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Ascertainment of Occupational Histories in the Working Population: The Occupational History Calendar Approach

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G.P. Herbison, MSc, and A-M. Feyer, PhD

Background Self-reported occupational histories are an important means for collecting historical data in epidemiological studies. An occupational history calendar (OHC) has been developed for use alongside a national occupational hazard surveillance tool. This study presents the systematic development of the OHC and compares work histories collected via this calendar to those collected via a traditional questionnaire.

Methods The paper describes the systematic development of an OHC for use in the general working population. A comparison of data quality and recall was undertaken in 51 participants where both tools were administered.

Results The OHC enhanced job recall compared with the traditional questionnaire. Good agreement in the data captured by both tools was observed, with the exception of hazard exposures.

Conclusions A calendar approach is suitable for collecting occupational histories from the general working population. Despite enhancing job recall the OHC approach has some shortcomings outweighing this advantage in large-scale population surveillance. Am. J. Ind. Med. © 2010 Wiley-Liss, Inc.

KEY WORDS: epidemiology; exposure assessment; questionnaires; survey methods; recall

INTRODUCTION

Occupational histories are an important means of assessing historical exposure in epidemiological studies and in the context of population-based surveys researchers are often solely reliant on self-reported occupational histories. There is concern that traditional direct questioning techniques for collecting self-reported occupational histories may not effectively detect and capture the potential

exposures of a working person in contemporary employment [Bond et al., 1988; Hoppin et al., 1998]. Increasingly, occupational history collections need to take into account increasing complexities of contemporary employment, such as multiple job holding and shorter, transient periods of employment.

These concerns centre around the effect of recall bias on the history obtained [McGuire et al., 1998]. On the one hand, the reliability of occupational histories collected by interview has been shown to be acceptable [Warneryd et al., 1991; Brower and Attfield, 1998], on the other hand validity is of concern with free recall of occupational histories shown to be poor [Bond et al., 1988]. The recall of occupational exposures have also been associated with the method of questioning with prompting questions less subject to recall bias compared with open questions [Teschke et al., 2000]. Optimizing occupational history recall and the quality of recalled information would be beneficial.

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The Life History Calendar (LHC) approach uses multiple recall cues, such as visual aids, key life and historical events, to stimulate memory recall on the less salient aspects of a person's life such as employment, medical events, and behaviors [Caspi et al., 1996; Axinn et al., 1999]. The LHC approach provides a number of mechanisms with distinct advantages for participant recall including: using multiple memory cues and utilizing personal histories providing a context to provoke more accurate recall of past events; and employing a visual element which captures and records more complete sequences of events [Belli, 1998].

The LHC approach has previously shown promise for collecting occupational histories and information on agricultural use from farmers [Hoppin et al., 1998]. Although not directly validated, the response to agricultural use collected by the icon/calendar were consistent with historical agricultural sales data indicating a degree of accuracy in recall [Hoppin et al., 1998]. Complex transient work histories, encountered among migrant farm workers, were more complete when collected using an icon/life events calendar compared with a traditional questionnaire [Engel et al., 2001a]. This same icon/calendar-based questionnaire displayed good reliability in recalling cumulative time undertaking work tasks [Engel et al., 2001b].

The aims of this paper are to: (1) describe the development of an occupational history calendar (OHC), capturing a broad range of employment and work hazards, for use in the general working population; and (2) compare the data quality between a traditional questionnaire and OHC approach. The use of a LHC approach to collecting occupational histories has been limited to agricultural workers within the United States. In contrast, in this paper we develop a method for, and present the results from, an application of a LHC approach to obtain occupational histories from a population sample from the New Zealand workforce (all industries). An OHC was developed to be used alongside a population survey tool collecting surveillance data on employment and working conditions for use primarily in the NZ workforce [Lilley et al., 2010]. The overall intention of the OHC was to collect data, for each job held during the participant's working life, on the following: job (occupational title, industry, employer, major tasks), period of employment, exposure to key identifiable occupational hazards, use of safety equipment, and any health effects experienced. The OHC will allow for the key workplace hazards to be identified (presence or absence) for previous jobs.

