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Evaluation and Treatment of Non-response in the ELFE Cohort: Results of the Pilot Studies

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Abstract

Non-response is inevitable in any survey, despite all the effort put into reducing it at the various stages of the survey. In particular, non-response can cause bias in the estimates. In addition, non-response is an especially serious problem in longitudinal studies because the sample shrinks over time. France's ELFE (Étude Longitudinale Française depuis l'Enfance) is a project that aims to track 20,000 children from birth to adulthood using a multidisciplinary approach. This paper is based on the results of the initial pilot studies conducted in 2007 to test the survey's feasibility and acceptance. The participation rates are presented (response rate, non-response factors) along with a preliminary description of the non-response treatment methods being considered.

Key Words: Non-response, Response rate, Cohort, Longitudinal survey, Longitudinal weighting.

1. Introduction

All surveys have to deal with the problem of non-response, to a greater or lesser degree, whether it is total non-response (none of the questions are answered) or partial non-response (non-response on some items only). In recent decades, a decline in response rates has been reported in many studies (De Leeuw and De Heer, 2002). It is becoming more difficult both to contact individuals and to persuade them to take part. Non-response is responsible for several kinds of difficulties in analyzing data.

First, a decrease in the sample size causes a loss of statistical power and, consequently, an increase in the variance of the estimates. Second, non-response may introduce a bias into the estimates for variables of interest. This is because non-respondents may differ from respondents in characteristics that are directly or indirectly related to the variables of interest. Third, non-response complicates variance estimation methods.

The first step is to limit non-response by implementing effective incentives to participate, such as reminders and address follow-up techniques, while also minimizing the response burden, and so on. Once the data have been collected, non-response can be processed by statistical methods designed to reduce non-response bias, including reweighting methods (increasing respondents' sampling weights to offset non-response) and imputation methods (replacing the missing value with a value selected by a method that produces the most plausible value). In general, reweighting methods are preferred for the treatment of total non-response, while imputation methods are better suited to handling partial non-response.

Non-response is an especially serious problem in longitudinal studies since the sample shrinks over time (through attrition or erosion). Longitudinal studies are also subject to wave non-response, which occurs when an individual does not respond in one or more waves. This paper is based on the initial results of the pilot studies for the ELFE longitudinal survey.

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2. Background: The ELFE cohort project

2.1 General description

France's ELFE (Étude Longitudinale Française depuis l'Enfance) is a nation-wide project to track a representative cohort of 20,000 children from birth to adulthood (www.elfe2009.fr). It will be the first birth cohort study of this size in France. Three major dimensions of child development will be analyzed: children's health, the relationship between the environment and health, and socio-demographic characteristics. It is thus a very broadly multidisciplinary project, with some 60 teams currently working on about 90 specific research projects. Children born in maternity hospitals during 16 selected days in a year will be tracked from the time they are born. During the survey period, data will be collected directly (questionnaires, biological samples, diaries, etc.) and will be combined with data from various external sources (medical examinations at school, academic records, health insurance data, etc.) at appropriate ages. The survey is expected to begin in 2010 or 2011, depending on the progress made in obtaining funding for the project.

2.2 Unit of inquiry and scope of the survey

The survey's aim is to obtain a representative sample of live births for a given year in France. For practical reasons, multiple births in excess of two will not be included. The longitudinal statistical unit is the child. The mother and/or father, depending on the survey, will answer the questions until the child is old enough to do so (age to be determined).

2.3 Description of the sampling design

Sample

The subjects will be the children born in all maternity hospitals in France on days selected for INSEE's updated permanent demographic sample (PDS), i.e. on 16 days (four periods of four days, one period in each quarter) in a given year. The frame is thus close to a 1/25 sample. Currently, the PDS collects all vital statistics records and all information reported in successive census questionnaires for all persons born on one of the reference days in any given year. The sample generated will be representative of births for the year, and the children will be easy to trace in other statistical sources through their dates of birth.

