



## Dropouts in Longitudinal Surveys

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**Abstract:** Different types of nonresponse threaten the validity of longitudinal studies: first, initial nonresponse during the recruitment in the baseline survey and second, successive dropout at each time point. Dropout in longitudinal surveys has three separate sources: failure to locate research participants, failure to contact participants, and failure to achieve cooperation. In this entry, specific attention is given to existing knowledge on the correlates of dropout and strategies to limit the problem. To limit nonresponse, a total design approach is advocated with specific attention to each source. That is to limit both noncontact (i.e., failure to locate and subsequent failure to contact a located research participant) and noncooperation.

In longitudinal studies, research units (e.g., households, individual persons, establishments) are measured repeatedly over time (*see* **Repeated Measures Analysis of Variance**). Usually, a limited number of separate measurement occasions or waves is used. The minimum number of waves is two, as in the classical pretest–posttest designs, that are well known in intervention studies and experiments (*see* **Clinical Trials and Intervention Studies**). But, longitudinal studies can have any number of measurement occasions (waves) in time. If the number of occasions is very large, this is called a *time series* (*see* **Time Series Analysis**). In a time series, a small number of research units is followed through time and measured on many different occasions on a few variables only. Examples of time series can be found in psychological studies, educational research, econometrics, and medicine. In social research and official statistics, a common form of longitudinal study is the panel survey (*see* **Panel Study**). In a panel, a well-defined set of participants is surveyed repeatedly. In contrast to time series, panel surveys use a large number of research units and a large number of variables, while the number of time points is limited. Examples are budget surveys, election studies, socioeconomic panels, and general household panels (*see* **Panel Study**).

In the following sections, most examples will come from panel surveys. However, the principles discussed also apply to other types of longitudinal studies and other disciplines. First, we discuss the nature and problems associated with nonresponse in longitudinal studies. In the second part, we focus on successful methods to prevent nonresponse.

The validity of *any* longitudinal study can be threatened by both initial nonresponse at the start of the survey and dropout (*see* **Dropouts in Longitudinal Studies: Methods of Analysis**).

Not everyone who is invited to participate in a longitudinal study will do so. This is called *initial nonresponse* (*see* **Nonresponse in Sample Surveys**). As in cross-sectional surveys, initial nonresponse

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can be high and threaten the representativeness of the entire longitudinal study. Therefore, one should first try to reduce the initial nonresponse in longitudinal studies as much as possible. Second, the fieldwork in the panel recruitment phase should aim to collect as much auxiliary data as possible about the nonrespondents. Initial nonresponse is beyond the scope of this entry, but it has been a topic of great interest for survey methodologist in cross-sectional surveys, and in the past decades, much empirical knowledge on nonrespondents and reduction of nonresponse has been collected, see Ref. 1.

After the initial recruitment, when research participants have agreed to cooperate in the longitudinal study, nonresponse can occur at every further time point or wave of the study. This is called *dropout*. Dropout can take the form of nonresponse at a particular wave (wave-nonresponse). If after a certain time point, research participants stop responding to all subsequent questionnaires or interviews, dropout takes the form of *attrition* (see **Attrition**) or *panel mortality*.

Besides initial nonresponse and dropout, there is a final source of nonresponse that may threaten the validity of longitudinal data: item nonresponse. When item nonresponse occurs, a unit (e.g., research participant, respondent) provides data, but for some reason not for particular items. Item nonresponse is beyond the scope of this entry; for an introductory overview on prevention and treatment of item nonresponse, see Ref. 2.

If initial nonresponse or dropout is *selective*, the missing data are called *not missing at random* (MAR) and the results of analyses from longitudinal data may be biased. Two examples of selective dropout are as follows: (i) in a panel of elderly, the oldest members and those in ill-health drop out more often or (ii) in a clinical trial for premature infants, the lightest infants are more likely to stay in the intervention group, while the healthier and heavier babies drop out over time.