MATERIALS AND METHODS

Design and Development of the Occupational History Calendar

The layout of the final OHC is presented in Figure 1. A life events calendar, used to obtain occupational histories

Historical Event	Year	Personal Event	Your Work	Occupational details
Aramoana mass shooting – Dunedin	1990			
Auckland Commonwealth Games.				
Gulf War – US liberates Kuwait.	1991			
	1992			
	1993			
Bain family murder – Dunedin.	1994			
Team NZ won Americas Cup.	1995			
Ben & Olivia disappear from Marlborough Sounds – New Years eve	1996			
Princess Diana dies in car crash.	1997			
	1998			
France beats All Blacks during World Cup.	1999			
New Millennium celebrations.	2000			
September 11 terrorist attacks on Twin Towers.	2001			
Bali terrorist attacks.	2002			
	2003			

FIGURE 1. Final occupational history calendar.

from farm workers in the United States [Hoppin et al., 1998], was used as the basis of the OHC design. Hoppin et al.'s design includes two fixed columns listing the calendar year and relevant historical events as recall prompters, with four additional columns capturing age, life events, farm activities, and jobs held particular to each individual. Our OHC was modified from that of Hoppin et al., 1998 in the following ways. The first two columns contain the fixed prompting information of the historical events selected for the NZ context and the calendar year. The OHC uses 11 events: 5 national and 6 international historical events. The third column collects personal events to be recalled by the participant. The fourth column, headed "your work," collects details regarding the participant's work history including occupation, key tasks, and employer. The fifth column collects details regarding the specific workplace exposures, safety equipment worn and any work-related health effects experienced specific to each job recalled. There is no separate column for the collection of age. The time units chosen for collection of occupational history data was years. The calendar maintains the flexibility to record jobs held for <1 year. More detailed description of the development of the OHC tool follows.

In order to develop Column 1 a list of historical events of national and international prominence relevant to the NZ context were selected from historical texts [Barracough,

1984; Overy, 1996; Day and Plant, 2002]. Events were selected on their likelihood to invoke memories, such as sudden deaths, natural disasters and significant sporting, or cultural achievements. A two round selection process was undertaken to identify those historical events most likely to simulate autobiographical recall around the event using two convenience samples selected from contacts of the authors across the wider university workforce. The convenience sample represented all levels of educational attainment (no formal education, secondary school only, trade/technical education, and tertiary education) and a broad range of ages (age range 21–65 years). Written ethical consent was obtained from each individual. The first round using 15 participants scored historical events from (1) “remember event well” to (3) “do not remember event,” with those events scored highest retained to the next round. In the second round, 14 participants selected the 5 most memorable world and NZ historical events. Those events selected were then scored from (1) “most clearly remembered” to (5) “least clearly remembered.” Participants then recalled their employment situation at the time of each event and assessed their confidence in the accuracy of their recall from (1) “very sure” to (4) “not sure at all.” Only those events found to stimulate autobiographical recall in more than a third of subjects during testing were retained. For the purposes of this paper only the results relating to a 14-year interval from 2003 to 1990 are presented. A short 14-year interval was chosen to reduce interview burden and keep total interview time down to 1 hr. This time period from 2003–1990 is somewhat arbitrary but it does represent a time in which NZ was undergoing significant economic and labor market reforms which would have impacted upon working situations and work conditions.

Personal event promoters used to fill in Column 3 were based upon an existing successful strategy using personal event prompts thought to be most likely to be associated with a change of employment, such as relocating city or country [Caspi et al., 1996]. Additional events likely to be related to occupational change were added to this list, such as overseas travel. Box 1 presents the personal prompting questions used. Interviewers, using separate lists of prompting questions, asked the ordered list of personal prompts to elicit responses from participants. If, for example, in recalling their educational history a participant recalled other personal history details they were recorded and the interviewer skipped the relevant prompts.

Prompting questions to elicit the job title, industry, major task, full-time/part-time status, physical, chemical, and biological exposures, and personal protective equipment use were adapted from an existing occupational history questionnaire [Lilley et al., 2010]. An additional question was added to record any work-related health effects experienced. To limit the potential for interview fatigue in participants, ergonomic hazard exposure data were not

Box 1: Table of Personal Prompting Questions

Education

Leave school?

Began any additional training like and apprenticeship, polytechnic, or university

Shifted

Shifted to a new house, city, or country?

