ORIGINAL ARTICLE

Assigning exposure to pesticides and solvents from self-reports collected by a computer assisted personal interview and expert assessment of job codes: the UK Adult Brain Tumour Study

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Objectives: To compare assignment of occupational pesticide and solvent exposure using self-reported data collected by a computer assisted personal interview (CAPI) with exposure based on expert assessment of job codes. To discuss the advantages and disadvantages of using a CAPI to collect individual occupational exposure data.

Methods: Between 2001 and 2004, 1495 participants were interviewed using a CAPI for a case-control study of adult brain tumours and acoustic neuromas. Two types of occupational data were collected: (1) a full history, including job title from which a job code was assigned from the Standard Occupational Classification; and (2) specific details on pesticide and solvent exposure reported by participants. Study members' experiences of using the CAPI were recorded and advantages and disadvantages summarised.

Results: Of 7192 jobs recorded, the prevalence of self-reported exposure was 1.3% for pesticides and 11.5% for solvents. Comparing this with exposure expertly assessed from job titles showed 53.6% and 45.8% concordance for pesticides and solvents respectively. Advantages of the CAPI include no data entry stage, automatic input validation, and a reduction in interviewer bias. Disadvantages include an adverse effect on study implementation as a consequence of resources required for programming and difficulties encountered with data management prior to analysis.

Conclusions: Different methods of exposure assessment derive different exposure levels for pesticide and solvent exposure at work. Agreement between self-reported and expert assessment of exposure was greater for pesticides compared to solvents. The advantages of using a CAPI for the collection of complex data outweigh the disadvantages for interviewers and data quality but using such a method requires extra resources at the study outset.

Data on occupational and environmental exposure in case-control studies are usually collected retrospectively from a variety of sources, including routinely available statistics, abstraction of medical records, postal surveys, and face-to-face interviews. Self-reported information from surveys or interviews may include occupational histories¹ as well as details of specific exposures.^{2,3} Information on job titles and industrial settings can be transformed by coding with standard classification schemes⁴ and exposure assigned through job-exposure matrices,⁵ as well as other methods.⁶ However, information on specific exposures may be reported by individuals in case-control studies across many job classifications and companies where historical data to validate these reports may be unavailable or incomplete. In addition, the limitations of using job titles to categorise exposure are well recognised.⁷ For example, factors such as method of application and use of control measures and personal protective equipment can influence levels of exposure which are not identified solely from job title,⁸ and thus may lead to misclassification. Processes, technology, and control measures change over time, resulting in changes in exposure levels, as has been reported previously for specific industries.^{9–12}

Computer assisted personal interview (CAPI) systems were originally developed to collect data from large numbers of participants at face-to-face interviews in a cost effective and systematic way.^{13,14} They have been used extensively in national household surveys, market research, and large scale

health surveys,^{15–17} but less frequently in epidemiological research.¹⁸ The UK Adult Brain Tumour Study (UKABTS), a case-control study investigating risk factors for brain tumours occurring in adults, was established in 1999, and the investigators agreed to develop a CAPI as the data collection tool. A CAPI was chosen for a number of reasons, including highly structured questioning to lessen bias by ensuring systematic data collection, efficient electronic data processing, and immediate data validation with consistency checks at the point of input.¹³ These qualities allow the collection of a complex and rigorous occupational dataset which will increase the accuracy of person specific occupational exposure^{19,20} where the need for exposure and occupation specific questions has been identified.^{21,22}

The UKABTS is part of the INTERPHONE study,²³ an international collaborative case-control study of brain tumours focusing primarily on investigating risk in relation to mobile phone use. The core data was collected using a customised CAPI with the facility for additional modules which were developed by the UKABTS for the capture of occupational data focussing on the area of exposure to solvents and pesticides.

This paper examines the agreement between self-reported exposure during a face-to-face computer assisted personal interview and assigned exposure based on Standard Occupational Code, where jobs were classified using occupational history details. An evaluation of the factors associated with collecting occupational data using a CAPI is made.

