Methods of selecting a person within a household:
Mailed invitations to complete an electronic questionnaire

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ABSTRACT

Currently, within-household selection for electronic questionnaire surveys follows the roster method, which consists in sending a paper invitation to a random sample of households to request an online roster of the eligible occupants. Then, a person is randomly selected within the electronic questionnaire. A household with more than one occupant might require two people to connect to the electronic questionnaire application. In such a case, there is a risk that the second person does not answer. This would constitute non-response even if the first person completes his or her part.

The challenges of the roster method raise some questions. What if the selected person can be determined from instructions in the mailed invitation instead? Would this be clear enough so that people know who is selected? Will the person follow the instructions? To answer these questions, the last-birthday method and a new version of the age-order method were tested and compared with the roster method. Response rates and selection accuracy rates were then analyzed.

KEY WORDS: Age order, last birthday, full roster, online survey, within-household sampling, respondent selection.

RÉSUMÉ

Actuellement, dans le cadre des enquêtes réalisées au moyen de questionnaires électroniques, la sélection d'une personne au sein d'un ménage suit la méthode d'énumération, ce qui consiste à envoyer à un échantillon aléatoire de ménages une lettre d'invitation par la poste demandant de fournir une liste électronique des membres admissibles. Ensuite, une personne est sélectionnée au hasard dans le questionnaire électronique. Dans le cas d'un ménage ayant plus d'un membre, il est possible que deux personnes doivent accéder à l'application du questionnaire électronique. Si cette situation se présente, il y a un risque que la deuxième personne ne veuille pas participer; ce qui constituerait un cas de non-réponse, même si la première personne a rempli sa partie du questionnaire.

Les défis de la méthode d'énumération soulèvent quelques questions. Que se passerait-il si la sélection d'un membre du ménage pouvait se faire à partir d'instructions sur la lettre? Serait-ce assez compréhensible pour que les membres du ménage sachent qui est sélectionné? Est-ce que la personne visée suivra les instructions? Pour répondre à ces questions, la méthode basée sur l'anniversaire le plus récent et une nouvelle version de la méthode basée sur l'âge ont été mises à l'essai, puis comparées à la méthode d'énumération en ligne. Les taux de réponses et d'exactitude de la sélection ont ensuite été analysés.

MOTS CLÉS : Méthode basée sur l'âge, méthode basée sur l'anniversaire le plus récent, énumération, questionnaire en ligne, sélection au sein d'un ménage, sélection d'un répondant.

1. INTRODUCTION

1.1 Background

Household surveys have historically rostered all eligible members of the household before randomly selecting one person to participate in the survey. The issue with this method in the context of an online self-administered questionnaire is that the selected person cannot be contacted directly if he or she is not the one who completed the roster. In such cases, the email address of the selected person is typically requested so that Statistics Canada can contact him or her. In other words, the selection of a secondary respondent leads to two contacts and contributes to lower response rates. In the past, methods such as the last-birthday approach or the age-order approach have been suggested as alternatives to a full roster that could reach the selected person as quickly as possible. However, such methods are not generally accepted in the literature. As

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household surveys are moving towards electronic questionnaires (EQs) administered via the Internet as the main mode of collection, and as response rates continue to decrease, the need to identify the respondent quickly and without interviewer interaction becomes more important.

Section 2 of this paper describes the National Travel Survey, and Section 3 presents three methods for randomly selecting a person within a household in an EQ environment, as they were tested within the survey. The results are presented in Section 4.

2. THE NATIONAL TRAVEL SURVEY

The National Travel Survey (NTS) is a monthly survey that will collect information about the domestic and international travel of Canadian residents, starting in February 2018. Its sampling frame will be extracted using a list of Canadian households based on data from the Census of Population and is updated every three months using administrative data. The frame will include households from the 10 Canadian provinces, excluding Indian reserves and collective dwellings. It will then be stratified using frame information, such as province and household income. A sample of households will be drawn using simple random sampling in each stratum. At second-stage, a sample of people will be obtained by randomly selecting a person within each selected household.

3. FIELD TEST

3.1 A pilot study

In March 2016, a pilot study within the NTS framework was conducted to compare three methods in an EQ environment: the last-birthday method, the age-order method and the roster method. The purpose of this test was to compare the response rates and self-selection accuracy rates for the three methods. Households were contacted by mail and could receive up to two mail reminders.

The accuracy rate of a selection method is the rate at which the person selected according to one of the three methods was the one who actually responded to the survey. Section 4 explains how this rate is computed. To determine the required sample size, a hypothesis test method based on the comparison of accuracy rates for the selection methods was used. The goal was to detect a global difference of 5% or more between two methods in terms of accuracy rate. With an expected response rate estimated at 20%, a conservative sample size of 22,500—which means 7,500 for each method of selection—was adopted.

