Survey Research Methods (2014)
Vol. 8, No. 1, pp. 57-66
ISSN 1864-3361
http://www.surveymethods.org

Collecting Biomarkers and Biological Samples Using Trained Interviewers. Lessons from a Pilot Study

Stephanie L. McFall
Universtiy of Essex
Colchester, UK

Anne Conolly
National Centre for Social Research
London, UK

Jonathan Burton
University of Essex
Colchester, UK

This paper reports the design and outcomes of a pilot study for the UK Household Longitudinal Study (UKHLS), *Understanding Society*, to develop and test the feasibility of collection of biomarkers and biological samples by trained non-clinical interviewers. The dimensions reported are recruitment and training of interviewers, completeness, acceptability and time required for data collection, and quality of the biological samples. Some comparisons are made with measures conducted by nurses in the main UKHLS survey. Biomarkers included anthropometrics, blood pressure, grip strength and the collection of saliva and dried blood spots. There was no difficulty in recruitment, though a health requirement for hepatitis B vaccination restricted the pool of interviewers. Nine of ten interviewers were certified for collection of biomarkers. The interviewers completed a high proportion of the individual measures, including the biological samples. The median time for data collection by interviewers was higher than for nurses in the UKHLS. The biological samples were of sufficient quantity and quality to support planned analyses. Interviewers were successful in implementing the data collection protocols for the pilot study. Decisions about interviewer collection of biomarkers depend on study design characteristics.
Keywords: Keywords: survey design; data collection; biomarkers; feasibility

1. Introduction

There is interest in enhancing interdisciplinary survey research by adding biomarkers to surveys (Weinstein, Vaupel, & Wachter, 2007; Hauser, Weinstein, Pool, & Cohen, 2010). Biomarkers are objectively measured indicators of normal or pathological biological processes. They are often of interest because they influence or predict health outcomes or disease. In survey research they form a contrast to self-reported health measures and offer the potential for identifying preclinical precursors of disease. In addition, the collection of biological samples, with the proper consents, permits study of genetic influences on health and behavioural outcomes.

There are different strategies for collection of biomarkers in surveys. One method asks participants to travel to a clinical examination centre for assessments conducted by clinical health professionals. An example of this is The Irish Longitudinal Study on Ageing (TILDA), with examination centres in Dublin and Cork to cover all of Ireland (Savva, 2011). This study has implemented an unusually wide range of biomarkers, including balance and vision tests. The centre-based assessments are supplemented with the collection of a core set of measurements in home visits. The home visit participants are typically more disabled than centre participants (Kearney et al., 2011). In a variation of the centre-based method, the U.S. National Health and Nutrition Examination Survey (NHANES) conducts assessments in a mobile facility.

Biomarkers may also be collected by health professionals in the respondents home. This approach reduces the burden on respondents relative to going to an examination centre. The Health Survey for England (HSE) and the English Longitudinal Study of Ageing (ELSA) (Craig & Hirani, 2010; Marmot & Steptoe, 2008) use trained nurses to conduct assessments in the home of participants who were interviewed earlier.

The integration of survey interviews with the collection of biomarkers by interviewers has been seen as a promising alternative. Relative to data collection in examination centres, the approach reduces the respondent burden and potentially results in less participation bias. Relative to nurse data collection, the wage rate for interviewers is somewhat lower. Integrated collection may also reduce the opportunity for attrition between the interview and biomarker sessions. Integrated collection of a relatively comprehensive set of biomarkers and questionnaire data has been implemented

Contact information: Stephanie McFall, Institute for Social and Economic Research, University of Essex, Wivenhoe Park, Colchester CO4 3SQ, United Kingdom (smcfall@essex.ac.uk)

in such studies as the Health and Retirement Survey (HRS) (Crimmins et al., 2008a, 2008b).

In this study, *Understanding Society,* the UK Household Longitudinal Study (UKHLS),tests the feasibility of collection of biomarkers by trained non-clinical interviewers. The UKHLS is a household longitudinal study with annual interviews and a large sample size (Buck & McFall, 2012). Its objectives include the support of interdisciplinary biomedical and social research. The study is funded by the UK Economic and Social Research Council (ESRC) and has scientific leadership from the University of Essex, University of Warwick and the Institute of Education. Data collection for the first five waves of the study has been carried out by the National Centre for Social Research (NatCen).

We report a pilot study to test the feasibility of collection of biomeasures by trained, non-clinical interviewers. We examine multiple dimensions: recruitment and training of interviewers; completeness, acceptability and time required for data collection; and quality of the biological samples.

