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

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Abstract

In demographic and health surveys (DHS) 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 probability of selection 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 and apply these to an example data set of couples (The Dominican Republic DHS of 1996). To see how results vary when using male or female weights instead of couple weights, we analyze couple data from this DHS survey which has wide variability in response rates and sampling weight. Utilizing women's weights, results for means and standard errors are within 2% of the values using couple weights in 23 of 28 comparisons, and 22 of 28 are within 2% using men's weights. Calculation and use of couple weights is straightforward and desirable.

Key Words: survey methodology, demographic surveys, data analysis

1. Introduction

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). Though analyses of men, women, and husbands and wives separately allow useful comparisons (e.g. Ezeh, Serrousi and Raggers, 1996), data from matched couples allow a richer array of hypotheses to be examined than is possible with individual data ((e.g. Bankole and

Singh 1997; Becker and Costenbader, 2001; Allendorf, 2007; Thomson, 1990). Note that in countries where polygamy exists, men can appear in the sample of couples multiple times.

Data collection for couples is obviously more complicated than that for individuals. 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 to non-response for the couple.

Population based samples are designed so that statistical inferences about the population can be made. In order to provide unbiased estimates, sampling weights based on probabilities of selection from the underlying population and non-response adjustment are necessary. When inferences for a sub-population are desired, then sampling weights appropriate for that group are needed; in particular, for a survey of men and women in households, which also therefore includes couples, weights need to include information on marital status in order to provide estimates for couples. Since the mid 1980s, the Demographic and Health Surveys (DHS) project has carried out nationally representative household surveys in over 75 countries (Macro International, 2008). In all occupied households, women are interviewed, while about one-third of selected households are sub-sampled for male interviews so married or in-union couples can be matched.

When men and women in union within households are matched, the question has been, what is the appropriate sample weight for the couple? For users of couple data from the DHS, it has not been clear whether a man's or woman's weight is more appropriate for the couple. 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, e.g. 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. Also, response rates for men and women in couples are very likely to be different from response rates for unmarried men and women.

For matched couples, several methods can be used to create weights. Post-stratification is one method if population level data on couples (e.g. census information) are available. But in many developing countries, such census data are not available. Alternatively, as

noted above, marital status can be used in developing weights. The main objective of this research is to derive estimates of appropriate couple weights for a representative household survey. Then we compare results of analyses using these with results using the women's or men's weights since, until now, these have been the only weights available for DHS data.

2. Methods

2.1 Venn diagram, sampling probabilities and weights

The women's, men's and couple samples and response/non-response are illustrated in the Venn diagram of Figure 1. Only area F represents completed couples, while completed men's interviews are represented by the sum of areas A, C and F and completed women's interviews by H, E and F. Among couples in a household in which both partners are eligible (i.e. in the appropriate age range), either the man, the woman, or both may have incomplete interviews.

We now define the appropriate probabilities for couples (including nonresponse adjustment) and then estimate these with data from one DHS survey. Corresponding to the definition used in the DHS, 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.

