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The World Fertility Survey is an international research programme whose purpose is to assess the current state of human fertility throughout the world. This is being done principally through promoting and supporting nationally representative, internationally comparable, and scientifically designed and conducted sample surveys of fertility behaviour in as many countries as possible.

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K.S. Srikantan

1 Objectives

1.1. INTRODUCTION

Empirical confirmation of social theories and the planning and evaluation of programmes of social action ultimately rest on the quality of the data gathered about social realities. It is, therefore, of great importance to evaluate the quality of the data before using them for these purposes.

In assessing the validity of the results, the estimates made from the data should be ideally compared with the 'real' value for the universe of study, which may not be obtainable! Hence one has to be content with the internal consistency of the results or the reliability of the results compared to independent external estimates. Such checks naturally depend on the manner in which the data are collected. For instance, the assessment of the quality of data provided by a continuous registration system for vital events would be concerned with the completeness in the coverage of the system, delays in registration, and biases and other systematic errors in reporting the events, such as by the place and date of occurrence and of registration. An evaluation of a sample survey should, by contrast, consider both the sampling and the non-sampling errors. The former type of error arises since the data are collected from a sample of units to represent the whole universe of units; and the latter type of error is introduced while making the relevant measurements and at various stages of recording and of processing the data.

The errors to which the data are subject can also be looked at in terms of whether they are variable or systematic. Variable errors introduce additional sources of variation in the data which cancel out in the average because they occur in both positive and negative directions which tend to balance each other. Systematic biases, on the other hand, are errors which tend to pile up in either the positive or the negative direction and are, therefore, present in the average. Both types of error may appear in sample surveys as well as in complete enumerations. Sampling errors and response variations are examples of variable errors. A biased estimation formula and systematic tendencies to falsify particular characteristics, like under-reporting of income or lapses in the recall of children ever born, are examples of biases.

The judgement of the overall quality and usefulness of survey data for a specific purpose cannot be based on a fragmentary assessment of only some sources of error. Rather it should be based on a comprehensive consideration of all important sources of error. Moreover, the comparison of errors arising from different sources would suggest possible avenues for improving the quality of data and for the relative allocation of attention and resources to the reduction of different types of errors. The major sources of such errors are the sampling error and its components; selectivity of non-response; errors arising from ambiguities and lack of standardization in concepts, definitions and interview procedures; poor design of the questionnaire and unclear wording of questions; lax recruitment procedures, inadequate training of interviewers and heavy work-load; errors in coding and punching; response arising from the repondent's limited educational background and his or her inability to articulate attitudes, relevance of the enquiry to the concerns of the respondent, the importance of the events and attitudes as perceived by the respondent and the accuracy with which the respondent recalls past events.

According to Srikantan (1977), such a comprehensive evaluation of the quality of survey data should, in general, be arrived at by assessing the various components of the total error and should be based on:

1) an evaluation of the bias due to non-coverage and non-response;
2) an examination of the representativeness of the sample;
3) an estimation of the magnitude of the sampling errors of the estimates; and
4) an assessment of the magnitudes of major non-sampling errors.

1.2 SCOPE OF THE REPORT

Certain aspects of an overall evaluation of the quality of the Fiji Survey results have already been examined in other studies. The Principal Report on the Fiji Fertility Survey, 1974 (1976) has examined the non-coverage and non-response errors and presents the sampling errors in key characteristics. Age reporting and age composition in the survey have been compared with the Registrar General's estimate for December 1973. The Report also provides a chapter on checks on the quality of data, containing a comparison between the dual responses obtained in the main and in the post-enumeration surveys and an independent external check of contraceptive use reported in the survey with the records of the Medical Department. Joseph E. Potter (1976) has examined the main survey results internally for consistency in the pattern of first marriage and fertility; and externally compared the results with cumulative fertility and child mortality estimated from population censuses. These studies indicate that while such errors may be present in the Fiji Survey, their magnitude is not large enough to vitiate the major results and conclusions.

The scope of the present report is limited to an analysis of the dual responses obtained in the main and post-enumeration surveys. The major aim of this study is to examine, in depth, the reliability of the dual responses given by the same respondent under almost identical conditions. Though the major source of variation would be the differences between the responses on the two occasions, other factors, such as interviewer variation and temporal changes, and the occurrence of events in the period between the two interviews, would also contribute to the variation between the dual responses. In this report, these sources are identified and their contributions examined in depth. The components are compared and interpreted in terms of the various phases of the survey operation. However, to get an overall picture of the total error and its components, the results of this report have to be taken in conjunction with the Principal Report and the special study mentioned earlier.

