique that uses snow-ball methods but adds incentives to recruit participants, and employs mathematical weights in the analysis to compensate for the non-random nature of the sample.<sup>9,10</sup> These three sampling methods have been widely used individually or in combination by researchers to sample hard-to-reach populations. For example, Southern et al. used a combination of paid and unpaid advertising to recruit a sample of

Americans living in Canada.<sup>11</sup> Researchers in the United States and Europe used RDS to recruit injection drug users for their studies.<sup>12,13</sup>

Studies in which advertising was used as the sole recruiting method have demonstrated its convenience as a recruiting strategy, despite being limited by it not generating the desired sample size in a certain period.<sup>14-16</sup> Studies in which snow-ball samples were obtained often have findings that are not generalizable due to the non-random nature of the resulting sample.<sup>3</sup> To contrast advertising and snow-ball methods, RDS may have significant advantages because recruitment of participants can be relatively fast, and the resulting sample is diverse and has less investigator bias.<sup>17</sup> However, RDS requires finding productive seeds and reaching six or more waves of recruitment.<sup>9,18,19</sup>

Hard-to-reach populations will be the focus of health research, as they will often have unique healthcare needs. To obtain valid and generalizable research results, mechanisms for sampling need to be optimized.

## **METHODS**

### **Design and Setting**

We generated samples of Francophones through advertising and RDS and then compared these with a random subsample from Canadian Community Health Survey (CCHS).<sup>20</sup> CCHS is a random digital dialing telephone survey and could be used as a ‘gold standard’ to determine if these two sampling strategies generate similar sample as CCHS based on reported socio-demographic characteristics, as well as elements of the CCHS: perceived weight, health status, and having a regular medical doctor.

This cross sectional survey of Francophones was conducted in Calgary, Alberta in 2010. In 2006, there were 64,750 Francophones in Alberta,<sup>21</sup> representing about 2% of the population

of Alberta. Although some small towns and villages in Alberta (e.g., Beaumont, Brosseau, Grand Prairie, and Lacombe) have clustered populations of Francophones, the majority of Francophones in the province reside in the Calgary and Edmonton metropolitan areas. Calgary has 1.1 million people and has accepted many migrants from other provinces, and immigrants from French speaking countries.<sup>21</sup> This study was approved by the Conjoint Health Research Ethics Board of the University of Calgary. Informed consent was obtained from participants.

### **Data Collection**

Survey questions were derived from the 2006 CCHS 3.1 English and French questionnaire,<sup>22</sup> keeping the same wording to maintain comparability across data sources. Survey questions included socio-demographic characteristics, self-perceived general health, perceived weight, and having a regular medical doctor.

Participants recruited by advertising and RDS, had the choice of completing the survey by telephone, mail or online. First however, potential participants had to meet eligibility criteria before proceeding. They included: aged 18 years or older, having resided in Calgary for the atleast 12 months and self-identify as Francophone based on mother tongue or first official language spoken. Both French and English versions of the survey questionnaire were developed and pilot tested.

### **Recruitment for the Canadian Community Health Survey**

The 2006 CCHS cycle 3.1 was a cross sectional telephone survey administered nationally to household residents aged 12 and older in all provinces and territories, with the exception of populations on Indian reserves, Canadian Forces Bases, and in some remote areas.<sup>20</sup> The CCHS uses a multi-stage survey design that includes stratification and/or clustering of population units prior to sampling. Survey weights are provided for analysis to account for the complex survey

design. The response rate for CCHS 3.1 was 84.7% nationally. A detailed description of the sampling frame and design methodology of CCHS can be found elsewhere.<sup>20</sup> The CCHS was chosen as the ‘gold standard’ because the sampling strategy was random at the regional level of geography. From the survey, 259 Francophones from Calgary aged at least 18 years were a random subsample of the CCHS. These are CCHS survey participants from Calgary who reported French as either their mother tongue or their first official spoken language.