Do any overseas travel?

Relationships

Met current partner?

Married?

Begun a de facto relationship?

Family

Birth of any child/grandchildren?

Health

Had any major injuries or illnesses?

collected by the OHC in this study. Box 2 presents the exposure collection prompts used. Once all jobs were identified, starting with the most current job interviewers asked each of the prompting questions in the order listed in Box 2. If, for example, in recalling the occupation and work tasks a participant freely recalled their hazard exposures and health effects, this would be recorded on the calendar and the relevant prompting questions would be skipped by the interviewer. To deal with the possibility of changing exposures during long employment, jobs held for ≥ 5 years were divided into 5-year periods similar to previous calendars [Torgen and Kilbom, 2000]. The exposure collection prompting questions were asked of each 5-year block.

The calendar was pre-tested in a further convenience sample of nine participants selected from the wider university workforce to identify improvements to the design and protocol, recall cues and calendar's data collection space. The only changes made following pre-testing was to increase the amount of space available to interviewers to collect information, with the calendar increased in size to fit on an A3 sheet of paper.

Administering the Occupational History Calendar

The calendar was introduced to participants at the beginning of the interview by a trained interviewer. The OHC interview began by introducing the historical events column,

Box 2: Table of OHC Exposure Questions

“Your Work” column

What was your occupational title for this job?

What industry was this job in?

What were your main tasks while in this job?

Was this work full time or part time?

“Occupational details” column

While in this job were you exposed to:

Any vibration from tools or machinery, loud noise, extremely high or low temperatures?

Did you breath in any chemicals, pesticides, solvents, or gases? If yes do you know what exactly you worked with?

Did you handle any chemicals, pesticides, poisons, solvents, or dangerous materials? If yes do you know what exactly you handled?

Did you breathe in any dusts like from woods, metals, concrete etc?

Did you have contact with any animal or human secretions like urine, blood, or feces?

While in this job did you have to wear any personal protective equipment like masks, safety glasses or earmuffs for example? If yes what did you wear?

While in this job did you experience any health problems or injuries that you feel were caused by the job?

with participants invited to recall personal events relevant to the time period examined. Participants were then invited to recall previous jobs held in reverse chronological order from current employment using the personal and historical prompts, followed by job-by-job prompting on employment and exposure information. Any additional details, outside the expected responses elicited using the prompting questions, which were spontaneously recalled by the participant, such as the specific names of chemicals were recorded on the calendar as this detail was not prompted for in either approach. Any aspects unable to be recalled by the participant were recorded on the calendar as “don’t remember.” A threshold, restricting the amount of detail collected to the job title and duration of employment only, was set for those jobs where employment was for <8 hr per week and held for <3 months in total.

Data Collection

A cross-sectional pilot study was undertaken to compare the OHC approach with a traditional questionnaire for collecting occupational histories. Participants resided within two defined study locations, one semi-rural location

(Mosgiel, South Island) providing a predominantly agricultural and sales/service workforce and one urban location (Wellington, North Island) providing a diverse ethnic, largely professional and clerical support workforce, with participants randomly selected from the NZ Electoral Roll. Participants were sent an introductory letter then telephoned by an interviewer, where a time for interview was made. Written ethical consent was obtained from participants individually at the time of interview with interviews conducted at the participant’s residence. Participants were reimbursed for their time with a \$NZ10 petrol voucher. The participation rate was 48% with young workers (<29 years of age), and those working as agriculture, forestry, and fisheries workers, elementary workers, or sales and service workers most likely to decline participation in this study.

The traditional questionnaire used a slightly abbreviated set of the questions used by the OHC in Box 2, delivered verbally by an interviewer in a face-to-face interview. Each participant was given both methods with the OHC delivered first followed by the question set embedded a further 10 min into an additional survey on working conditions. An abbreviated set of questions was used for the question set approach, due to question set being positioned within the questionnaire immediately after a block of questions on current employment exposure to occupational hazards. The current employment occupational hazard exposure questions were identical to those used by the OHC in Box 2. A total of 51 employed participants completed both an OHC and question set at the same face-to-face interview.