The contents of the report are as outlined below: first the concepts, methods and measures are developed. Then the representativeness of the post-enumeration survey respondents is examined to ensure that they do not form a self-selective group. Various measures of net and gross errors are calculated for a wide range of characteristics and they are ordered by the relative magnitudes of such errors. The major differences in the conditions of the original and the post-enumeration interviews and temporal changes

between the two interviews are identified; and their effects on the net and gross errors of selected characteristics are assessed. Next the sampling and non-sampling variations in the estimates for a few important characteristics of the population are calculated using a simple model and compared. Finally, some general conclusions are drawn as to the relative contributions of the various sources of errors and their effects on the measurement of current and retrospective factual data, and attitudes of repondents and their expectations for the future.

2 Concepts and Measurements

2.1 THE CONCEPT OF ERROR

The standard for assessing the quality of the information obtained from the respondent is the "real" value of such information which is free of distortions arising from the measurement. The term *error* is used in this technical sense and refers to the deviation from the "real" value. No blame or responsibility for committing such errors is implied. Where appropriate, alternative terms such as *difference* and *variation* are used in preference to the term error.

2.2 IDENTITY OF CONDITIONS BETWEEN THE DUAL INTERVIEWS

The original interviews were conducted from mid-February to mid-April 1974 and the post-enumeration interviews were conducted from the first to the third week of May 1974. Thus there was an average time lag of about seven weeks between the two interviews, and events, such as births, deaths and marriages, could have taken place between the two interviews. Also the respondent would have aged by about seven weeks by the time of the re-interview. In this sense, the conditions differed to some extent in the dual interviews. Moreover, in the post-enumeration survey, only a shorter list of questions was taken from the original questionnaire. Such a shorter questionnaire may gain in brevity but lose in terms of the continuity of questions and the depth of probes. The post-enumeration survey used mostly the supervisory staff for field work. No clear views as to their skills compared to the original interviewers are held. These considerations suggest that neither of the two surveys could be regarded as superior in quality to the other.

As there is no reason to believe that either of them was closer to the standard, a model which treats the errors in both surveys symmetrically is used. The only exception to use of this model is in the treatment of questions on contraceptive knowledge where, for obvious reasons, the experience of the first interview had a major effect on the reponse at the second interview.

2.3 NET AND GROSS ERRORS

A clear distinction is drawn between net and gross errors. The net error is based on a comparison of the distribution of the various possible answers to a question in the original interview with the distribution of answers given in the re-interview. It disregards mutually cancelling errors in the answers. Such a measure is appropriate in comparing overall estimates, proportions, rates, ratios or marginal distributions based on answers to a question. The gross error, in contrast, is based on a comparison of the answers provided on the two occasions by each respondent. It depends on the number of pairs of answers to a question, given by the same respondent, which do not match. This measure is valid in analyzing the interrelations among the respondent characteristics. The larger the gross error, the more it attenuates the "real" relationship.

Net and gross errors refer to a situation where a pair of matched dual responses is given by the same respondent. In addition to the response variation, which would be a major component in these errors, the errors would include other sources of variation, such as interviewer variability. Even if the measurement is not repeated for each unit, but only two (independent) aggregative estimates or distributions are available – such as from a census and from a survey – the net error measure defined in the previous paragraph can still be used as an indicator of the net difference between the two distributions. This measure would reflect all sources of deviation between the two distributions and is, therefore, conceptually quite distinct from the net error and is termed the net difference.

2.4 NOMINAL, ORDINAL AND CONTINUOUS MEASURES

Measurement of error in a nominal characteristic – one classified into nominal (unordered) categories -- has to take account of three main sources of variation:

1) the difference between the dual responses, which is of primary concern to us;
2) the number of categories in the nominal classification; and
3) the marginal distribution over the categories.

The several measures used for this purpose are described in the technical Appendix I. Generally, measures based on dissimilarity of distributions are adjusted for the number of categories but not for the marginal distributions whereas measures based on the contingency-X^2 (Cramer measures) and game-theoretic measures are adjusted for both sources of distortion. Hence the latter measures can be more readily compared for characteristics with dissimilar categories and marginal distributions.

If the characteristic is an ordinal classification – i.e. a classification into categories which are ordered in some sense – then the gross error measure can be taken to be unity minus the ordinal measure of association between the original and the post-enumeration responses. The ordinal measures used for this purpose are Gamma, Somers' measure and Kendall's Tau B. These measures could be expected to be better for ordinal characteristics than the nominal measures outlined in the preceding paragraph since the ordinal measures utilize more information in the data than the nominal measures do.

