Sample substitution can be an acceptable data-collection strategy: the case of the Belgian Health Interview Survey

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Introduction

Sample substitution, in which non responding units are replaced ('substituted') by other units in the fieldwork process, is used to assure that the net-sample that meets the size of the target sample (Baldissera et al., 2014;Li et al., 2014;Nishimura, 2015) and, at the same time, as a corrective strategy to attenuate unavoidable non-response bias in survey estimates (Chapman, 1983;Chapman, 2003;Chapman and Roman, 1985;Chiu et al., 2005;Kish and Hess, 2004;Rubin and Zanutto, 2002;Vehovar, 1994;Vehovar, 1995;Vehovar, 1999;Vehovar, 2003). Contrary to other techniques such as weighting, substitution is regarded with a strong degree of skepticism in survey methodological literature and is rarely advocated in survey textbooks (David et al., 2014;Pickery and Carton, 2008;Vehovar, 1994).

The most fundamental criticism is that using sample substitution violates the principle of probabilistic sampling, given that substitutes have different selection probabilities than initial selected units, and should be regarded as a form of quota sampling (Nishimura, 2015).

However, equating quota sampling with sample substitution strategies ignores the fact that there are many substitution techniques, ranging from basic permissive approaches – as often applied in quota sampling – to very complex, rigorous procedures. Besides, a probability sampling mechanism can be made to operate at all stages. Based on features such as how substitute units are selected (random or not random), to what extent the data-collection is controlled (loose versus tight), the presence or absence of common characteristics between initial units and substitutes (unmatched or matched substitution) and the level of substitution (substitution at the lowest unit level, i.e. the individual or substitution at intermediate levels such as schools, enterprises,…), at least several dozen types of substitution designs can be distinguished even without getting into more exotic

hybrids such as using earlier cross-sections or panel design (Kish and Hess, 2004;Lynn, 2004;Nishimura, 2015;Smith, 2007).

Although not acknowledged as such, inflating the initial sample size according to the expected response rates in order to achieve a stated power – common practiced and advocated in survey methodology - can also be regarded as a very basic substitution design: extra units are added to the initial sample that will serve as uncontrolled and unmatched replacements for non -respondents (Smith, 2007). From this perspective, it seems doubtful to state that one of the most important disadvantages of applying substitution is that it results in higher levels of non-response. The latter is indeed inevitable since, on the whole, non-respondents among the substitutes will be added to the initial non-respondents. It can even be presumed that non-response is higher in substitutes than in initial units which might be seen as a sign that the substitutes were representing the initial non-respondents (Nishimura, 2015;Smith, 2007). A regrettable practice is that initial non-respondents are sometimes not added to the denominator when calculating the response rate creating "the illusion that a non-response problem has been solved" (Vehovar, 1999). Another shortcoming associated with sample substitution is that it may attenuate the interviewers' efforts to contact units, although this remains controversial: some interviewers may limit their efforts to obtain participation from an initial case since they know that this case will be substituted, other will do whatever is possible to obtain participation from an initial case since they know that, in case of substitution, the whole process of contacting the substitute will restart again (Dorsett, 2010;Vehovar, 1999;Vehovar, 2003). Yet, these arguments are only relevant if one assumes that the interviewer plays a predominant role in the substitution process, while in more advanced applications of substitution, the decision to substitute a non-responding unit is made by the central office to the extent that interviewers are not even aware if an unit is an initial unit or a substitute (Smith, 2007).

Sample substitution was applied in the first Belgian Health Interview Survey (BHIS) from its start in 1997 and in all the surveys since then (2001, 2004, 2008, 2013) (Demarest et al., 2013a;Van der Heyden et al., 2014;Van Oyen et al., 1997). The basic reason for applying substitution in the BHIS is to ensure that at the end of the fieldwork the predefined number of interviews and the initial composition of the sample in terms of sex, age-group and household size is met (Demarest et al., 2007;Demarest et al., 2013a;Van Oyen et al., 1997).

The aim of this article is twofold: its first aim is to verify if the substitution process in terms of (non-)participation yields indeed higher levels of non-response. The second is to assess the possible impact of applying substitution on the survey results, taking into account a number of health estimates.

