Sampling Weights for Analyses of Couple Data in Demographic and Health Surveys

Short title: Sampling weights for couples in demographic surveys

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Abstract

In demographic and health surveys sometimes both women and men are interviewed in selected households allowing matching of partner information and analyses of couples. Typically individual data from such sample surveys have sampling weights which incorporate factors for both the sampling probability and non-response. For analyses of couple data neither the weights for females nor the weights for males are appropriate. We present formula for estimating the appropriate weights for couples. To see how results vary when using male or female weights instead of couple weights, we analyze couple data from one DHS survey--The Dominican Republic survey of 1996. Utilizing women's weights, results for means, standard errors, and regression coefficients and their standard errors were within 2% of the values using couple weights in 43 of 52 comparisons, and also 43 of 52 were within 2% using men's weights. Calculation and use of couple weights is straightforward and desirable.

The married or in-union couple is the unit of interest in many studies in reproductive health and more generally in family sociology. Fertility decision-making in the couple has been one area of special interest to demographers. Studies with a longitudinal design have shown the importance of measuring fertility intentions and desires of both partners in order to best predict future contraceptive use and fertility in the couple (Thomson and Hoem, 1998, Thomson 1997, Bankole 1995, Schoen et al. 1999; Hossain, Phillips and Mozumder, 2007).

Data collection for couples is obviously more complicated than that for individual members of a couple. For example, to avoid potential contamination of responses between spouses, interviews are ideally done with the husband and wife separately and simultaneously (Fennell, 2008). Also, non-response of either partner leads of non-response for the couple.

Since the mid 1980s, the Demographic and Health Surveys (DHS) project has carried out nationally representative household surveys in over 70 countries (Macro International, 2008). Many countries have had two, three, or more surveys at about five-year intervals. In 1987, a separate questionnaire and sample design for males in households was added, particularly to allow study of their knowledge of HIV and their sexual behaviors. Now men are interviewed in most DHS surveys. With women interviewed in all selected households, men are typically sampled in 1/3 of households. In a few surveys only husbands rather than all men in a certain age group were interviewed (Blanc, 1993).

Other demographic surveys have also included both men and women in households (see references above). Though analyses of men, women, and husbands and wives separately have been done and allow useful comparisons (e.g. Ezeh, Serrousi and Raggers, 1996) it is also feasible to match husband-wife pairs and undertake analyses of couples (e.g. Bankole and Singh 1997; Becker and Costenbader, 2001; Allendorf, 2007). Analyses of data from partners are more complex but allow a richer array of hypotheses to be examined than is possible with individual data (Thomson, 1990). Note that in countries where polygamy exists, men can appear in the sample of couples multiple times.

Results from national demographic and health surveys are representative but usually only after weighting as there is typically over-sampling in urban areas. In addition some national implementing organizations desire to have estimates separately for regions. Since regions may vary widely in population but similar sample sizes are required for similar precision of estimates for each region, weighting is then required to derive national estimates.

The weights for men and women in the surveys are formed from the inverse of the product of the sampling probabilities and the response rates. First a household sampling probability is derived from the sample design. This is multiplied by the response rate for households. The latter is estimated at the level of the sample domain; estimates at lower levels in the sample design would be unstable due to small sample sizes. Details depend on the particular survey. (See Macro International, 1996 for generic DHS procedures.)

Since all women in the age range in each household are eligible for interview, the probability that a woman is in the survey is simply the household probability times the response rate for eligible women. To obtain the sample weights, the probabilities multiplied by the response rates are first inverted and then normalized so that the sum of the weights is equal to the number of respondents. If this normalization is not done, then weighted standard errors will be biased. A similar procedure is used to calculate sample weights for the male data, though in this case the household sampling probability is typically about 1/3 of the probability for women in the sample.