Table 1 Participants by case-control and interview status, sex, and number of jobs reported in occupational histories (percentages given in parentheses)

		Cases*			Controls			Cases + controls
		M	F	M + F	M	F	M+F	
Interviewed participants	Not asked	276	223	499	64	54	118	617
	Asked†	233 (45.8)	277 (55.4)	510 (50.5)	483 (88.3)	502 (90.3)	985 (89.3)	1495 (70.8)
	Total	509	500	1009	547	556	1103	2112
	Median age‡	50	52	52	52	52	52	52
Exposure reported in CAPI	Pesticides§	18 (7.7)	4 (1.4)	22 (4.3)	45 (9.3)	7 (1.4)	52 (5.3)	74 (4.9)
	Solvents§	107 (45.9)	50 (18.1)	157 (30.8)	217 (44.9)	94 (18.7)	311 (31.6)	468 (31.3)
Number of jobs (occupational histories‡)	Median	5	4	4	5	4	4	4
	Maximum	13	14	14	18	15	18	18

*Case participants were aged 18–69 years and diagnosed with one of the following: gliomas, meningioma, acoustic neuroma, "other brain tumours".

†Percentage of total participants interviewed.

‡Includes only participants who completed the occupational pesticide and solvent exposure modules.

§Percentage of participants asked the solvent and pesticide questions.

METHODS

The UKABTS was a population based case-control study conducted across four UK regions: West Yorkshire, West Midlands, Trent, and Scotland between 1 January 2001 and 28 February 2004. Multicentre research ethics committee approval was given along with all appropriate local research ethics committee approvals. Written informed consent was obtained from all subjects at interview. Cases included patients aged 18–69 years diagnosed with gliomas, meningiomas, other brain tumours, and acoustic neuromas. Controls were matched to cases by age (up to 1 year older), sex, and general practice, and were randomly selected from the lists of the general practitioner of a case in a 1:1 case-control ratio for all tumours, apart from acoustic neuromas, where two controls were selected. This paper does not examine risk estimates, and therefore information from case and control participants is combined. Three versions of the CAPI were implemented, but only the third version for the UKABTS contained the pesticide and solvent questions.

Two types of occupational information were collected:

- Full occupational histories from leaving full time education up to the time of interview. Before the interview, participants were sent a paper occupational calendar to complete with job title, duties carried out, main business of employer, and years worked; this provided a guide during the main CAPI interview. The study interviewers were trained to code job titles and descriptions according to the Standard Occupational Classification (SOC).²⁴ Training included a specific session, ongoing monitoring, and a quality control exercise after three months, where interviewers were given 30 jobs to code; agreement and performance were consistently good across the study. For

each job recorded at interview, a SOC code was assigned, except for 36 reported jobs which had insufficient information. Part-time, temporary (less than 3 months), and occasional work was not included; any non-vocational study (for example, university student) was excluded, as were periods when not in active employment (for example, time taken to bring up a family).

- Customised modules were developed for the CAPI, with input from occupational hygienists and pesticide exposure experts, to collect information on use of pesticides and solvents. This included hours spent on different tasks, types and trade names of pesticides and/or solvents used, ventilation available during their use, and personal protective equipment worn. Figure 1 illustrates the structure of the specific occupational exposure questions; the example given is for exposure to solvents through printing.

Independently of the data, all job codes (SOC) were independently assessed by two experts (MvT and AB) as to the likelihood of involving exposure to pesticides and solvents. Exposure for each occupation was categorised as "not likely", "possible", or "probable" based on the full 4-digit SOC code. To compare agreement between expert assessment and self-reported exposure, all job codes with probable exposure were classed as exposed, and those coded as not likely or possible were classed as unexposed. Kappa statistics, sensitivity, specificity, and positive and negative predictive values were then calculated to assess correlations between reported and assessed exposure levels; expert assessment was used as the reference.²¹

The 13 study interviewers provided feedback on the use of CAPI using a semi-structured postal questionnaire, three

Table 2 Comparison of occupational pesticide and solvent exposure between expert assessment of standard occupation codes (SOC) and self-reported exposure collected using the CAPI for 1495 participants

Expert exposure assessment from occupation code	Self-reported exposure by occupation*							
	Pesticides				Solvents			
	Yes		No		Yes		No	
	n	(%)	n	(%)	n	(%)	n	(%)
Probable	45	(53.6)	39	(46.4)	164	(45.8)	194	(54.2)
Possible	22	(8.4)	241	(91.6)	320	(18.7)	1389	(81.3)
Not likely	28	(0.4)	6817	(99.6)	344	(6.7)	4781	(93.3)
Total	95	(1.3)	7097	(98.7)	828	(11.5)	6364	(88.5)

*7192 jobs were reported and could be coded.