Methods

The BHIS is a national cross-sectional survey organized thus far in 1997, 2001, 2004, 2008 and 2013 and directed towards the general population. Details on the methodology and content of the questionnaires can be found elsewhere (Demarest et al., 2013a). The net-sample size is predefined and should yield 10,000 face-to-face interviews: 3,500 in each of the Flemish and Walloon Regions and 3,000 in the Brussels Capital Region, i.e. the three geopolitical entities of the country. Specific for the BHIS 2013 was that 600 additional interviews had to be obtained at the level on one Walloon province. This oversampling did not impact the overall methodological strategy.

Sampling procedure

The addresses of households to be contacted in the BHIS2013 were selected in the national register by applying a multistage, clustered procedure. In a first step, 12 geographical strata (or provinces) were defined. In the Flemish and Walloon Regions, the number of interviews per province was proportional to the number of inhabitants in each province. Within each stratum, municipalities were selected according to a probability proportional by size method. In each selected municipality,

one or more groups of 50 individuals had to be sampled. This was first done via a systematic sampling of households. The step size for the systematic sampling was calculated by dividing the total number of households in the selected municipality by the required number of households taking into account the average household size in the municipality. As the sampling was spread over 4 quarters it means that in each group (on average) 12.5 individuals had to be interviewed per quarter.

Systematic sampling was based on households ordered by statistical sector (a subdivision of a municipality), household size and age category of the reference person. Statistical sectors were ranked from north to south, based on the geographical coordinates of the center of the statistical sector. For each selected household, three consecutive households in the ordered list were selected too, creating a cluster of four households presumably living in the same statistical sector, with the same household size and with the same age-category of the reference person. The choice for a cluster size of four households (initial selected household and three potential substitutes) was arbitrary: it was presupposed that using large clusters would jeopardize the cluster-homogeneity. To account for the fact that all households within one quadruple of households would refuse, the step size was set to half its original value, which doubled the number of selected clusters.

Once the clusters of households were selected for each group, a procedure of vertical and horizontal scrambling was applied. Vertical scrambling of the clusters randomized the original order of the clusters. The first half of the clusters was the actual sample to start with. The other half of clusters was kept as reserve and would only be used in case an initial cluster was exhausted, that is if none of the households in the initial cluster participated in the study. Horizontal scrambling randomized the order in which households in a particular cluster had to be activated, that is as initial household or as first, second or third substitute.

Substitution procedure

At the start of every trimester, a pre-notification letter was sent to all initial selected households. At the same time, the interviewers received a list of the addresses of these households and could access the preloaded information on these households (first name, sex and date of birth of all household members according to the National Register) and the contact-form on their laptop (CAPI application). Every contact attempt had to be registered using the contact-form in terms of date of contact attempt, time of the day, mode of the attempt (by phone, at doorstep) and result of the contact (no contact, incorrect info on the address, refusal, and agreement to participate). In case no contact could be established with a household, the interviewer had to continue trying to contact the household at least four more times, using alternative days, time of the day and mode of contact (at least one 'at doorstep' contact attempt). After five unsuccessful attempts, the interviewer could indicate that a household was 'not contactable' and stop the contact trials. In case a household was 'not contactable', refused to participate or the info on the address was incorrect, a (first) matched substitute household was activated (that is: a pre-notification letter was sent to the household). At the same time, access to the information of the initial household was blocked in the laptop management system and interviewers could access the preloaded information on the (first) substitute household instead. Exactly the same contact procedure had to be applied for the substitute-household. In case contact attempts with the first substitute household did not result in participation, the (second) substitute household was activated. This process was repeated until a household participated in the survey or until the two clusters were exhausted.

Although the BHIS is basically a survey directed towards households, its target is expressed in terms of individual participation. For each participating household at most four members are invited for the interview: the reference person, his/her partner (if any) and two other ad random sampled members (in case of a partner) or three other members (in case of no partner). At the start of the interview the interviewer had to run to a preloaded household grid to assure that administrative data of the household composition coincides with the real composition. If not, the interviewer could delete and/or add household members (this practice was not possible for the household's reference

person). Once this check was done, the CAPI application selected the household members eligible for participation.

Intra-household substitution was not allowed; a selected household member that refused to participate and did not allow an interview-by-proxy, was not substituted.