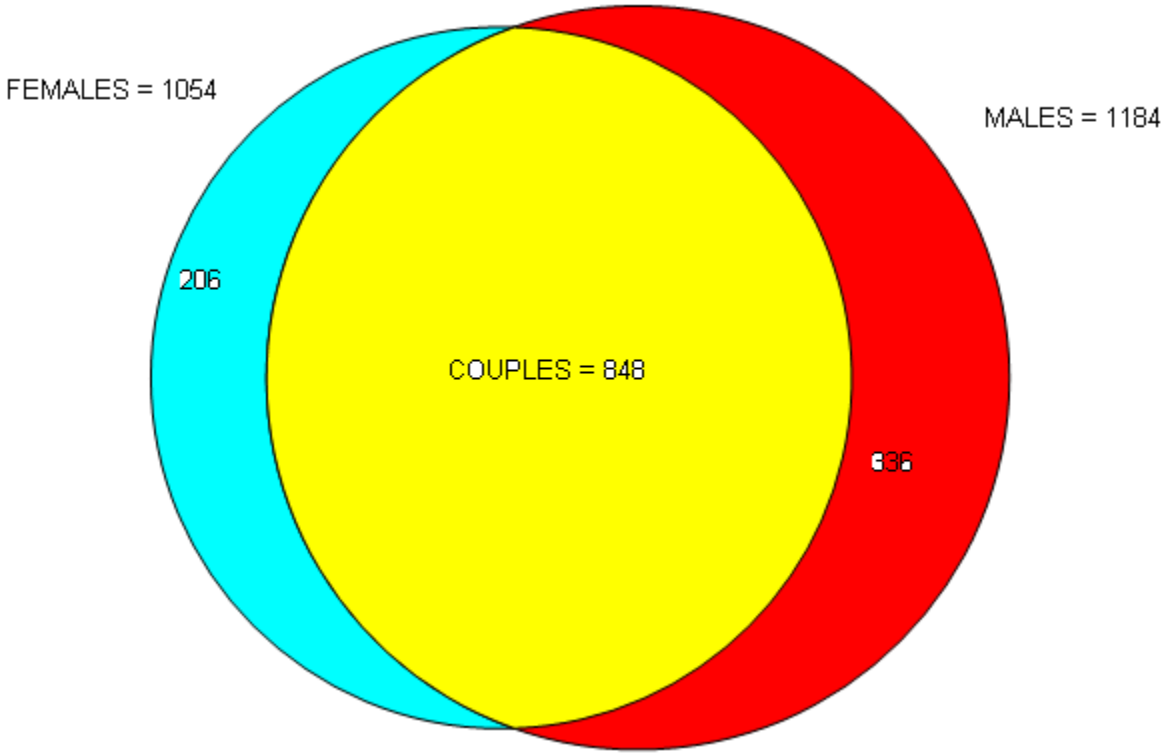

Figure1: Completed Interviews, Dominican Republic, 1996

The probability that both partners in a couple within a household have completed interviews can be decomposed into a series of conditional probabilities, as shown in Table 1. Typically, selection probabilities vary by cluster so household weights are determined at the cluster level. Thus a household weight is derived from the probability of selection of the cluster (p1), the probability of selection of a household 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 household interview is completed, followed by the probability that at least one eligible couple resides in the household (p5). The final probability (p6) represents the completion rate for couples.

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

Probability	Description
1	Pr(cluster sampled)
2	Pr(household) selected in cluster | cluster selected)
3	Pr(household selected for men's sample | household selected)
4	Pr(household completed | household selected for men's sample
5	Pr(at least one eligible couple in household | household selected for men's sample and completed)
6	Pr(couple completed | at least one eligible couple in household)

The probabilities of Table 1 are estimated in a straightforward fashion. 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. P5 is 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. P6 is estimated at the level of couples, not households, since there may be multiple couples in a given household. Consistent with the derivation of weights for men and women, we estimate p5 and p6 at the level of the domain or strata.

The product of the estimated conditional probabilities is then calculated. Therefore, for the DHS example it is only necessary to estimate 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 for couples with completed information, to form the couple weight.

2.2 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 surveys with smaller variation it probably matters little which weight is used.

In making the selection, we considered all DHS surveys which had household questionnaires that recorded information to identify couples. There are eleven such surveys, all 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 is The Dominican Republic 1996 survey.

The sampling frame for The Dominican Republic survey was drawn from the 1993 census and included eight domains/strata and 375 clusters (PSUs). Eligible women were age 15-49 years and for the male subsample, eligible men were age 15-64. Table 2 summarizes the counts of households, women, husbands and couples in households selected for the men's sample (Centro de Estudios Sociales y Demographicos, 1997).

Table 2: Number of households, women, men and couples selected and completed in Dominican Republic DHS (men's subsample)

Unit	Number selected	Number completed	Percent completed
Households	2754	2309	83.8
Women	2327	2163	93.0
Men	2837	2279	80.3

Couples	1142	848	74.3

2.3 Comparisons

After deriving the couple weights and appending them to each record, we tabulated a set of variables separately with the women, men and couple weights and compare the results. These variables 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 weight is deemed essential if either the mean or standard error of an indicator varies by more than 2% from the respective value using couple weights, when instead, female or male weights are used. The value of 2% is based on the largest DHS sample which was Bangladesh (1996) with 3037 couples [1]. Using the average design effect for the survey of 1.56, this yields an effective sample size of 3037/1.56 = 1947. One half of the width of the 95% confidence interval for a proportion in a sample of this size is given by 1.96*[p*(1-p)/1947]**.5. Choosing p=0.5 maximizes the estimated variance and gives a value of 0.022 or about 2% (Mitra et al. 1997). For surveys with smaller effective sample sizes, standard errors would be greater than this. Thus errors within 2% would be virtually always within sampling error of these surveys. 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. All the analyses adjust the variance estimates for stratification and intra-cluster correlations between observations due to the survey design, using the SVY commands in STATA Version 9 (STATACorp, 2005).