#### **Recruitment through Advertising Method**

Internet/email, newspapers, radio/television, and posters/flyers were advertising mechanisms used to generate a sample. The advertisements were all in French. -

**Internet/email.** Advertising was launched on Friday November 27, 2009, via direct emailing and by posting study information on our website. Flyers were emailed to leaders of agencies and community associations serving the Francophone community in Calgary, asking them to pass on emails to their various networks. These leaders had participated in a focus group in September 2009 to discuss how they could facilitate access to the Francophone community for this study. A reminder email was sent on January 23, 2010, and a final reminder was sent on February 4, 2010. Potential participants were provided with options to call the research office, follow a link and access the survey online, or request a paper copy of the questionnaire.

**Newspapers.** We advertised our study in two local monthly French newspapers in December 2009 and January 2010 respectively and a newspaper distributed through the Calgary metropolitan transit system for three days between February 3 and 5, 2010.

**Radio/Television.** We recorded an advertisement for the study that was aired on Radio Canada/CBC television during the evening news and several times during a popular evening radio program on December 9, 2009. These networks broadcast in French.



**Posters/Flyers.** On December 4, 7, 8, and 20 2009, eye-catching posters and flyers were distributed to various locations throughout Calgary including Francophone schools, primary care practices, the French Centre at the University of Calgary, churches frequented by Francophones, a Francophone job centre, and affixed to notice boards at Francophone serving agencies. Each poster had an envelope-sized tri-fold in which wallet-size flyers were available for interested individuals to take.

**Community Events.** Public information sessions about the study and how to participate were held at ethno-cultural association meetings and Francophone serving agencies. Direct recruitment was not undertaken at these events.

### **Recruitment through RDS**

RDS was launched on March 1, 2010; two weeks after the advertising campaign was completed to diminish residual effect from advertising. Eight eligible seeds were identified. Seeds were purposively<sup>23</sup> sampled to ensure balance in sex and immigration status. Each seed who completed the survey received three coupons to recruit others. The coupon included instructions on how to access the survey, a request to refer three other participants for which they would receive \$10 per eligible participant who completed the survey, as well as a 4 digit unique serial number that enhanced the linkage of recruits to recruiters. A slow response from initial seeds resulted in recruitment of 35 others during the course of RDS, for a total of 43 seeds.

### **Analysis**

Descriptive statistics were employed to examine participant characteristics among the three methods of recruitment. First, data from participants in the advertising and RDS groups were merged. The merged data and CCHS data were analyzed separately for two reasons: (1) Analyses and reporting of CCHS data requires applying sampling weights to account for the

multi-stage complex sampling design,<sup>20</sup> (2) This study used CCHS raw data, which could only be analyzed in a secure monitored environment – the Regional Data Centre (RDC). Additionally, Statistics Canada places some restrictions on reporting findings from CCHS data and making inferences on sub-populations. As a consequence, we did not perform significance tests to determine whether the two samples (merged and CCHS) are from the same population.

RDS data were analysed for recruitment chains (number of recruits originating from active seeds) using the software RDSAT version 5.6.<sup>24</sup> Logistic models were fitted for each sample to assess likelihood of having a regular medical doctor after adjustment for age, sex, marital status, education, personal income, general health, and perceived weight. For CCHS data, we used sampling weights provided by Statistics Canada to compute estimates.<sup>25</sup> Data were analyzed using STATA version 11.

## **RESULTS**

The study was advertised for 3 months from November 27, 2009 to February 15, 2010 and yielded a total of 120 participants. Recruitment of eligible participants peaked in December of 2009, declined in January, and then improved in February (Figure 1). Advertising continued to yield recruits until May 2010, three months after the campaign was finished. The most effective source of information for recruiting via advertising was word-of-mouth (30.8% of recruits); the lowest yield was from posters/flyers (1.7% of recruits) (Table 1).

