# Impact of Correcting for Nonresponse by Weighting on Estimates of Alcohol Consumption

PIA MÄKELÄ, PH.D.[†]

*STAKES, Alcohol and Drug Research Group, P.O. Box 220, 00531 Helsinki, Finland*

**ABSTRACT.** *Objective*: This study describes the characteristics of nonrespondents and assesses the impact of unit nonresponse on estimates of central alcohol consumption variables by examining the impact of corrective weighting. *Method*: The data came from a Finnish general population random sample of 1,932 respondents (987 women) (response rate: 78.1%). The survey was carried out in the year 2000 using face-to-face interviews. The impact of unit nonresponse was assessed by comparing results using (1) no weighting; (2) poststratified weights adjusted for age, gender and region; (3) weights obtained from a statistical model predicting response propensity; and (4) weights from the model, adjusted to match the population distribution for age, gender and region. Extensive auxiliary information used to predict response propensity came from administrative registers. *Results*: Compared with respondents, both male and female nonrespondents had fewer children, lived in urban areas and lived in southern Finland. Male nonrespondents were also older; female nonrespondents more often had only a basic education and were less often in the second-highest income quartile. The change in alcohol variables resulting from the adjustment for nonresponse was small, however, and the difference between the different weighting schemes was even smaller. *Conclusions*: If nonrespondents' drinking differs considerably from that of respondents, this difference cannot be captured even by using extensive auxiliary information and an elaborate model predicting propensity of nonresponse. (*J. Stud. Alcohol* **64:** 589-596, 2003)

THE RELATIVELY LOW and declining response rates to general population surveys continue to pose serious problems to survey researchers in the alcohol field. This is because nonrespondents may differ in their alcohol consumption habits from respondents and such selective nonresponse could severely bias the results. In his review of the literature on nonresponse that had a special focus on alcohol and drug surveys, Caetano (2001) concluded that, first, there are too few studies in the alcohol field on the subject and, second, that survey respondents do seem to differ from nonrespondents in their use of alcohol and illicit drugs, but "the jury is still out" on the question of whether nonrespondents are more likely than respondents to be drinkers, heavier drinkers or dependent on alcohol and illicit drugs.

A few studies have been published in which extra effort has been made to obtain information on nonrespondents' drinking. Lemmens et al. (1988) followed up the nonrespondents to a face-to-face survey with a telephone interview, with a response rate of 39% in the follow-up survey. The secondary respondents (those who were nonrespondents in the original study but responded to the follow-up) had lower mean consumption levels, were less often frequent heavy drinkers and were, among women, more often abstainers compared with the primary respondents (those who participated in the original study). Lahaut et al. (2002) did a follow-up face-to-face survey of nonrespondents to a survey using mailed questionnaires, with a response rate of 52%. The secondary respondents were more often abstainers compared with the primary respondents. Their slightly higher rate of frequent excessive drinking was not statistically significant. Hill et al. (1997) used telephone interviews to follow up a sample of the nonrespondents in a survey conducted using postal questionnaires. The response rate was 54%. Compared with the primary respondents, the secondary respondents were less often heavy drinkers.

In other studies, the respondents in a survey have been asked to participate in a follow-up study, and the respondents and nonrespondents in the follow-up survey have been compared. In both Gmel's (2000) and Wild et al.'s (2001) studies, the original respondents came from a telephone interview (that included alcohol questions) and the follow-up was done by means of a mail questionnaire. In Gmel's (2000) study, nonrespondents to the mailed questionnaire were more often abstainers than were respondents, and the drinkers among the nonrespondents were more often hazardous drinkers and had a slightly higher level of mean consumption; however, the differences were not statistically significant. In Wild et al.'s (2001) analysis, agreement to receive the follow-up questionnaire was unrelated to alcohol use, but the return rate was relatively low among those who drank any alcohol weekly and even lower among those who drank five or more drinks weekly.

Received: November 18, 2002. Revision: March 31, 2003.

[†]Correspondence should be sent to Pia Mäkelä at the above address, or via email to: pia.makela@stakes.fi.

In these study designs, researchers have compared the drinking of those who replied in the first survey to that of those who replied in the follow-up only (or, alternatively, the drinking of those who replied in two rounds to those who replied in one round only). It seems that those nonrespondents who reply after extra effort are more often abstainers than are respondents. Subsamples of respondents who agree to respond in a follow-up study, however, may not be at all representative of the remaining nonrespondents. It could be, for example, that the secondary respondents are recruited from among those who refused to participate due to lack of time in the first round, and that the subsamples of nonrespondents that could not be found or who refused on principle did not participate in the follow-up and have very different drinking habits. In addition, the survey mode has usually been different for the two groups of respondents, which may bias the results.