2. Methods

The pilot study was conducted with participants from the 2010 NatCen Omnibus Survey, who had agreed to be re-contacted, not with current UKHLS sample members. The Omnibus Survey sample design has a random sample of addresses in Britain with one adult selected for interview per address. A total of 26 primary sampling units (PSUs) and 267 respondents were selected.

The pilot study took place in April May 2011. Ethical approval was granted by Oxfordshire A Research Ethics Committee Understanding Society - UK Household Longitudinal Study: IBIO Pilot (REC 10/H0604/70).

Description of biomarkers

The biomarker measurement protocols built on those of other studies. The protocols for collection of height and weight and saliva samples were taken from the HSE (Craig & Hirani, 2010), and the grip strength and blood pressure protocols were adapted from ELSA (Marmot & Steptoe, 2008). The blood spot data collection methods, not previously used in UK population surveys, was adapted from the HRS (Crimmins et al., 2008a; Weir, 2008). The two biological samples collected were saliva samples for DNA and the collection of capillary blood onto filter paper using a disposable safety lancet, referred to as dried blood spots (DBS). The set of measures collected overlapped substantially with those collected by nurses in the UKHLS (S. L. McFall, Booker, Burton, & Conolly, 2012).

Table 1 summarizes the biomarker procedures and eligibility criteria. For more detailed information, the full measurement protocols are an appendix in the pilot study technical report (https://www.understandingsociety.ac.uk/documentation/health-assessment/pilot-study-report).

Interviewer recruitment and training

Recruited interviewers were required to have been immunised against Hepatitis B, an infectious disease carried through blood.[1] The vaccination course takes six months, so only interviewers with an existing immunity were considered. In addition, interviewers with prior clinical training were excluded from working on the pilot study. In total, 85 interviewers reported that they had been vaccinated against Hepatitis B. From that list, Field Area Managers nominated 32 interviewers who they felt were likely to be competent and who were conveniently located to a selected sample point.

Training must prepare the interviewers to persuade respondents to participate, take accurate and consistent measurements, and collect and prepare biological samples for transport. The structure and content of the training program was influenced by the HRS and the U.S. National Social Life, Health and Aging Project (Jaszczak, Lundeen, & Smith, 2009).

The overall aims of the training were to:

- Fully train interviewers in each of the measurement/collection protocols,
- Ensure interviewers have knowledge and skills to conduct procedures with safety for themselves and participants,
- Ensure interviewers were confident and well-prepared to conduct fieldwork remotely, and
- Formally certify interviewers in the procedures.

Much of the training time focused on the specific measurement protocols and the operation and calibration of several kinds of equipment. Table 2 summarises the training schedule. Multiple modes of communication (written measurement protocols, DVDs of lectures and demonstrations, paired practice of skills, and individual feedback) were used to support learning (Jaszczak et al., 2009).

Interviewers working on the study were required to be certified. The certification process is an objective performance-based evaluation with assessment by members of the research team who had, in turn, been trained and certified themselves. Each procedure had major and minor criteria. One major or four minor errors required re-testing in a specific procedure, and inadequate performance on four or more procedures required a full re-evaluation. A single additional attempt at certification was permitted.

Before being permitted to work independently, interviewers were evaluated in the field by a nurse supervisor using a checklist. Physician clinical advice was available by telephone to interviewers.

Data collection procedures

Each interviewer was issued between 20 and 35 potential respondents and asked to conduct 10-12 interviews and to obtain at least 7 blood samples within 4 weeks of fieldwork. Several features of the data collection were different from the UKHLS. For example, potential participants had said they could be contacted for additional research. In addition, the

[1] This is a health and safety procedure to protect health professionals exposed to blood. NatCen has applied this requirement to interviewers and survey nurses. The same requirement has not been applied to interviewers undertaking DBS collection in the United States or Germany.