Only if one knows who the dropouts are and why the dropout occurs, it is possible to statistically adjust for dropout (see **Dropouts in Longitudinal Studies: Methods of Analysis; Missing Data**). The statistical adjustment process is far from simple and risks introducing other types of error to the data. The more one knows about the missing mechanism, the better one can adjust. So, the first step in good adjustment procedures is to prevent dropout as much as possible and collect as many data as possible of people who may eventually drop out.

Even if the dropout is not selective, it may still cause problems in the analysis. Longitudinal studies often are used to study change between two consecutive measurements in time. Missing data at wave  $t$  will make it impossible to measure change between  $t - 1$  and  $t$ , as well as  $t$  and  $t + 1$ . The smaller number of cases will also result in less statistical *power* (see **Power**) and increased variance. Furthermore, in *subgroup* (see **Subgroup**) comparisons, dropout may lead to a very small number of persons in a particular subgroup. Again, the best strategy is to limit the problem by avoiding dropout as far as possible.

Survey methodologists have developed successful strategies to reduce initial nonresponse and to build trust so that dropout can be limited. This needs careful planning and a total design approach. As research participants will be contacted over time, it is extremely important that the study has a well-defined image and is easily recognized and remembered at the next wave. A salient title, a recognizable logo, and graphical design are strong tools to create a positive study identity and should be consistently used on all survey materials. For instance, the same logo and graphical style should be used for questionnaires, interviewer identity cards, information material, newsletters, and thank-you cards. When incentives are used, one should try to tie these in with the study. A good example comes from a large German study on exposure to printed media. The logo and mascot of this study is a little duckling, Paula. In German, the word "Ente" or duck has the same meaning as the French word "canard": a false (newspaper) report. Duckling Paula appears on postcards for the panel members, as a soft toy for the children, as an ornament for the Christmas tree, printed on aprons, T-shirts, and so on, and has become a collector's item.

Dropout in longitudinal studies originates from three sources: failure to locate the research unit, failure to contact the potential respondent, and failure to obtain cooperation.

Thus, the first task is limiting problems in *locating* research participants. At the recruitment phase or during the baseline study, the sample is fresh and address information is up-to-date. With time, people



move and address, phone, and e-mail information may no longer be valid. It is of the utmost importance that as often as possible, special locating information is collected from all study participants. Besides the full name, also the maiden name should be recorded to facilitate follow-up after divorce. It is advisable to collect full addresses and phone numbers of at least three good friends or relatives as “network contacts.” Depending on the study, names and addresses of parents, school administration, or employers may be asked as well. One should always provide “change-of-address-cards” with mailings, and if the budget allows for this, print a message conveying that if one sends in a change of address, the researchers will send a small “welcome in your new home-gift” (e.g., a flower token, a DIY-shop token, a monetary incentive). It goes without saying, that the change-of-address cards are preaddressed to the study administration and that no postage is needed. For an overview of tracking techniques, see Ref. 3. When the waves or follow-up times are close together, there is reasonable certainty that locating information will stay up-to-date if this forms a special part of the interview. If this is not the case, for instance in an annual or biannual study, it pays to incorporate between-wave locating efforts. For instance, sending a Christmas card with a separate “change-of-address card,” birthday cards for panel members, and a newsletter with a request for an address update. Additional strategies are to keep in touch and follow-up at known life events (e.g., pregnancy, illness, completion of education). This is not only motivating for respondents, it also limits loss of contact as change-of-address cards can be attached. Any mailing that is returned as undeliverable should be tracked immediately. Again, the better the contact ties in with the goal and topic of the study, the better it works. Examples are mother’s day cards in a longitudinal study of infants, and individual feedback and *growth curves* (see **Growth Curves**) in health studies. A total design approach should be adopted with material identifiable by house style, mascot, and logo, so that it is clear that the mail (e.g., child’s birthday card) is coming from the study. Also ask regularly for an update of, or additional, network addresses. This is extremely important for groups that are mobile, such as young adults.