3.2 Methods of selection

For the last-birthday method, a letter is mailed to the selected household, and the adult member with the most recent birthday is selected via the letter to complete the electronic questionnaire. This person accesses the online questionnaire on the Internet and completes the survey.

For the age-order method, a letter is mailed to the selected household, and an adult member is selected via the letter to complete the electronic questionnaire according to the age of all adult members of the household. Six possible versions of the letter are available and are assigned randomly to the sample. These versions select one of the following person:

- the oldest adult member
- the second-oldest adult member
- the third-oldest adult member
- the youngest adult member
- the second-youngest adult member
- the third-youngest adult member.

The selected person accesses the online questionnaire on the Internet and completes the survey. This method gives a non-zero probability of selection to all members of households with at most six eligible members; this corresponds to

99.7% of Canadian households. For the 0.3% of households with more than six eligible people, only the three youngest and the three oldest have a non-zero probability of selection. We consider this potential bias negligible.

The roster method was considered the control group. The letter mailed to the household invites any household member to access the electronic questionnaire on the Internet. The person who starts completing the questionnaire must enumerate all household members. Once the enumeration is completed, the electronic application randomly selects one household member within the eligible members to complete the rest of the survey. If the selected person is the same as the person who first logged in, the matter is clear to the respondent and the survey continues. However, if a different person is selected, the member who started the questionnaire is asked to provide the email address of the selected person. Finally, an email is sent to the selected person with a new access code and a hyperlink to the electronic questionnaire.

4. RESULTS

To assess whether the differences between methods are statistically significant, a Wald test was performed with an α of 0.05. Van den Brakel and Renssen (1998) noted that: "… the sampling design of the survey forms a prior framework for the design of an embedded field experiment. To ensure external validity, statistical methods from sampling theory should support the analysis of these experiments…." This motivated the use of Wald tests based on weighted rates to compare the performance of two methods (Van den Brakel and Renssen 2005). To perform the tests, the SAS macro Xper was used (Statistics Canada, 2017). For the following results, the weighting is obtained from the inverse sampling fraction in each stratum, with a small naive adjustment according to the out-of-scope units.

4.1 Response rates

A completed questionnaire is a questionnaire that provides the key survey variables. For the analysis of selection methods, a household is considered a respondent when a completed questionnaire is received from someone in the household. The weighted response rates are shown in Table 1.

Table 1 – Weighted response rate by method of selection

Method	Weighted response rate (%)
Last-birthday method	19.2
Age-order method	20.4
Roster method	13.6

Wald tests were performed based on weighted rates to compare different response rates. Comparing the methods in pairs gives the *p*-values and conclusions shown in Table 2.

Table 2 – Wald test on weighted response rates

Methods compared	*p*-value	Result
Last-birthday and age-order methods	0.15	Not significant
Last-birthday and roster methods	2.23E-8	Significant
Age-order and roster methods	1.75E-12	Significant

The age-order method seems to perform better than the last-birthday method, but the difference is not statistically significant (*p*-value $0.15 > \alpha$). In contrast, the roster method leads to a weighted response rate that is significantly different from both the last-birthday method and the age-order method.

4.2 Accuracy rates

A household contributes to the selection accuracy rate when the person who fills in the electronic questionnaire (i.e., the respondent) is the person who was selected (i.e., the person who was supposed to answer). To assess whether a given respondent was the selected person, the questions on age and sex are asked twice. In the first module of the questionnaire, date of birth and sex are asked for each member of the household. From this information and the letter that the household

received, the age and sex of the selected person are derived. At the end of the questionnaire, the age and sex of the respondent are asked a second time for validation purposes. If the two sets of information are the same, the case is deemed an "accurate case."

The accuracy rate corresponds to the rate of accurate cases over all responses. It is important to mention that a low accuracy rate may introduce bias at the estimation stage, as it means that a higher proportion of respondents were not actually selected. The weighted accuracy rates are shown in Table 3.

Table 3 – Weighted accuracy rate by method of selection

Method	Weighted accuracy rate (%)
Last-birthday method	77.2
Age-order method	87.0
Roster method	96.8

Wald tests were performed based on weighted rates to compare different accuracy rates. Comparing the methods in pairs gives the *p*-values and conclusions shown in Table 4.