When men and women in union in households are matched, the question becomes, what is the appropriate sample weight for the couple? There has been a debate about whether a man's or woman's weight is more appropriate for the couple. The fact is that neither is appropriate in general. To see this consider the probability of non-response. The couple non-response rate is obviously different (and greater) than that of either the women or the men in partnerships but it is not a simple function of either or both. In particular husband and wife absences are not independent, i.e. if they plan any trip away from home together then they are more likely to be absent together than would be estimated by the product of the marginal probabilities.

The main objective of this research is to derive estimates of appropriate couple weights for data from a household survey. Then we compare results of analyses using these with results using the women's or men's weights.

Methods

Sampling probabilities and weights

We first define the appropriate probabilities to consider and then estimate them with data. A definition of a couple is first needed. For current purposes, an eligible couple is a heterosexual pair of married or in-union partners with both partners either usual residents of the household or who slept there the previous night. This corresponds to the definition used in the DHS.

The probability that a couple is in a household sample with completed interviews of both partners can be decomposed into a series of conditional probabilities. These are shown in Table 1. Typically, selection probabilities vary by cluster so household weights are determined at that level. Thus household weights are derived from the probability of selection of the cluster (p1) which typically varies between and within strata, the probability of selection of households within the cluster (p2) and the probability that the selected household is also selected for male interviews (p3). The next conditional probability (p4) is that the selected household has a completed interview. Then the probability of an eligible couple residing in the household (p5) must be estimated by considering the persons in union in the household and then who is in union with whom;

the latter is possible with the coding of line number of the partner in the household questionnaire. The last probability (p6) is the completion rate for couples which is estimated at the level of couples, not households, since there may be multiple couples in a given household.

TABLE 1 ABOUT HERE

The conditional probabilities of Table 1 are estimated in a straightforward fashion by processing household, woman and couple data files. The product of these estimated conditional probabilities is then calculated. In fact, for DHS surveys, probabilities p1 to p4 are incorporated in the household weight which Macro International calculates and provides with the household survey data file. Therefore, for the present example it was only necessary to calculate p5 and p6 and their product, invert this and then multiply this by the household weight. This result is then normalized (to sum to the sample size of couples with completed information) to form the couple weight.

Data

We selected a DHS survey where the couple weights are likely to be quite different from the male or female weights. The logic of this strategy is that if no or only minimal differences in results are found using male, female, or couple weights for such a case, then for other DHS surveys with smaller differences it probably matters little which weight is used. The couple weights will thus be compared with the male and female weights and the effects of using different weights on analyses of couple data will be examined.

In making the selection, we considered all DHS surveys which had questionnaires that recorded information to identify couples in the household file (i.e. partner's line number is coded). There were eleven such surveys which were completed between 1991 and 1998. [Burkina Faso 1992/93; Cameroon, 1991; Dominican Republic, 1996; Kenya, 1993; Nicaragua, 1997/98; Niger 1992; Tanzania, 1996; Uganda, 1995; Bangladesh 1993/94; Bangladesh 1996/97; Ghana, 1988). Across surveys we compared the response rates for the household, women's and men's questionnaires for the country and by region within the country, as well as the ratio of the household weight at the 90^{th} percentile to that at the 10^{th} percentile. We chose the survey with the highest such ratio; it also had close to the lowest response rates. The selected survey was The Dominican Republic survey of 1996.

The sampling frame for The Dominican Republic survey was drawn from the 1993 census and had eight strata and 375 clusters (PSUs). Eligible women in this survey were women age 15-49 years and eligible men were age 15-64 in about 1/3 of sampled households. Regarding coverage of the survey, of 10,534 households selected, 8831 were completed (97.8%). In completed households 9034 eligible women were identified with a 93.2% completion rate. 2837 eligible men were identified in the 1/3 sample of households for the men's survey and 2279 (80.3%) were completed (Centro de Estudios Sociales y Demographicos, 1997). From the matched data 848 couples were identified. Table 2 summarizes the counts of households, women, husbands and couples in the survey .

TABLE 2 ABOUT HERE

We estimate p5 and p6 at the level of the strata (health regions). These could be estimated at a lower level of sampling (e.g. province) but with only 848 total cases, the estimates would be unstable.