If the data are collected by means of face-to-face (see **Face-to-Face Surveys**) or telephone interviews, the interviewers should be clearly instructed in procedures for locating respondents, both during training and in a special *tracking* (see **Tracking**) manual. Difficult cases may be allocated to specialized “trackers.” Maintaining interviewer and tracker morale, through training, feedback, and bonuses, helps to attain a high response. If other data collection procedures are used (e.g., mail or internet survey, experimental or clinical measurements), staff members should be trained in tracking procedures and use of specific resources to locate sample members (e.g., databases or phone books).

The second task is limiting the problems in *contacting* research participants. The first contact in a longitudinal study takes effort to achieve, just like establishing contact in a *cross-sectional* (see **Cross-Sectional Study**), one-time survey. Interviewers have to make numerous calls at different times, leave cards after a visit, leave messages on answering machines, or contact neighbors to extract information on the best time to reach the intended household. However, after the initial recruitment or baseline wave, contacting research participants is far less of a problem. Information collected at the initial contact can be fed to interviewers and used to tailor later contact attempts, provided, of course, that good locating information is also available. In health studies and experimental research, participants often have to travel to a special site, such as a hospital, a mobile van, or an office. Contacts to schedule appointments should preferably be made by phone, using trained staff. If contact is being made through mail, a phone number should always be available to allow research participants to change an inconvenient appointment, and trained staff members should immediately follow-up on “no-shows.”

The third task is limiting dropout through lost willingness to cooperate. There is an extensive literature on increasing the cooperation in cross-sectional surveys. Central in this is reducing the cost for the respondent, while increasing the reward, motivating respondents and interviewers, and personalizing and tailoring the approach to the respondent, see Refs 1 and 4. These principles can be applied both during recruitment and at subsequent time points. When interviewers are used, it is crucial that interviewers are



kept motivated and feel valued and committed. Interviewers can and should be trained in special techniques to persuade and motivate respondents, and learn to develop a good relationship. It is not strictly necessary to have the same interviewers revisit the same respondents at all waves, but it is necessary to feed interviewers information about previous contacts. Personalizing and adapting the wording of the questions by incorporating answers from previous measurements (dependent interviewing) have positive effect on cooperation.

Web surveys became a prevalent mode of data collection in the twenty-first century, and following this trend, online panels were established. There are two types of online panels: probability-based and nonprobability-based panels. As the name indicates, respondents in probability-based panels are randomly selected from a frame covering the target population, while this is not the case in nonprobability panels. Nonprobability panels can be seen as convenience samples. Online panels often function as “access panels,” which are an online sample database of potential respondents who declare that they will cooperate for future data collection if selected, see Ref. 5. In this sense, an online panel is mainly used for cross-sectional studies. There are online panels that also have a longitudinal component. A prime example is the LISS panel, a probability-based online panel in the Netherlands that in their core studies yearly presents the whole panel with the same set of questions on important topics, like health, politics, economic conditions, and so on. This core study is designed to parallel existing household panels, see Ref. 6.

Dropout in online panels differs slightly from dropout in other survey modes. Because the main mode of contact is through e-mail, it is hard to know whether the e-mails actually reached the respondent, and whether contact was made. Only when e-mails get “bounced,” do researchers know about this. For this reason, the distinction between nonlocation, noncontact, and willingness is less useful in understanding and preventing online dropout. In online panels, a profile update should be minimally done once every 12 month as recommended by the ISO26362 norm for access panels. If panel members do not react to a profile update, they should be dropped from the panel as active members.

Another difference between offline and online surveys is that dropout rates are generally much higher in online survey, see Ref. 7. For probability-based online panels, the first contact and recruitment are usually made by an interviewer, either face-to-face or by telephone. After this, respondents need to switch to online administration, which leads to additional dropout. The absence of personal contact with interviewers and high frequency of data collection also lead to higher dropout. This dropout is, however, often in the form of wave nonresponse, rather than permanent attrition, meaning that in online panels’ respondents may drop out, come back, and drop out again, see Ref. 8.

