3

QUESTIONNAIRE DESIGN

OBJECTIVES

After reading this chapter, you should be able to:

1. Plan a questionnaire with appropriate content.
2. Write well-crafted questions for that questionnaire.
3. Format the questionnaire for ease of administration and coding.
4. Pre-test the questionnaire to identify problems such as excessive length, poorly worded or confusing questions, or other problems.
5. Administer the questionnaire in a manner which will maximise response rate.
6. Code data from the questionnaire as a precursor to data entry.

3.1 INTRODUCTION

Questionnaires are one of the most commonly used tools for collecting data in veterinary epidemiological research. The terms **questionnaire** and **survey** are often used interchangeably, but we will use them as follows.

> **Questionnaire**: A data-collection tool that can be used in a wide variety of clinical and epidemiological research settings.
> **Survey**: An observational study designed to collect descriptive information about an animal population (such as prevalence of disease, level of production *etc*). Surveys often use questionnaires to gather data.

This chapter will focus on the design of questionnaires regardless of whether they are to be used in a survey or other type of research study. Further discussion of surveys is presented in Chapter 7.

As a primary means of data collection for epidemiological studies, questionnaires play a significant role in the quality of epidemiological research. However, less attention has been paid to the data-collection aspects of this research than to the methods used in data analysis. As one method of improving the quality of questionnaires, it has been suggested that all questionnaires used in published epidemiological research be posted on a public website and made available to all readers (Rosen & Olsen, 2006; Schilling *et al*, 2006; Wilcox, 1999). It would be desirable to have all journals adopt such a policy. The issue of validation of questionnaires is covered in more detail in Section 3.8.

The development of a questionnaire is a complex process involving consideration of many aspects of its design. These are discussed below. Some useful texts on the subject include (Converse & Presser, 1986; Gillham, 2000; Jackson & Furnham, 2000; McColl & Thomas, 2000). Two introductory articles covering the use of questionnaires in health research have been published recently (Boynton, 2004; Boynton & Greenhalgh, 2004).

3.1.1 Study objectives

In order for a questionnaire to be effective, it must be carefully planned with consideration given to a number of design elements. First and foremost, it is essential that the objectives and information requirements of the study be established. This process could involve consultation with subject 'experts', and with the ultimate 'users' of the information (if the data are being collected for use by another group, *eg* policymakers). A structured process such as a Delphi technique could be used to assist in this process (Hotchkiss *et al*, 2006). Members of the population to be surveyed should also be consulted at this early phase of the planning process. If previous questionnaires covering the subject matter of interest have been published, copies should be obtained. Previous questionnaires are particularly valuable if a formal validity assessment of the questionnaire has been carried out; unfortunately, this is not often the case in animal-health studies.

3.1.2 Focus groups

Focus groups consisting of 6-12 people provide an opportunity for a structured form of consultation with members of the intended study population, the end users and/or the interviewers. An independent moderator can ensure that the focus group stays on topic and the

discussion is not dominated by 1 or 2 individuals. Focus groups can offer insight into attitudes, opinions, concerns, experiences of the various stakeholders and help to clarify objectives, data requirements, research issues to be addressed, salient definitions and concepts. It may be helpful, but not necessary, to ensure the information is preserved and to avoid ambiguity by audio or video recording of the group's discussion.

3.1.3 Types of questionnaire

Questionnaires can be **qualitative** or **quantitative**. The former are sometimes referred to as 'explorative' questionnaires and consist primarily of open questions (see Section 3.3) designed to allow the participant to express their views and thoughts on the subject matter. Qualitative questionnaires can be used in the hypothesis-generation phase of research when it is necessary to identify all of the issues pertaining to the research subject. These types of questionnaire are often administered through interviews and could be taped (with permission) to allow for a detailed evaluation of the content of the material discussed at a later time. Qualitative questionnaires will not be discussed further in this chapter and the reader is referred to Creswell (1998) for more details and Vaarst *et al* (2002) for an example.