Table 1 Description of biomarker procedures

Biomarker	Equipment and outline of procedures	Exclusion
Height	Portable stadiometer; participant places head in Frankfort plane[a]	Pregnant; Too stooped; Difficulty standing (painful, unsteady, chair-bound)
Weight/body fat	Tanita BF 522W scales.[b] Respondent is weighed in light clothing with shoes and stockings removed.	Pregnant, Pacemaker, Unable to stand upright, Limit of 130 kg on scale
Waist circumference	Respondent places measuring tape around their body, over light clothes, at the level of the navel. Repeat measurement two times (three times if variation in the reading).	Pregnant; Confined to chair or stooped; Colostomy/ileostomy[b]
Blood pressure	Omron HEM 907 blood pressure monitor with three cuff sizes. Respondent sits quietly for five minutes. Three readings are taken. The interviewer gives scripted feedback based on the readings.	Pregnant
Grip strength	Smedley adjustable dynamometer. Respondents stand with upper arm against their trunk and their forearm at a right angle to the upper arm. The respondents squeeze as hard as they can for two seconds. Three trials of measurement with alternation of dominant and non-dominant hand.	Pregnant; Swelling, inflammation, pain or injury to hand Hand surgery in past 6 months
Dried blood spots	#903 Whatman filter paper and disposable Becton-DickinsonBD Microtainer™ lancet . Interviewer cleans finger with alcohol wipe and pricks the side of the finger pad with lancet. The first blood drop is wiped away with a sterile gauze pad. The interviewer collects additional spots on the filter card, aiming for five good spots. Respondent is given a gauze pad and adhesive when done.	Pregnant; Clotting disorder or use of blood thinning medications; Positive for HIV, Hepatitis B or C .
Saliva sample	Oragene 500 whole saliva DNA collection kit. Respondent is asked to rinse mouth to remove food particles. Respondent deposits saliva (spits) in container to 2 ml mark. The funnel lid is closed to release a buffered preservative. The interviewer puts on a separate lid prior to transport and gently inverts the tube to mix contents.	Pregnant; Positive for HIV; Hepatitis B or C

[a] Imaginary line that goes from the external ear canal to the bottom of the eye socket. Placing the head with this line parallel to the floor makes the height measurement accurate.
[b] External bag which holds bodily wastes.

fieldwork period was shorter than the 10 week period of the UKHLS. Note, however, that the pilot was not intended to test the effects on survey response.

Participants were told that the purpose of the study was to assess and improve methods for data collection and received a £10 conditional incentive for their participation. The interviewers recorded data in a computer-aided personal interview program (CAPI). The assessment began with the anthropometric measurements, blood pressure and grip strength, followed by collection of DBS and saliva. The session concluded with twenty minutes of questions to assess the integration of biomarker collection and interview. The time was also important to permit the blood spots to dry before being packed for transport. The question modules were about health behaviours, hypertension, diabetes, and use of health services. Finally, there was a short self-completion questionnaire about the data collection process (informed consent, reactions to obtaining the biological samples, and overall satisfaction with the interview). The CAPI program also recorded time stamp information for the interview.

On top of the usual laptop and survey materials, interviewers carried additional equipment: a portable stadiometer (for measuring height), bio-impedance scales, a tape measure, a blood pressure monitor, a dynamometer (to measure grip strength), saliva and DBS collection kits, consumables and packaging for the transport of biological samples. Interviewers were offered different storage and transportation solutions for the equipment including a wheeled case. The health and safety module covered manual handling techniques.

Participants were told that the saliva sample would be sent to a secure storage facility, where DNA would be extracted to determine the amount of DNA, and laboratory analyses would be conducted on the DBS samples. The consent procedures were written for the biological samples and oral for other measures.

Interviewers wore gloves, a universal precaution for handling biological substances, when handling saliva or blood samples. The DBS cards and saliva collection tubes were labelled with the respondents ID number and their date of birth immediately before sample collection.

Table 2 Description of the training sessions

Day 1	Introduction	Introductions Background to bio-measures Overview of the study Explanation of certification
	Measurement protocols (for each measure)	DVD presentation Demonstrations Practice Feedback
	Optional evening practice session	
Day 2	Sample and fieldwork structure Mock interview with volunteer respondents	
	Fieldwork procedures	Gaining informed consents Labelling and dispatching samples Respondent feedback The role of the Survey Doctor
	Certification Homework on consent, labelling and dispatch	
Day 3	Health and Safety	Dealing with biological substances Physical contact with respondents Equipment and manual handling
	Addressing respondent concerns	Doorstep techniques Achieving high response
	Research findings from bio-social research	
	Review and summary	Getting started Wrap up
	Additional re-certification attempts	

Process measures for data collection

Time data was collected from the keystroke audit trail in the CAPI program (Olson & Parkhurst, 2013). We removed several outlier values for the height module, the first measure in the interview, because some interviewers at the study debrief reported they began the height measurement while their computers booted up, recording the results on the measurement card and entering it later in the CAPI program. We compare median times for the measures which overlap with measures from the nurse health assessment component of the UKHLS because medians are less influenced by extreme values. Since whole blood samples obtained by the nurses provide materials for assays and genetic analysis (S. McFall, Petersen, Kaminska, & Lynn, 2013), we compare the times for nurse blood samples to the combined time for DBS and saliva samples collected by interviewers.

Transport of biological samples

The Oragene 500^{TM} whole saliva DNA collection kit (DNA Genotek, Inc., Ottawa, Ontario, Canada) has a preservative to stabilize the samples for prolonged storage at ambient temperature or in low temperature freezers Analytes from the dried blood spots have been found to be stable at ambient temperatures and when frozen, with the period varying by analyte and storage temperature (McDade, Williams, & Snodgrass, 2007).

