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Analysing the Probability of Attrition in a Longitudinal Survey

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Abstract

This paper aims to analyse predictors of attrition in a major UK longitudinal survey, the Family and Children Study, and thus to contribute to a deeper understanding of the process and reasons for attrition as a social phenomenon. Multilevel modelling techniques are used to analyse attrition across several waves accounting for clustering of sample members within interviewers. The models are guided by current conceptual frameworks and theories of survey participation. The analysis also explores the role of the interviewer in gaining cooperation in a longitudinal study, in particular investigating effects of changes of interviewers across waves. An advantage of the data is that relatively rich information on both respondents and non-respondents is available from early waves and from interviewer observations.

Keywords:

Attrition, interviewer effects, interviewer variance, multilevel modelling, UK Families and Children Study

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1. Introduction

Attrition is a major problem in longitudinal studies which require continued involvement of respondents. By attrition we mean the dropout of respondents at follow-up waves after wave 1. As time passes, more respondents will tend to drop out for a variety of reasons and this not only reduces the amount of information available, it also may create important biases if dropout is informative, that is those who drop out are not a random sample of the target population. Non-response rates and non-response bias may both affect the quality of survey data, with potentially serious consequences for data analyses underpinning social science research. For this reason an important goal of survey research is to develop ways to minimise non-response, through survey design and data collection methodology, and to reduce the impact of non-response bias through modification of data analysis methods. As a key intermediate aim, and of social science interest in itself, it is crucial to gain a better understanding of the nature and predictors of non-response and attrition. Current conceptual frameworks for survey participation have identified a number of key factors influencing non-response, such as individual and household characteristics, interviewer attributes, the social environment and survey design features. Much of this research has been carried out for cross-sectional surveys (Groves, Cialdini and Couper, 1992; Groves and Couper, 1998; Groves et al., 2002; Durrant et al., 2009). Non-response in longitudinal surveys, however, is regarded as more complex and may involve wave 1 unit non-response and attrition in subsequent waves, making the problem of non-response more severe due to a potentially large amount of loss of information over time. Whilst wave 1 unit non-response may be similar to non-response in a cross-sectional survey, the reasons for attrition may be expected to differ (Lepkowski and Couper, 2002).

This paper aims to investigate the variables that are predictive of the propensity to drop out from a large household survey carried out in the UK into the circumstances of families with dependent children, and thus to contribute to a deeper understanding of the process and reasons for non-response as a social phenomenon. The models presented here are guided by current conceptual frameworks for survey participation. Some studies exist that have analysed non-response for particular longitudinal surveys (e.g. Pickery and Loosveldt, 2002; Lepkowski and Couper, 2002; Nicoletti and Peracchi, 2005; Hawkes and Plewis, 2006). This paper aims to build on this previous work and to extend it as follows.

Studies of the determinants of non-response require information on both respondents and nonrespondents, as well as information on the factors influencing the non-response process, including information on interviewers. However, it is not often possible to link survey data to appropriate sources (Durrant et al. 2009), including data on both respondents and nonrespondents and interviewer information. The analysis of attrition has the advantage that, in principle, information from previous waves is available for both respondents and nonrespondents at a particular wave. Some of the previous work on longitudinal surveys has only analysed non-response at the first and second wave (e.g. Lepkoswki and Couper, 2002). The analyses presented in this paper are based on the UK Family and Children Study (FACS), which started in 1999 and data for analysis was available until wave 8.

In face-to-face surveys, it is generally recognised that interviewers have a vital role in contacting sample members and achieving their cooperation (Groves and Couper,

1998; O'Muircheartaigh and Campanelli 1999; Hox and De Leeuw, 2002), leading to clustering of response behaviour for sample units allocated to the same interviewer. Although some work has been carried out for cross-sectional surveys (Schnell and Kreuter, 2005; Hansen, 2007; Flores-Macias and Lawson, 2008; Durrant et al. 2010), only very few studies exist that have tried to analyse the role of the interviewer in a longitudinal survey. O'Muircheartaigh and Campanelli (1999) looked at one particular wave of the British Household Panel Study, making the research comparable to a cross-sectional survey setting. When the role of interviewers was investigated it was only for the start of a longitudinal study, i.e. waves 1 and 2 (e.g. Pickery and Loosveldt, 2002; Pickery, Loosveldt and Carton, 2001). Since the effects may be changing over time, it is of interest to investigate the influence of the interviewer also at later waves. An advantage of our study is that information on interviewers from administrative data can be linked to the survey data, which allows us to investigate the influence of the interviewer over time. Of particular interest are the effects of changes of interviewers on attrition.