In studies using register data, it has been possible to follow the whole study sample. In Romelsjö's (1989) study, a sample of 6,217 was sent a questionnaire (response rate 65.8%); the nonrespondents were interviewed by telephone (another 12.7% responded, response rate: 37%) and register data existed for all. Romelsjö found that the secondary participants were more often hospitalized with alcohol diagnoses than were the primary respondents (3.3% vs 1.9% among men, 1.0% vs 0.8% among women); however, the rate was even higher among those who did not participate in either survey (4.8% among men, 1.2% among women). Ohlson and Ydreborg (1985) studied the nonparticipants in a health examination for men formerly employed at an asbestos cement plant in Sweden (participation rate: 57%). The nonparticipants (particularly those who did not answer and those who accepted but did not participate) were more often found in the register of the Temperance Board for excessive alcohol intake, compared with participants.

In the current study, the approach taken to study the effects of nonresponse was more indirect than in the studies cited above. Although we had no measurement on the drinking of the nonrespondents, we had extensive data on the background factors of both respondents and nonrespondents.

When a survey researcher has a data-set at hand and would like to do something about the possible bias caused by selective nonresponse, the standard approach is to construct and use weights that restore the representativeness of the sample. Often, however, the pool of background variables available for nonrespondents and respondents alike is small. Whether one uses only a few basic variables or a wide range of variables to describe the sample may be very important to the functioning of the weighting.

Finnish drinking-habits surveys have the advantage that the samples have been drawn from a population register with extensive background information on the subjects. This information can be used to find out more about who responds to the surveys and who does not. The data on respondents can be used to explore whether these background factors are strongly related to alcohol consumption variables. If this is the case, the information on the relationship between background factors and nonresponse can be used for constructing weights to improve the results on alcohol consumption variables obtained using the respondent sample.

Lemmens et al. (1988) used gender, age, marital status, urbanization and region to predict and correct for nonresponse. The effect of the corrections on typical consumption, mean consumption level and quantity-frequency-variability measure was marginal. In the current study, the auxiliary information used to predict nonresponse includes age, gender, mother tongue, marital status, education, income of the dwelling unit, size of the dwelling unit, number and age of children in the dwelling unit, and region and urbanization of the area.

The aims of this article are (1) to describe the nonrespondents in the Finnish drinking-habits survey of the year 2000, (2) to assess how the background factors associated with nonresponse are related to drinking variables (among respondents) and (3) to compare the results on central alcohol consumption variables obtained with different corrections for nonresponse and sampling error.

Comparisons were made between (1) raw results, with no weighting used (no correction); (2) results with weight adjustment, in which the distribution by a few basic variables has been matched with that of the population (rough correction for both sampling error and nonresponse); (3) results obtained using weights from a statistical model predicting propensity to respond (an elaborate way to correct for nonresponse); and (4) results with the model-based weights additionally adjusted to match the population distribution by a few basic variables (an elaborate correction for nonresponse combined with a rough correction for sampling error).

## Method

### *Sample*

The data came from the Finnish Drinking Habits Survey carried out in September-October 2000 using face-to-face interviews. Finns between the ages of 15 and 69 were sampled. Excluded were those living in the Åland Islands; the homeless and those with an unknown place of residence (0.5% of the population); the institutionalized (0.7% of the population); and people known not to reside in their official place of residence (0.3% of the population). Of a simple random sample with a size of 2,500, 1,932 (987 women) responded. Subjects were first approached by means of a letter notifying them of the survey and then contacted via telephone by the interviewer. There was no limit to the number of times the interviewer tried to contact the respondents. The mean number of contacts was 3.5 for respondents and 6.5 for nonrespondents.

*Measures*

The sample was drawn from census records (the census in Finland is now based on computerized databases rather than questionnaires). Background variables available to researchers included age, gender, marital status, mother tongue (Finnish or other), number of children younger than 18 living in the same dwelling, age of these children, educational level, income decile in state taxation (calculated separately for women and men), income decile in municipality taxation and municipality. We had two measures of urbanization for the municipalities. These were "urbanization rate" (i.e., the percentage of the population living in densely populated areas) and "urbanization" (a categorization made by Statistics Finland—based on the rate of urbanization and the size of the largest population center—into urban, midurban and rural municipalities). Geographical classifications of the municipalities consisted of 6 "greater regions," 13 old and 5 new administrative counties and 19 "cultural regions" or provinces.