Comparisons

After deriving the couple weights and appending them to each record, we then tabulate a set of variables separately with the women, men and couple weights and compare the results. The variables chosen are: place of residence (urban/rural), difference in age between spouses, number of children ever born (wife's report), whether both spouses are literate, whether both read a newspaper, whether they live in a household with a radio (television), whether they both want no more children, whether either (or both) spouse(s) report that they discussed family planning with the other in the past year, whether the wife reported current use of family planning, and whether both know of the IUD, the condom, female sterilization and male sterilization.

The couple weights are deemed essential if either the mean (standard error) of an indicator varies by more than 2% from the value using couple weights, when instead, female or male weights are used. The value of 2% is only somewhat arbitrary. Specifically, of the over 50 DHS surveys currently available in which couples can be matched, the largest sample was in Bangladesh (1996) with 3037 couples [1]. One half of the width of the 95% confidence interval for a proportion in a random sample of this size is given by 1.96*[p*(1-p)/3037]**.5. Choosing p=0.5 maximizes this quantity and gives a value of 0.018 which is about 2%. For surveys with smaller sample sizes, standard errors would be greater than 2%. Thus errors within 2% would be virtually always within sampling error of these surveys, particularly since cluster samples have considerably larger sampling error than simple random samples. Also differences of less than 2% typically are of no policy relevance. Since couple weights are the correct ones, differences in estimates due to use of other weights are considered errors.

Weighted OLS and logistic regression analyses are then carried out for two couple variables, the difference in years of schooling between partners (e.g. man's minus woman's years of schooling) and whether both partners agree that they want more children or not. For the OLS regression the covariates are: years of schooling of the man, his age, difference between his age and that of his partner, and place of residence. Estimated regression coefficients and standard errors using the three sets of weights are compared. Again the 2% criterion is used to judge whether couple weights are essential. For the logistic regression of partner agreement regarding wanting no more children, two covariates are added to those used in the OLS regression: difference in years of education and number of children ever born (wife’s report). All the analyses adjust the variance estimates for correlations between observations due to the survey design. This was accomplished with the SVY commands in STATA Version 9 (STATACorp, 2005).

RESULTS

Table 3 gives the estimates of the conditional probabilities p3 to p6. No region had consistently low or high values. The maximum values are 12%, 12% and 26% above the minimum values for p4, p5 and p6 respectively. (Note that p3 is nearly constant by design.)

TABLE 3 AND FIGURE 1 ABOUT HERE

Table 4 shows the estimated percentages and means of the selected survey variables and their standard errors using couple weights as well as per cent deviations from these if women’s or men’s weights are used instead. The percentage differences are calculated as 100*(estimated-actual)/actual. For the percentages and means, there is no systematic pattern in the differences and none of the differences using either women’s or men’s weights reaches 2%.

Regarding the standard error estimates, the errors are larger and in some cases the male weights give more accurate estimates and in some cases the female weights do so. With women's weights three of the 14 estimates are off by more than 2% and with male weights 4 are more than 2% off.

TABLE 4 ABOUT HERE

Table 5 gives the linear regression estimates for coefficients predicting the difference in years of schooling between partners. Of the five coefficient estimates, two using women's weights are more than 2% off from those derived with couple weights and the corresponding number when men's weights are used is one. With regard to the standard errors, none of the estimates using either the women's or men's weights is off by more than 2%.

TABLE 5 ABOUT HERE

For the logistic regressions (Table 6), five of the seven coefficients derived with woman weights differ by more than 2% from the respective values estimated with couple weights. Using male weights, three of the coefficients are in error by more than 2%. Using either female or male weights the coefficient for urban residence was more than 20% too low. With regard to the standard errors of the coefficients, all but one of the estimates using women's weights are within 2% of the respective values using couple weights and all but two are more than 2% using male weights.