In RDS, 43 seeds were involved in 9 waves of recruitment and yielded a total of 164 participants (see Figure 2). Of these participants, 19 were excluded from the analysis due to significant missing responses on questionnaire items. There was attrition of seeds from the survey. Twenty-six seeds did not complete the survey, and 9 completed survey but did not successfully recruit one or more participants. Of the 8 active seeds (completed survey and

recruited at least one other participant), 3 were male (ID: 13, 47, 102) and 5 were female (ID: 10, 54, 61, 64, 73). Participants were likely to refer people with similar cultural and immigration status as their own.

Of the 265 participants recruited through advertising and RDS, 256 (96.6%) completed the survey in French and 9 (3.4%) in English. Modes of participation were 128(48.3%) online, 12(4.5%) by telephone, and 125(47.2%) by mail. Compared to those who responded online/phone, those who responded by mail were less likely to have college or higher education (77.3% vs. 89.8%), but were more likely not to report personal income (28.1% vs. 14.3%) and not to have a regular medical doctor (31.1% vs. 15.5%) (Table 2). A greater proportion of online/phone participants (46.2%) were individuals aged 30 to 39, while respondents aged 40 to 49 years accounted for 35.5% in mailing survey.

Of 285 Calgary Francophones counted in the CCHS, 16 did not meet study criteria (see Table 3). The samples generated through three survey methods differed in female sex (43.4% for CCHS, 73.9% for advertising, and 59.4% for RDS), post-secondary education (59.1%, 86.7% and 77.9%), birth place outside in Canada (3.7%, 43.0% and 54.2%), missing on personal income (12.1%, 14.2% and 30.3 %) and having a regular medical doctor (83.4%, 84.0% and 66.9%).

Being female was associated with not having a regular medical doctor for those in the CCHS subsample only [risk adjusted OR (aOR): 0.35, 95% confidence interval (95%CI): 0.13-0.92]. Being single, separated, or divorced (aOR: 0.26, 95% CI: 0.11-0.61) and having perceived fair or poor health (aOR: 0.08, 95% CI: 0.01-0.52) were associated with not having a regular medical doctor for those in the combined sample of advertising and RDS. Perceived under/normal weight was associated with having a regular medical doctor in all samples.

## INTERPRETATION

We tested the adequacy of using advertising and RDS to recruit separate samples of Francophones in Calgary in comparison with a gold standard random sample from the CCHS. Francophones residing primarily in English speaking city such as Calgary are hard-to-reach for research purposes. We found that the survey samples recruited in this study differed from the gold standard CCHS subsample in terms of basic demographic characteristics (age, sex, education and place of birth) and thus were not representative of the Francophone population in Calgary, as defined by the gold standard. The two study samples generated from advertising and RDS methods were similar to a large extent, but different from the gold standard CCHS subsample even when these two samples were pooled. The advertising strategy resulted in an over-sampling of females, and having post-secondary education compared to the gold standard. Meanwhile in the RDS sample, females, having post-secondary education, being an immigrant, and missing data on personal income were over-represented. Over-representation of females and immigrants in RDS likely relates to the fact that most of the active seeds were female immigrants.

Use of combined strategies to sample hard-to-reach populations has been documented in other studies not involving Francophones. In Canada, Southern, et al. found that use of a media conference, supplemented by a nation-wide media release and paid advertisements in newspapers produced large enough analysable responses from Americans living in Canada.<sup>11</sup> In the United States, use of direct mailing and media releases improved ethnic minority participation in a clinical trial.<sup>15</sup> However, representativeness of the sample was not examined in these studies. We compared the sample from advertising with the random survey gold standard sample. The

difference between the two samples raises questions about the impact of selection bias on conclusions made by studies in which advertising recruitment methods have been used.