Quantitative, or structured, questionnaires are designed to capture information about study subjects and their environment. They are used more often in veterinary epidemiology than qualitative questionnaires. Unless otherwise specified, all examples used in this chapter are derived from a structured questionnaire designed to capture information about veterinary use of post-operative analgesics in dogs and cats (Dohoo and Dohoo, 1996a,b).

3.1.4 Methods of administration

Questionnaires can be administered through an in-person interview, a phone interview, as a mailed (postal) questionnaire, or as a web(internet)-based questionnaire. The method of administration could have substantial effects on both the response rate and the data quality (Bowling, 2005; Kaplan *et al*, 2001; Pinnock *et al*, 2005; Vuillemin *et al*, 2000). (**Note** To conform with common usage, the term response rate refers to the proportion of study subjects who complete the questionnaire and hence, it is actually a risk, not a rate).

The advantages of an in-person interview are that the purpose of the study can be fully explained, a high participation rate usually can be obtained, and audio-visual aids can be used (*eg* photos of medications when ascertaining what products have been used). In-person interviews also help to develop a rapport between the investigator and participant which might be important if ongoing participation in the study is required. The disadvantages of this approach is that it is time consuming, expensive, geographically limited to areas close to interviewers and might be subject to interviewer bias. This last problem can be avoided, at least in part, by careful training of interviewers. In-person interviews have been found to have lower proportions of missing values compared with mailed questionnaires (Smeeth *et al*, 2001).

Telephone interviews share many of the advantages of in-person interviews (*eg* high response rate, opportunity to explain the study) and are less time consuming and less expensive. They might be less susceptible to interviewer bias than in-person interviews (*eg* no visual cues can be given) but are limited in terms of time that a participant can be expected to spend answering the questionnaire. Telephone surveys have been reported to result in under-reporting of some health conditions compared with mail surveys (Frost *et al*, 2001) but in more complete reporting of

sensitive information compared with in-person surveys (Midanik *et al*, 2001). There are also many issues related to telephone communication which need to be considered (*eg* some potential study participants might not have a phone or might have an unlisted number).

Mailed questionnaires are used commonly because they are inexpensive and, being administered by the respondent, have no potential for interviewer bias. However, they are more likely to suffer from low response rates, there is no ability to control who completes them and they are completely inappropriate if the respondents have poor literacy. A mean response rate of approximately 60% has been reported from a survey of 236 mailed health-related surveys (Asch *et al*, 1997) although there are many examples of 70%+ response rates. In one study, mailed questionnaires (with suitable follow-up) elicited a higher response rate than telephone interviews (Hocking *et al*, 2006). If feasible, delivery of the questionnaire by hand may increase the response rate (Mond *et al*, 2004). Selection bias is a serious concern if the response rate is low (see Chapter 12), but being able to collect data relatively easily from a widely dispersed study population makes this an attractive option for many studies.

Internet questionnaires have become feasible recently and might even be less expensive than mailed questionnaires. They have the additional advantage that responses can go directly into an electronic database with no data-coding and entry required. However, they suffer from the same drawbacks as mailed questionnaires and, in addition, are applicable only to respondents who have access to the Internet. Care must also be taken to prevent individuals from completing multiple copies of the questionnaire. There has been much less research done into the design of web-based surveys, but 2 texts cover the subject (Best & Kreuger, 2004; Dillman, 2000). One issue which is stressed in the design of web-based surveys is the need to maintain consistency in the use of design elements (*eg* font, bolding, colour) throughout the questionnaire (Dillman & Smyth, 2007).

3.2 DESIGNING THE QUESTION

When drafting questions, you must keep in mind: who is responding, whether or not the data are readily available, the response burden (*ie* the length and complexity of the questionnaire), the complexity, confidentiality and sensitivity of the data being collected, the reliability of the data (*ie* validity of question), whether the interviewer or respondent might find any of the topics embarrassing, and ultimately, how the data will be processed (coding and computer entry).