We will use multilevel modelling techniques that take account of changes across waves and the clustering of households within interviewers. First, a multinomial multilevel model is used that analyses the different types of nonrespondents depending on when and how often a sample member responded at previous waves. Secondly, we explore a multilevel cross-classified model to analyse interviewer effects at two different waves of the FACS, taking account of the interviewer at the previous and the current wave. Thus, this paper contributes to methodology for the analysis of attrition in longitudinal surveys. We only focus on the cooperation and refusal stage conditional on contact having been made with the household, since, as

pointed out in Lepkoswki and Couper (2002), the problem of noncontact, although significant for wave 1, is relatively small in later waves.

The remainder of the paper is organised as follows. Section 2 describes the data. Analysis of the different attrition response patterns across waves 4 to 8 is carried out in Section 3, and Section 4 analyses attrition across waves 7 and 8, allowing for changes of interviewers. The paper ends with a conclusions section.

2. Data

The Families and Children's Study (FACS) is funded by the UK Department of Work and Pensions, and investigates the circumstances of British families with dependent children. The study began in 1999 with a survey of all lone parent families and low/moderate-income couple families. The dual objectives of the initial sample design were to provide a representative sample of Britain's low-income families, while at the same time generating a sample of sufficient size for a longitudinal study. Child Benefit records were used as the sampling frame for the initial sample as well as for subsequent refreshment (or 'booster') samples.

In 2001 the third annual study (wave 3) was enlarged to be representative of all families with dependent children across Great Britain, regardless of income level. In this analysis we only focus on responses from wave 3 onwards. The study is currently in its 12th wave and data for this analysis was available to us until wave 8.

The main objectives of the FACS surveys are to provide information on:

- The effects of work incentive measures;
- The effects of policy on families' living standards; and
- Changes in family circumstances over time.

The study provides data on employment-related behaviour of parents and also on outcomes for children – such as educational attainment, health and behaviour. The survey comprises of an annual interview with a 'mother figure' in a household and a shorter interview with his or her partner and a child self-completion interview. In this analysis we will only focus on the response behaviour of the 'mother-figure'.

In 2005, the National Centre for Social Research was the lead organisation for the survey and took responsibility for determining the design of the sample, conducting fieldwork, coding and editing of data. Along with researchers at the Department for Work and Pensions, the National Centre for Social Research was also responsible for reporting the results. A detailed description of the data as well as attrition patterns is given by Lyon et al. (2007). Table 1 is adapted from that report and shows the pattern of attrition across waves 4 to 8. Here, attrition is defined as the first instance of unit-non-response at a wave, conditioning on contact has been made. In fact, a few families return to the survey after a non-response, but for simplicity, and because there are insufficient cases to explore these additional patterns, we shall treat such cases in the same way as those who do not return. The study includes only those eligible at each wave, that is who still had at least one dependent child.

Table 1 Attrition patterns from waves 4-8 (families who participated at wave 3 and were eligible at all subsequent waves)

Attrition pattern of participation Wave 4 → Wave 8	N	%
OOOOO	991	15.2
XOOOO	523	8.0
XXOOO	499	7.7
XXXOO	386	5.9
XXXXO	380	5.8
XXXXX	3,733	57.3
Total	*6,512*	*100.0*

The symbol X means that a response occurred at the occasion in the sequence and O indicates no response.

The following sections present two analyses. In the first analysis we use the response patterns across all these waves and the second analysis concentrates on waves 7 and 8 only. The reason for this separation of the analysis is that certain variables are only available for wave 7 and 8, notably interviewer characteristics and some interviewer observation variables. After exploring the effects of a wide range of available explanatory variables, the final set used in the models were the maternal characteristics of ethnic group, number of dependent children, education, tenure and parental status. Previous research has demonstrated that they are associated with response propensity (Durrant and Steele, 2009). The results of fitting models with these variables for the two types of analysis, are shown in Tables 2 and 4.