The use of RDS as an effective strategy to recruit a representative sample of a hard-to-reach population is well documented in a study involving drug users in New York City.<sup>18</sup> Starting with eight seeds, the investigators recruited 618 drug users during six waves of recruitment in 13 weeks. This study sample may have been representative of the population as the sample characteristics were similar to the characteristics of drug users recruited in other studies conducted in the same city. Our use of RDS did not achieve the same results. The inconsistency is possibly caused by difference in study populations and recruitment process. A specific population with low socio-economic potential was surveyed in New York City. Monetary incentives might have influenced their participation. In our study, the population comprised of Francophone immigrants and interprovincial migrants, who had varying economic potential and socio-demographic characteristics. Monetary incentives may not have had the same impact. The oversampling of immigrants observed in this sampling mechanism is likely due to the fact that immigrants tend to cluster in certain geographic areas and have strong social ties. Thus, immigrant seeds were more likely to be active in recruiting participants in their communities and the same language group than non-immigrants. The benefits of RDS should be optimized, in a repeat study, by assuring that RDS retains active seeds through appropriate amount of incentives and selecting diverse seeds to curb oversampling of participants of a similar trait.

A series of challenges occurred while undertaking this study. Advertising was scheduled for three months, with a two week washout period prior to RDS. However, there was a residual effect of advertising that extended into the RDS period. Survey respondents during the RDS phase reported learning about the study from at least one of several advertising sources of

information. It was not possible to recall all forms of advertising about the study during the RDS period (e.g., poster/flyers, newspapers, and internet/email information). However, use of media (newspapers and radio) and posters/flyers were of limited effectiveness in recruiting participants.

The Haitian earthquake of December 2010 might have been a major distraction to the advertising strategy because during that time, media attention was focused on the state of devastation and on relief efforts for victims. Haitians form a considerable portion of the Francophone community in Calgary, and might have been more concerned about the safety of family members and loved ones than participating in a study. Second, preparation for the launch of RDS began late in January 2010, but intensified at washout with the distribution of coupons to initial seeds. The first RDS respondents completed the survey earlier than the scheduled launch date of March 1, 2010 suggesting that initial seeds had been making referrals prior to the official start of the study. Despite early referrals for RDS, recruitment was slow in the beginning due to inactive seeds. We addressed this problem by identifying new seeds – a strategy that significantly improved our final study sample.

This study has limitations. First, the study was restricted to one geographic area and one hard-to-reach population. As a consequence, generalizability of our findings is limited. Second, the CCHS survey was used as gold standard. However its response rate was unknown among Francophones. Third, we did not weight the RDS sample in the analysis. RDS analysis requires integrating network size to estimate the probability of recruitment from a seed. This probability is used to generate mathematical weights to adjust for sampling deficiencies because the RDS sample depends on the design and weights. A reason for not weighting sample is that there was substantial missing data on the number of Francophones in each network. For the few seeds that provided network sizes, the range was wide (5 – 40) rendering the quality of reported network

size questionable for weighting. Fourth, different statistical methods were used to analyze data. As a consequence, it was not possible to combine datasets and perform multivariate comparisons to assess variability in estimates in order to determine whether the samples were significantly different. Without showing variability around the estimates, it is likely that the differences in magnitude of the findings between the combined sample and the individual samples (advertising or RDS) may simply be due to selection size. Merging CCHS data with study survey data was not feasible given data access and reporting requirements from Statistics Canada.

In conclusion, we examined the yield and adequacy of using advertising and RDS to recruit minority Francophones in the absence of a sampling frame. We determined that samples generated through advertising or RDS were different from the gold standard in terms of basic demographic characteristics such as age, sex, and were thus not representative of the general Francophone population. The biased samples could have generated misleading conclusions in terms of having a regular doctor, for example.

**Contributors:** For this work, all authors (Emmanuel Ngwakongnwi, Brenda Hemmelgarn, Richard Musto, Kathryn King-Shier, and Hude Quan) participated equally in the conception, design and interpretation of data. Emmanuel Ngwakongnwi and Hude Quan did the analysis and drafted the article. All authors revised, read, and approved the final manuscript prior submission. Emmanuel Ngwakongnwi is the guarantor for the manuscript.