Data were extracted, coded, and double entered onto a SPSS (version 13) database by the author (R.C.L.). Occupation was coded to five digits using the New Zealand Standard Classification of Occupation (NZSCO) and industry was coded to four digits using the Australian and New Zealand Standard Industry Classification (ANZSIC) [Statistics New Zealand, 1999, 2001].

Qualitative Research

Focus group studies were undertaken to receive feedback at community halls within our study locations on the methods of interview. Two focus groups were undertaken with 10 voluntary participants drawn from the 51 participants completing both an OHC and question set. Signed ethical consent was obtained. Structured discussion covered acceptability of the calendar method and the ease of recalling previous occupational histories. Participants were reimbursed for their time with a \$NZ 20 petrol voucher. Focus group sessions were audio-taped, transcribed, and reviewed by two reviewers to identify emergent themes. Additionally, interviewer feedback was obtained using in-depth interviews, with four of the six interviewers employed interviewed, to assess participant acceptability of

the calendar method with these interviews reviewed by the author (R.C.L.) only to identify emergent themes.

Data Analysis

The degree of completeness was used to assess the “quality” of the data captured by the occupational history collection tool, as follows:

job pairings. The number of additional jobs (beyond the matched job pairs) and occupational exposure cases for each specific hazard captured by each tool was also calculated for each tool and compared.

Data concordance is the percent who recalled identical data with both tools (e.g., the same occupation was recorded by the OHC and question set) out of the total number of identified job pairs and was calculated for occupation and industry.

(Presence/Absence)

$$\text{Data concordance} = \frac{\sum \text{complete data (presence or absence) pairs captured by both methods}}{\sum \text{complete data pairs} + \sum \text{incomplete data pairs (data presence captured by one method only)}}$$

(NZSCO/ANZSIC major code)

$$\text{Data concordance} = \frac{\sum \text{identical NZSCO/ANZSIC major code reported by both methods}}{\sum \text{identical major code} + \sum \text{non-identical major codes}}$$

- (1) comparing each tool’s ability to collect and capture the data (any response captured by tool versus no response captured), hereon referred to as data completeness; and
- (2) comparing the agreement in the data recorded by each tool, hereon referred to as data concordance.

For each assessment, data were matched initially using the order of recall (e.g., first job recalled for each tool matched, second job recalled matched etc) to form job pairings for analysis. Each pair of jobs created by the recall order matching process was checked against one another using the reported occupation, employer and duration of employment. Any mismatched job pairings were examined to ascertain the cause of the mismatch and to identify jobs missed by either tool using the total work history of the individual. For example, three jobs were recalled using the OHC (community officer, shop assistant & taxi driver) but on the questionnaire two jobs were recalled (community officer and taxi driver), in which case the shop assistant job is recorded as an absent job for the questionnaire and present for the OHC. Each job pairing contributed one unit.

Data completeness was calculated by counting the number of present answers collected and captured by each tool for each of the variables examined (occupation, industry, duration of job, presence of specific exposures, PPE worn, and health effects). For example, if the question set had an occupation present for a recalled job but a corresponding occupational title was absent in the OHC one count would be added to the question set total while no count would be added to the OHC total. If occupation was absent for both tools no count would be added to either tool’s total. Data completeness was calculated for each tool as a percent of data collected and captured out of the total number of identified

Percent concordance and unweighted kappa values were calculated for level one major sub-group NZSCO occupation and ANZSIC industry classification [Statistics New Zealand, 1999, 2001] between the two methods of occupational history data collection. For example, if the occupational title was recorded as “property valuer” (NZSCO major code 3) using the OHC, while using the questionnaire the occupational title was recoded as “general manager” (NZSCO major code 1), the outcome is no concordance.

Exposures to specific occupational hazards were treated as a dichotomous variable (exposure reported/no exposure reported) with percent agreement and kappa values for occupational hazard exposures calculated on the basis, for example, that if any chemical exposure is mentioned in the response to both methods it represents concordance in exposure reporting (one potential match per job pair). A Kappa value of 1.0–0.75 was considered to represent excellent concordance, a value between 0.75 and 0.40 represents fair to good concordance and a value below 0.40 represents poor concordance between tools [Armitage and Berry, 1994].