If the characteristic is a continuous or discrete variable, then the net error measure is based on a two sample test-statistic which is symmetric with regard to the main and post-enumeration samples. This measure is given in Appendix I. The gross measure, however, cannot be based on the regression parameters since they are asymmetric with regard to the two samples. Hence, as described in Appendix I, a symmetric measure based on the first principal component is used.

2.5 SAMPLING AND NON-SAMPLING VARIATIONS

It is important to compare the variations arising from sampling and non-sampling sources as their implications for improving the quality of the estimates could differ. The sampling variations are taken from the Principal Report

(1976) and the non-sampling variations are estimated from the dual responses. A simple model, described in Appendix I, is utilized for this purpose. The sum of the sampling and non-sampling variations is termed the total variation. Two indices of the relative magnitude of the non-sampling variation to the sampling and to the total variation have been developed for comparative purposes.

2.6 EMPIRICAL ASSESSMENT OF NON-SAMPLING ERRORS

Chapter 3 examines the representativeness of the post-enumeration interviews. In the subsequent chapters, the various measures of errors are calculated empirically from the main and post-enumeration survey data for a large set of variables. The calculations are illustrated, summarized and then interpreted. Subsequently the error measures for certain key characteristics are adjusted, eliminating extraneous sources of variation. Then, for estimates of selected characteristics, the non-sampling variability is compared with the sampling variability. Finally, some general conclusions are drawn regarding the nature of the non-sampling errors, their relative magnitudes for selected characteristics and in comparison with the sampling errors and their implications for survey research in the areas of fertility and family planning.

3 Representativeness of the Post-Enumeration Survey

3.1 THE SUBSAMPLE FOR POST-ENUMERATION

A subsample of women successfully interviewed in the main survey was drawn for re-interview. The sampling design was similar to the one adopted for the main survey, except that the scale of subsampling was about one-tenth of the main sample. Twenty areas were chosen systematically from the 100 sample areas of the main survey after re-ordering by percentage of Fijian households in each area. Within each area selected for the subsample, a sample of households was chosen systematically with probability inversely proportional to the number of sample households in the main survey. This made the sampling design self-weighting.

The sub-sample consisted of 545 households containing 509 women who had been successfully interviewed in the main survey. Of these, twelve households with nine eligible women were removed from the sample because of inaccessibility or inconvenience, leaving an effective sample of 500 women.
In this subsample of 500 women, only 384 women, or 76.8 per cent, were successfully re-interviewed. The main reason for the large non-response was that the post-enumeration field work was carried out within a brief period of two weeks which did not allow time for call-backs on women not at home. In fact, the reasons that 'no one was at home' and 'temporarily away' accounted for 9 per cent of the subsample. Perhaps respondent resistance to being re-interviewed also reduced the success rate, there being 3 per cent refusals to the re-interview. Interviewer fatigue should also have had a similar effect on the success rate since unspecified reasons for failure to interview accounted for another 2.8 per cent.
Matching of the dual interviews was carried out manually, on the basis of the name of the respondent, her address, and the names of her family. The ten cases where the wrong woman had been re-interviewed were counted as non-response. The rest of this analysis is based on the reasonable assumption that no cases of mis-matches remained undetected.

Thirteen women selected in the subsample were deleted from the main survey analysis because they were incorrectly included in the main survey due to an error of mapping. These 13 women were deleted from the subsample also. Thus, in effect, the present analysis of dual responses was limited to 371 re-interviewed women in the subsample of 487 women, with a success rate of 76.2 per cent.
In view of the large failure rate (23.8%), in this chapter the characteristics of the re-interviewed women in the subsample are analysed for self-selection and lack of representativeness of those women who were successfully interviewed in the main survey. Since the principal objective of this report is to assess the non-sampling errors based on the re-interviewed subsample, it is essential to examine whether these women are representative of all women interviewed in the main survey, before proceeding further with the analysis. Such a critical assessment is essential to ensure that the conclusions drawn here about non-sampling errors can be validly generalized to all the women interviewed in the main survey and hence also to all the women in the population, and interpreted accordingly.