TABLE 6 ABOUT HERE

To summarize, of the 26 estimates of means and regression coefficients, the mean absolute error was 1.9% using male weights and 2.3% using female weights. On the other hand, of the 26 estimates of standared errors, the mean absolute error was 1.5% using male weights but 1.1% using female weights. Thus, with couple data, neither female nor male weights give estimates that are consistently closer to the estimates derived with the appropriate couple weights.

CONCLUSIONS

If survey information is collected from men and women in the same household in demographic surveys, and data from couples are later matched, then the question has arisen whether the women's or men's weights should be used in the analyses. The answer is that neither is appropriate and couple weights should be derived and assigned to each couple. The conditional probabilities of Table 1 may need modification for a different survey design but the principles remain the same. We have shown the steps in the derivation.

Since, except for the eleven surveys listed above, all couples are not identified in the DHS household questionnaires, the couple weights for existing surveys cannot be calculated with the data distributed by Macro International. Data on relationship of members to the household head can be used as proxy for matching couples, but these codes do not uniquely identify all couples. (For example, there may be two sons and two daughters-in-law in a household but there may or may not be two couples.) For future surveys, we strongly recommend that line numbers of partners be recorded in household questionnaires for surveys including both men and women in a household, so couple weights can be accurately derived.

The analyses done with women's or men's weights instead of couple weights in The Dominican Republic DHS show mostly minor differences for means and their standard errors. However, several coefficient estimates and their standard errors in linear and logistic regressions had sizable errors if women's or men's weights were used instead of the correct couple weights. The largest error occurs for the coefficient of urban residence. This is understandale since the proportion urban varies greatly between regions in the Dominican Republic (from 29% in region 6 to 87% in the Distrito nacional). Mathematically a given regression coefficient in Table 5 or 6 is a weighted average of the coefficients for the same regression in each region, where the weights are a function of both the sample size and the sampling weights for each region. To the extent that the coefficients vary between regions, different weights may accentuate those differences.

Since The Dominican Republic had very low response rates among all DHS surveys, and large differences in the male and female response rates between regions which are major factors distinguishing couple weights from women’s weights, we expect that differences in many other DHS surveys would be less than those documented here. In summary, couple weights are needed for analyses of couple data from demographic and health surveys.

The matter of polygyny needs consideration. Among polygamous men one or more wives may be in the sample. This is implicitly dealt with in the calculation of p5 which considers households with at least one eligible couple; the same weight is assigned to each of the completed couples that includes the polygamous husband. (Note that if co-wives are not co-resident in a household, then a couple is not matched under DHS matching rules.) Therefore, the couples’ sample is correctly weighted for polygynous couples. However, the couples’ sample is not the appropriate sample nor are its weights appropriate in studies of polygamous men themselves; male weights should be used for such analyses[2].

FOOTNOTES

1. The India National Family Health Survey of 2005/06 which was completed in late 2007, actually had 39,000 couples.)

2. This is similar to the distinction between birth-intervals for births and birth intervals for women; just as a woman may be

represented several times in the birth interval-birth data but only once in the birth interval-woman data, a polygamous man is represented several times in the couple data but only once in a sample of men.

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Table 1: Sequential conditional probabilities needed to estimate the probability associated with a couple having completed interviews in a DHS survey

Prob.	Description
1	Pr(cluster sampled)
2	Pr(household) selected in cluster | cluster selected)
3	Pr(household selected for male(husband) sample | household selected)
4	Pr(household completed | household selected for male(husband) sample
5	Pr(at least one eligible couple in household | household completed and selected for husband sample)
6	Pr(couple completed | at least one eligible couple in household)

Table 2: Estimates of conditional probabilities, by region in The Dominican Republic DHS of

Region	Conditional probability*			
	p3**	p4**	p5	p6
Federal Distr	.2625	.8621	.4884	.7457
1	.2652	.8490	.4279	.6915
2	.2678	.8341	.5142	.6684
3	.2610	.8596	.4667	.7972
4	.2522	.8397	.4606	.7308
5	.2564	.7684	.4880	.7019
6	.2644	.8190	.4906	.8421
7	.2626	.8592	.4950	.7632