Interviewers packed the biological samples for transport to the storage facility, Fisher Bioservice, using a plastic transport box moulded to hold the saliva sample tube. The blood spot cards were placed in a foil zip-lock envelope, along with a desiccant pack to retard moisture.

The saliva and blood packages were transported by first class post in a plastic biological substances envelope. The storage facility received about half of the samples within two days and more than two-thirds within 4 days of the interview. Two samples took the maximum time of 12 days.

Staff at the storage facility logged the samples and added the barcode label used in their retrieval system. The blood spots were protected from moisture and stored at ambient temperature until shipped to the analytic laboratory. Saliva samples were frozen at −20C.

3. Results

The empirical results focus on interviewer recruitment and training, issues related to data collection such as cooperation and time requirements, reactions of interviewers and respondents, and quantity and quality of the biological samples.

Interviewer recruitment and training

Initially, 22 of the 32 nominated interviewers were approached to work on the pilot: ten were not available during

Table 3 Completion of measures among eligible respondents

Measurement	Percent	Eligible respondents
Height	100.0	92
Weight	97.7	90
Body Fat	95.5	90
Waist	98.9	91
Blood pressure	100.0	91
Grip strength	100.0	92
Blood sample	90.8	87
Saliva sample	92.4	92
n	92	

the relevant period and two had no immunity to Hepatitis B based upon a blood test. The remaining ten interviewers (eight male and two female) agreed to work on the study. The requirement for Hepatitis B vaccination influenced recruitment since fewer female interviewers were already vaccinated. In contrast, the UKHLS interviewers are 55% female, and over 99% of NatCens nurse workforce is female. While none of the approached interviewers refused to work on the study, it does not follow that all field interviewers would be willing to work on a similar project.

All recruited interviewers completed training, but one was not certified to collect data on the study, despite a repeat attempt. In addition, partial re-certification was required for three individual interviewers; two on the blood pressure module (one for incorrectly positioning the cuff; one for taking down a reading incorrectly) and two interviewers mislabelled samples. Nine out of the ten interviewers were certified and given their assignments. Because the assessment criteria were detailed and stringent such that we did not expect all trainees to succeed in certification in all measures in a single attempt.

At the conclusion of the study, interviewers were debriefed and asked about training and certification. Their feedback was positive, but a common recommendation was to add a day or half day to the training to provide additional time to practice their newly acquired skills. Interviewers also said they valued the accompanied launch with nurse supervisors, because it boosted their confidence prior to working alone. Concerning certification, they said it focused their efforts during training and that their successful certification enhanced their confidence in their skills.

Participation

At the end of the four-week data collection period, 40% of the issued cases had not been contacted by the interviewer. Among contacted cases, 92 were interviewed (64%) and 51 refused (36%). The level of refusal to nurse visits in the UKHLS was 28% (McFall, et al., 2012). Interviewers described at the debrief that refusals tended to be firm: people were not open to persuasion when they had decided that this type of thing definitely wasnt for them.

Participants were more likely to be female (63%) than male. The age range was from 18 to 91; 38% were aged 18-44, 36% were 45-64 and 26% were 65 or older.

Cooperation rates among eligible respondents to the individual biomeasures are shown in Table 3. Cooperation was high for all measures, with the lowest participation for the DBS. For reference, in the nurse health assessment component of the UKHLS, 65% of participants provided a blood sample via venepunture (taking blood from a vein) (S. L. McFall et al., 2012).

The interviewers mostly met or exceeded the targets for collection of biological samples. All but one of the interviewers got the number of biological samples requested, and 100% cooperation was shown by some interviewers for the DBS (3 interviewers) and saliva samples (4 interviewers). Examination of individual interviewer performance in the pilot study should be viewed with caution since there were few respondents per interviewer.

Reactions to biomarker collection

As part of the interview, respondents were asked to complete a short self-completion questionnaire about the data collection process. Nearly all the respondents completed the self-completion (89 out of 92). When asked about providing a saliva sample, two-thirds of participants said it was very or fairly easy, but one-third found it difficult. Participants who gave a blood sample and had prior experience with venepuncture were asked which method they would prefer if giving a blood sample in the future. Two-thirds preferred the finger prick, and 20% would be willing to do either. However, 10% preferred venepuncture and one respondent would not give a blood sample in the future. With respect to the overall biomarker collection, more than three-quarters of respondents said they would be willing to do another interview with health measures and samples in the future.

At the interviewer debrief, interviewers gave recommendations in relation to individual biomarker procedures. These recommendations are summarized in Table 4.