Time Requirements

This cross-sectional pilot study comparing two methods of collecting occupational histories was conducted as part of a larger study comparing methods of hazard exposure data collection [Lilley et al., 2010]. Comparisons of interview durations were made between face-to-face interviews with an OHC and without an OHC to examine the time required to complete the OHC. Mean and percentile ranges were calculated to compare the time required to

complete the interview with *t*-tests undertaken to assess the differences in mean interview duration between tools.

Ethical approval was obtained for this study from the Otago and Wellington Regional Ethics Committees.

RESULTS

Participant Characteristics

Study participants represented the entire range of working ages from 18 to 65 years of age (Table I). The median age group of the study participants was 40–49 years old. The majority of the sample were male (57%), were of European ethnicity (84%) and had education beyond secondary school (55%). All major occupational groups were represented with 51% white collar legislators, managers, professional, or technician/associate professionals, 19% pink collar sales, service or clerical workers, and 22% blue collar agricultural, trades, plant/machinery operators, and assemblers or workers undertaking elementary tasks (e.g., packers, cleaners, general labourers).

TABLE I. Table of Demographic Characteristics of Sample (n = 51)

Variable	n	(%)
Occupation		
Legislators, managers, and professionals	18	36
Technicians and associate professionals	8	16
Clerks, sales, and service workers	13	26
Agricultural and trades workers	5	10
Plant and machinery operators and elementary workers	6	12
Age		
18–29	3	6
30–39	17	33
40–49	10	20
50–59	17	33
≥60	4	8
Education		
No formal qualifications	13	25
Secondary qualifications	10	20
Tertiary qualifications	28	55
Ethnicity		
NZ European	43	84
Pacific peoples	2	4
NZ Maori	1	2
Other	5	10

Comparisons of Methods of Occupational History Collection

Data completeness

There were 157 jobs identified in total using the OHC, the question set or both. Of those 157, 156 (99%) were identified using the OHC and 139 (89%) were identified using the question set. Table II presents the simple comparison of the presence of a variable (answer present and recorded by tool) for each occupational history variable collected. This comparison is used as a measure of each tool's ability to stimulate recall and capture occupational history data. Of the 138 jobs identified by both tools very good data completeness was found for the question set with regards to occupation, duration of job, hazard exposure presence, and industry of employment with over 85% of the records complete. Similarly for the OHC the best data completeness was obtained for the duration of job, exposure presence and occupation with over 85% of the records complete. Data completeness was poorer for industry with only 36% of the recalled jobs capturing industry with the OHC compared with 85% data completeness with the question set approach. The poorest data completeness for both tools was found for the question set with regards to health effects related to work and PPE presence with both infrequently reported by either tool.

In terms of total numbers of unique job pairs recalled 138 job data pairings were made, with the majority of participants recalling identical numbers of jobs in both tools. For 12 (24%) participants 18 additional unique jobs were recalled using the OHC compared with the question set (Table II—extra jobs identified). The extra jobs recalled by the OHC were mostly precarious forms of employment such as part-time (n = 6), temporary, or short-term (n = 9) jobs, mostly covering small gaps in full-time employment. One participant recalled one extra job using the question set.

TABLE II. Table of Comparison of Data Completeness Between Occupational History Calendar and Question Set

Variable	Presence of variable (total pairs n = 138)	
	OHC n (%)	Question set n (%)
Occupation	117 (85)	133 (96)
Industry	50 (36)	117 (85)
Duration of job	134 (97)	130 (94)
Exposure present	125 (91)	123 (89)
PPE present	76 (55)	70 (51)
Health effects	65 (47)	18 (13)
Number extra jobs identified		
1 Extra job	7	1
2 or More extra jobs	11	0

TABLE III. Occupational Hazard Exposure Data Concordance and Extra Exposure Cases Recalled Between the Occupational History Calendar and Question Set

Exposure	Data concordance		Total exposure cases recalled ^a (n)	Exposure cases recalled	
	Percent agreement (%)	Kappa (95% CI)		OHC (n)	Question set (n)
Biological	88.8	0.46 (0.31–0.61)	16	16	11
Chemical	93.1	0.86 (0.80–0.92)	28	20	28
Extreme temperatures	93.3	0.83 (0.76–0.90)	23	18	23
Noise	88.8	0.75 (0.72–0.87)	31	28	31
Vibration	93.1	0.79 (0.70–0.88)	17	11	17

^aRecalled either by the OHC, question set or both tools.