Previous research (e.g. O'Muircheartaigh and Campanelli 1999; Hox and De Leeuw, 2002; Durrant et al., 2010) also showed significant effects of interviewer characteristics on response rates in cross-sectional surveys and our second analysis additionally includes information on the change of interviewer across two waves.

3. Analysis of Attrition Across Waves 4 to 8

3.1 Patterns of Response Across Waves 4 to 8

The response variable in our first model is multicategorical based on refusal patterns given that contact was made and that the member participated at wave 3. It is defined as follows:

Category	Description
XXXXX	Responded all 5 occasions (base category)
00000	Did not respond at any occasion 4-8
X0000/XX000	Responded either occasion 4 or 4+5 only
XXX00/XXXX0	Responded either occasions 4+5+6 or 4+5+6+7 only.

The response variable in our first model is therefore a 4-category variable. Since we are studying all possible response patterns, our explanatory variables in the analysis were those measured at wave 3. The model allows for the influence of the interviewer at wave 3. In fact for about 73% of families the interviewers did change at least once over these five waves. A full analysis of all possible patterns, involving cross-classifying interviewers across waves is not feasible given the size of the dataset and we restrict this analysis to a 2-level model where interviewer at wave 3 defines the higher level. In our second analysis we shall study the effect of changing interviewer across waves 7 and 8 and some interviewer characteristics.

3.2 Modelling Attrition Across Waves 4-8

This first model for analysing attrition across waves 4 to 8 can be written as:

$$\log\left(\frac{\pi_{ij}^{(s)}}{\pi_{ij}^{(t)}}\right) = \beta_0^{(s)} + \beta_1^{(s)} x_{ij} + u_j^{(s)}, \quad s = 1,\ldots,t\text{-}1 \qquad (1)$$

where for simplicity we have included only a single predictor variable apart from the intercept (see Goldstein, 2003, Chapter 4 for further details). The superscript (*s*) indicates the category of response and (*t*) is the base category, in our case responses at every wave. The subscript *i* indexes the respondent and *j* the wave 3 interviewer. Each response has its own set of coefficients and these are essentially interpreted as the log odds of that category compared to the base category for a unit increase in *x*. In addition, we have a (3 x 3) covariance matrix, Ω_u, at interviewer level for the three log odds contrasts. Thus the diagonal terms in this matrix are the residual (between-interviewer) variances for the three log odds contrasts.

A series of increasingly complex models with increasing numbers of predictors were fitted and the final one only is reproduced here in Table 2, followed by comments.

3.3 Results from Analysis of Waves 4-8

Table 2. Probability of refusal related to interviewee characteristics. Two level model with wave 3 interviewer defining level 2. Response patterns relative to XXXXX response (response across all waves). Quasi-likelihood (PQL2) estimation used (Goldstein, 2003 Chapter 4).

Predictor	Response pattern (standard error in brackets)		
	00000 (no response)	X0000/XX000 (response at one or two waves)	XXX00/XXXX0 (response at 3 or 4 waves)
Intercept	1.54 (0.22)	1.08 (0.21)	1.81 (0.23)
Ethnic group (base=white):			
Black	0.90 (0.23)	0.30 (0.26)	0.26 (0.29)
Asian	1.84 (0.17)	1.00 (0.19)	1.10 (0.22)
Other	1.20 (0.35)	0.82 (0.27)	0.96 (0.24)
Age mother*	0.12 (0.03)	0.06 (0.03)	0.00 (0.03)
Number of dependent children**	-0.28 (0.05)	-0.08 (0.05)	0.01 (0.05)
Highest qualification***	-0.14 (0.03)	-0.20 (0.03)	-0.10 (0.03)
Income****	0.08 (0.03)	0.01 (0.03)	0.01 (0.03)
Lone parent (yes)	-0.33 (0.11)	-0.21 (0.10)	0.23 (0.11)
Tenancy (base =owner)			
Social tenant	0.06 (0.12)	-0.14 (0.11)	-0.08 (0.13)
Private tenant	0.22 (0.18)	0.38 (0.16)	0.14 (0.20)
Other including shared owner	0.72 (0.22)	0.26 (0.25)	0.04 (0.30)

Level 2 covariance matrix. Variances on diagonal correlations off-diagonal

	00000	$X0000/XX000$	$XXX00/XXXX0$
00000	0.29(0.06)		
$X0000/XX000$	0.91(0.04)	0.21(0.05)	
$XXX00/XXXX0$	0.62(0.04)	0.70(0.04)	0.21(0.06)