3.2 COMPARISONS FOR REPRESENTATIVENESS

For each characteristic, three comparisons were made to check the representativeness of the women re-interviewed in the post-enumeration survey as a sample from the women interviewed in the main survey. First the post-enumeration sample of 484 women were compared with the 4,928 women interviewed in the main survey.
The comparison was made for a large number of characteristics obtained in the main survey. The two net difference measures – dissimilarity and Cramer measures – were calculated for each characteristic as explained in Appendix II. The X^2-value was tested to find whether the subsample was significantly different from the women interviewed in the main survey which is the 'population' in this instance.
A similar comparison was made between the 371 re-interviewed women and the 4,928 women in the main survey to assess the representativeness of the dual respondents. Finally, to examine the selectivity of non-response in the subsample, the 371 re-interviewed women were compared with the 113 women not re-interviewed. The procedure and the interpretation of the results are illustrated in the next section.

3.2.1 ILLUSTRATION: REGION OF RESIDENCE

The procedure is illustrated with reference to region of residence of the interviewed women. Table 3.1 shows the distribution of the region of residence for the 4,928 main survey respondents *(A)*, the 484 post-enumeration subsample women *(B)*, and among them the 371 re-interviewed women *(C)*, and the 113 women who were not re-interviewed *(D)*. All the data were taken from the original interview since the purpose here is to assess the representativeness of the re-interviewed women as a sample of the "population" of women interviewed in the main survey.
It is meaningful to compare first the post-enumeration subsample of women *(B)* with the main survey respondents *(A)*, since the question may be raised whether the particular sample departed from the population due to chance factors and the deletion of nine inaccessible women. Next, a similar comparison is made between the 371 re-interviewed women *(C)* with the population of 4,928 women *(A)*. If these characteristics are different from those in which *A* and *B* differ significantly, then the difference cannot be ascribed to chance factors, and the representative character of the re-interviewed women as a sample of the main survey women may be questioned. Finally, within the subsample *(B)*, it may be examined whether the 113 women not re-interviewed *(D)* were self-selective and differed from the 371 re-interviewed women *(C)*. If *D* and *C* differ in a characteristic, we may suspect some degree of self-selection by that characteristic among the women re-interviewed. In the presence of such self-selection, caution is necessary in generalizing the results of the dual response analysis to the main sample. Thus the following three comparisons were made:

a) Post-enumeration subsample *(B)* with main survey *(A)*;
b) Re-interviewed women *(C)* with main survey *(A)*; and

TABLE 3.1 Distribution of Women by Their Region of Residence According to the 4,928 Main Survey Respondents *(A)*, the Post-Enumeration Subsample of 484 Women *(B)*, the 371 Re-interviewed Women *(C)* and the 113 Women not Re-interviewed *(D)*

Region of Residence	Main Survey *(A)*		Subsample *(B)*		Re-interviewed *(C)*		Not Re-interviewed *(D)*	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
All regions	4928	100.0	484	100.0	371	100.0	113	100.0
Central	1722	34.9	163	33.7	128	34.5	35	31.0
Western	2045	41.5	220	45.5	156	42.0	64	56.6
Northern	967	19.6	76	15.7	63	17.0	13	11.5
Eastern	175	3.6	25	5.2	24	6.5	1	0.9
Not stated	19	0.4	0	0.0	0	0.0	0	0.0

Comparison	(a) *B* with *A*	(b) *C* with *A*	(c) *D* with *C*
Net dissimilarity	0.022	0.014	0 73
X^2-value	11.26	11.69	11.26
Significance level	5%	5%	5%
Net Cramer measure	.152	.178	.153

c) Women in the subsample not re-interviewed *(D)* with those re-interviewed *(C)*.

As explained in Appendix II, the formula for net dissimilarity is the same for all three comparisons. Its values are seen to be .022, .014 and .073 for comparisons (a), (b) and (c) respectively. The X^2-test and Cramer measure of net difference would, however, depend on the numbers in the two groups compared and whether both groups or only one is a sample. The appropriate forms are given in Appendix II. For the classification by region of residence, the X^2-values for all three comparisons were significant at 5 per cent level, and the Cramer measures were respectively .152, .178 and .153 for comparisons (a), (b) and (c).

The significance of the X^2-value for comparison (a) suggests that the selected subsample was unrepresentative of the main sample for this characteristic. The significance of the X^2-value for comparison (b) confirms this result. These two comparisons, therefore, indicate that, for region of residence, the subsample was unrepresentative of the main sample due to chance selection factors. Moreover, comparison (c), between the subsample women who were re-interviewed and those not re-interviewed, has also a significant X^2-value. It appears that the subsample women who were re-interviewed were different, by region of residence, from those not re-interviewed. In fact, from Table 3.1, it is seen that women not re-interviewed were over-represented in the Western region and under-represented in other regions. However, as discussed later, the magnitude of the net difference by both dissimilarity and Cramer measures, for all three comparisons, were not large enough to vitiate generalization of the results of the dual response analysis to the main sample for this characteristic.