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**Table 1:** Information sources leading to participant recruitment through advertisement, Calgary.

Source	n=120 (%)
Radio	6(5.0)
News paper	7(5.8)
Poster/flyer	2(1.7)
Internet surfing	6(5.0)
Word of mouth	37(30.8)
Community event	24(20.0)
*Others	38(31.6)

\* include church, friends, and school

**Table 2.** Respondent characteristics by participant's mode of response  
(N=265)

<b>Characteristic</b>	<b>Mail (n=125)</b>	<b>Online/phone (n=140)</b>	<b>P value</b>
<b>Mean age [range]</b>	38.9 [19-86]	39.8 [18-67]	
<b>Age group (%)</b>			
18-29	19.4	15.4	0.003
30-39	36.1	46.2	
40-49	35.5	17.6	
50+	9.0	20.9	
<b>Sex (%)</b>			
Male	37.0	29.0	0.197
Female	63.0	71.0	
<b>Marital status (%)</b>			
Single	23.9	12.1	0.059
Married/common law	70.6	79.1	
Separated/divorced	5.5	8.8	
<b>Education (%)</b>			
Primary or less	7.8	5.1	0.028
Secondary/High school	15.0	5.1	
College/University	77.3	89.8	
<b>Born in Canada (%)</b>			
Yes	49.7	52.7	0.645
No	50.3	47.3	
<b>Place of residence (%)</b>			
Urban	89.2	89.7	0.892
Rural	10.8	10.3	
<b>Personal income (%)</b>			
Lowest[<\$50 K]	41.3	38.8	0.025
Middle[\$50-\$80 K]	7.2	15.3	
Upper middle[\$60-\$80 K]	8.4	13.3	
Highest[>\$80 K]	15.0	18.4	
Missing	28.1	14.3	
<b>General health (%)</b>			
Excellent	34.7	29.6	0.779
Very good	39.5	40.8	
Good	21.6	23.5	
Fair/poor	4.2	6.1	
<b>Perceived weight (%)</b>			
Overweight	28.9	38.5	0.084
Underweight	5.8	1.1	
Just about right	65.4	60.4	

**Has regular doctor (%)**

Yes	68.9	84.5	0.005
No	31.1	15.5	

Some percentages may not add up due to rounding. Online/phone respondents were grouped together to assess modes of response given that only 12 participants used phone.

**Table 3.** Respondent characteristics by sampling method (N=265)

<b>Characteristic</b>	<b>CCHS* (n=259)</b>	<b>Combined sample** (n=265)</b>	<b>Advertising sample (n=120)</b>	<b>RDS sample (n=145)</b>
<b>Mean age, [range]</b>	42.5	39.2[18-86]	41.0 [18-86]	37.6[19-73]
<b>Sex</b>				
Male	56.6	34.1	26.1	40.6
Female	43.4	65.9	73.9	59.4
<b>Marital status (%)</b>				
Single	23.9	19.7	10.6	27.9
Married/common law	66.7	73.6	79.7	68.8
Separated/divorced	9.4	6.7	9.7	4.3
<b>Education (%)</b>				
Primary or less	8.4	6.8	5.0	8.3
Secondary/High school	32.5	11.3	8.3	13.8
College/University	59.1	81.9	86.7	77.9
<b>Born in Canada (%)</b>				
Yes	96.3	49.1	57.0	45.8
No	3.7	50.9	43.0	54.2
<b>Place of residence (%)</b>				
Urban	94.7	89.4	90.8	88.2
Rural	5.3	10.6	9.2	11.8
<b>Personal income (%)</b>				
Lowest[<\$50 K]	51.8	40.4	41.7	39.3
Middle[\$50-\$80 K]	10.5	10.2	12.5	8.3
Upper middle[\$60-\$80 K]	13.6	10.2	11.7	9.0
Highest[>\$80 K]	11.8	16.2	20.0	13.1
Missing	12.1	23.0	14.2	30.3
<b>General health (%)</b>				
Excellent	26.0	32.8	31.7	33.8
Very good	42.1	40.0	40.0	40.0
Good	20.3	22.3	22.5	22.1
Fair/poor	11.6	4.9	5.8	4.1
<b>Perceived weight (%)</b>				
Overweight	43.2	32.4	37.5	28.2
Underweight	4.6	4.0	2.7	5.2
Just about right	52.2	63.6	59.8	66.7
<b>Has regular doctor (%)</b>				
Yes	83.4	74.7	84.0	66.9