* 16-19=1, 20-24=2, 25-29=3, 30-34=4, 35-39=5, 40-44=6, 45+=7
** 1,2,3, 4=4+
*** None=0, GCSE D-G =1, GCSE A-C = 2, A level =3, first degree +=4, other academic=6
**** Quintiles = 1,2,3,4,5 Self employed =6

The most extreme comparisons, between those who did not respond at any wave from 4-8 and those who responded to all are shown in the first column of Table 2. Compared to whites, all ethnic groups were less likely to respond, i.e. more likely to refuse, especially Asians. These ethnic group effects are the largest among the

predictors. A lower probability of response is also shown by older mothers, those on higher incomes and those in accommodation other than private ownership. Those with higher qualifications were more likely to respond as were lone parents and those with higher numbers of dependent children. All of these effects are adjusted for the other predictors. We obtain rather similar patterns for the other response patterns given in columns 2 and 3 of Table 1. The sizes of the effects are, however, smaller, especially for ethnic group, income, number of dependent children and tenancy.

To help interpret these estimates Table 3 shows the amount the odds are multiplied by, corresponding to different values on the logistic scale; so that these represent the multiplicative change in odds corresponding to the relevant movement between categories. Thus for example, conditional on the values for the other predictors the odds of refusing for 00000 compared to XXXXX is increased by a factor of 2.5 (0.9 on the logistic scale) for a black as opposed to a white respondent.

Table 3. Logistic scale values and odds multipliers

Logistic scale value (x)	Odds multiplier (e^x)
-0.4	0.67
-0.2	0.82
0.0	1.00
0.4	1.50
0.8	2.23
1.2	3.32
1.6	4.95
2.0	7.39

Compared to cross-sectional analyses these longitudinal data allow us to study different degrees of a persistent refusal to respond. Thus, from the third column of Table 2 we see that age of mother is unrelated to response propensity when comparing those who always respond with those who fail just once or twice. For persistent refusers, however, a positive effect emerges with older mothers being more likely to

refuse persistently. Likewise for those with larger numbers of dependent children at wave 3 they are less likely to persistently refuse, but no difference is apparent for those who refuse just once or twice. On the other hand, being a lone parent does not show a marked difference, nor does tenure, apart from the category of 'other tenancy'.

The residual variation between interviewers is moderate. On the logistic scale, the standard deviation for the 00000 – XXXXX contrast is 0.54 which is somewhat less than most of the ethnic group differences. When we do not adjust for the covariates the corresponding standard deviation is 0.61, so that not very much of the between-interviewer variation is accounted for by the predictor variables.

We have also looked at adding a term for whether the respondent had participated at waves 1 and 2. Those who had participated were less likely to be in the first two categories, that is they were more likely to have a positive response pattern. The broad conclusions, however, remain unaltered.

4. Analysis of Attrition for Waves 7 and 8

4.1 Modelling Attrition for Waves 7 and 8

In this analysis we look at survey members who fully cooperated at wave 7 and we analyse their response behaviour at wave 8, conditioning on contact made and being eligible (in effect still having dependent children). This means that the outcome variable of interest is refusal versus cooperation at wave 8 given the characteristics we know about the individual at wave 7. We fitted 2-level logistic models with household or person characteristics at level 1 and the interviewer level effect at level 2 (initially

from interviewer at wave 7 only). We also explored including both interviewers (from wave 7 and wave 8) in the model, using a multilevel cross-classified logistic model. For this, we denote by $y_{i(j_1 j_2)}$ the outcome for person i contacted by interviewer j_1 at wave 7 and interviewer j_2 at wave 8, where the cross-classification of interviewers is indicated by placing their indices in parentheses. The dependent variable is coded as

$$y_{i(j_1 j_2)} = \begin{cases} 0 & \text{refusal} \\ 1 & \text{cooperation} . \end{cases}$$