3.3 REPRESENTATIVENESS OF THE POST-ENUMERATION SURVEY

The three comparisons, (a), (b) and (c), were made for a large list of 1 14 characteristics chosen from the main survey data as recoded for the analysis and the results are given in Table II.1 [comparisons (a)], Table II.2 [comparisons (b)] and Table II.3 [comparisons (c)]. Those characteristics whose comparisons were statistically significant at five per cent level are summarized in Table 3.2.

Of the 22 characteristics listed in Table 3.2, at 5 per cent level, 20 characteristics were significant for (a) comparisons, 13 for (b) comparisons and four for (c) comparisons. If the characteristics were independent, only about six of the (a) comparisons should be significant at 5 per cent level while actually 20 such comparisons are significant due to intercorrelations among the 114 characteristics examined. The subsample was not representative of the main sample for a few characteristics relating to the woman's background – her residence, ethnicity, literacy, religion and work status – and number of children and sons ever born and living, number of contraceptive methods known and husband's education and occupation. But these differences may be ascribed to chance factors in the selection of the subsample.

Only 13 comparisons of the re-interviewed women with the main sample were significant at 5 per cent level. All but two of them were also significant for (a) comparisons. Thus the re-interviewed women were unrepresentative of the main sample with regard to fewer characteristics compared to all the women in the subsample – residence, ethnicity, literacy, children still alive, number of contraceptive methods known, spacing preference, and husband's education and occupation. Again the differences may be ascribed in (b) comparisons to chance factors. Hence, in the next section, the magnitude is further examined and an identification is attempted of the characteristics with large net differences so that due caution can be exercised in generalizing the results of the analysis of dual responses to the main sample and to the universe.

The comparisons (a) and (b) are based on single samples of sizes 484 and 371, whereas (c) is based on two samples of size 371 and 113. Hence it would yield less conclusive results. Only four (c) comparisons between the women re-interviewed and not re-interviewed were significant at 5 per cent level: region of residence, ethnicity, literacy and current husband's years of education. For these four characteristics, women not re-interviewed appear to form a rather selective group compared to the women who were re-interviewed. The distribution for the two groups of women for the four characteristics are shown in Table 3.3. It is seen from Table 3.3 that the 113 women of the sub-

TABLE 3.2 Characteristics Significant at Five Per Cent Level in the Comparison of A) Main Survey Respondents (4,928) Vs. Post-Enumeration Subsample (484); B) Main Survey Respondents (4,928) Vs. Post-Enumeration Respondents Re-interviewed (371) Vs. not Re-interviewed (113)

Variable	Whether Significant at 5% Level or Not		
	a	b	c
Region of residence	x	x	x
Type of place of residence	x	x	–
Childhood type of place of residence	x	x	–
Ethnicity	x	x	x
Literacy	x	–	x
Religion	x	–	–
Work status before first marriage	x	–	–
Have you worked before and after first marriage	x	–	–
Number of children even born (10 classes)	x	–	–
Number of children still alive (4 classes)	x	–	–
Number of sons still alive	x	–	–
Numbers of sons still alive (4 classes)	x	–	–
Number of sons ever born	x	–	–
Total number of children still alive	x	x	–
Number of live births in past 5 years	–	x	–
Know of any other method	x	x	–
Ever used breastfeeding as contraceptive	x	x	–
Number of modern methods known	x	x	–
Spacing preference	–	x	–
Current husband's years of education	x	x	x
Current husband's occupation	x	x	–
First husband's occupation	x	x	–

x Significant at five per cent level.
– Not significant at five per cent level.
Source: Tables II.1 to II.3

sample who were not re-interviewed, compared to 371 re-interviewed women, were over-represented in the Western region; that a higher percentage among them, 72.6 per cent, were Indian compared to 58.2 per cent among the re-interviewed women; that they had a higher percentage of illiteracy – 38.1 per cent as against 24.5 per cent for re-interviewed women; and, at the same time, a higher percentage of their husbands had education above 8 years – 26.5 per cent as against 15.9 per cent among husbands of the re-interviewed women. These characteristics are themselves inter-related and suggest some degree of self-selection among women not re-interviewed, by Western region, Indian origin, illiteracy and more educated husbands. Therefore greater caution is necessary in generalizing, to the universe, the results of our dual response analysis for these characteristics.