Number of subjects

There were about 830,000 births in France in 2006 (Richet-Mastain, 2007), which ensures that we will have a sample of at least 20,000 children in the cohort, with a response rate of at least 55%. With that number of subjects, we will be able to attain the project's longitudinal, multidisciplinary goal (allowing for the expected attrition rates) and carry out analyses based on subgroups or rare characteristics. The sample of 20,000 children will also make it possible to correlate exposure and effect (in the broader sense, in the health field or the social sciences) for rare exposures and/or effects.

2.3 Collection method

A number of meetings and collection methods are already planned, including recruitment in maternity hospitals and the survey administered when the child is two months old.

The in-hospital survey

Subjects will be recruited by midwife interviewers dedicated specifically to the project in the maternity hospitals. This approach will entail cooperation from obstetric units during recruitment periods in all of the nearly 600 maternity hospitals in France. It will require the selection and training of about 1,200 people for each four-day collection period. The options being considered are to recruit midwives employed by the hospitals themselves, student midwives and younger retirees. Regional offices will have to be established to facilitate coordination among the various parties and provide the interviewers with proper training. This initial in-hospital phase includes

collecting information from medical records and administering a questionnaire to mothers concerning their pregnancy, the perinatal period and the health of women and their babies for all births regardless of whether they agree to participate in the rest of the survey; obtaining consent to take part in the ELFE; taking biological samples, for which consent is also required (cord blood, the mother's urine, hair and milk); and having mothers who agree to participate in the ELFE complete a questionnaire on nutrition and lifestyle during the pregnancy.

The two-month survey

The survey will be administered by an interviewer from the Institut national de la statistique et des études économiques (INSEE) using a computerized questionnaire in a personal interview at home for the mother (about one hour) and by telephone for the father (20-30 minutes). The questionnaires will cover a wide range of subjects: household composition, the health of the child and the mother, housing, family, child care, the child's nutrition, living conditions, etc. After administering the questionnaire, the interviewer will provide the mother with either a diet diary to complete, a radon meter, or a dust trap (subsamples). The mothers will mail the items back in a postage-paid envelope after two to three months. One of the difficulties of this part of the survey lies in the short interval between the collection of addresses in maternity hospitals and administration of the questionnaire two months after the birth. There is very little time for local staff to input and check the addresses and transmit them to INSEE and for INSEE to hire contract interviewers in the locations where the mothers live.

Subsequent collection waves

The plan is to survey the mothers and/or the fathers by telephone on an annual basis. At pivotal stages in the child's development, there will be more extensive personal interviews (at age 3, for example) and medical examinations (probably at age 6). The survey information will also be combined with administrative data such as health insurance records.

3. Evaluation of non-response: results of the pilot studies

The survey's feasibility and acceptance were tested in pilot studies initiated in four regions of France in 2007. The children included in the pilot studies will be tracked over time to test the later stages of the collection process. The participation results presented here relate to the survey's initial phases in maternity hospitals and at two months of age.

3.1 Extent of total non-response

One type of total non-response is refusal by the maternity hospital to take part in the survey. Of a total of 75 maternity hospitals approached, 62 (83%) agreed to participate. Hospital participation was particularly low in one *département* (Seine-Saint-Denis). The 35% refusal rate may be due to a difficult health and social situation there.

The other type is non-response by individual mothers in participating maternity hospitals (Table 3.1-1). Medical record information was collected for 95% of the births. Of the mothers for whom midwives collected medical record information, 88% agreed to the in-hospital interview (85% of the live births targeted for the interview). These high rates were expected, since this type of survey is conducted regularly (every three to five years) in maternity hospitals (national perinatal surveys). The information is valuable because it provides data for many of the ELFE non-respondents and permits comparison of respondents and non-respondents, which is useful for non-response adjustment.

Acceptance of the ELFE, which involves answering subsequent surveys, was lower, at about 55% of live births in participating hospitals. This rate is satisfactory, however, in view of the difficulty of in-hospital recruitment (high workloads in the hospitals and the mothers' fatigue after childbirth). Acceptance of biological sampling was also high, as the proportion of participating mothers who agreed to the taking of the samples, their retention for further study and their use in future genetic studies was 98%, 91% and 81% respectively. For practical reasons, the samples could not be taken for all mothers; this was particularly true for the milk sample, as some mothers left the hospital before lactation began.