Responding to a question usually involves 4 distinct processes: understanding the question, retrieval of information (from memory or records), thinking and/or making a judgement if the question is at all subjective, and communicating the answer (written or verbal). All aspects must be considered for each question. Once a draft of a question is prepared, ask yourself:

(1) Will the respondent understand this question? (The question must be clearly worded in a non-technical manner.)
(2) Will the respondent know the answer to the question or have to seek out additional information to be able to answer it? (If additional information is required, the respondent might skip the question or fabricate an answer.)
(3) If answering the question involves a subjective decision (*eg* about opinions or beliefs), is there any way to make it less subjective? Special care will be required in the design of these questions to ensure they elicit the desired information.
(4) Are the possible responses clear with an appropriate method of recording the response?

Questions can be classified as open (if there are no restrictions on the types of response expected) or closed (if the response has to be selected from a pre-set list of answers). Both types are discussed below. Regardless of the format, questions can be regarded as a diagnostic test and can be evaluated using the same methods discussed in Chapter 5.

3.3 OPEN QUESTION

In general, open questions (also referred to as open-ended questions) are more often applicable to qualitative than quantitative research because they generate information that might not be applicable for standard statistical analyses. By their nature, open questions allow the respondent to express their opinion. Sometimes a 'comments' section on a closed question could be included for this purpose.

One type of open question used in quantitative research, particularly for capturing numerical data, is the 'fill-in-the-blank' question. If possible, it is preferable to capture numerical data as a value (*ie* continuous variable) rather than as part of a range. For example, knowing that a dog weighs 17 kg is preferable to simply knowing which of the following ranges the weight falls in: (<10, 10-20, 20-30, >30 kg). Numerical data can be categorised during analysis if need be.

In some circumstances, such as when seeking sensitive information (*eg* total family income), a respondent might be more willing to indicate a category (range) than to give a specific numerical value. When capturing numerical data, it is important to specify the units being used (*eg* lb, kg), and it is often desirable to give the respondent a choice of measurement scale (*eg* inches or cm). Example 3.1 shows an open question with an expected numerical response.

Some categorical data are better captured using fill-in-the-blank questions if the range of possible responses is not known before the questionnaire is administered (*eg* for breed of cow: Angus or Angus cross-breed or Angus-Charolais-cross are all possible valid answers).

3.4 CLOSED QUESTION

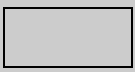
In designing closed questions (also called closed-ended questions), the researcher can choose from a range of possible options. They include:

- checklist questions (*ie* check all options that apply)
- two-choice/multiple-choice questions
- rating scale questions (*ie* rate the response on a defined scale)
- ranking questions (*ie* rank the options in order of priority).

The advantages of closed questions are that they are generally easier for the respondent to answer (while maintaining consistent responses) and it is easier to code the responses (prior to data entry).

However, closed questions are difficult to design and there is always a risk that closed questions might either oversimplify an issue or elicit answers where no knowledge or previous opinion exists. Sometimes a closed question might request information in a format that is different from

Example 3.1 Open question

3. Year of graduation from veterinary school: 

what a respondent usually uses (*eg* you might ask for herd-average milk production based on litres per cow per day while the producer assesses milk production using average 305-day production values).

3.4.1 Checklist question

A checklist question is similar to a multiple-choice question except that the respondent is asked to check all responses that apply (so they need not be mutually exclusive or jointly exhaustive). They are equivalent to having a series of 'yes/no' questions for each category. Consequently, each option on the list requires a separate variable in the database.