Databases

Two databases were used for the analysis: the first one with information on the contact-procedure with the activated households (that is: households to which a pre-notification letter was sent); the second one with data collected through the survey both at the level of the households and individual household members. Combining both database allowed to disentangle the whole substitution process and to assess the (non-)participation for each substitution stage. In the presented tables, the results for the substitute-cluster (that is the cluster of 4 households that substitutes an exhausted cluster) are grouped, given the relatively small numbers of activated households in substitute clusters.

When combining the two afore-mentioned databases a technical problem arose: to assess the total sample size and the size of the activated sample at individual level, one has to account for the fact that in households larger than 4 members, only 4 members could be selected. For such households, a random sampling of 2 household members (or 3 members in case of no partner) – next to the reference partner and partner - was performed, resulting in a total sample of 105,103 household members belonging to 48,691 households, of which one out of eight is part of the initial sample while the others are part of the first, second … till the seventh substitute, respectively.

Statistical analysis

For every stage (initial and substitutes), the response rates at both household level (RR_{hh}) and at individual level (RR_{ind}) were calculated, defined as the proportion of participating units among the activated units, regardless of the reason for non-participation. The substitution process is implemented to hasten the realization of a predefined number of individual interviews. Therefore the Accrual Rate (AR), defined as the number of interviews realised after each (initial, substitute) stage of the data-collection divided by the target (10,600 interviews) was also calculated. To assess the impact of substitution on the estimates, post stratified weighted estimates for the initial participants, the substitutes and for all participants are compared for a selection of health indicators (indicators listed in table 3).

Weights were based on age, gender, household size and province and were calculated separately for each health indicator (taking into account item non-response) and for the initial participants, the substitutes and for all participants. Differences between the estimates based on, respectively, initial participants, substitutes and all participants were calculated together with their 95% confidence intervals.

Results

Table 1 presents an overview of the results of the applied substitution process throughout the data-collection phase in terms of the composition of the initial activated sample of households and of the successive substitute-samples (sex and age-group of the reference person, size of the household). Added to the table is the nationality of the reference person, which is not used as a criterion when selecting the sample and is to be considered a latent characteristic. The size and composition of every substitute-sample is associated with the RR_{hh} of the previous phase. Table 2 presents the same overview as Table 1, yet at the individual level, that is at the level of the household-members invited to participate in the BHIS. The results are presented after random sampling of 4 household members in households counting more than 4 members. Individual non-participation comprises both non-

participation due to the fact that the household as such did not participate as well as to intra-household refusal.

Of the 10,468 members of 4,878 initial activated households invited to participate in the survey throughout the four quarters of the data collection year, 5,904 members (RR_{ind_in}: 56.4%) of 2,707 households (RR_{hh_in}: 55.5%) participated. It should be noted that the total size of the initial individual sample is somewhat lower that the number of interviews to be achieved (10,600). This is due to the fact that in a few municipalities no interviewer was available during the start-up of the data-collection, so the number of initial activated units for such municipalities was lower than scheduled.

As seen in table 1, participation in the survey differed according to the characteristics of the households; initial selected households with a young reference person (15 – 24 years), for example, were less prone to participate ($RR_{hh\_in\_15\text{-}\_24}$: 42.3%) than households with a reference person aged 65 – 74 years ($RR_{hh\_in\_65\_74}$: 60.0%). One-person households had the lowest response rate ($RR_{hh\_in\_size1}$: 49.7%). More disturbing is the finding that households with a non-Belgian reference person have a much lower response rate than households with a Belgian reference person (respectively $RR_{hh\_in\_nbel}$ of 48.5% and $RR_{hh\_in\_bel}$ of 56.7%), given that the nationality of the reference person is not addressed in the substitution process.

This differential participation obtained at household level is smoothened at the individual level, as the response rates at that level appear to be more homogeneous. What holds is the lower response rate for the members of one-person households in comparison with members of three- or four persons households (respectively $RR_{ind\_in\_size1}$ of 57.8% and $RR_{ind\_in\_size4}$ of 59.0%). Lower response rates for households with a non-Belgian reference-person, is also reflected in lower response rates at the individual level ($RR_{ind\_in\_nbel}$ for non-Belgians is 51.0%, versus $RR_{ind\_in\_bel}$ of 57.3% for Belgian citizens). It should be mentioned that in a limited number of cases (402 individuals, or 3.7%) linkage at individual level was not possible, given that these cases were not listed in the national register (new-born babies, new partners, unregistered household members,…)

Differential response-rates are accounted for in the substitution process as follows: as soon as a household turns out to be a non-participating household – regardless of the reason – it is checked whether the prescheduled number of interviews (12.5 per quarter or 50 in total) in the group to which the household belongs is realized or not. In case this number is realized, no substitution of the non-participating household will occur. If not, the first merged substitute household of the cluster is activated. The substitution process is thus an interplay between (non-) participation at individual level and the need to substitute households.