In terms of the number of additional occupational hazard exposure cases captured the question set consistently captured more cases of exposure in four of the five specific occupational hazards examined compared to the OHC approach (Table III). The exception was biological hazard exposure where the OHC captured more cases of exposure compared to the question set. Additionally, the OHC approach identified additional spontaneously recalled occupational hazard exposures, not collected by the question set in a fifth of the job pairs recalled (data not shown). These additional hazard exposures recorded by the OHC included physical, ergonomic, and psychosocial hazard exposures that were not specifically prompted for. For example, stressful working conditions and heavy lifting were spontaneously recalled and captured with the OHC approach. Extra detail was also recalled and captured with the OHC approach, such as specific chemical exposures at work. For example, brand names of pesticides used were spontaneously recalled and captured with the OHC approach. This level of detail was not captured using the question set approach.

Data concordance

Data concordance, where the responses captured by both tools were in agreement, was assessed for occupation, industry, and hazard exposure. There was 96% concordance in occupation and industry to the major sub group level of occupation and industry classification (Table IV). Kappa indices for level 1 major sub group agreement in NZSCO classification for occupation and ANZSIC classification for industry was excellent at 0.83 and 0.95, respectively (Table IV). Even though only 41% of participants gave an answer in the industry question with both tools the data concordance was excellent.

Data concordance, as measured by Kappa indices and percent agreement (Table III), was assessed between the categories of exposures recalled by both methods. The concordance between the question set and the OHC was excellent for chemical, and the physical hazards of extreme

temperature, noise, and vibration exposures ranging from Kappa indices of 0.85–0.75. A lower but fair concordance was found for human biological hazard exposure with a Kappa of 0.46. The percentage agreement was excellent with more than 95% of exposures recalled consistent between the two methods.

Time requirements

Comparison of face-to-face interviews without an OHC with interviews with an OHC revealed the OHC took on average an extra 8 min on top of the hazard exposure survey. The mean time for completion of a face-to-face interview without an OHC was 51 min while the mean time for those interviewed with an OHC was 59 min. Independent t-testing found this difference to be significant ($t = 3.59$, $P < 0.001$). The spread of interview durations was less for interviews without an OHC with 50% and 75% of interviews taking ≤ 45 and 60 min, respectively, compared with 60 and 70 min for those interviews with an OHC.

Qualitative results

Ability to recall work histories was discussed during focus groups studies. Recalling work histories over 14 years,

TABLE IV. Comparison of Occupational and Industry Data Concordance Between the Occupational History Calendar and Question Set

Variable	Percent agreement		Kappa (95%CI)
	n	%	
Occupation			
Agreement	110	95.7	0.83 (0.78–0.88)
No agreement	5	4.3	
Industry			
Agreement	43	95.6	0.95 (0.93–0.97)
No agreement	2	4.4	

as required for this study, was not seen as difficult for the majority of people. The majority of participants were “fairly” to “very” confident that their recollection of previous jobs held over this period was correct. However, participants lost confidence in their ability to recall their work histories as the number of jobs held over the 14-year period increased and the period of recall increased. Those who felt the calendar approach was more helpful had a greater number of jobs to recall over the 14-year period so found the personal and/or historical events helpful to recall previous jobs held.

Focus group and interviewer feedback also assessed participant acceptability of the calendar method for collecting occupational histories. Interviewers observed that females responded more favorably to the calendar method freely linking work histories with historical and personal events, while males relied on calendar year prompts and were generally less accepting of the OHC approach than females. Overall it appears the OHC approach is acceptable to participants and flexible enough to adapt to each individual’s needs. However, the increased time to administer the calendar was not acceptable to some participants, especially when employment histories were simple (e.g., two jobs held over 14 year period).

DISCUSSION

Principal Findings

We developed and studied the use of an OHC approach to collect occupational histories from a cross-sectional sample of 51 working adults in NZ. An OHC approach using calendar time, as well as historical and personal events, was favorably received by participants and was particularly well suited to those with long or complex occupational histories.