Denoting the probability of cooperation by $\pi_{i(j_1 j_2)} = \Pr(y_{i(j_1 j_2)} = 1)$, and taking refusal as the reference category, the multilevel cross-classified logistic model for cooperation can be written as

$$\log\left(\frac{\pi_{i(j_1 j_2)}}{1-\pi_{i(j_1 j_2)}}\right) = \beta x_{i(j_1 j_2)} + u_{j_1} + u_{j_2}, \qquad (2)$$

where $x_{i(j_1 j_2)}$ is a vector of person/household and interviewer covariates, β is a vector of coefficients, and u_{j_1} and u_{j_2} are random effects, representing unobserved interviewer effects from wave 7 and 8 respectively. The random effects are assumed to follow normal distributions, i.e. $u_{j_1} \sim N(0, \sigma_{u1}^2)$ and $u_{j_2} \sim N(0, \sigma_{u2}^2)$. The variance parameters σ_{u1}^2 and σ_{u2}^2 are respectively the residual between-interviewer variances in the log-odds of cooperation versus refusal.

4.2 Results of Modelling Attrition for Waves 7 and 8

Fitting multilevel cross-classified logistic models we found that the wave 7 interviewer level variance was not significant once wave 8 interviewer (i.e. the most recent interviewer) was in the model. In other words, it is the current (wave 8) rather than previous (wave 7) interviewer that is associated with propensity to respond. This is somewhat in contrast to findings in Pickery, Loosveldt and Carton (2001), who found that the interviewer from the first wave was more important than the interviewer at the second wave. However, this difference may arise since Pickery, Loosveldt and Carton analysed the first two waves of a new longitudinal study and one may assume the first wave to be crucial in any further participation (Lepkowski and Couper, 2002). However, in our exploration we analyse interviewer effects at a later stage of a longitudinal study.

We have therefore focussed on 2-level logistic models with women at level 1 and interviewer from wave 8 at level 2, as shown in Table 4. Note that in this analysis we are modelling the propensity to respond rather than refuse. Using a 1-tailed test (Self and Liang, 1987) we find a statistically significant between-interviewer variance (0.13) for interviewer from wave 8.

The variance partition coefficient (VPC) measures the proportion of residual variation that can be attributed to the different classifications in a multilevel model. For a multilevel logistic model different definitions of the VPC exist. Here we use the idea of reformulating the multilevel logistic model as a threshold model (Snijders and Bosker, 1999, p. 224; Goldstein, 2003, Chapter 4). The VPC for interviewers, the proportion of variability that is due to interviewers in the model is just under 4% {=0.130/(0.130+3.29)}, which is in line with findings in other research (e.g. see Durrant, and Steele, 2009; Durrant et al. 2010).

Table 4. Analysis of propensity to refuse at wave 8: data from waves 7 and 8. Two-level model with logistic link. Quasi-likelihood (PQL2) estimation used (Goldstein, 2003 Chapter 4).	
Explanatory variable	**Estimate (standard error)**
Intercept	-2.37 (0.21)
Age (base = 40+)	
16-29	-0.31 (0.14)
30-39	-0.26 (0.10)
Ethnic group (base=white)	
Black	0.27 (0.27)
Asian	0.62 (0.20)
Other	0.65 (0.21)
Education level (base = below GCSE level)	
GCSE	-0.13 (0.12)
A level	-0.25 (0.16)
Academic degree	-0.32 (0.16)
other	-0.32 (0.28)
Income (base = highest income group)	
Lowest	0.16 (0.17)
Band 2	0.04 (0.17)
Band 3	0.23 (0.16)
Band 4	-0.15 (0.16)
Band 5	-0.22 (0.16)
Band 6	-0.06 (0.17)
Tenure (base = owner occupier)	
Tenant	-0.20 (0.12)
other	0.16 (0.24)
Change of interviewer waves 4 - 7 (base = change)	
No change	-0.36 (0.11)
Change of interviewer waves 7 - 8 (base = change)	
No change	-0.41 (0.10)
Number of waves successfully interviewed (base = 6)	
0	0.81 (0.18)
1	0.38 (0.18)
2	0.56 (0.17)
3	0.12 (0.17)
4	-0.04 (0.14)
5	0.05 (0.17)
Sex of interviewer (base = female)	
Male	0.10 (0.10)
Age of interviewer (base = 60-69)	
<30	0.42 (0.37)
30-39	0.29 (0.26)
40-49	0.22 (0.14)
50-59	0.08 (0.12)
70+	0.23 (0.25)
Level 2 variance	0.13 (0.06)

In terms of demographic and other variables measured on households and individuals, most variables showed a weaker relationship with propensity to respond. These variables included income and housing tenure. Variables showing no appreciable relationship, such as number of dependent children, urban/rural, accessibility of residence, car ownership, health status and strength of social relationships have not been included in Table 4.