Table 3.1-1
In-hospital participation results

| | Mothers | | | | | |
|---|---------|-----|---------|-----|--------|-----|
| | Pilot 1 | | Pilot 2 | | Total | |
| | number | % | number | % | number | % |
| Total births | 340 | 100 | 560 | 100 | 900 | 100 |
| Collection of medical records | 318 | 94 | 538 | 96 | 856 | 95 |
| Live births | 338 | 100 | 552 | 100 | 890 | 100 |
| In-hospital survey | 294 | 87 | 461 | 84 | 755 | 85 |
| Acceptance of subsequent ELFE participation | 191 | 57 | 301 | 55 | 492 | 55 |

Of the mothers for whom we have medical record information, nearly 50% of the non-response to the in-hospital interview was due to refusal and 22% to language difficulties. Other reasons included departure of the mother before she could be contacted by the interviewer (12%) and difficulties associated with the health of the child (9%) or the mother (3%).

Of the mothers who responded to the in-hospital interview but did not agree to further participation in the ELFE, 83% were refusals, 7% had language-related problems that made it difficult to explain the project and obtain consent, and 10% had other reasons (results of Pilot 2 only). Ten percent of the refusals were by the father, which indicates the importance of involving fathers and giving them information about the study.

The participation results for the survey at age two months are presented in Table 3.1-2. The results are based on addresses used; they do not include residences outside the pilot regions (which will not be the case for the national survey) and a few unusable addresses. For the families approached by INSEE, 86% of the mothers and 79% of the fathers agreed to take part. The refusal rate was 7% for the mother's questionnaire and 11% for the father's questionnaire (54% of non-response in both cases); 5% of the mothers and 6% of the fathers could not be contacted.

Table 3.1-2
Participation results for the survey at age two months

| | Pilot 1 | | Pilot 2 | | Total | |
|-------------------------------|---------|------|---------|------|--------|------|
| | number | % | number | % | number | % |
| In-hospital acceptance | 191 | ... | 301 | ... | 492 | ... |
| Addresses used | 171 | 100 | 277 | 100 | 448 | 100 |
| Mother's questionnaire | | | | | | |
| Response | 154 | 90.1 | 233 | 84.1 | 387 | 86.4 |
| Refusal | 13 | 7.6 | 20 | 7.2 | 33 | 7.4 |
| No contact | 4 | 2.3 | 17 | 6.1 | 21 | 4.7 |
| Other non-response | 0 | 0.0 | 7 | 2.5 | 7 | 1.6 |
| Father's questionnaire | | | | | | |
| Response | 146 | 85.4 | 206 | 74.4 | 352 | 78.6 |
| Refusal | 16 | 9.4 | 31 | 11.2 | 47 | 10.5 |
| No contact | 7 | 4.1 | 21 | 7.6 | 28 | 6.3 |
| Other non-response | 2 | 1.2 | 10 | 3.6 | 12 | 2.7 |
| Unknown | 0 | 0.0 | 10 | 3.6 | 10 | 2.2 |

... not applicable

3.2 Non-response factors

The acceptance rate for the in-hospital survey varied widely by hospital, from a low of 4% to a high of 100%, which suggests that either the hospital or the interviewer had a major effect; their effects are difficult to differentiate because each interviewer was generally assigned to just one hospital and each hospital generally had only one or two interviewers.

In addition, in Pilot 1 the acceptance rate declined with the level of care that the hospital was equipped to provide.² The rates were higher for level 1 hospitals (an average of 89% for 15 hospitals, ranging from 40% to 100%) than for level 2 hospitals (an average of 57% for 14 hospitals, ranging from 19% to 100%) or level 3 hospitals (an average of 29% for three hospitals, ranging from 17% to 48%). The response rate also declined in linear fashion as the number of births in the hospital increased (this factor is very closely linked to the level of care). This pattern was observed only in Pilot 1, which may be at least partly due to the widely varying situations in Pilot 2 hospitals (*département* of Seine-Saint-Denis).