3.4. CHARACTERISTICS WITH LARGE NET DIFFERENCE

In order to identify the characteristics with large net differences, those which showed a net difference of .200 or over in terms of the Cramer measure are listed in Table 3.4 for comparisons (a), (b) and (c) mentioned earlier. In the next chapter, the reasons for preferring the Cramer measure of net difference to the dissimilarity measure are indicated. Place of residence, respondent's years of education and religion, number of children and sons ever born and still alive, total number of children wanted and spacing preference, current (last) husband's years of education and occupation are characteristics with large net difference for comparison (a) of the main survey with the post-enumeration subsample. Some of these show large net difference for comparisons (b) and (c) also. Moreover, all these characteristics, except three, were shown to have significant differences at five per cent level in Table 3.2. Only "respondent's years of education" (with 19 classes), "total number of children alive plus current pregnancy" (with 17 classes) and "number of children ever born" (with 18 classes) are not significant at the five per cent level. The large number of classes and hence degrees of freedom for the X^2-test may account for their non-significance.

By and large, therefore, the same characteristics which show significant difference at the five per cent level also have large values (.200 and over) for the Cramer measure of net difference. Most of these characteristics are classified into a large number of refined categories which may partly account for the larger measures of net difference. Place of residence, religion and husband's occupation are the only characteristics with less than 10 classes and a large net difference. The distribution by these characteristics among the four groups, main survey *(A)*, subsample *(B)*, re-interviewed women *(C)* and women in the subsample not re-interviewed *(D)*, are shown in Table 3.5

For the five characteristics given in Table 3.5, compared to the main sample, the post-enumeration subsample women had a larger per cent of rural residents both at the time of survey and in childhood; had a higher percentage of Hindus; and had a larger percentage of husbands engaged in farming or agricultural labour. This is also true of the re-interviewed women. Thus the subsample over-represented rural women and, to a lesser extent, Hindus, and wives of farm managers, farmers and agricultural workers. These characteristics are themselves interrelated. More caution is, therefore, called for in extending, to the main sample, conclusions regarding the errors in these characteristics as revealed by the present study of dual responses.

The characteristics by which re-interviewed women were self-selected are themselves closely related to the characteristics by which the subsample was unrepresentative, since ethnicity and religion are related as also are husband's education and occupation. Fortunately, the effects of these two factors on the group of re-interviewed women were opposite. While the subsample tended to over-represent Hindu women with husbands working as farm managers, the re-interviewed women were selected for Fijian women with less educated husbands. The net result of these opposite effects was to slightly improve the group of re-interviewed women as representative of the main sample for these characteristics. This tended to moderate, rather than reinforce, the joint effect of the unrepresentativeness of the subsample and self-selection of the re-interviewed women as is seen in Table 3.5, the only exception being rural residence.
Although the failure rate was large (23.8%), from the results of this analysis, it may be concluded that the 371 re-interviewed women were not self-selected for most of the characteristics associated with better response and correlated to fertility and its concomitants. Therefore, it is meaningful

Table 3.3 Distribution of Subsample Women Re-interviewed and Those Not Re-interviewed by Four Significant Characteristics

Characteristic	Number		Per Cent Distribution	
	Re-interviewed	Not re-interviewed	Re-interviewed	Not Re-interviewed
Region of residence:	371	113	100.0	100.0
Central	128	35	34.5	31.0
Western	156	64	42.0	56.6
Northern	63	13	17.0	11.5
Not applicable	24	1	6.5	0.9
Not stated	0	0	0.0	0.0
Ethnicity:	371	113	100.0	100.0
Fijian	153	29	41.2	25.7
Indian	216	82	58.2	72.6
Other	2	2	0.5	1.8
Literacy:	371	113	100.0	100.0
Literate in English	202	54	54.4	47.8
Literate in mother-tongue but not in English	76	16	20.5	14.2
Illiterate	91	43	24.5	38.1
Not stated	2	0	0.5	0.0
Current husband's years of education:	371	113	100.0	100.0
None	38	9	10.2	8.0
1 year	5	4	1.3	3.5
2 years	11	4	3.0	3.5
3 years	14	6	3.8	5.3
4 years	27	8	7.3	7.1
5 years	41	5	11.1	4.4
6 years	36	12	9.7	10.6
7 years	28	10	7.5	8.8
8 years	112	25	30.2	22.1
9 years	6	3	1.6	2.7
10 years	23	14	6.2	12.4
Primary school (class not stated)	12	3	3.2	2.7
Secondary school (form not stated)	4	0	1.1	0.0
University (Year not stated)	0	0	0.0	0.0
School not stated	3	5	0.8	4.4