Data collection time

Table 5 shows the time required for collection of biomeasures. The mean time for collection of all biomarkers was 61 minutes (SD 16.6), with a median of 58 minutes. The table also presents times for comparable procedures from the UKHLS nurse assessment (wave 2). Medians are used for the comparison since they are less affected by extreme values. The median times for interviewers were about 40% higher than for the nurses.

3.5 Quality and quantity of biological samples

The quality of the blood spots can affect the utility of samples for analysis. When spots are smeared or doubled, the analyte is not evenly distributed over the paper (Williams & McDade, 2009), and the spot may not be usable. We used educational materials from the U.S. Centers for Disease Control & Prevention as reference material for evalu-

Table 4 Summary of Interviewer comments about individual measures

Measure	Comments/suggestions
Height, weight/body fat	CAPI checks for unusually low or high measurements should be discussed in training. Requested information about normal ranges for percent body fat.
Waist circumference	Interviewers said that the navel is not an accurate pointer to the waist, particularly on larger respondents. Some also suggested that the respondent materials use the word "middle" instead of "waist". Interviewers said the procedure was difficult, except on slim respondents; however, they did not perceive specific gender issues.
Blood pressure	Interviewers suggested a CAPI help screen with a list of error messages for the Omron device and solutions. Interviewers requested information to use as a rationale for the five minute resting time to reduce respondents impatience.
Grip strength	Interviewers said it is important in the demonstration to convey a sense of effort so respondents are more likely to try hard.
Dried blood spots	Interviewers reported feeling confident with this measurement: "100% confident as a result of the training" and were surprised by how willing the respondents were to take part. Interviewers found major variation in the length of time required depending on how easily the respondent bled. Training should have more information about blood spot quality.
Saliva	Some respondents were self-conscious about giving a saliva sample. Interviewers sometimes allowed some people to go elsewhere to do this. The length of time to provide the saliva sample varied. In a future study, interviewers would want more information about how DNA can be used for research. Interviewers suggested that respondents, as well as interviewers, should clean their hands after the saliva sample, as participants later touched show-cards and the laptop.

ating whether spots were satisfactory (Mei, 2010). Two researchers visually inspected the 79 DBS cards using an approach suggested by Williams and McDade (2009). Spots, classified as large or small, were counted. We also noted whether spots were blotted, smeared, or double dropped. One in four cards (n=19) were classified as being of highest quality: five large spots with no blots or smears. The number of small spots was generally the obverse of the number of large spots, so we only present the number of large spots. There were 22 cards with five large spots, 25 with three to four, 15 with one to two, and 17 with no large spots. With respect to smearing or double spotting, 22 of the cards were classified as having blots or smears.

We assessed the adequacy of the DBS to conduct analysis for three assays which have been used in several major surveys. The Institut fur Klinische Chemie, University of Mannheim, conducted analysis of total cholesterol, glycated haemoglobin and c-reactive protein. The laboratory procedures can be obtained from the authors. We estimated that the three assays would require two large spots or the equivalent amount of blood from smaller spots. All cards provided sufficient material from either large or small spots to conduct the assays (and indeed the tests were completed). Of course, having larger quantities would provide more material for additional assays.

For the saliva samples, we followed the recommendations of an evaluation study of whole saliva and buccal (cheek) cell collection techniques (Rogers, Cole, Lan, Crossa, & Demerath, 2007). One of the 85 samples was destroyed because too little saliva was collected. For the remaining 84 samples, the mean quantity of DNA extracted was above the benchmark chosen, and, indeed, typical of quantities obtained from blood. The DNA processing was done by Fisher Bioservice.

4. Discussion

The purpose of this pilot study was to examine the feasibility of interviewer collection of multiple biomeasures, particularly with the collection of biological samples. Feasibility involves demonstration that the procedures can be conducted, that they are technically satisfactory and that the performance is reasonable in relation to alternatives. Clearly, the pilot study demonstrated that the procedures could be implemented by interviewers. The interviewers collected data from the requested number of individuals and obtained biological samples from a high proportion of participants.

Interviewer recruitment and training

We did not experience difficulty in recruiting interviewers to collect biomarkers. However, a lack of Hepatitis B vaccination shaped the pool of recruits. The importance of this particular barrier may vary by location, insurance company, or by the level of perceived risk associated with collection methods (for example, this vaccination would not be required in a biomarker collection which does not collect biological samples.