On the basis of preliminary analyses of the predictive value of the background variables on response rate, some overlapping variables were removed from the analysis at this early stage. Of the geographical classifications listed above, the six "greater regions" was selected, with one of the greater regions divided into two (i.e., a total of seven regions).

Annual intake was calculated on the basis of the amounts consumed on all drinking occasions within a period of time preceding the interview; this period of time varied between 1 week and 12 months depending on the average drinking frequency of the respondent (for details, see Mäkelä, 1971).

The frequency of drinking was measured by a variable with 11 categories ranging from "never" to "daily." This variable was transformed into times per year. The frequency of intoxication was measured by the question "How often do you drink enough to really feel it?" with the same response categories and transformation as for frequency of drinking. Heavy drinking was defined as drinking 10 liters of absolute alcohol per year (slightly less than two standard Finnish drinks per day) for men and 5 liters for women.

*Weighting procedures*

The basic weights provided by the interviewer organization, Statistics Finland, were based on poststratification. These weights were constructed in each combination of gender, age (four age groups) and geographical greater region (combined into three categories); thus, there were 24 different subgroups. The weights were constructed so that the weighted proportion of respondents in each subcategory equaled the corresponding proportion in the target population. In practice, the weights were obtained by dividing the latter proportion with the former. These weights varied between 0.62 and 1.47, with a mean of 1.0.

By forcing the demographic distribution of the respondents to be the same as that in the population, the method simultaneously corrects for possible sampling error (the difference between target population and the original sample) and for response bias (the difference between the original sample and the respondent sample). This method cannot be used with a large number of background variables because with new variables added the number of cells in the cross-classified table quickly increases and the number of observations per cell decreases. Also, the full distribution of the variable combinations in the target population has to be known in order to use this type of analysis.

The second set of weights was constructed with the aim of making the respondent sample correspond as much as possible to the original sample (not to the whole target population, for whom similar data is not available). Hence, these weights correct for nonresponse more thoroughly, taking more factors into account than do the poststratified weights, but do not correct for sampling error. Logistic regression models predicting the response probability (0 = nonresponse, 1 = response) were fitted by gender, to help decide which variables to use in the adjustment and to derive less-random estimates for the response propensity in each cell. A stepwise selection procedure was used, in which main effects and all first-order interaction effects were used as the pool of potential terms to be included. After this, it was further checked whether there was a need to include some additional main effects, interaction effects or dummy variables (identified from the examination of residuals). The $\alpha$ level of 0.05 was used to decide whether to include terms or not. The inverses of the predicted probabilities of response were used for weighting adjustment. These were scaled so that the weighted total of respondents remained the same as the unweighted total. The weights varied between 0.78 and 2.63, with a mean of 1.0. (cf., Ekholm and Laaksonen, 1991; Kalton and Kasprzyk, 1986; Rizzo et al., 1996).

In the next stage, the weights from the regression model were further adjusted so that the weighted distribution by age, gender and greater region in the respondent sample equaled that observed in the population (i.e., these weights corrected for sampling error as well). The weights varied between 0.56 and 2.62, with a mean of 1.0.

*Statistical analysis*

The statistical significance of the association between background factors and the percentage of nonrespondents and heavy drinkers was assessed using logistic regression models, in which the background factors were included as categorical variables. For annual consumption (volume of drinking), frequency of drinking and frequency of intoxication, a linear regression model was fitted using a logarithmic transformation of the outcome variables.

## Results

### *Reasons for nonresponse*

The response rate was 78.1% (Table 1). Among men, 7 of 10 nonrespondents refused to participate; among women the number was 8 of 10. "Lack of time" and "principle" were the most popular single reasons given for refusal; refusal due to the theme of the study was mentioned by one tenth of all nonrespondents (by women more often than by men). Approximately half of the rest of nonrespondents were "not-at-homes." Difficulties in tracing the subject were not common, in part because some groups that are close to impossible to reach for interview were excluded from the sampling frame (1.5% of population, see Method section).

### *Response by background factors*

Many of the background variables were statistically significant predictors of nonresponse (Nonrespondents, Tables 2 and 3). Characteristics associated with a high nonresponse rate were not having any children, living in an urban municipality and living in southern Finland. Among men, higher age and, among women, basic education and other than moderately high (third quartile) income also were associated with nonresponse.

The associations between background variables and the rate of refusals were quite similar as for any nonresponse (data not shown in a table). Lack of time was given as the reason for refusal more often among younger age groups, parents whose youngest child was under 7 years (the age when school starts), people who lived in urban municipalities or in southern Finland, and women who earned either very little or very much. "Principle" most commonly was given as the reason for refusal among older age groups, among married people and among men living in eastern and northern Finland. The theme of the study was mentioned more often as the cause for refusal among the oldest age group (both men and women), among the youngest (men only) and in some parts of southern Finland.