We then examined the ELFE in-hospital acceptance rates in relation to the mothers' socio-demographic characteristics (Table 3.2-1). This initial exploratory analysis was carried out for all mothers who responded to the in-hospital survey, which explains the high rates compared with the overall acceptance rate of 55% presented in 3.1. In-hospital participation increases with age for mothers up to age 35, after which it declines ($p=0.04$), increases with level of education ($p=0.03$), is lower for labourers, paid employees and unemployed people ($p<0.01$), is lower for mothers of foreign nationality ($p<0.01$), and increases with the number of previous births up to three, above which it decreases ($p=0.01$).

These exploratory results are useful in understanding the reasons for non-response and in planning for non-response adjustment (see section 4.3).

Table 3.2-1
ELFE in-hospital acceptance rates by mothers' socio-demographic characteristics collected in the in-hospital interview

| | Acceptance rate | Number | P (chi-square) |
|---------------------------------------|-----------------|--------|-------------------|
| Mother's age | | | |
| < 25 | 54% | 92 | 0.04 |
| 25-29 | 61% | 234 | |
| 30-34 | 70% | 262 | |
| ≥ 35 | 65% | 157 | |
| Level of education | | | |
| None/elementary/ <i>collège</i> | 58% | 78 | 0.03 |
| Vocational training | 61% | 143 | |
| French <i>baccalauréat</i> | 61% | 173 | |
| <i>Baccalauréat</i> + 1 or 2 years | 65% | 189 | |
| <i>Baccalauréat</i> + 3 or more years | 75% | 155 | |
| Occupational category | | | |
| Unemployed | 53% | 125 | <0.01 |
| Managers, craftspeople, merchants | 76% | 84 | |
| Intermediate occupations | 70% | 132 | |
| Paid employees | 64% | 316 | |
| Labourers | 63% | 82 | |
| Nationality | | | |
| French | 66% | 641 | <0.01 |
| Foreign | 51% | 104 | |
| Number of previous births | | | |
| 0 | 60% | 291 | 0.01 |
| 1 | 64% | 261 | |
| 2 | 76% | 123 | |
| 3 or more | 57% | 60 | |

² There are three levels of maternity hospitals based on the care they are able to provide: level 1 hospitals handle pregnancies with no complications; level 2 hospitals have a neonatology unit; level 3 hospitals have a neonatal resuscitation unit.

4. Weighting and treatment of non-response

4.1 Target population and weighting principle

The main purpose of the project is to produce longitudinal estimates. The longitudinal target population is the same for each collection wave and consists of the target population at recruitment, i.e., live births in France in the year of recruitment. Longitudinal weights will be produced for each collection wave and each collection method in order to generate estimates that are representative of that population.

Traditionally, the weighting process has three steps: (1) calculation of initial weights, (2) adjustment for non-response, and (3) calibration.

The need for cross-sectional weights (to produce estimates that are representative of the population of a particular age in France at a particular time, e.g., five-year-olds in 2015) remains to be assessed and will depend on the available information and the subsequent inclusion of children not covered in 2010 (e.g. immigrants).

4.2 Initial weights

The initial weights are the same as the PDS initial weights and are equal to the total number of days in the year divided by the number of days selected for the survey:

$$w_{initial} = \frac{365}{16}.$$

An adjustment might be made to compensate for the fact that births are not distributed evenly over the year (seasonal and weekly fluctuations).

Home births are excluded except in cases of admission to a maternity hospital after the birth. This coverage gap, which probably makes up less than 1% of all births, will be dealt with through calibration on vital data (see section 4.4).

4.3 Adjustment for total non-response

Total non-response will be dealt with wherever possible by reweighting. However, total non-response by fathers (when the mother responds) could be treated with imputation (see section 4.5). The production of two different sets of weights (one for fathers and one for mothers) would complicate the use of weights in statistical analyses, particularly if the data for both parents are being used at the same time, and it would be preferable to have only one set of weights.

The first type of non-response to be treated is total non-response due to hospital non-participation. The weights will be adjusted to compensate for hospital non-response by multiplying the initial weight by the total number of births in all maternity hospitals during the 16 days, divided by the number of births in participating maternity hospitals during the 16 days, which requires a knowledge of the number of births in participating and non-participating maternity hospitals (non-participating hospitals will be contacted for information about the number of births).