Table 5 Times in minutes for biomarker collection in Pilot Study and Median time for UKHLS nurse assessment for corresponding measures

	Pilot Study (n=92)	UKHLS nurse assessment (n= 15,431)
Height[a]		
Mean ± SD	4.4 ± 2.4	3.9 ± 3.2
Median	3.8	3.3
Interquartile range	2.7 – 5.4	1.7 – 5.3
Weight/Body fat		
Mean ± SD	4.6 ± 1.9	2.0 ± 1.9
Median	4.7	1.3
Interquartile range	3.2 – 5.9	0.8 – 2.6
Waist circumference		
Mean ± SD	4.0 ± 2.3	1.9 ± 1.6
Median	3.7	1.6
Interquartile range	2.5 – 5.1	0.6 – 2.5
Grip strength and blood pressure		
Mean ± SD	19.6 ± 5.6	11.6 ± 5.2
Median	17.9	11.6
Interquartile range	15.4 – 23.1	8.4 – 14.6
Blood sample (if provided)[b]		
Mean ± SD	16.6 ± 5.7	12.9 ± 6.6
Median	17.9	12.4
Interquartile range	12.3 – 20.7	8.8 – 16.6
Saliva (sample taken)[c]		
Mean ± SD	10.7 ± 5.3	
Median	10.2	Not applicable
Interquartile range	7.6 – 12.9	
Both biological samples		
Mean ± SD	27.3 – 8.8	12.9 ± 6.6
Median	25.7	12.4
Interquartile range	20.5 – 33.2	8.8 – 16.6
All biomarkers[d]		
Mean ± SD	60.9 ± 16.6	28.6 ± 12.0
Median	57.7	27.4
Interquartile range	48.7 – 71.8	20.2 – 35.6
Survey questions[e]		
Mean ± SD	18.2 ± 5.2	
Median	17.3	Not applicable
Interquartile range	14.5 – 20.9	

[a] Excludes 7 cases with times less than 1 minute
[b] n = 79
[c] n = 85
[d] Excludes cases with times less than 1 minute for height and who did not provide DBS
[e] Excludes 3 cases with time greater than 2 hours

However, survey designers should anticipate that there are differences in recruiting interviewers to collect biomarkers: the role will not be for all interviewers. It is important to inform potential interviewers about the nature of the tasks (Jaszczak et al., 2009). Their enthusiasm for the modified role may depend on their level of interest, concern about their ability to be certified or maintain certification in the biomarker collection, finding the equipment burdensome, and other features related to perceived difficulty. Such disincentives may, of course, be offset by other factors such as the pay rate set for interviewers in this type of study, though this would increase the cost of using interviewers. In scaling up for larger projects, interviewer selection is likely to be an important issue.

Successful implementation of the training and certification process is a major accomplishment of the pilot study. Certification, a form of performance-based evaluation, ensured accurate and safe implementation of the protocols and boosted interviewer confidence in their skills.

Participation and time required for data collection

In examining the feasibility of biomarker collection by interviewers we considered not only what was technically possible but the performance of interviewers in comparison to nurses. Comparison of the pilot study interviewers with the experience of nurses shows some interesting contrasts. With respect to cooperation, a larger proportion of individuals refused to participate in the pilot study compared to the UKHLS nurse component (S. McFall et al., 2013). However, once an individual agreed to participate they were more likely to provide a blood sample via finger prick (86%), a less invasive technique, than via venepuncture (65%) as used by the nurses. Interviewers also obtained a high rate of agreement to provide saliva samples. There is a trade-off between the level and potential for bias in overall participation and in provision of biological samples. Their relative importance should be evaluated in study design decisions.

There were also trade-offs between nurses and interviewers in relation to the time and costs of data collection. The ratio of the direct cost of an interviewer day compared to a nurse day was 1:1.25. This includes fees, holiday pay and national insurance, and travel costs.

We have also compared the time required to collect a set of biomarkers by interviewers and nurses. If the time differences had been narrow, we might attribute this difference to the different levels of experience in the two groups. However, the median times showed substantial and consistent differences favouring the nurses and so at least a portion of the time differences is due to clinical experience. Thus, pay rates and productivity are both relevant to comparisons of interviewers and nurses.

Comparison of cooperation rates is difficult because the pilot study was not conducted to maximise response. However, we can see that the comparison of costs and productivity is not simple. Even with the limited comparisons possible in this study, the cost balance does not clearly favour interviewers in relation to nurses. The precise balance will depend on the study objectives and design parameters. Researchers planning biosocial surveys may find the information presented useful since few studies have presented time requirements for biomarkers. It is not unusual to find that these procedures require substantial time. For example some studies have reported adjusting their designs, trimming measures or delivering different modules to random subsets of their sample in order to balance the collection of different biomeasures and their time requirements (Smith et al., 2009). Survey designers will need to weigh the value of each measure and its time requirements.