3. RESULTS

The estimates of the conditional probabilities p3 to p6 by region are given in Appendix Table 1. No region has 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 shows the estimated percentages and means (with standard errors) of selected couple-level variables 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 value with women's or men's weights - estimated value with couple weights)/estimated value with couple weights]. For the percentages and means, the differences of the point estimates tend to be negative but none of the differences using either women's or men's weights reaches 2%.

In comparison to the point estimates, the standard error estimates are generally larger using couple weights. With women's weights, five of the fourteen estimates are off by more than 2% and with male weights six are more than 2% off. Nearly all of the differences are negative, indicating that the results using male or female weights underestimate the standard errors.

Table 3: Estimates of means and standard errors of selected couple variables in The Dominican Republic DHS of 1996 using couple weights, and per cent difference from these values if wife or men weights are used instead

Variable	Mean			Standard Error		
	Value with couple weights	Per cent difference from value if weights used are for[a]		Value with couple weights	Per cent difference from value if weights used are for[a]:	
		Women	Men		Women	Men
MEANS						
Difference in age (yrs)	5.4	0.0	0.0	.256	-0.5	-1.1
Children ever born	3.1	0.2	0.3	.094	-0.6	0.2
PER CENT OF COUPLES WHO:						
Live in rural area	45	-1.3	-0.2	.017	-3.0	-1.8
Both are literate	98	0.0	0.0	.006	0.0	1.7

Both read a newspaper	23	1.1	0.1	.018	-1.6	-2.7
Own a radio	67	-0.2	-0.3	.020	-2.5	-2.5
Own a television	77	-0.2	-0.4	.019	-2.7	-2.1
Both want no more children	57	-0.4	-0.3	.023	-1.7	-3.1
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	0.0	-0.1	.015	-3.3	-2.0
Both know of condom	98	0.0	0.0	.004	-2.5	-2.5

[a] Per cent differences for women are 100*(value with women's weights - value with couple weights)/ value with couple weights. Differences for men are derived similarly.

In summary, of the fourteen estimates of averages for couple level variables, the mean absolute error is 0.2% using male weights and 0.3% using female weights. On the other hand, of the 14 estimates of standard errors, the mean absolute error is 1.8% using male weights and 1.5% using female weights. In total, 5 of the 28 estimates using women's weights and 6 of the estimates using men's weights are off by more than 2%. For the standard errors, the estimates clearly understate the correct value, and for the means, the general direction of error is to underestimate the correct estimate. With couple data, neither female nor male weights give estimates that are consistently closer to the estimates derived with the appropriate couple weights, though for means the estimates with either set of weights are close to those using couple weights.

4. CONCLUSIONS

In order to obtain unbiased estimates of couple level data from household surveys, couple weights should be derived and assigned to each couple, as neither the male nor the female weight is appropriate. The conditional probabilities of Table 1 show an example for one survey (Dominican Republic, 1996) and may need modification for other surveys. How clusters, households and males are sampled determines the specifics but the principles remain the same.

Since (except for the eleven surveys listed above) all couples are not identified in the DHS household questionnaires, the couple weights for most existing surveys cannot be calculated using the public use data. 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 Macro International provide explict couple weights with the couple data using the appropriate methodology.

The matter of polygomy 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. 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].

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

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Appendix table 1: Estimates of conditional probabilities, by region in The Dominican Republic DHS of 1996

Probability	Region								Ratio of max. to min.
	Fed Distr.	1	2	3	4	5	6	7	
p3 = Pr(household selected for male(men) sample | household selected)*	.2625	.2652	.2678	.2610	.2522	.2564	.2644	.2626	1.06
P4 = Pr(household completed | household selected for male(men) sample)*	.8621	.8490	.8341	.8596	.8397	.7684	.8190	.8592	1.12
P5 = Pr(at least one eligible couple in household | household completed and selected for men sample)	.4884	.4279	.5142	.4667	.4606	.4880	.4906	.4950	1.20
P6 = Pr(couple completed | at least one eligible couple in household)	.7457	.6915	.6684	.7972	.7308	.7019	.8421	.7632	1.26

* Derived or taken from DHS First report (Tables A.1.1 and A.1.2), CESDEM, 1997.

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