Of the initial 4,878 activated households, 2,171 did not participate, resulting in a shortage of 4,564 individual participants. To cope with this, 2,232 (matched) substitute households were activated (first substitutes), accounting for 4,614 possible individual participants. One can note the overshoot in both the activated substitute-households and consequently the number of expected individual participants. This is due to the fact that the substitution-process is a permanent process throughout the data-collection period which could be avoided in case the substitution process would only start once the participation status of all initial activated households is known, that is at the end of each quarter. Such an approach would, of course, hinder the data-collection in an unacceptable way.

Of all 2,232 first substitute households, 1,118 did participate (RR_{hh_s1}: 50.1%), enabling to have an interview with 2,326 household members (RR_{ind_s1}: 50.4%). The decreasing response rates, both at household level as at the individual level, can – in overall terms – be found for every household or individual characteristic, with exception of the stable response rates for households with a reference person aged 55 – 74 years. The decline in overall response rates holds for the second and third substitute-households ($RR_{hh\_s2\text{-}3}$: 44.6.0%). Contrary to the first three substitute households, the 4th till 7th substitute households (belonging to the second substitute cluster of 4) have common within-cluster characteristics (statistical sector, sex and age-group of the reference person, size of the household), which are different from the initial selected household and its first three substitute households (from the initial cluster). Given the relatively low number of units in which they were

activated, the results for the 4th till 7th substitute household were grouped. Even after three successive substitutions, 802 households where involved in the continuing substitution process, resulting in an additional participation of 418 households ($RR_{hh\_s4\text{-}7}$: 52.0%) counting 921 participating individuals ($RR_{ind\_s4\text{-}7}$: 51.2%). Compared to the previous substitution stages, response rates of the 4th till 7th substitution households were relatively higher both at household and at individual level.

The initially activated households combined with the substitution process, resulted in a net sample of 10,829 participating members (RR_{ind_tot}: 53.1%) of 5,048 households (RR_{hh_tot}: 51.9%). The net sample is slightly higher than the targeted sample (surplus of 289 individuals). This overshoot is a result of an approach in which the interviewers could continue interviewing the households for which an appointment was scheduled, even if the target sample size was already realized.

When comparing the estimates for a selected number of weighted health indicators, the results show very limited and not statistically significant differences between estimates based solely on the initial sample and estimates based only on the substitutes (Table 3). As a consequence, no significant difference could be found between the estimates before and after substitution: the substitution process does not produce any important distorting effects on the estimates.

Discussion

In the BHIS, a sophisticated substitution approach is applied, in which the decision to substitute a non-participating unit follows a clear algorithm which cannot be controlled by the interviewers. It has not more than its name in common with very basic, uncontrolled and uncontrollable substitution schemes of mere quota sampling. In this manuscript, it is shown that fieldwork substitution in the BHIS2013 can be used to preserve the size and composition of the initial sample with little consequences on the survey estimates. Of course, the ability to apply fieldwork substitution in such way, heavily depends on the availability of several matching variables; statistical sector, household

size, sex and age category of the reference person, nationality,... Absence of such variables – as in many surveys - implicates that field substitution, as described in this manuscript, cannot be applied. The results show that in almost 60% of all cases, the initial selected units did participate, making the rather complex substitution process, as applied in the BHIS2013, superfluous. Doubling the initial sample looks to be a more adequate approach than multiplying the sample size with factor 8, since the substitution process only affects a minority of units. Yet different response rates at both household-level and individual level, although limited, can be accounted for using substitution. Artificially increasing the sample size of initial selected households would probably yield the same differences in response rates. Applying substitution can be linked to a decline in participation rates. It looks that 'hard to reach' households are substituted with similar households. Their relatively increasing share in the groups of successive substitutes does impact the participation rate. The main advantage of substitution is that it increases the chance that the composition of the net-sample reflects the composition of the initial sample regarding the variables used in the construction of the sample.