Biological samples

Population surveys in the UK have not much used the finger prick method to collect blood samples, and we encountered some challenges in this area. First, we found it difficult to identify laboratories with sufficient expertise in the less standard methods of DBS analysis, but eventually we were referred to the Institut fur Klinische Chemie, University of Mannheim. This laboratory and chief scientist has a program of research in biomarker development and implementation. Researchers in other locations may not experience finding a laboratory to be difficult. There were additional scientific and administrative challenges related to DBS. While assays for DBS are becoming more available, they are not standard. Study designers should consider research to validate, calibrate, and assess stability in relation to each assay planned for the study. McDade and colleagues describe a useful general strategy to be followed in such a program of research (McDade et al., 2007).

The collection of the biological samples (blood and saliva since both are required to provide the DNA and blood analytes) was a major share of the time required for biomarker collection and interviewer training. Interviewer training is extremely important in addressing biosafety concerns and collecting and recording accurate data; however, its content is shaped by the breadth and complexity of the measures selected.

Despite these challenges there were successes in the collection of biological samples. The quality of the biological samples as assessed by visual inspection showed relatively good quality. In addition, both saliva and blood samples yielded sufficient material for analysis.

Limitations

There are several limitations in the applicability of the pilot study to the design dimensions of the UKHLS. With respect to sample design, the pilot study was a sample of individual adults who had previously completed a brief interview, not a household design. So the pilot study does not have the same demands of collecting data from multiple household members. In addition the priority given to the interviewers was to get experience in collecting the biomeasures rather than in obtaining cooperation. Fieldwork was stopped when sufficient cases had been obtained. It may be, therefore, that the households who participated were easier to

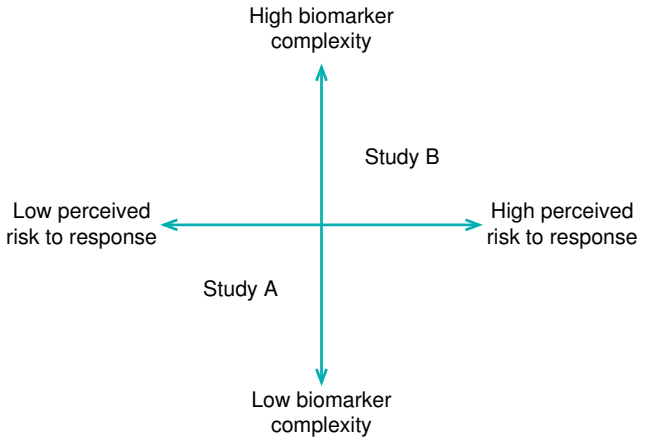

Figure 1. Design considerations in decisions to add biomarkers

contact and that they differ from those who were never contacted. Consequently, we cannot generalise about whether the observed rate of cooperation would be produced with a longer and more complex interview or to studies where the interviewers make every effort to maximise response rates. An additional limitation was in not including a component validating the collection of the biomarkers, such as nurse collection of the same measures on the same individuals. For an example see the report produced for the Scottish Health Survey (ScotCen Social Research, 2013).

Conclusions

Interviewers successfully implemented collection of biomarkers and biological samples in the pilot study. However, feasibility is also relative to several features of study design. Figure 1 defines a two dimensional space to characterize the decision about interviewer collection of biomarkers. The horizontal dimension represents the complexity of the planned biomarkers and biological samples. Complexity increases with number of procedures, type of equipment, time demands, and difficulty of obtaining biological samples. For example, in the pilot study, the biological samples required a major share of the data collection time. However, other types of biological samples, for example nail or hair, could be more easily collected. The vertical dimension is the perception that biomarker collection will adversely affect the response rate or future attrition in a longitudinal study.

We illustrate with two contrasting cases. Study A could be a cross-sectional study of children considering the addition of objective height and weight measurements to its interview. The biomarker collection should present no technical problems, especially if the total interview length was kept reasonable. There should also be no barriers to implementation in a similar longitudinal study.

Study B represents study design issues seen in the UKHLS. The range of biomarkers was relatively comprehensive. Study objectives also called for establishment of a biological sample repository to support research about emerging research questions. As a longitudinal household study, it was sensitive to the effects of time for data collection for individuals and all interviewed household sample members. Thus, there is concern about the potential effects of biomarker collection on attrition.

While the UKHLS learned much from the pilot study, we have implemented the nurse model for the initial biomarker collection. The lessons from the pilot study will be important in future waves of the UKHLS (*Understanding Society*). We hope that this pilot study will also contribute to the design of other studies.

Acknowledgements

This research is part of the *Understanding Society* programme, funded by the UK Economic and Social Research Council. We recognize the assistance of Kavita Deepchand, Maya Agur, Rachel Craig, and Josephine Taylor.