Figure 1 Example flowchart of solvent exposure question.

months after the completion of interviewing. The questions related to training with the laptop and CAPI, general usability, specific aspects of the pesticide and solvent questions, and suggestions for improvement. These were combined with the authors' experiences during the study to give a summary of advantages and disadvantages.

RESULTS

In total, 2112 participants were included in the UK Adult Brain Tumour Study; however, due to delay in implementation of the CAPI version with the occupational questions on pesticide and solvent exposure, data were available for 1495 participants (70.8%) (table 1).

For participants who completed the occupational pesticide and solvent exposure modules, a total of 7192 jobs were coded. Table 2 compares exposure from the expert assessment for pesticides and solvents with participants' self-reported exposure, for example, exposure to pesticides were reported for 53.6% of jobs that were assigned probable

pesticide exposure through expert assessment of job code. The percentage of all jobs where subjects had reported occupational exposure to pesticides was lower than exposure to solvents (1.3% v 11.5%). The prevalence of expertly assessed probable exposure was similar to self-reported exposure for pesticides (1.2% of jobs were classified by experts as probable exposure, compared to 1.3% of jobs with self-reported exposure). In the case of solvent exposure, expert assessment resulted in 5.0% of jobs being classified as probably exposed, which was much lower than the 11.5% of jobs with self-reported solvent exposure. Comparing the three expert exposure assessment categories for pesticides and solvents, it appeared that there was more agreement between the two for pesticides. Of all jobs classed as not likely to have solvent exposure, 7-8% had self-reported exposure; whereas for pesticides this was less than 1%.

Table 3 gives the results of calculating agreement between job (SOC) codes categorised as having probable exposure and positive self-report. Kappa statistics for pesticides and

Table 3 Kappa, sensitivity, specificity, and positive and negative predictive values for expert exposure assessment when using expert assessment as reference

	Pesticides		Solvents	
	Estimate	95% CI	Estimate	95% CI
All (n=7192 occupations)				
Kappa	0.50		0.22	
Sensitivity	53.6	52.4 54.7	45.8	44.7 47.0
Specificity	99.3	99.1 99.5	90.3	89.6 91.0
Positive predictive value	47.4	46.2 48.5	19.8	18.9 20.7
Negative predictive value	99.5	99.3 99.6	96.9	96.6 97.4

solvents were 0.50 and 0.22 respectively, suggesting that agreement was poorer between the two methods for solvent exposure. This was also reflected in a low positive predictive value for solvents, but both pesticides and solvents had a similar sensitivity. The kappa statistic tended to be slightly lower for females compared to males (pesticides: $M = 0.50$, $F = 0.43$; solvents: $M = 0.23$, $F = 0.15$).

Table 4 identifies the advantages and disadvantages of employing a CAPI as evaluated by the authors and the interviewers.

DISCUSSION

Classifying exposure

Our data contained information on occupational histories and specific exposures associated with each job. We have illustrated how different methods of exposure assessment derive different exposure levels for occupations. The comparison of different exposure methods suggests it is more difficult to define jobs likely to involve solvents than pesticides; a similar pattern has been found in other studies comparing self-reported exposure with a job exposure matrix.²⁵ There could be several reasons for this, including the greater variability of occupations that would involve exposure to solvents, therefore making it more difficult to classify jobs only using job code; also participants may also be unsure about what products contain solvents as they are used in a wide range of activities.

It appears that there was slightly more agreement for the occupational exposures assigned for males than for females for

both pesticides and solvents. A previous study found agreement between self-report, and a full industrial hygiene review of job description also showed a lower level of agreement for females compared to males when exposure was assessed at the individual rather than occupational level.²¹

As a computer assisted personal interview was used for this study, the complexity of the data that has been collected will allow for a more rigorous assessment of exposure by combining the self-reported detail and occupational codes to create a more accurate assessment using a combination of exposure methods.