3.4.2 Two-choice/multiple-choice question

In 2-choice/multiple-choice questions, it is important to have categories that are **mutually exclusive** (*ie* no overlap) and **jointly exhaustive** (*ie* cover all possibilities). The addition of a category of 'Other (please specify)' (semi-open question) as the last choice can ensure that the options are jointly exhaustive. However, if the question has been well designed, there should not be a lot of responders selecting this category. It is recommended that the list of possible choices not exceed 5 for in-person or telephone-interview questionnaires and 10 for mailed/internet questionnaires. There is some evidence that respondents more frequently choose items at the top of a list. This problem can be avoided by having multiple versions of the questionnaire with varying orders to these questions. However, this adds complexity to the data-coding process. Data derived from a 2-choice/multiple-choice question can be stored as a single variable in the database (Example 3.2) based on the numerical listing of the categories.

3.4.3 Rating question

Rating questions require the respondent to assign a value based on some pre-defined scale. Responses might be ordinal, such as a Likert scale in which the respondent states their level of agreement with a statement (*eg* strongly agree, agree, neither agree nor disagree, disagree and strongly disagree) or recorded on a more continuous numerical scale (*eg* a scale of values from 1 to 10) as in Example 3.3. Continuous data can also be captured using a visual analog scale (described below).

Example 3.2 Multiple-choice question (questionnaire sent only to veterinarians doing some companion animal practice)

6. Type of practice (check one only):

   1. Mixed ☐
   2. Small animal exclusively ☐
   3. Feline exclusively[1] ☐
   4. Referral (please specify type) ☐ _____
   5. Other (please specify type) ☐ _____

[1] To be jointly exhaustive a category of 'Canine exclusively' might have been added but at the time of creation of this questionnaire, it was believed that there were no such practices.

Example 3.3 Rating question

In your opinion, how severe would the pain be in dogs in the first 12 hours after each of the following surgeries if no post-operative analgesics were given? Estimate the pain on a 10-point scale where 1 equals no pain at all and 10 equals the worst pain imaginable (circle one number).

11.	Major orthopaedic surgery	1 2 3 4 5 6 7 8 9 10 don't know
12.	Repair of ruptured cruciate	1 2 3 4 5 6 7 8 9 10 don't know
13.	Abdominal surgery (non-HOE)	1 2 3 4 5 6 7 8 9 10 don't know
14.	Ovarian-hysterectomy (OHE)	1 2 3 4 5 6 7 8 9 10 don't know
15.	Castration	1 2 3 4 5 6 7 8 9 10 don't know
16.	Dental surgery	1 2 3 4 5 6 7 8 9 10 don't know

There are several issues to be considered when developing rating questions. If there are distinct categories, you must decide how many categories there should be and whether or not there should be a middle 'neutral' category (*eg* neither agree nor disagree). The scale should contain a minimum of 5 to 7 points in order to avoid a serious loss of information resulting from translating an underlying continuous response into a series of categories (Streiner and Norman, 1995). Scales with an even number of points are referred to as forced-choice scales because there is no neutral middle value. For data on a numerical scale, respondents might be unwilling to select values at either end of the scale, particularly if many values (*eg* 1 through 10) are available. It is also advisable to provide an option for 'don't know/no opinion' or 'not applicable' in order to differentiate these responses from ones in which no answer was recorded (*ie* missing data). Debate is ongoing about the suitability of assuming that the ordinal data obtained from a rating question are interval data and using parametric statistics, for the analysis of these data (Jamieson, 2004; Pell, 2005). In general, parametric statistics (*eg* mean, standard deviation) should only be computed if there is a minimum of 5 points on the scale and the assumption that the points are equally spaced is reasonable.

Some rating scales consist of a series of questions with 2 or more options for each question. Results from this series of questions could be combined to create rating-scale variables. Results from a set of Likert scale questions are usually added (hence, this is sometimes called a summated scale) and the total treated as interval data. Thurstone scaling and Guttman scaling are 2 other methods of combining results from multiple rating questions. These are beyond the scope of this text, but a useful website describing the development and use of Likert, Thurstone and Guttman scales is available (http://socialresearchmethods.net/kb/). Alternatively, the results from individual questions can be combined using more complex multivariable techniques such as factor analysis (discussed briefly in Chapter 15).