Table 4 – Wald test on weighted accuracy rates

Methods compared	*p*-value	Result
Last-birthday and age-order methods	1.00E-4	Significant
Last-birthday and roster methods	0	Significant
Age-order and roster methods	1.08E-9	Significant

All comparisons by method show differences that are statistically significant at an α of 0.05. In other words, the roster method is the most accurate method and the last-birthday method is the least accurate method in terms of selecting the respondent.

4.3 Accurate response rates

At this point, it has been shown that the roster method yields a lower response rate, but a higher accuracy rate. The accurate response rate gives an overall picture of the situation because it corresponds to the rate of accurate responses over the sample size (including accurate responses, inaccurate responses and non-responses). In other words, the inaccurate cases are considered non-responses to compute a new response rate referred to as the accurate response rate. The weighted accurate response rates are shown in Table 5.

Table 5 – Weighted accurate response rate by method of selection

Method	Weighted accurate response rate (%)
Last-birthday method	14.5
Age-order method	17.3
Roster method	13.2

Wald tests were performed based on weighted rates. Comparing the methods in pairs gives the *p*-values and conclusions shown in Table 6.

Table 6 – Wald test on weighted accurate response rates

Methods compared	*p*-value	Result
Last-birthday and age-order methods	2.37E-3	Significant
Last-birthday and roster methods	0.21	Not significant
Age-order and roster methods	1.65E-5	Significant

Wald tests demonstrate that the accurate response rate obtained using the age-order method is significantly different from the accurate response rates obtained using the two other methods. The age-order method outperformed the last-birthday method, especially in terms of the accuracy rate. The roster method does show a higher accuracy rate, but this comes at the cost of a significantly lower response rate. Even when inaccurate cases are considered non-responses, the roster method yields a lower response rate.

4.4 Comparison with demographic totals

To account for non-response, the sample for each method was adjusted by a simple reweighting within strata. In other words, it was assumed that the non-response cases were missing completely at random within each stratum. These adjusted weights were used to produce estimates of totals for age and sex groups, shown in Table 7.

Table 7 – Demographic proportions estimated by method

Sex	Age group	Demographic proportions	Proportions of the last-birthday method (%)	Proportions of the age-order method (%)	Proportions of the roster method (%)
Male	18 to 34	14.5	11.3	11.5	6.6
Male	35 to 44	8.2	8.5	8.2	6.8
Male	45 to 54	8.9	11.0	7.2	10.2
Male	55 to 64	8.5	9.7	13.0	10.1
Male	65 and older	9.2	10.6	10.7	16.1
Female	18 to 34	14.3	10.3	11.2	8.2
Female	35 to 44	8.3	8.3	9.1	10.6
Female	45 to 54	8.9	10.2	11.3	10.0
Female	55 to 64	8.6	11.8	9.6	11.8
Female	65 and older	10.7	8.4	8.3	9.6
Euclidean distance of the method from the demographic proportions			7.1	7.5	13.1

The demographic proportions in Table 7 are the real proportions, based on the 2011 Census of Population and updated with other sources. We can observe that the roster method seems very far from the demographic proportion in some cases. The last row of Table 7 contains the Euclidean distance between a given method and the demographic proportions. The closer this distance is to 0, the better the estimated proportions, as the average calibration factors would be smaller. Given this simplistic non-response adjustment, the roster method suggests a larger bias than the two other methods.

For estimations other than the response and accuracy rates, the weights for the National Travel Survey will be calibrated by province, age and sex. Thus, Table 7 gives an overview of the calibration needed.

5. CONCLUSION

As a result of this analysis, the last-birthday method can be discounted because the performance of the age-order method is superior in terms of response rates and self-selection accuracy rates. It was also shown that the age-order method yields much higher response rates than the roster method. On the other hand, the roster method outperformed the age-order method on accuracy rates. The decision whether to use the age-order method or the roster method is not obvious; the choice will be influenced by many factors, such as the survey budget, the resources available for non-response follow-up and the survey's expected response rate.

The age-order method is recommended for surveys like the National Travel Survey, where the mode of collection is a self-administered electronic questionnaire and the only contact with the households is by mail. Table 1 shows that the weighted response rate for the age-order method is 20.4%, which is 7 percentage points higher than the roster method's weighted response rate of 13.6%. Moreover, Table 7 suggests that the bias associated with non-response could be more significant than the bias associated with inaccurate responses. For surveys with more non-response follow-up resources

and requiring more precise estimates, evaluations should be conducted to determine whether the self-selection inaccuracy generated by the age-order method could lead to bias in the estimates.

The National Travel Survey will use the age-order method, possibly with stronger non-response follow-up strategies. Other surveys such as the General Social Survey will also use the age-order method, with a version of the method that is adapted to computer-assisted telephone interviews.

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