Reasons for nonresponse other than refusal were usually associated with the same factors that were associated with nonresponse in general (data not shown in a table). The exceptions were that the rate of nonresponse due to other reasons was low among women in general and among married men, and it was high in groups with lower than median income and, among women, in both young and old.

The fact that nonrespondents do not come equally from all sociodemographic groups alone is not sufficient to yield biased results on alcohol consumption. What is needed, in addition, for the bias to occur is that the same background variables that are associated with nonresponse also be associated with the outcome variables of interest, that is, with some central variables on alcohol consumption (for example, "the old respond less and drink less"). Therefore, the last four columns in Tables 2 and 3 show, among respondents, the mean values of annual intake, annual frequency of drinking, annual frequency of intoxication and the proportion of heavy drinkers in categories of the background variables.

TABLE 1. Gross and net sample size, nonresponse and reasons for not participating

| | | | % of nonresponse | | |
|---|---|---|---|---|---|
| | *N* | | All | Men | Women |
| Gross sample size | 2,500 | | | | |
| Did not belong to the sampling frame | 26 | | | | |
| Net sample size | 2,474 | (100%) | | | |
| Respondents | 1,932 | (78.1%) | | | |
| Nonrespondents, total | 542 | (21.9%) | 100 | 100 | 100 |
| Refusals | 401 | | 74.0 | 68.4 | 80.7 |
| Lack of time | 86 | | 15.9 | 12.2 | 20.2 |
| Principle | 92 | | 17.0 | 19.4 | 14.1 |
| Theme of the study | 56 | | 10.3 | 7.8 | 13.3 |
| Other or unknown reason | 167 | | 30.8 | 29.0 | 33.1 |
| Not at home | 74 | | 13.7 | 17.7 | 8.9 |
| Inability to participate (lack of time, sickness, language problems, etc.) | 41 | | 7.6 | 8.8 | 6.1 |
| Untraced (address unknown or cannot be found) | 10 | | 1.8 | 3.4 | 0.0 |
| Other | 16 | | 3.0 | 1.7 | 4.4 |

All background variables were associated with at least one of the four alcohol consumption variables and, hence, it was reasonable to include all of them as potential predictors in the derivation of weights. In general, the same variables that were associated with nonresponse were also associated with alcohol consumption (as based on the analysis among respondents). The direction of the associations often was such that we would expect the nonrespondents to have higher than average values for drinking. Nonrespondents were often urban residents, who usually drink a lot; they came more often from regions in which alcohol is drunk more and they often did not have children (associated with more drinking). It is, however, important to note that some associations worked in the opposite direction. For example, old age was associated with higher than average nonresponse and a lower than average alcohol intake, and this applied to low income, for the most part, as well. To some extent, these associations varied between the drinking measures used; the nonrespondents more often had only a basic education, which is associated with less drinking overall but a higher frequency of intoxication-oriented drinking, at least among men.

### *Models for response propensity*

Modeling of response propensity as a function of the different background variables listed in Tables 2 and 3 was carried out as explained in the Method section. For men,

TABLE 2. Distribution of whole sample and nonrespondents, and the connection between background variables and alcohol consumption variables among respondents: Men