In all types of panels, respondents may drop out temporarily because of time pressure or lifetime changes (e.g., change of job, birth of child, death of spouse). If a special attempt is made, the respondent may not be lost for the next waves. In general, prior experiences and especially “respondent enjoyment” is related to cooperation at subsequent waves. A short and well-designed questionnaire (*see Survey Questionnaire Design; Questionnaire Design; Question-Wording Effects in Surveys*) helps to reduce response burden. Researchers should realize this and not try to get as much as possible out of the research participants at the first waves.

Many survey design features that limit *locating* problems, such as sending birthday and holiday cards and newsletters, also serve to nurture a good relationship with respondents and keep them motivated. In addition to these intrinsic incentives, explicit incentives also work well in retaining cooperation, and do not appear to have a negative effect on data quality, see Ref. 9. Again, the better the incentives fit the respondent and the survey, the better the motivational power (e.g., free downloadable software in a student-Internet panel, air miles in travel studies, cute T-shirt and toys in infant studies). In addition to the general measures described above, each longitudinal study can and should use data from earlier time points to design for nonresponse prevention. Analysis of nonrespondents (persons unable to locate again and refusals) provides profiles for groups at risk. Extra effort then may be put into research participants with similar profiles who are still in the study (e.g., offer an extra incentive, try to get additional network information). In addition, these nonresponse analyses provide data for better statistical adjustment.



With special techniques, it is possible to reduce dropout in longitudinal studies considerably, but it can never be prevented completely. Therefore, adjustment procedures will be necessary during analysis. Knowing why dropout occurs makes it possible to choose the correct statistical adjustment procedure. If data are missing completely at random (MCAR), the missingness is not related to the outcome variable and all other variables. The missing cases are a subsample of all cases, the analyses will not be biased, and the only disadvantage of dropout is a loss of statistical power (*see Missing Data*). Research participants may drop out of longitudinal studies for various reasons, but of one thing one may be assured: they do not drop out completely at random. It is, therefore, very important to investigate the correlates of missingness, using data collected in earlier waves, or available auxiliary information from the sampling frame.

When the process of missingness and the outcome variable can be sufficiently explained by covariates (e.g., age, education, socioeconomic status), the data are Missing at Random (MAR). In other words, if the reasons for dropout are only related to covariates and are not related to the topic of the study, responses are Missing At Random and relatively simple weighting or imputation procedures can be adequately employed.

Finally, if the reasons for dropout *are* related to the topic of interest, responses are missing not at random (MNAR). For example, victims of serious crimes do not respond to a crime survey, because it is too emotional or confronting. In the case of MNAR, the missingness is said to be nonignorable, simple adjustment methods will not suffice, and a special model for the dropout must be included in the analysis to prevent bias. In longitudinal studies, usually auxiliary data are available from earlier time points, but one can only guess at the reasons why people drop out. It is advisable to ask for these reasons directly in a special short exit-interview. The data from this exit interview, together with auxiliary data collected at earlier time points and information from the sampling frame, can then be used to statistically model the dropout and avoid biased results.

### Related Articles

**Dropouts in Longitudinal Studies: Methods of Analysis; Longitudinal Designs in Genetic Research; Nonignorable drop-out in Longitudinal studies; Nonresponse in Sample Surveys; Nonresponse; Bias from Nonresponse; Longitudinal Studies; Longitudinal Data Analysis; Longitudinal Data; Baseline Adjustment in Longitudinal Studies; Panel Study; Panel Data; Repeated Measurements.**

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- The archive of the open access *Journal of Official Statistics* at <http://www.jos.nu> contains many interesting articles on survey methodology, including longitudinal studies and panel surveys.