No	16.6	25.3	16.0	33.1
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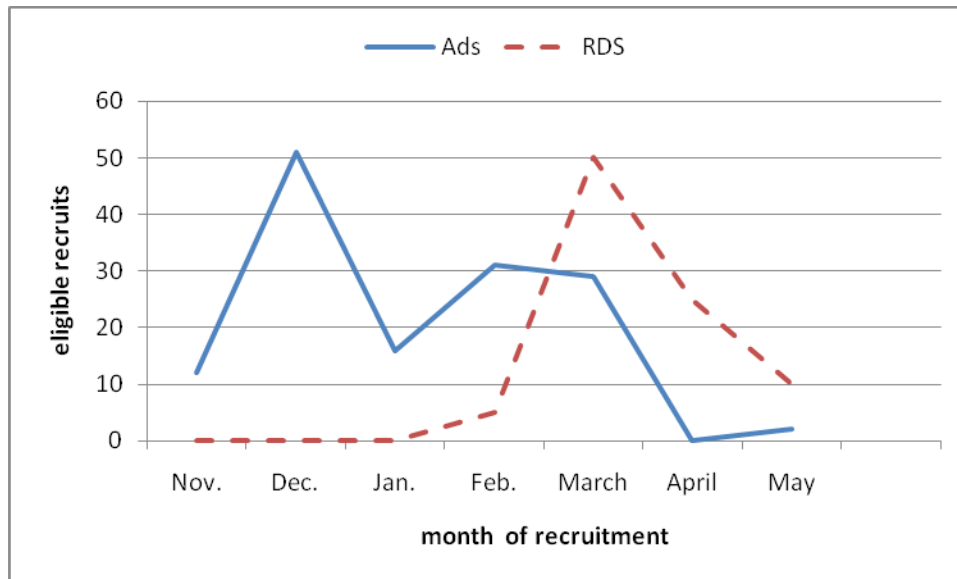
\* Weighted percentages reported for Canadian Community Health Survey (CCHS) as the gold standard sample, \*\* advertising plus RDS

**Table 4.** Likelihood of having a regular medical doctor: A comparison of odds ratios [OR, 95%CI] between combined sample and gold standard.

Predictors*	CCHS** as gold standard sample	Combined sample
<b>Age group (years)</b>		
18-29	1	1
30-39	0.47[0.12-1.85]	1.85[0.62-5.51]
40-49	1.37[0.26-7.24]	0.64[0.21-1.90]
50+	2.87[0.53-15.48]	1.10[0.30-4.06]
<b>Sex</b>		
Male	1	1
Female	0.35[0.13-0.92]	0.71[0.32-1.57]
<b>Marital status</b>		
Married/Common-Law	1	1
Single/Separated/divorced	0.58[0.19-1.81]	0.26[0.11-0.61]
<b>Education</b>		
College/University	1	1
High school or less	2.06[0.79-5.39]	0.60[0.19-1.86]
<b>Personal income</b>		
Lowest[<50k]	1	1
Middle[50-80K]	0.85[0.25-2.88]	1.23[0.50-3.02]
Highest [>80,000]	0.33[0.09-1.20]	5.33[1.30-21.86]
<b>General health</b>		
Excellent/V. good	1	1
Good	0.97[0.30-3.13]	1.35[0.58-3.14]
Fair/poor	0.28[0.07-1.14]	0.08[0.01-0.52]
<b>Perceived weight</b>		
Overweight	1	1
Underweight/About right	11.07[1.25-98.11]	13.21[3.24-53.86]