to analyse the non-sampling variations of these women with dual interviews, and it is valid to generalize, to the main sample and the population it represents, the results obtained for the subsample of 371 re-interviewed women for most of the characteristics examined. However, there is evidence of some departure from representativeness of women by residence, religion and husband's occupation and of some degree of selectivity of re-interviewed women by such background characteristics as residence, ethnicity, literacy and husband's years of education, although the combined effect of unrepresentativeness and self-selection is moderated slightly. Hence, in extending to the universe, the conclusions of the dual response study relating to these characteristics, greater caution should be exercised.

Table 3.4 Characteristics for Which Cramer Measure of Net Difference Exceeded .200: (A) Main Survey Respondents (4,928) Vs. Post-Enumeration Subsample (484); (B) Main Survey Respondents (4,928) Vs. Post-Enumeration Respondents (371); and (C) Post-Enumeration Respondents Re-interviewed (371) Vs. Not Re-interviewed (113)

Characteristic	No. of Classes	Cramer Measure of Net Difference for Comparison		
		(a)	(b)	(c)
Type of place of residence	4	.492	.456	–
Childhood type of place of residence	3	.264	.275	–
Respondent's years of education	19	.205	–	–
Religion	5	.204	–	–
Number of children ever born	18	.223	.220	–
Number of children ever born	10	(.198)	.201	–
Number of children still alive	17	.215	.223	–
Total children alive plus pregnancy	17	.214	.232	–
Number of sons still alive	11	.219	.222	–
Number of sons ever born	13	.225	.208	–
Total number of children wanted	20	(.198)	.256	.211
Spacing preference	22	–	.323	–
Current husband's years of education	23	.298	.325	.254
Current husband's occupation	7	.282	.301	–
First husband's occupation	7	.227	–	–

Cramer net difference below .200.
Source: Tables II.1 to II.3

Table 3.5 Distribution of Women by Five Characteristics According to the 4,928 Main Survey Respondents *(A)*, the Post-Enumeration Subsample of 484 Women *(B)*. The 371 Re-interviewed Women *(C)* and the 113 Women Not Re-interviewed *(D)*

Characteristic	Main Survey *(A)*		Subsample *(B)*		Re-interviewed *(C)*		Not Re-interviewed *(D)*	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Type of place of residence:	4.928	100.0	484	100.0	371	100.0	113	100.0
Suva and peri-urban Suva	800	16.2	46	9.5	36	9.7	10	8.8
Other urban areas	964	19.6	31	6.4	19	5.1	12	10.6
Rural areas	3,146	63.8	407	84.1	316	85.2	91	8.5
Not stated	18	0.4	0	0.0	0	0.0	0	0.0
Childhood type of place of residence:	4,928	100.0	484	100.0	371	100.0	113	100.0
Urban area	690	14.0	24	5.0	17	4.6	7	6.2
Rural area	4,231	85.9	460	95.0	354	95.4	106	93.8
Not stated	7	0.1	0	0.0	0	0.0	0	0.0
Religion:	4,928	100.0	484	100.0	371	100.0	113	100.0
Methodist	1,706	34.6	115	32.4	127	34.2	30	26.5
Catholic	406	8.2	26	5.4	24	6.5	2	1.8
Hindu	2,183	44.3	239	49.4	117	46.9	65	57.5
Islam	385	7.8	51	10.5	38	10.2	13	11.5
Other	248	5.0	11	2.3	8	2.2	3	2.7
Current Husband's Occupation:	4,928	100.0	484	100.0	371	100.0	113	100.0
Professional and Clerical	774	15.7	62	12.8	47	12.7	15	13.3
Sales and Service	399	8.1	31	6.4	21	5.7	10	8.8
Farm Managers	575	11.7	79	16.3	54	14.6	25	22.1
Farmers and Agricultural workers	1,071	21.7	146	30.2	120	32.3	26	23.0
Semi-skilled	1,323	26.8	109	22.5	87	23.5	22	19.5
Unskilled	781	15.8	56	11.6	42	11.3	14	12.4
Not stated	- 5	0.1	1	0.2	0	0.0	1	0.9
First Husband's occupation:	4,928	100.0	484	100.0	371	100.0	113	100.0
Professional and Clerical	777	15.8	62	12.8	47	12.7	15	13.3
Sales and Service	407	8.3	33	6.8	22	5.9	11	9.7
Farm Managers	573	11.6	75	15.5	52	14.0	23	20.4
Farmers and Agricultural workers	1,092	22.2	139	28.7	114	30.7	25	22.1
Semi-skilled	1,287	26.1	115	23.8	93	25.1	22	19.5
Unskilled	731	14.8	54	11.2	39	10.5	15	13.3
Not stated	61	1.2	6	1.2	4	1.1	2	1.8