| | Proportion of sample % | Non-respondents (%) | Average annual: Consumption, centiliters | Average annual: Frequency of drinking, times per year | Average annual: Frequency of intoxication, times per year | Heavy drinkers (%) |
|---|---|---|---|---|---|---|
| All | 50 | 25 | 484 | 76 | 9.5 | 14 |
| Age, years | | (.04) | (<.001) | (<.001) | (<.001) | (.08) |
| 15-24 | 16 | 22 | 496 | 56 | 15.2 | 14 |
| 25-39 | 28 | 20 | 581 | 80 | 10.1 | 19 |
| 40-54 | 35 | 28 | 472 | 85 | 9.3 | 13 |
| 55-70 | 21 | 25 | 357 | 72 | 4.4 | 10 |
| Marital status | | | | (.04) | (<.001) | |
| Single | 39 | 25 | 538 | 69 | 13.3 | 16 |
| Married | 50 | 24 | 435 | 82 | 6.2 | 14 |
| Other | 11 | 26 | 526 | 74 | 11.5 | 12 |
| Mother tongue | | | | | (<.001) | (.04) |
| Finnish | 94 | 25 | 496 | 77 | 9.8 | 15 |
| Other | 6 | 24 | 288 | 64 | 3.9 | 6 |
| Children aged 0-17 years living in the same dwelling | | (.009) | | | | |
| No | 65 | 27 | 510 | 76 | 10.7 | 14 |
| Yes, youngest 0-6 | 17 | 18 | 432 | 77 | 6.4 | 13 |
| Yes, youngest 7-17 | 18 | 23 | 448 | 76 | 8.5 | 16 |
| Children aged 0-17 years living in the same dwelling | | (.01) | (.003) | (.05) | | |
| No | 65 | 27 | 510 | 76 | 10.7 | 14 |
| Yes, 1-2 | 27 | 21 | 472 | 80 | 7.6 | 16 |
| Yes, 3 or more | 8 | 17 | 329 | 65 | 6.6 | 9 |
| Urbanization of municipality | | (<.001) | (.04) | | (.02) | (.001) |
| Urban | 61 | 29 | 555 | 83 | 10.9 | 18 |
| Midurban | 16 | 15 | 361 | 68 | 7.0 | 7 |
| Rural | 23 | 19 | 409 | 67 | 8.1 | 12 |
| Urbanization rate of municipality[a] | | (<.001) | | | (.03) | (.001) |
| <62.8 | 21 | 18 | 428 | 70 | 7.3 | 13 |
| 62.9-85.4 | 19 | 17 | 349 | 65 | 8.0 | 6 |
| 85.5-95.9 | 18 | 30 | 511 | 73 | 10.2 | 16 |
| 96.0-97.6 | 15 | 30 | 534 | 89 | 11.9 | 18 |
| 97.7-100 | 28 | 28 | 596 | 86 | 10.8 | 19 |
| Region | | (<.001) | (.002) | (.005) | (.007) | (.04) |
| Capital area | 18 | 28 | 656 | 96 | 12.5 | 21 |
| Other Uusimaa | 8 | 40 | 468 | 74 | 9.0 | 15 |
| Kanta-Häme and Pirkanmaa | 12 | 17 | 487 | 87 | 10.6 | 15 |
| Other southern Finland | 24 | 31 | 529 | 80 | 7.7 | 16 |
| Eastern Finland | 14 | 16 | 382 | 62 | 9.0 | 8 |
| Middle Finland | 13 | 18 | 355 | 65 | 9.6 | 11 |
| Northern Finland | 11 | 20 | 451 | 64 | 7.9 | 11 |
| Income in state taxation | | | (.04) | (<.001) | | (.04) |
| 1st decile | 9 | 24 | 455 | 50 | 14.4 | 13 |
| 2-5 deciles | 35 | 28 | 471 | 67 | 10.4 | 13 |
| 6-9 deciles | 42 | 23 | 462 | 82 | 8.2 | 13 |
| 10th decile | 14 | 21 | 593 | 97 | 8.3 | 23 |
| Education | | | (<.001) | (<.001) | (.006) | (.045) |
| Basic or missing | 35 | 27 | 436 | 61 | 8.8 | 11 |
| Middle | 41 | 24 | 488 | 76 | 10.7 | 14 |
| High | 24 | 21 | 542 | 97 | 8.4 | 19 |

*Notes*: $p$ values smaller than 0.1 are given in parentheses. A $p$ value less than .05 is considered to indicate statistical significance. [a]Proportion of the population in the municipality living in densely populated areas.

TABLE 3. Distribution of whole sample and nonrespondents, and the connection between background variables and alcohol consumption variables among respondents: Women