Recall was assessed for specific occupational hazard exposures and the number of jobs held in the last 14 years by comparing recall between the two data collection approaches. The OHC approach identified slightly more jobs, especially more precarious part time and temporary forms of employment, compared with the question set. Improved recall of previous jobs held with a LHC approach has been reported previously [Engel et al., 2001a]. Improvement in recall is likely to be due to the continuous visual nature of the OHC, allowing participants to view the life course with the interviewer to identify gaps in employment histories. The use of the OHC’s historical and personal prompts is also likely to contribute to improvements in participant recall. However, as similar, but slightly different, employment and exposure prompting questions were used by each approach to elicit occupational history recall, the effects of OHC historical and personal prompts on recall of occupational histories cannot be singled out as the only factor affecting response in our study. The identification of improved recall of precarious employment periods, which

potentially carry higher risks to worker health and safety compared with permanent, full-time employment [Sverke et al., 2000; Goudswaard and Andries, 2002], has not been found previously. From this perspective this gives the OHC approach improved data capture in comparison to the question set.

While the OHC captured more jobs overall compared with the question set, data completeness for occupational title was poorer overall for the OHC when both tools captured the same job. The flexible nature of the OHC administration where jobs and the associated occupational detail can be recalled in any order may have resulted in missing data, especially in cases where the jobs recalled immediately prior to or after the missed title were similar. Focus group feedback indicated participants were confident of their ability to recall previous employment although the confidence in recall of exposures deteriorated with increasing number of jobs held and increasing length of recall, as indicated by previous research [Stewart et al., 1987; Bond et al., 1988].

Data completeness, as measured by agreement in response capture by the two methods, varied between the two approaches. For the most part, data completeness was relatively high, however, the poorest data completeness occurred in the industry section where the OHC method under-reported the industry of employment, not even covering half the data captured by the question set. This apparent shortcoming was identified during in-depth interviews to be due to an interviewer diversion in the interview protocol. Interviewers put emphasis during the administration of the OHC on collecting the correct occupation, inadvertently missing the industry-prompting question, rather than any inherent flaw in the OHC approach. This error can be averted in the future with training and closer monitoring of the data quality. The poorest data completion for both tools occurred in the work-related health effects and PPE presence sections. This finding may indicate that the majority of workers in this study, in professional and semi professional occupations were less likely to require PPE, as they were less likely to be exposed to occupational hazards, and did not experience work-related health effects. Both tools were consistent in capturing a low prevalence of PPE presence and work-related health effects.

Data concordance, as measured by agreement in the data collected by the two methods, for occupation and industry was excellent with <5% of answers completely disagreeing, indicating no one method produces substantially poorer quality data when both tools capture the same job.

The OHC approach resulted in some under-reporting of all the exposures examined compared with the question set. This was a surprising finding and to the best of our knowledge has not been reported previously. Enhanced recall of historical occupational exposures using the question set approach may have occurred due to the positioning of the question set within the interview, immediately following a

block of questions on current employment exposure to occupational hazards. There is little doubt this will have enhanced the recall of occupational hazard exposures with the question set approach. Considering that the OHC is the first interview item undertaken in this study, our study suggests the free recall of occupational hazard exposures using this method is very good. Additionally, the OHC captured additional spontaneously recalled details on occupational hazard exposures not captured by the question set. This study demonstrated the OHC approach promotes spontaneous recall of exposures and captured more detailed recall by participants compared with the question set approach.

Little research to date has compared the ability of calendar approaches to recall occupational histories and occupational hazard exposures with a question set approach. In a direct comparison of question set and calendar approaches to recall events occurring in the prior year, the calendar approach was found to provide better quality recall on weeks of sickness absence, weeks unemployed and income [Belli et al., 2001]. Further analysis found better quality data obtained with the calendar was associated with greater prevalence of favorable interviewer verbal behaviors such as a higher use of retrieval cues [Belli et al., 2004]. In another comparison of methods of collecting occupational histories, a traditional questionnaire and an icon-calendar based questionnaire reporting on both the number of jobs and the duration of employment was significantly greater using the icon-calendar [Engel et al., 2001a]. The icon-calendar had greater completeness of reporting, capturing, and describing a greater proportion of the time period under examination compared with the traditional questionnaire [Engel et al., 2001a]. Our study was in agreement with some of these previous findings, with the OHC capturing a greater number of jobs compared with the question set approach, indicating that completeness of occupational job history capture is enhanced using the OHC approach. Improvements in data completeness using an OHC approach were less clear-cut in our study. While the OHC approach was found to have better data completeness for duration of job, the presence of an occupational hazard exposure, use of PPE, and work health effects data completeness was poorer for occupation and industry compared with a question set approach.