Based on a selection of health-indicators, it was shown that the estimates derived solely on the initial participants or solely on the substitutes coincide with those calculated by taking the total net sample into account. This finding is in line with that of a similar study showed that using field substitution enables to maintain the characteristics of the original sample without affecting the results, independently of the magnitude of substitution (Baldissera et al., 2014).

As shown, the assumption of an added value of using substitute clusters is disputed. In overall terms, 96.7% of the target sample-size was realized after, at most, the third substitute household was activated. The availability of substitute clusters serves as an ultimate mean to realize the prefixed number of interviews, yet activating substitute clusters negatively impacts the resemblance of the composition of both the initial and the net-sample.

It is important to note that the substitution method is predominantly used to reduce bias as much as possible. As such, the focus is more on bias and less on precision. At the same time, the method enables us to reach the pre-determined sample sizes per stratum (Flanders, Brussels, Wallonia, the German speaking community, and hence Belgium as a whole) much more easily than when a simple oversampling is specified. As such, the method helps to reach the pre-specified precision, without undershooting or overshooting. In addition, there is evidence that the method works well because the initial and substitute sub-samples do not significantly differ. While this cannot be seen as formal proof, it is nevertheless comforting evidence in favour of the method.

The aim of the paper is to present some evidence that field substitution should not be treated as a suspicious survey method but rather as a method that is suitable in specific circumstances, e.g. in case the net-sample is predefined by the commissioners, the data-collection phase is rather long, the sample frame is 'rich' to enable high qualitative matching and response rates are uncertain. Yet, a comparison of the demographic characteristics of the initial participants and the substitutes show very limited differences, while also the health estimates based on the initial participants are not significantly different of those based on the substitutes. It can be argued that a simple increase of the sample size to account for an expected non-participation would yield in the same results, without the necessity of a complex, time-consuming substitution process. As stated in the introduction, using inflated sample sizes can be viewed as applying uncontrolled and unmatched substitution that would probably favour 'easy to reach' units. The declining participation rates throughout the substitution process clearly indicates that substitution, as applied in BHIS, at least incorporates some assurance that also 'hard to reach' units are reached with the survey.

Limitations

The matching variables of initial households and substitutes are limited to what is available in the sampling frame. In case of the BHIS only the statistical sector, the age of the reference person and the household size served as matching variables. Information on e.g. socio-economic status and

health characteristics which would, in the context of a health survey, be more fruitful in matching initial households and substitute households were not available. Previous studies have e.g. shown that lower educated people and less healthy people are more reluctant to participate in the BHIS (Demarest et al., 2013b;Lorant et al., 2007). This can lead to the practice that such people are substituted by more highly educated and healthier people. Nevertheless, the finding that health estimates before and after substitution are very alike, provides evidence that the process of expelling less healthy people is very limited.

The BHIS is a survey directed to (selected members of) households. The participation status (participation, refusal, non-contactable) is attributed to all members, while the decision to participate or not might be taken by just one household member, probably the reference person. An analysis of the consequences of applying substitution at the individual level (level of household-members) is as such artificial. Yet, the analysis at the household member participation was found necessary, given that the substitution process in BHIS was applied in order to assure a pre-fixed net sample of individuals.

Strengths

As the substitution process was completely managed by a central secretariat using a specifically developed ICT-tool, the whole substitution process could be re-constructed. Every participating household in the BHIS2013, could be attributed to a specific stage in the substitution process. Such level of detail enabled to check if the substitution process progressed as scheduled (that is; if a non-participating household is effectively substituted by a similar household).

Conclusion

Although the results of the analysis presented in this manuscript advocate the use of sample substitution as a means to achieve prefixed net-sample sizes, further research is necessary to address potential differences in the use of substitution for refusing versus non-contactable

households. Indeed, for refusing households – that is, households effectively contacted by an interviewer – effective substitution was legitimate. Yet, for non-contactable households, the requested number of contacts can alter the necessity to apply substitution. Using information on the number of (unfruitful) contact attempts to the analysis will enable a further fine-tuning of the substitution process in the BHIS.