The following variables had a relatively marked relationship with response propensity. Age of respondent was found significant with lower refusal rates for age groups 16-19 and 30-39 in contrast to age group 40+. If this variable is used as a continuous variable then it has a positive and significant coefficient (+0.091 (0.033)) also indicating that the older respondents are less likely to respond. Higher refusal rates are found for Asian and other ethnicities in comparison to being white; the category 'black' was not significantly different from 'white'. This finding is in line with the analysis in the third column of Table 2 for the comparison between persistent and slightly less persistent refusals. The lowest cooperation rates are found for those with no qualification; the highest response rate is found for those with an academic degree. There is an indication that the higher the qualification the lower the refusal rate. This finding too is in line with the analyses in Table 2. All of these findings are in line with previous cross-sectional research (see Durrant et al., 2010). The number of successful interviews the household has had is highly significant. The larger the number of successful interviews the lower is the probability of refusal at wave 8.

All variables dealing with change in interviewer are very significant. A change in interviewer during waves 4-7 and a change between waves 7 and 8 are both

significant indicating that if there was a change in interviewer this is associated with a larger probability of refusal; of the two variables there is some indication that a most recent change in interviewer (i.e. between wave 7 and 8) may be more important then a change of interviewer that had occurred previously (change of interview between waves 4-7.

Two variables on interviewers were available, namely their age and sex. Neither was statistically significant.

7. Conclusions and Discussion

In this paper we have studied associations between socio-demographic variables measured on mother-figures having dependent children and survey response patterns over time. We have also looked at the effect of interviewer characteristics on the propensity to respond.

Of the household level variables, income, tenancy, age, ethnicity and education are significantly associated with response propensity in both analyses. From the analysis of waves 4-7 we found that the number of dependent children predicted response propensity. Bearing in mind the fact that our sample consists of those with dependent children, our results do provide a valuable confirmation of those found by others. Being an owner occupier, having high income, education and belonging to the majority ethnic culture are associated with a higher propensity to respond to the survey. We found that the effects on refusal for these variables increases with

increasing number of times the refusal happens over time, although we could detect no such effect for being a lone parent or for tenancy type.

None of the interviewer observation data variables were found significant for predicting cooperation (these were variables such as whether there was a locked gate, security staff etc). In fact these types of variables would be expected to be more predictive of non-contact rather then refusal.

Based on the results from the multilevel cross-classified logistic model we found that the wave 7 interviewer level variance was not significant once wave 8 interviewer (i.e. the most recent interviewer) was in the model. In other words, it is the current (wave 8) rather than previous (wave 7) interviewer that is associated with propensity to respond. We found change of interviewer significant, where a change is associated with a higher probability of refusal. However, this does not enable us directly to adduce causal effects. To do this we would need to know why the survey organisation might change an interviewer and a separate experimental study has been set up to examine such a possibility. We did find variation between interviewers but we have very few interviewer level variables available to help to explain this in our current analysis. The age and sex of the interviewer are not found to be predictive of propensity to respond, although there is some suggestion that older interviewers are less likely to be refused. Analyses are currently in progress to study the effects of interviewer characteristics for longitudinal surveys further. In particular we will study the effect of interviewer characteristics such as experience level, attitudes and

personality traits, and possible interactions between interviewer and respondent characteristics.

Our results have implications for both survey design and analysis. In terms of designing a longitudinal survey, it would seem sensible to concentrate attempts to reduce non-response on the individuals with the characteristics we have identified. This should be possible since these characteristics are generally available from the first wave of a survey. Among the factors over which a survey organisation has control is the allocation of interviewers. Having the same interviewer is associated with a higher response propensity, so that keeping the same interviewer, where possible, for those identified as less likely to respond seems advisable. The fact that the current interviewer is the one most closely associated with the probability to respond implies that survey agencies should keep up efforts to use highly trained interviewers also in on-going longitudinal studies, rather than switching to potentially less experienced interviewers at later waves, e.g. for cost reasons.