| | Proportion of sample % | Non-respondents (%) | Average annual Consumption, centiliters | Average annual Frequency of drinking, times per year | Average annual Frequency of intoxication, times per year | Heavy drinkers (%) |
|---|---|---|---|---|---|---|
| All | 50 | 21 | 158 | 40 | 3.0 | 7 |
| Age | | | (<.001) | (<.001) | (<.001) | (.002) |
| 15-24 | 19 | 20 | 194 | 35 | 6.2 | 8 |
| 25-39 | 24 | 17 | 153 | 43 | 2.5 | 7 |
| 40-54 | 34 | 23 | 201 | 48 | 3.1 | 11 |
| 55-70 | 22 | 23 | 67 | 29 | 0.5 | 2 |
| Marital status | | | (<.001) | | (<.001) | |
| Single | 34 | 22 | 177 | 37 | 4.5 | 6 |
| Married | 47 | 20 | 146 | 42 | 1.8 | 7 |
| Other | 19 | 23 | 151 | 39 | 3.1 | 8 |
| Mother tongue | | | | | (.08) | |
| Finnish | 95 | 21 | 159 | 40 | 3.0 | 7 |
| Other | 5 | 18 | 134 | 35 | 1.8 | 9 |
| Children aged 0-17 years living in the same dwelling | | (.02) | | | | (.022) |
| No | 60 | 23 | 177 | 43 | 3.2 | 9 |
| Yes, youngest 0-6 | 17 | 17 | 103 | 35 | 1.8 | 2 |
| Yes, youngest 7-17 | 23 | 17 | 149 | 36 | 3.3 | 7 |
| Children aged 0-17 years living in the same dwelling | | (.02) | (.002) | (.04) | (.003) | (.04) |
| No | 60 | 23 | 177 | 43 | 3.2 | 9 |
| Yes, 1-2 | 32 | 17 | 143 | 38 | 3.0 | 6 |
| Yes, 3 or more | 8 | 16 | 80 | 29 | 1.3 | 1 |
| Urbanization of municipality | | (.01) | (<.001) | (.02) | (.002) | (.002) |
| Urban | 63 | 24 | 189 | 44 | 3.3 | 9 |
| Midurban | 16 | 16 | 114 | 32 | 3.0 | 4 |
| Rural | 21 | 17 | 105 | 36 | 1.9 | 4 |
| Urbanization rate of municipality[a] | | (<.001) | (<.001) | (.005) | (<.001) | (.003) |
| <62.8 | 18 | 13 | 97 | 35 | 1.7 | 3 |
| 62.9-85.4 | 20 | 19 | 123 | 32 | 3.3 | 4 |
| 85.5-95.9 | 17 | 18 | 146 | 36 | 2.5 | 6 |
| 96.0-97.6 | 14 | 30 | 227 | 53 | 3.7 | 11 |
| 97.7-100 | 30 | 24 | 199 | 45 | 3.6 | 11 |
| Region | | (<.001) | (<.001) | (<.001) | (.04) | (.001) |
| Capital area | 19 | 23 | 249 | 54 | 3.9 | 15 |
| Other Uusimaa | 8 | 23 | 112 | 37 | 1.9 | 3 |
| Kanta-Häme and Pirkanmaa | 11 | 20 | 169 | 43 | 2.9 | 7 |
| Other southern Finland | 25 | 28 | 189 | 43 | 3.3 | 8 |
| Eastern Finland | 12 | 11 | 119 | 42 | 3.3 | 5 |
| Middle Finland | 13 | 18 | 98 | 27 | 2.5 | 3 |
| Northern Finland | 11 | 14 | 85 | 22 | 1.8 | 3 |
| Income in state taxation | | (.006) | (<.001) | (<.001) | (<.001) | |
| 1st decile | 9 | 24 | 147 | 37 | 4.8 | 4 |
| 2-5 deciles | 38 | 25 | 154 | 32 | 4.0 | 8 |
| 6-9 deciles | 40 | 16 | 154 | 44 | 2.2 | 6 |
| 10th decile | 13 | 22 | 186 | 51 | 1.5 | 11 |
| Education | | (.009) | (<.001) | (<.001) | (.007) | |
| Basic or missing | 35 | 26 | 140 | 31 | 3.8 | 8 |
| Middle | 38 | 19 | 176 | 42 | 3.3 | 8 |
| High | 28 | 18 | 153 | 47 | 1.6 | 6 |

*Notes*: $p$ values smaller than 0.1 are given in parentheses. A $p$ value less than .05 is considered to indicate statistical significance. [a]Proportion of the population in the municipality living in densely populated areas.

the final model included age, marital status, mother tongue, urbanization, region and the interactions between marital status and age and between marital status and mother tongue. The estimated effects of urbanization and region on the response rate were very similar to their marginal effects in Table 2.

The interaction effect between marital status and age among men could be summarized such that the probability of not responding was particularly high in marital status groups that were "nonstandard" for the age group and particularly low in the most common marital status groups. Hence, the nonresponse rate in the group aged 15-24 was high among married and low among single men; in the group aged 25-39 it was high among widowed and divorced men and low among single and married men; in the group aged 40-54 it was high among single and low among married men. In the group aged 55-70, the greatest probability of not responding was found among married men and the lowest among widowed and divorced men; perhaps this is an effect of the fact that the interviewers were predominantly female. The interaction effect between mother tongue and marital status was such that among non-Finnish speakers it was the single men in particular who tended not to respond, whereas married, widowed and divorced men responded more often than among the Finnish speakers

The predicted propensity to respond was a statistically significant explanatory variable for most of the alcohol consumption variables tested (annual intake, overall frequency of drinking, frequency of light intoxication, abstinence and indicator for frequent drinking) although not for all (frequency of intoxication or indicator for heavy drinking). Therefore, it is justified to calculate weights for the respondents based on this predicted response propensity.