Using a computer assisted interview

Using a CAPI permits complex questioning related to occupational exposures to be delivered relatively simply by an interviewer, but it is easy to underestimate the time required for programming and development, which can impact on crucial piloting of the system before interviewing begins; the pesticide and solvent sections alone took 455 hours to program. Using this type of computerised interviewing system also requires that question format is fully standardised to make sure data collected can be easily amalgamated. It is the nature of occupational questionnaires that they will become repetitive where people report a specific associated exposure. One of the disadvantages of the UKABTS CAPI was the inability to navigate “back” and edit responses if participants changed their mind during a sequence or loop of questions. Future designs should accommodate for this.

Table 4 Summary of the advantages and disadvantages of the development and implementation of the UKABTS CAPI

Advantages	Disadvantages
Programming, interviewing, and procedures Allows for more complexity than paper questionnaires Reduction in interviewer bias as questions are highly structured Data security easily managed through encryption, immediate electronic data storage, and backup Immediate data validation through automatic checks Removal of the need for data entry stage, reducing errors Automatic question routing reduces interviewer and participant fatigue Collecting and analysing occupational exposure data Allows occupational exposure to be assessed more precisely with a combination of specific exposure questions	Initial design stage and extensive piloting is crucial to prevent inconsistencies in data Highly specific programming and data management skills are required and need to be adequately resourced Technical problems can lead to loss of data Blaise programs do not facilitate making a hard copy Visualisation of the interview data is difficult as the data are held in multiple tables If screening questions are not clearly worded, irrelevant data may be collected that needs subsequent exclusion
Interviewer perspectives Interviewers found the CAPI an acceptable tool and fears about a “physical barrier” were unfounded Prompts and images on screen improve participants’ understanding of complex questions	Interviewers require extensive training on laptop use, the interview tool, and the submission of data Question routing makes it difficult to exit sections when participants changed their mind about exposures Carrying laptops can leave interviewers feeling vulnerable to theft

Main messages

- Confirming previous reports, assignment of exposure will vary according to whether it is based on self-reported interview data or expert assessment of job titles.
- Agreement between the two methods is stronger for occupational exposure to pesticides as compared with solvents.
- Using a computer assisted interview allows the collection of highly detailed self-reported information at interview, but has the disadvantage of requiring extra resources for programming, processing, and interpretation.

The CAPI was an excellent tool for data validation with consistency and range checks at the point of input. This can be especially important in the collection of occupational data where exposure patterns are complex so as to prevent mistakes in inputting. The use of a CAPI also allowed the data cleaning stage of the study to be reduced, with the removal of the need for data entry and the extra error this can incur in the dataset.²⁶

Individual modules of questions that make up the computerised interview are independent and therefore can be extracted and used in the future. This will be a valuable resource to other studies where they can be adapted to collect information on a range of occupational exposures; this would then greatly reduce the resources needed in the setting up process of similar future studies.

Personal self-reporting of jobs and activities related to exposure is a useful way to collect information on individuals to inform an exposure model, but other information sources also need to be used to complete the exposure assessment. In this paper pesticide and solvent exposure was only considered at the exposed/unexposed level and further work will be needed to complete a full exposure assessment for use in a more detailed analysis of brain tumour risk and occupational exposure to pesticides and solvents. For the exposure assessment in the UKABTS, the responses to the CAPI questions will be reviewed by experts in exposure assessment and occupational hygiene and linked to available data from peer reviewed literature, databases (such as the National Exposure DataBase, NEDB, held by the Health and Safety Executive),²⁷ and exposure and risk assessment models.

Conclusions

Using data from a population based case-control study, we have confirmed as reported by other authors previously, that self-report and expert assessment will derive different exposure levels for occupations. Agreement between the two methods was greater for pesticide exposure than for solvents. It is unclear why this may be, but could be due to the wider variety of occupational tasks involving solvents. This may lead to more variation in exposure to solvents within job codes compared to pesticides. It may also make it more difficult for participants to recall exposures compared to pesticides which are linked to a smaller number of defined tasks. For exposure assessment, the comprehensive nature of data that are collected using a computer assisted interview are particularly informative for chemicals such as solvents, where exposure occurs in a wider range of occupational settings compared to pesticides, giving more information for occupational hygienists to classify exposure in more detail. The advantages of using a CAPI for the collection of complex data outweigh the disadvantages for interviewers and data quality, but the extra time and resources needed for designing and programming in the early stages of

the study need to be considered when deciding to use this method of data collection.

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