* See Table 1 for a description of each probability
** Derived or taken from DHS First report (Table zz)

Table 3: Estimates of means and standard errors of selected couple variables in The Dominican Republic DHS using couple weights, and per cent difference from these values if wife or husband weights are used instead

Variable	Mean			Standard Error		
	Value with couple weights	Per cent difference from value if weights are for[a]		Value with couple weights	Per cent difference from value if weights are for[a]:	
		Wives	Husbands		Wives	Husbands
MEANS						
Difference in age (yrs)	5.4	0.0	0.0	.250	1.9	-1.6
Children ever born	3.1	0.3	0.2	.094	1.2	1.9
PER CENT OF COUPLES WHO:						
Live in rural area	45	-0.2	-1.3	.031	-1.3	-0.2
Both are illiterate	98	3.6	0.0	2.2	0.0	3.6
Either reads a newspaper	23	0.0	0.0	.006	-0.5	-1.1
Own a radio	67	-0.3	-0.2	.022	-0.2	-0.3
Own a television	77	-0.2	-0.4	.019	-0.2	-0.4
Both want no more children	57	-0.4	-0.3	.021	-1.9	-2.0
Either or both say discussed family planning with spouse	82	-0.2	-0.1	.015	0.0	-0.7
Currently use family planning	68	-0.2	-0.2	.019	1.1	-1.6
Both know of IUD	80	1.1	0.1	.016	-1.8	-1.2
Both know of condom	98	0.0	0.0	.004	-5.0	-5.0
Female sterilization	97	0.0	0.0	.001	1.4	0.0
Male sterilization	31	0.3	-0.2	.020	-1.5	-2.0

[a] Per cent difference for wives are 100* (value with couple weights - value with wife weights)/ value with couple weights. Differences for husbands are derived similarly.

Table 4: Estimates of linear regression coefficients and standard errors for covariates predicting the difference in husband's and wife's education using couple weights, and per cent difference from these values if wife or husband weights are used instead

Covariate	Coefficient			Standard Error		
	Value with couple weights	Per cent difference from value if weights used for:		Value with couple weights	Per cent difference from value if weights used for:	
		Wives	Husbands		Wives	Husbands
Constant	-4.774	0.2	-0.3??	0.585	-0.7	-1.0
Husband's age	0.032	-1.6	-1.3	0.011	0.0	0.9
Husband's education	-0.869	-0.2	0.6	0.043	0.7	-0.2
Difference in age	-0.028	-2.9	0.7	0.019	1.1	-1.6
Urban residence	.400	4.1	4.3	0.218	-0.2	-0.4

[a] Per cent difference for wives are: 100* (value with couple weights - value with wife weights)/ value with couple weights. Differences for husbands are derived similarly.

Table 5: Estimates of logistic regression coefficients and standard errors for covariates predicting whether both spouses want no more children using couple weights and per cent difference from these values if wife or husband weights are used instead

Variable	Coefficient			Standard error		
	Value with couple weights	Per cent difference from couple value if weights used for:		Value with couple weights	Per cent difference from couple value if weights used for:	
		Wives	Husbands		Wives	Husbands
Constant	-6.175	-2.2	-2.2	0.671	-1.4	-1.3
Husbands's age	0.120	-1.8	1.6	0.016	-0.6	-1.2
Difference in age	-0.030	-9.6	-7.3	0.018	-0.6	-1.1
Number of children ever born	0.734	-1.5	-1.8	0.115	-0.3	0.7
Husband's education	0.127	-4.0	-1.7	0.048	-0.4	-0.6
Difference in education	-0.042	-5.9	-1.7	0.041	-2.7	-3.0
Urban residence	-0.145	22.2	24.4	0.226	-1.8	-2.7

[a] Per cent difference for wives are: 100* (value with couple weights - value with wife weights)/ value with couple weights. Differences for husbands are derived similarly.