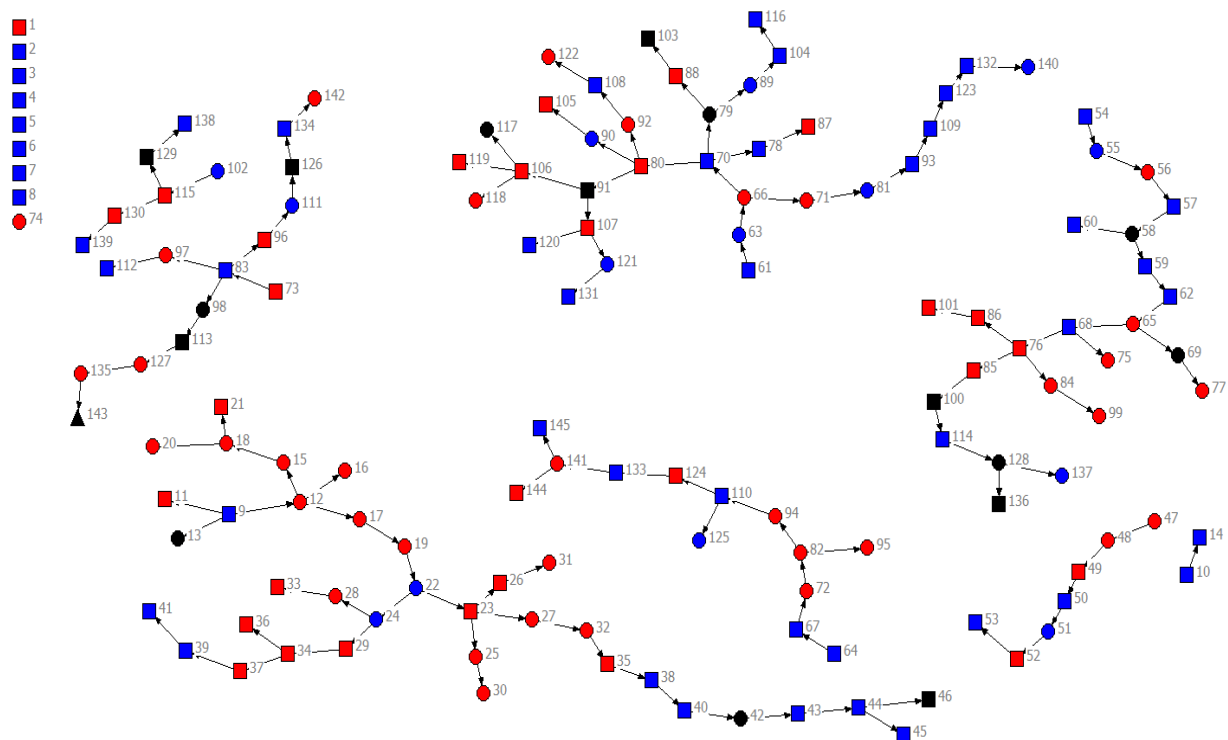
\* Immigration status and place of residence was excluded because of low cell counts in gold standard sample. \*\* Canadian Community Health Survey (CCHS)

**Figure 1.** Recruitment trend following advertising and respondent driven sampling





**Figure 2.** Netdraw visualization of recruitment chains\*



\*Isolates at top left corner are inactive seeds, eight chains represent (8) active seeds, circles denote males, square denote females, blue and red color represent immigrants and non-immigrants respectively. Black colors are males and females missing immigration status.