Visual analogue scale (VAS) questions, developed relatively recently, are types of rating question well suited to capturing subjective, semi-quantitative information (situations in which the respondent may have difficulty assigning a precise numerical value). The respondent puts a mark on a horizontal line of a given length and the rating assigned is based on how far along the line the mark is (Cohen, 2004; Houe *et al*, 2002). VAS questions have been used extensively to score pain in human medical research (Kane *et al*, 2005), but whether or not it is linear has been questioned (Myles, 2004; Pesudovs *et al*, 2005). Whether a single item Likert scale question or a VAS question is preferable will depend on the situation in which it is being used (Davey *et al*, 2007; van Laerhoven *et al*, 2004). Example 3.4 shows a VAS (not from the analgesic use survey).

Example 3.4 Visual analogue scale

Indicate by placing an 'x' on the following line how you would rate your work habits with regard to how you milk your cows.

3.4.4 Ranking question

Ranking format questions ask the respondent to order all of the possible responses (or a subset of responses) (Example 3.5). They are often difficult for respondents to complete, especially if the list of choices is long because all the categories must be kept in their mind at once. For in-person interviews, cards with the various responses on them can be prepared and provided to the respondent. This might simplify the ranking process because the respondent only has to choose between a pair of responses at one time (and repeat the process until the cards are in the appropriate rank order).

Rank intervals are unknown to the respondent and might not be equal (*ie* the difference between 2 and 3 is not the same as between 1 and 2). Respondents could frequently assign 'tied' rankings (*ie* the respondent lists 2 items as 1) if they have difficulty choosing between 2 options. Decisions about how the data will be analysed (including how tied ranks will be handled) should be made before the questionnaire is administered. Computing average ranks for various options assumes that the ranks were approximately equally spaced and this might not be the case. Averaging ranks is also a problem if some possible categories have been omitted as these would influence how the respondent might rank the options that were listed. Alternatively, the proportion of respondents who rank an option highly (*eg* proportion who assign a rank of 1 or 2 to each option) might be computed.

Example 3.5 Ranking question

Please rank the following as sources of your knowledge of recognition and control of post-operative pain in dogs and cats (1 = most important source, 6 = least important source).

Question	Source of knowledge	Rank
37	Undergraduate veterinary school	
38	Post-graduate training	
39	Journal articles	
40	Continuing-education lectures/seminars	
41	Experience gained while in practice	
42	Discussion with other veterinary practitioners	

3.5 WORDING THE QUESTION

Wording of questions has a major impact on the validity of the results; questions should rarely exceed 20 words. It is important to avoid the use of abbreviations, jargon and complex or technical terminology. At all times, bear in mind who the respondent is and what level of technical knowledge they have. For example, 'How many fatal cases of neonatal diarrhea occurred during the time period?' is a poorly worded question if the respondent is a dairy producer. 'How many calves died from scours during January?' would be more appropriate.

Make the question as specific as possible. For example, if asking for information about annual milk production, specify the time frame (*eg* January 1, 2002 to December 31, 2002) and clearly define how milk production is to be measured (*eg* total weight of bulk-tank shipments).

Avoid double-barrelled questions—asking 'Do you think BVD is an important disease that producers should vaccinate for?' is really asking 2 questions (one about the importance of BVD and one about the utility of vaccination). These issues should be separated into 2 questions.

Avoid 'leading' questions. Asking a question such as 'Should dogs be allowed to suffer in pain after castration without the benefit of analgesics?' might very likely produce a biased response compared with a more neutral question such as 'Do you think dogs should be given analgesics following castration?'

3.6 STRUCTURE OF QUESTIONNAIRES

Questionnaires should begin with an introduction explaining the rationale and the importance of the questionnaire, and how the data will be used. In it, you should also assure the respondent of the confidentiality of their answers. Telling the respondent approximately how long it will take to complete the questionnaire will help to improve response rates (provided the questionnaire has been kept to an acceptable length). In mailed questionnaires, the introduction might be incorporated into the first page, but it is usually desirable to have it as part of a separate cover letter that is sent with the questionnaire. For interview format questionnaires, the information must be provided verbally at the start of the interview.