References

Buck, N., & McFall, S. (2012). Understanding society: Design overview. *Longitudinal and Life Course Studies*, *3*(1).

Craig, R., & Hirani, V. (2010). *Health survey for England, 2009. Vol 2., methods and documentation*. London: NHS Information Centre.

Crimmins, E., Guyer, H., Langa, K., Ofstedal, M. B., Wallace, R., & Weir, D. (2008a). *Documentation of biomarkers in the Health and Retirement Study*. Ann Arbor: Survey Research Center.

Crimmins, E., Guyer, H., Langa, K., Ofstedal, M. B., Wallace, R., & Weir, D. (2008b). *Documentation of physical measures, anthropometrics and blood pressure in the Health and Retirement Study (No. dr-011)*. Ann Arbor: Survey Research Center.

Hauser, R. M., Weinstein, M., Pool, R., & Cohen, B. (Eds.). (2010). *Conducting biosocial surveys: Collecting, storing, accessing, and protecting biospecimens and biodata*. Washington, DC: National Academies Press.

Jaszczak, A., Lundeen, K., & Smith, S. (2009). Using nonmedically trained interviewers to collect biomeasures in a national in-home survey. *Field Methods*, *21*(1).

Kearney, P. M., Cronin, H., O'Regan, C., Kamiya, Y., Whelan, B. J., & Kenny, R. A. (2011). Comparison of centre and home-based health assessments: early experience from the Irish Longitudinal Study on Ageing (TILDA). *Age Ageing*, *40*(1).

Marmot, M., & Steptoe, A. (2008). Whitehall II and ELSA: Integrating epidemiological and psychobiological approaches to the assessment of biological indicators. In M. Weinstein, J. W. Vaupel, & K. W. Wachter (Eds.), *Biosocial surveys.* Washington, D.C.: National Academy Press.

McDade, T. W., Williams, S., & Snodgrass, J. J. (2007). What a drop can do: dried blood spots as a minimally invasive method for integrating biomarkers into population-based research. *Demography*, *44*(4), 899-925.

McFall, S., Petersen, J., Kaminska, O., & Lynn, P. (2013). *Understanding society, the UK Household Longitudinal Study Wave 2 nurse health assessment, 2010–2012. Guide to nurse health assessment.* Retrieved 14/03/2014, from https://www.understandingsociety.ac.uk/documentation/health-assessment/

McFall, S. L., Booker, C. L., Burton, J., & Conolly, A. (2012). *Implementing the biosocial component of Understanding Society – nurse collection of biomeasures.* Understanding Society working paper series. Retrieved 14/03/2014, from

https://www.understandingsociety.ac.uk/research/publications/working-paper/understanding-society/2012-04

Mei, J. (2010). *External quality assurance for HIV rapid testing using dried blood spots.* Retrieved 28/02/2014, from http://wwwn.cdc.gov/mlp/pdf/GAP/mei.ppt

Olson, K., & Parkhurst, B. (2013). Collecting paradata for measurement error evaluations. In F. Kreuter (Ed.), *Improving surveys with paradata: Analytic uses of process information.* New York: John Wiley & Sons.

Rogers, N. L., Cole, S. A., Lan, H. C., Crossa, A., & Demerath, E. W. (2007). New saliva DNA collection method compared to buccal cell collection techniques for epidemiological studies. *American Journal of Human Biology*, *19*(3).

Savva, G. (2011). Methodology. In G. S. Barrett & V. T. . R. A. Kenny (Eds.), *Fifty plus in Ireland 2011.* Dublin: Trinity College Dublin.

ScotCen Social Research. (2013). *Waist and blood pressure validation study.* Retrieved 28/02/2014, from http://www.Scotland.gov.uk/Topics/Statistics/Browse/Health/scottish-health-survey

Smith, S., Jaszczak, A., Graber, J., Lundeen, K., Leitsch, S., & Wargo, E. (2009). Instrument development, study design implementation, and survey conduct for the National Social Life, Health, and Aging Project. *The Journals Of Gerontology. Series B, Psychological Sciences And Social Sciences*, *64*(Suppl. 1), i20-i29.

Weinstein, M., Vaupel, J. W., & Wachter, K. W. (2007). *Biosocial surveys*. Washington, DC: National Academies Press.

Weir, D. (2008). Elastic powers: The integration of biomarkers into the Health and Retirement Study. In M. Weinstein, V. J. W., & K. W. Wachter (Eds.), *Biosocial surveys.* Washington, DC: National Academy Press.

Williams, S. R., & McDade, T. W. (2009). The use of dried blood spot sampling in the National Social Life, Health, and Aging Project. *The Journals Of Gerontology. Series B, Psychological Sciences And Social Sciences*, *64*(Suppl. 1), i131-i136.