In terms of data analysis, Goldstein (2009) suggests that, if attrition is viewed as a special case of missing data, then multiple imputation techniques provide an efficient modelling approach. Since, as we have shown, attrition is likely to be informative in terms of specific socio-demographic variables such as education, tenure and ethnic group, conditioning on the values of these variables during the imputation process will help to reduce potential biases.

8. References

Durrant, G. and F. Steele (2009). Multilevel Modelling of Refusal and Non-contact in Household Surveys: Evidence from Six UK Government Surveys. *Journal of the Royal Statistical Society, Series A,* 172, 361-381.

Durrant, G.B., Groves, G., Staetsky L. and Steele, F. (2010). Effects of Interviewer Attitudes and Behaviours on Refusal in Household Surveys. *Public Opinion Quarterly*, 74, 1-36.

Flores-Macias, F. and Lawson, C. (2008). Effects of Interviewer Gender on Survey Responses: Findings from a Household Survey in Mexico. *International Journal of Public Opinion Research*, 20, 1, 100-110.

Goldstein, H. (2003). *Multilevel Statistical Models*. Third edition. London, Edward Arnold.

Goldstein, H. (2009). Handling Attrition and Non-Response in Longitudinal Data. *International Journal of Longitudinal and Life Course Studies*, 1, 63-72.

Groves, R.M. (2006). Non-response Rates on Non-response Bias in Household Surveys, *Public Opinion Quarterly*, 70, 5, 646-675.

Groves, R.M. and Couper, M.P. (1998). *Non-response in Household Interview Surveys*, New York.

Groves, R.M., Cialdini, R.B. and Couper, M. (1992). Understanding the Decision to Participate in a Survey, *Public Opinion Quarterly*, 56, 475-495.

Groves, R.M., Dillman, D.A., Eltinge, J.L., and Little, R.J.A. (2002). *Survey Non-response*, New York, Wiley.

Hansen, K. M. (2007). The Effects of Incentives, Interview Length, and Interviewer Characteristics on Response Rates in a CATI-Study. *International Journal of Public Opinion Research*, 19, 1, 112-121.

Hawkes, D., and Plewis, I. (2006). Modelling Non-Response in the National Child Development Study. *Journal of the Royal Statistical Society A (Statistics in Society)*, 169, 3, 479-491.

Hox, J. and De Leeuw, E. (2002). The Influence of Interviewers' Attitude and Behavior on Household Survey Non-response: An International Comparison, in: Groves, R.M., Dillman, D.A., Eltinge, J.L., and Little, R.J.A. (2002), *Survey Non-response*, New York, 103-119.

Lepkowski, J.M., and Couper, M.P. (2002). Nonresponse in Longitudinal Household Surveys. In R.M. Groves, D.A., Dillman, J.L., Eltinge, and R.J.A. Little (Eds.), *Survey Nonresponse* (pp. 259-272). New York, Wiley.

Lyon, N., Mangla, J., Tait, C. and Scholes, S. (2007). *Families and Children Study (FACS) 2005, Wave 7.* London, National Centre for Social Research.

Nicoletti, C. and Peracchi, F. (2005). Survey Nonresponse and Survey Characteristics: Microlevel Evidence from the European Community Household Panel. *Journal of the Royal Statistical Society A (Statistics in Society)*, 168, 4, 763-781.

O'Muircheartaigh, C. and Campanelli, P. (1999). A Multilevel Exploration of the Role of Interviewers in Survey Non-response, *Journal of the Royal Statistical Society, Series A*, 162, 3, 437-446.

Pickery, J. and Loosveldt, G. (2002). A Multilevel Multinomial Analysis of Interviewer Effects on Various Components of Unit Non-response, *Quality and Quantity*, 36, 427-437.

Pickery, J., Loosveldt, G. and Carton, A. (2001). The Effects of Interviewer and Respondent Characteristics on Response Behavior in Panel Surveys, *Sociological Methods and Research*, 29, 4, 509-523.

Schnell, R. and Kreuter, F. (2005). Separating Interviewer and Sampling Point Effects. *Journal of Official Statistics*, 21, 3, 389-410.

Self, S. G. and Liang, K. (1987). Asymptotic properties of maximum likelihood estimators and likelihood ratio tests under nonstandard conditions. *Journal of the American Statistical Association*, 82, 605-610.

Snijders, T.A.B. and Bosker, R.J. (1999). *Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling*, London, Sage Publishers.