Competing interests

Non declared

Keypoints

- Although sample substitution is regarded with a strong degree of skepticism in survey methodological literature, it has shown to be a powerful tool to assure a pre-fixed net sample size
- Based on the results of the Belgian Health Interview Survey, sample substitution does not seem to affect the health estimates
- Sample substitution is an appropriate tool to conquer declining response rates in public health surveys

Reference List

Baldissera S, Ferrante G, Quarchioni E, Minardi V, Possenti V, Carrozzi G, Masocco M, Salmaso S, The PASSI Coordinating group (2014) Field substitution of nonresponders can maintain sample size and structure without altering survey estimates. Τηε experience of the Italian behavioral risk factors surveillance system (PASSI). Annals of epidemiology 24:241-245

Chapman (1983) The impact of substitution on survey estimates. In: Madow WG, Olkin I, Rubin DB (eds) Incomplete data in sample surveys, 2 edn. Academic Press, New York, pp 45-61

Chapman DW (2003) To substitute or not to substitute that is the question. The Survey Statistician 48:32-34

Chapman, Roman AM (1985) An investigation of substitution for an RDD survey. American Statistical Association, pp 269-274

Chiu WF, Yucel RM, Zanutto E, Zaslavsky AM (2005) Using matched substitutes to improve imputations for geographically linked databases. Surv Methodol 31:65-72

David MC, Ware RS, Alati R, Dower J, Donald M (2014) Assessing bias in a prospective study of diabetes that implemented substitution sampling as a recruitment strategy. Journal of clinical epidemiology 67:715-721

Demarest S, Gisle L, Van der Heyden J (2007) Playing hard to get: field substitutions in health surveys. International journal of public health 52:188-189

Demarest S, Van der Heyden J, Charafeddine R, Drieskens S, Gisle L, Tafforeau J (2013a) Methodological basics and evolution of the Belgian Health Interview Survey 1997-2008. Arch Public Health 71:24

Demarest S, Van der Heyden J, Charafeddine R, Tafforeau J, Van Oyen H, Van Hal G (2013b) Socio-economic differences in participation of households in a Belgian national health survey. The European Journal of Public Health 23:981-985

Dorsett R (2010) Adjusting for nonignorable sample attrition using survey substitutes identified by propensity score matching: An empirical investigation using labour market data. Journal of Official Statistics 26:105

Kish L, Hess I (2004) A "Replacement" Procedure for Reducing the Bias of Nonresponse. The American Statistician 58:295-297

Li L, Krenzke T, Mohadjer L (2014) Considerations for Selection and Release of Reserve Samples for In-Person Surveys. Survey Methodology 40:105-123

Lorant V, Demarest S, Miermans PJ, Van Oyen H (2007) Survey error in measuring socio-economic risk factors of health status: a comparison of a survey and a census. International Journal of Epidemiology 36:1292-1299

Lynn P (2004) The use of substitution in surveys. The Survey Statistician 49:14-16

Nishimura (2015) Substitution of Nonresponding Units in Probability Sampling. University of Maryland,

Pickery J, Carton A (2008) Oversampling in relation to differential regional response rates. Survey Research Methods 2:83-92

Rubin DB, Zanutto E (2002) Using matched substitutes to adjust for nonignorable nonresponse through multiple imputations. Survey nonresponse389-402

Smith (2007) Notes on the use of substitutions in surveys.

Van der Heyden J, Demarest S, Van Herck K, De Bacquer D, Tafforeau J, Van Oyen H (2014) Association between variables used in the field substitution and post-stratification adjustment in the Belgian health interview survey and non-response. International journal of public health 59:197-206

Van Oyen H, Tafforeau J, Hermans H, Quataert P, Schiettecatte E, Lebrun L, Bellamammer L (1997) The Belgian health interview survey. Arch Public Health 55:1-13

Vehovar (1994) Field substitutions-a neglected option. American Statistical Association, pp 589-594

Vehovar (1995) Field Substitutions in Slovene Public Opinion Survey. In: Ferligoj A, Kramberger A (eds) Contributions to Methodology and Statistics pp 39-66

Vehovar V (1999) Field substitution and unit nonresponse. Journal of Official Statistics 15:335-350

Vehovar V (2003) Field substitutions redefined. The Survey Statistician35-37