In the model for women, the predictors of response propensity included age, marital status, income, region, urbanization (as measured by both the "urbanization" variable and the "rate of urbanization" variable), as well as interactions between urbanization and marital status and between urbanization and age. There were also some competing interaction terms, which were alternative factors to be included in the model instead of the interaction between urbanization and marital status. Because this interaction was clearly the most important predictor in models for many alcohol consumption variables, however, it was kept in the model predicting response propensity. The estimated effects of the proportion of urban areas in the municipality, region and income on the response rate were quite similar to their marginal effects in Table 3.

The interaction effect between age and urbanization (keeping in mind the fact that women in urban municipalities generally had a high rate of nonresponse) was such that in urban municipalities 40 to 54 year old women were particularly likely not to respond, whereas in other municipalities they were very likely to respond. In addition, in the rural municipalities women over the age of 55 had a surprisingly large rate of nonresponse (32%), whereas the rate of nonresponse in all the younger age groups was very low.

The interaction effect between marital status and urbanization was such that divorced and widowed women in municipalities in the middle category were very likely to respond. Married women had a particularly high response rate when they lived in rural municipalities.

Among women, the predicted propensity to respond was not a statistically significant explanatory variable for alcohol consumption variables as often as it was among men. It was a good predictor for annual intake and overall frequency of drinking, but not for the frequency of intoxication, abstinence or the indicators of frequent or heavy drinking. In these latter cases, the usefulness of the weighting may be questionable.

*Comparison of results adjusted for and not adjusted for nonresponse*

Table 4 shows the average of overall drinking frequency, annual intake and annual frequency of intoxication, and the proportion of heavy drinkers by gender, obtained by different weighting schemes that reflect different strategies for the adjustment of bias caused by nonresponse and sampling error. These are (1) no weighting or adjustment; (2) standard poststratification weights; (3) weights from the logistic model; and (4) weights from the logistic model further adjusted so that the weighted distribution by age, gender and region matched that observed in the whole population.

Weights for (2) and (3) correlated only a little ($r = 0.15$), whereas both sets of weights correlated strongly with

TABLE 4. The effect of adjustments for nonresponse on the means (standard errors) of some central measures of alcohol consumption, by gender

| | Annual consumption, centiliters (SE) | Annual frequency of drinking (SE) | Annual frequency of intoxication (SE) | Proportion of heavy drinkers % (SE) |
|---|---|---|---|---|
| Men | | | | |
| 1. Raw data | 482 (23.6) | 76 (2.7) | 9.5 (0.67) | 14.4 (1.1) |
| Adjustment with | | | | |
| 2. Poststratification | 488 (23.7) | 76 (2.7) | 9.6 (0.68) | 14.7 (1.2) |
| Proportional change, % | 1.1 | 0.1 | 1.8 | 2.4 |
| 3. Logistic model | 487 (24.4) | 77 (2.8) | 9.5 (0.70) | 14.7 (1.2) |
| Proportional change, % | 1.0 | 1.1 | 0.8 | 2.0 |
| 4. Poststratification and logistic model | 489 (24.1) | 76 (2.7) | 9.7 (0.72) | 14.8 (1.2) |
| Proportional change, % | 1.4 | 0.1 | 3.1 | 2.9 |
| Women | | | | |
| 1. Raw data | 159 (10.2) | 40 (1.6) | 3.1 (0.27) | 7.3 (0.8) |
| Adjustment with | | | | |
| 2. Poststratification | 163 (10.7) | 41 (1.7) | 3.0 (0.26) | 7.6 (0.9) |
| Proportional change, % | 2.4 | 2.7 | -2.3 | 2.8 |
| 3. Logistic model | 166 (13.6) | 40 (1.7) | 3.2 (0.28) | 7.7 (0.9) |
| Proportional change, % | 4.6 | 1.5 | 1.5 | 5.2 |
| 4. Poststratification and logistic model | 165 (13.2) | 41 (1.7) | 3.1 (0.28) | 7.6 (0.9) |
| Proportional change, % | 4.1 | 2.9 | 0.2 | 3.9 |

weights for (4) (2 and 4: $r = 0.64$; 3 and 4: $r = 0.75$). This was not surprising as these weights were a kind of combination of the two other sets of weights.

The results on the four alcohol consumption variables shown in Table 4 depended very little on the set of weights used. A larger difference was observed between the raw unweighted results and the three weighted results, but even this difference was quite small. The proportional change caused by the different corrections were not very much different for those alcohol consumption variables for which the predicted propensity to respond had been a significant explanatory factor (annual intake and overall frequency) than for the two others (frequency of intoxication and proportion of heavy drinkers).