Individual total non-response will then be dealt with in each collection wave. First, adjustments will be made by forming response homogeneity groups (RHGs), which consist of individuals whose response probability is assumed to be homogeneous. Information from the in-hospital survey and medical records for respondents and many non-respondents will be used. Analyses of the non-response factors presented in section 3 will provide a preliminary idea of what factors might be used in this adjustment: the mother's age, occupational category, nationality, level of education and number of previous births and the hospital's characteristics (number of births, level of care), and so on.

The non-response adjustment will then be made within the RHGs. The initial weight (adjusted for hospital non-response) will be divided by the response rate for the RHG.

$$W_{non-response\ adjustment} = \frac{W_{initial}}{RR_{RHG}} \quad \text{where } RR_{RHG} \text{ is the response rate observed in the RHG}$$

Tests will be conducted in 2009 to determine the most appropriate method of forming the RHGs (e.g. segmentation, score method).

A large volume of information is collected at the age of two months (questionnaire data and metadata), and it makes sense to use that information to make non-response adjustments in subsequent collection waves. In addition to the factors used in the initial wave, information such as household composition, income and housing characteristics (type of dwelling, rent/own) may be used. Metadata collected in the survey at age two months may also be exploited (number of contacts, time of last contact, etc.) (Beaumont, 2005).

4.4 Calibration

Auxiliary information from external sources may also be used to improve the estimates' precision and calibrate the sample on known totals (Deville and Särndal, 1992). The selection and availability of external sources are being assessed and could include vital statistics records, which provide data on all live births and stillbirths in France (INSEE, 2007). Those records contain information about date and place of birth, the child's sex, characteristics of the parents (age, occupation and nationality), birthing conditions (specialized institution/home or other location with or without assistance) and type of birth (single or multiple). In practice, the SAS macro CALMAR2 (Sautory, 2003) will be used.

4.5 Imputation

Traditionally, imputation is the preferred method of treating partial non-response. In some cases, however, imputation may also be useful in dealing with total non-response, particularly wave non-response or cases where the mother responds but the father does not. Donor imputation (the donor is a respondent selected on the basis of his or her characteristics) may be more appropriate in this case in view of what has been done in some Canadian longitudinal surveys (Simard, 2008).

For item non-response in individual questionnaires, systematic imputation that maintains the relationships between variables seems impractical in view of the project's size and multidisciplinary nature. More precise analyses of partial non-response in the pilot studies will be conducted in 2009 to determine the value of imputing all or some variables.

4.6 Variance estimation

In surveys that involve complex sampling designs, non-response adjustments and imputation, traditional methods of estimating the variance may produce erroneous estimates (understatements of the variance of the estimates). In such cases, bootstrap methods offer alternatives that are easy to use because they rely on a method of re-sampling the observed sample and on a single formula for calculating the variance of the estimates (Rao, Wu, Yue, 1992). For the ELFE in particular, which has a simple sampling design but involves non-response adjustments, calibration and possibly imputation, bootstrap with replacement appears to be the most suitable method. The difficulty will lie in explaining how to use bootstrap weights correctly to a very broad group of users with varying educational and statistical backgrounds.

5. Conclusion

The pilot studies provided initial estimates of the expected non-response, and those initial results are satisfactory for pilot studies involving in-hospital recruitment. The pilot studies helped us identify opportunities for improving

response rates (training of hospital interviewers, information from the various parties involved at hospitals, lack of information from and involvement of fathers who initiate refusals, and so on), as well as demonstrated the difficulties of field work (shortage of staff, etc.).

Non-response varied widely by hospital, which may be an interviewer effect but also seems to reflect varying degrees of difficulty in conducting the survey in some hospitals (high workloads, communication between teams). There was also a selection of the sample based on some of the mothers' socio-demographic characteristics: age, level of education, occupation, nationality and number of previous births. These initial results are useful in understanding the reasons for non-response and devising non-response treatment strategies for the full-scale survey. The plan is to carry out further non-response analyses, in particular using a multivariate model that incorporates the various non-response factors. The non-response treatment methodology will also be refined and finalized in 2009-2010.

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