After the introduction, it is a good idea to start with questions that build confidence in the respondent. If it is necessary to give instructions to the respondent, make sure they are clear and concise. Highlight instructions in some way (*eg* **bold typeface**) to draw attention to them. Remember that people only read instructions if they think they need help.

Questions should be grouped in sections either according to subject (housing, nutrition) or chronologically (calving, breeding period, pregnancy diagnosis). Within a section, questions might follow a 'funnel' approach in which the subject matter is increasingly specific and focused. Pairs of questions which capture essentially the same information ('date of installing a milking system' and 'age of milking system') might be included at different locations in the questionnaire either for verification of critical information or as a general check on the validity of responses to the questionnaire.

It is important that mailed (or online) questionnaires be visually appealing and easy to complete. Professional-looking questionnaires will enhance the respondents perspective on the importance of the study (Salant & Dillman, 1994).

When designing the form layout, consider ease of data-coding and entry in order to minimise mistakes and reduce the required effort. If at all possible, questions should be pre-coded (*ie* the numerical codes assigned to possible responses are printed beside the various options). It is advisable to leave space on the questionnaire (*eg* a column down the right-hand edge of the page) to allow for the recording of all responses that are to be entered into a computerised database. This will allow data-entry personnel to simply read down a column of responses rather than having to jump around the page (see Example 3.6).

Given that the length of the questionnaire is likely to affect the response rate (discussed below), one approach to shortening questionnaires is to use a partial questionnaire design (Wacholder *et al*, 1994). In this case, information about a key item of interest (*eg* the exposure in a case-control study) is determined from all study subjects, but disjointed subsets of questions about potential confounders are given to randomly selected groups of participants. The missing values are treated as 'missing at random' and methods of analysing these types of data (including estimation of attributable fractions (*AF*)) have been published (Andrés Houseman & Milton, 2006).

3.7 PRE-TESTING QUESTIONNAIRES

All questionnaires need to be pre-tested before applying them to the study population. Pre-testing allows the investigator to identify questions that are confusing, ambiguous or misleading and to determine if there are any problems with the layout of, or the instructions on, the questionnaire. When you pre-test a questionnaire, you can determine if there are questions that respondents will be unable or unwilling to answer or perhaps you can identify additional categories required for multiple-choice questions. Pre-testing also serves to estimate the time required to complete the questionnaire.

A first step in pre-testing the questionnaire is to have colleagues or experts in the field evaluate it to ensure all important issues are identified and covered. Pre-testing on a small sample from the study population can be used to obtain feedback on the clarity of questions and other issues that might be raised by the study subjects. This might be done by having the respondent complete the questionnaire as it will be done in the study and then discussing any problematic aspects. Alternatively, a 'think-aloud' pre-test can be carried out in which the respondent explains all of their thought processes as they work through the questionnaire.

If feasible, it is desirable to have a second pre-test in which the questionnaire is re-administered to the same test group of respondents in order to assess the repeatability of questions. The time interval between the 2 pre-tests needs to be long enough that the respondent does not recall how

Example 3.6 Coding questionnaires

The space at the right allows for direct coding of responses on the questionnaire.

	For office use only
1. Sex 1. Male 2. Female	1. [ ]
2. Age years	2. [ ]
3. Year of graduation from veterinary school	3. [ ]

they answered questions the first time, but short enough that the information being sought is unlikely to have changed. A test-retest evaluation is only valid if the questionnaire is not changed much after the first pre-test. It will also require quite a few more respondents if the repeatability of the questions is to be evaluated.