## Discussion

The main result from this study was that the effect of corrective weighting for nonresponse was small, and the effect of a correction beyond a basic poststratification was negligible. Nonrespondents did differ from the respondents in many respects, but the differences were not always unidirectional with respect to alcohol consumption; some factors which increase nonresponse are associated with heavier than average drinking (e.g., living in an urban municipality), others with lighter than average drinking (e.g., old age).

This result can hardly be taken to prove that there are no considerable differences in drinking between respondents and nonrespondents. This is one potential explanation for the results obtained, but there is also a competing explanation. Even though it has here been possible to describe the sampled individuals with a wide range of background variables, it is possible that the nonrespondents and respondents who are identical with regard to these background variables differ in their drinking. In statistical terms, this would be a violation of the assumption of data being missing at random (MAR); weighting methods are not able to fully correct for the nonresponse bias if the data are not MAR (Little and Rubin, 1987). It is impossible to say to what extent each of these two competing explanations contributes to the current results.

There is another statistical approach, in addition to corrective weighting, for analyzing the effect of nonresponse on estimates of alcohol consumption: (multiple) imputation methods. In this approach, models are constructed separately for all variables one wishes to use in further analyses. In the models, information obtained from the respondents on the associations between background variables and alcohol consumption variables is used to predict the most likely values of the alcohol consumption variables among the nonrespondents. The correction achieved by imputation remains small when the variation explained by the imputation model is modest (this would be the expected outcome in the current case), and the approach does not work as well for unit nonresponse (in case of nonrespondents) as for item nonresponse (respondent has left some questions unanswered), when all other responses can be used to predict the one missing. Also this method assumes that the data are MAR.

In conclusion, if it were the case that nonrespondents' drinking differed considerably from that of respondents, this difference could not be captured, even using extensive auxiliary information and an elaborate model predicting propensity of nonresponse. Further studies should be carried out to find out more about nonrespondents' drinking habits. Two approaches could be worth pursuing: It would be beneficial to follow the Swedish tradition (e.g., Romelsjö, 1989) of linking survey data to register-based information on alcohol-related harm in other countries, and it would be also worthwhile to deepen the current knowledge on what modern imputation methods can offer to the alcohol field.

## References


Caetano, R. Non-response in alcohol and drug surveys: A research topic in need of further attention. Addiction **96:** 1541-1545, 2001.

Ekholm, A. and Laaksonen, S. Weighting via response modeling in the Finnish household budget survey. J. Official Stat. **7:** 325-337, 1991.

Gmel, G. The effect of mode of data collection and of non-response on reported alcohol consumption: A split-sample study in Switzerland. Addiction **95:** 123-134, 2000.

Hill, A., Roberts, J., Ewings, P. and Gunnell, D. Non-response bias in a lifestyle survey. J. Publ. Hlth Med. **19:** 203-207, 1997.

Kalton, G. and Kasprzyk, D. The treatment of missing survey data. Survey Meth. **12:** 1-16, 1986.

Lahaut, V.M.H.C.J., Jansen, H.A.M., van de Mheen, D. and Garretsen, H.F.L. Non-response bias in a sample survey on alcohol consumption. Alcohol Alcsm **37:** 256-260, 2002.

Lemmens, P.H.H.M., Tan, E.S. and Knibbe, R.A. Bias due to non-response in a Dutch survey on alcohol consumption. Brit. J. Addict. **83:** 1069-1077, 1988.

Little, R.J.A. and Rubin, D.B. Statistical Analysis with Missing Data, New York: John Wiley & Sons, 1987.

Mäkelä, K. Measuring the Consumption of Alcohol in the 1968-1969 Alcohol Consumption Study, No. 2, Helsinki, Finland: Social Research Institute of Alcohol Studies, 1971.

Ohlson, C.-G. and Ydreborg, B. Participants and non-participants of different categories in a health survey: A cross-sectional register study. Scand. J. Social Med. **13** (2): 67-74, 1985.

Rizzo, L., Kalton, G. and Brick, J.M. A comparison of some weighting adjustment methods for panel nonresponse. Survey Meth. **22:** 43-53, 1996.

Romelsjö, A. The relationship between alcohol consumption and social status in Stockholm: Has the social pattern of alcohol consumption changed? Int. J. Epidemiol. **18:** 842-851, 1989.

Wild, T.C., Cunningham, J. and Adlaf, E. Nonresponse in a follow-up to a representative telephone survey of adult drinkers. J. Stud. Alcohol **62:** 257-261, 2001.