This study compared the time to complete the questionnaire and OHC with the time to conduct the questionnaire only. While, in practice, both the question set and OHC approach are unlikely to be used in the same interview we have included this comparison to indicate the time required to conduct an OHC, over and above another questionnaire. The estimate derived from our study provides an upper limit to the additional time required to administer the OHC, hence the total interviewee burden will be less than indicated in this study.

In the context of large-scale national surveys, the OHC approach presents a number of practical concerns that affect the feasibility of this tool for surveillance. The OHC currently is administered in a face-to-face interview, increasing administration time and costs relative to telephone interviewing. A self-administered calendar to jog people's memories prior to a telephone interview has been used previously [Hunter et al., 1997; Cook et al., 2003], and is worthy of further evaluation. The increased length of interview with OHC was identified in focus groups as adding to unnecessary burden on participants, and so is a drawback of the approach.

Inclusion of the OHC tool in any large-scale population survey would need to balance the additional resource requirements and participant burden with any benefits in recall. In a national surveillance survey, where time constraints are considerable and the interview duration can affect participation rates, the calendar was found to be an inappropriate tool for collecting this data [Lilley et al., 2010]. The OHC tool might be useful in the clinical setting when comprehensive occupational histories are required, however further research is needed to determine the utility of the calendar approach in this setting.

Strengths and Limitations of the Study

A strength of this study is the inclusion of a broader range of occupational hazard exposures than captured by previous occupational hazard exposure studies [Hoppin et al., 1998; Zahm et al., 2001], demonstrating the potential application of the tool for the capture of a broad range of exposures in the working population. A further strength of our study is the inclusion of qualitative data to assess participant acceptability of the OHC. Our study is the first we are aware of to include qualitative perspectives on the calendar approach to collecting historical data. Qualitative analysis found the OHC to be generally well tolerated by interviewers and participants alike but also identified some drawbacks to using this tool.

There are a number of limitations to this study. Firstly, the unavailability of universally available official work records as a gold standard for comparison meant that we were unable to determine which method was the most valid. The second limitation is the contamination of the response to the question set due to the positioning of the OHC preceding the question set. If contamination due to ordering had occurred it would be expected that the question set would reveal at least the same number of jobs or more. Despite this, the OHC approach still displayed improved recall of individual jobs held in the last 14 years. However, due to the strong likelihood of ordering contamination, this study was unable to reach a conclusion on which tool is able to capture more occupational exposure data. Thirdly, this cross-sectional pilot study tested the OHC approach within a

moderately short period of 14 years recall. Further examination of the OHC methodology is warranted to quantify the potential benefits of this approach in epidemiological studies with substantially longer periods of recall. However, this study replicates the findings of larger studies with longer periods of occupational history recall [Engel et al., 2001a; Zahm et al., 2001] suggesting the OHC approach would be useful in studies requiring longer recall periods. A further limitation is that job duration was not controlled for in the analysis. We have assumed that participant recall would be better for those jobs recalled within the relatively short 14-year period examined in this study. The limitations of the Kappa statistic also need to be considered with Kappa values less precise when the prevalence is below 10% or above 90%. Despite its limitations Kappas are considered to be the superior measure of inter-rater agreement as they take the role of chance into account. In this study results have been interpreted using Kappas in tandem with percent agreement statistics to assess agreement.

CONCLUSIONS

Our study demonstrated the OHC approach has both benefits and limitations for occupational health surveillance. While the OHC approach offers an opportunity to capture the complexity of contemporary employment and ensure more complete capture of occupational histories, these advantages can be outweighed by significant resource requirements in large-scale population surveys. While the OHC approach offers promise in a research study context, the OHC approach could be considered unsuitable for collecting occupational histories in the context of surveillance. Further research is needed to overcome the limitations described here before an OHC approach could be recommended for use in a surveillance context.

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