3.8 VALIDATION

Validation of a questionnaire (or key questions) may involve several aspects. Responses obtained from the questionnaire may be compared with directly measured quantities (*eg* a food frequency questionnaire (Paul *et al*, 2005) or clinical disease (Hotchkiss *et al*, 2006)). Alternatively, responses may be compared with results obtained from a well-established method of estimating an item (*eg* anxiety in humans (Davey *et al*, 2007)). In situations in which it is not possible to compare responses with data collected in other ways, it is at least desirable to assess the repeatability of the questionnaire through repeated administration (Fabricant & Harpham, 1993; Harbison *et al*, 2002). Finally, the method of administration may be evaluated by comparing several methods (Frost *et al*, 2001).

3.9 RESPONSE RATE

Regardless of the type of questionnaire used, efforts must be made to maximise the response rate in order to reduce the possibility of selection bias (see Chapter 12). Methods of increasing response rates (with an emphasis on postal questionnaires) have been reviewed (Boynton, 2004; Edwards *et al*, 2002; Edwards *et al*, 2007). Some items already discussed above, which play an important role in maximising response rate, include the following.

- Make the objective of the study clear to the participants.
- Ensure a clear structure and professional layout to the questionnaire.
- Thoroughly pre-test the questionnaire and provide the respondent with an estimate of the time required for completion.
- Have follow-up contact with the respondents (including repeat delivery of the questionnaire) (Wensing & Schattenberg, 2005).
- Minimise the length of the questionnaire. It has been suggested that questionnaires be kept to under approximately 1,000 words (Jepson *et al*, 2005).

In addition to items included here, other things a researcher can do to improve response rate include the following.

- Provide incentives for completion.
- Including a pen with the questionnaire (Sharp *et al*, 2006; White *et al*, 2005).
- Financial incentives have been found beneficial although the response rate did not necessarily increase with larger payments (Doody *et al*, 2003).
- Provide a stamped (first-class post) return envelope.
- Provide advance notice to the participants about the questionnaire.
- Personalise the questionnaire and cover letter.
- Include university sponsorship of the study.
- Deliver the questionnaire by hand, courier or first-class post.
- Paper, envelope and ink colour (in particular, use of coloured ink instead of black or blue ink can have a positive effect) may affect response rates (Taylor *et al*, 2006).
- Avoid asking for sensitive information unless absolutely necessary.

3.10 DATA-CODING AND EDITING

Before administering any questionnaire, procedures for coding of responses and computer data entry should be considered. When coding responses, it is wise to have a single value to represent missing values. Do not simply leave these blank as, subsequently, it will be impossible to differentiate items that were not answered on the questionnaire from those that were missed in coding or data entry. A unique value (*eg* -999) that could not be a legitimate answer to any of the questions should be used for missing values. Consistency of coding is important and, because it is convenient to analyse no/yes (dichotomous) variables coded as 0/1, it is advisable to use this coding throughout the questionnaire.

Coding of responses is best accomplished directly on the paper forms (either mailed questionnaires or data capture forms used in interviews). Do not attempt to combine coding and data entry into a single step. It is a good idea to use a distinctive colour of ink for recording all codes on the forms so it is easy to differentiate writing done by the coder from that done by the respondent or interviewer.

Computer data entry can be done using specialised software or general purpose programs such as spreadsheets and database managers. Two advantages of specialised software are that they allow you to set validation criteria easily (such as acceptable ranges for values in a given variable) that preclude entry of illogical values and they also facilitate the transfer of data to statistical packages. One useful public domain program for data entry is EpiData (http://www.epidata.dk/). The larger or more complex the anticipated database, the more benefit there is to using specialised software.

Spreadsheets must be used with caution. While they are convenient and easy to set up for data entry, the ability to sort individual columns in the spreadsheet makes it possible to completely destroy the data (*ie* responses from one individual will no longer be on the same row). General-purpose database managers are useful and allow greater manipulation of the data. However, because most data will ultimately be transferred to a statistical package for verification and analysis, it is advisable to perform all data manipulations in that statistical package, where it is easier to document and record all procedures carried out. The process of data verification and processing is discussed further in Chapter 30.

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