4 Comparison of Dual Responses from the Main and the Post-Enumeration Surveys, Net and Gross Errors.

In this chapter, a calculation and comparison is made of the net and gross errrors for various characteristics on which data were collected in the main and post-enumeration surveys. Two measures of net errors and seven measures of gross errors are obtained firstly, to arrive at reliable conclusions that are not influenced by the error measure used; secondly, to find the inter-relationships among the gross error measures; and thirdly, to recommend, for use in similar studies, measures of net and gross errors which are easy to calculate and yield reliable conclusions.

In this study of dual responses, extensive and almost exclusive use is made of summary measures of net and gross errors. As with all summary measures, those used in this study are not satisfactory in all respects. However, since this is an analytical and not a descriptive study, intended to compare and rank different characteristics by the degree of their errors, it is sufficient to examine the summary measures of net and gross errors and no attempt is made to present and comment on the basic cross-tabulations by characteristics, except by way of illustration.

The data relate to 371 women who were interviewed in the main survey and re-interviewed in the post-enumeration survey. In this chapter, the characteristics are treated as either nominal characteristics or ordinal variables. Their net errors are compared and interpreted. The relationships among the gross error measures are examined. The characteristics are re-ordered by their gross errors and their implications for analysis of fertility and its correlates are considered.

In the next chapter, various adjustments are made to the net and gross errors in order to determine the effect of sources other than response variation and to obtain closer measures of response variation. However, such adjustments are difficult to make for every characteristic and are, therefore, limited to some key characteristics. Net and gross errors of all characteristics used in this study are presented and discussed only in this chapter.

4.1 ILLUSTRATION

The several error measures have been discussed in Chapter 2 and are described in Appendix I. The following illustration relates to the number of sons living away from the respondent women. This characteristic is a discrete (non-negative integral) variable but could also be looked upon as a nominal or ordinal classification. Hence it is meaningful to calculate the nominal and ordinal measures for this characteristic. Table 4.1 shows the cross-tabulation of the answer given in the main survey by the answer given in the re-interview to the question on number of sons living away from the respondent. The total number of dual responses was 371. The net error measures of dissimilarity and Cramer measures calculated from the marginal distributions were respectively .014 and .064. The Cramer measure is to be preferred since it takes account of the skewness of the marginal distribution.

First the nominal gross error measures were obtained. The proportion of identical responses on the two occasions (the diagonal proportion) was

$$335/371 = .903$$

and the off-diagonal proportion was .097. Since there are five non-null classes, the diagonal error measure is

$$.097/(5/2) = .039.$$

The contingency-X^2 value was 460.7 and the Cramer measure is

$$460.7/(371 \times 4) = .443.$$

On the symmetric assumption, the marginal proportions were .849, .096, .034, .020 and .001, the expected proportion of cases with identical responses on the two occasions is:

$$(.849)^2 + (.096)^2 + (.034)^2 + (.020)^2 + (.001)^2 = .732$$

against an actual proportion of .903. Hence the value of the game-theoretic measure of gross error is:

$$(1 - .903) \;/\; (1 - .732) = .362.$$

Table 4.1 Number of Sons Living Away From Women: Cross Tabulation By 371 Dual Responses

	Post-enumeration					
Main Survey	0	1	2	3	4	All
0	301	16	3	1	0	321
1	7	22	2	0	0	31
2	1	1	7	3	0	12
3	0	0	1	5	0	6
4	0	1	0	0	0	1
All	309	40	13	9	0	371

Chi-square: 460.706 with 16 degrees of freedom.
Net error measures: Dissimilarity .014; Cramer .064
Gross error measures:
Nominal: Off-diagonal .097; Diagonal measure .039; Cramer .443; Game .362
Ordinal: Gamma .045; Somers .346; Tau B .282.

Next, the ordinal gross error measures were obtained using the formulae given in Appendix I:

Measure	Association	Error
Gamma	.955	.045
Somers	.654	.346
Tau B	.718	.282

For a large set of characteristics, these measures have been obtained and are summarized in Appendix I, in Table I.1 for the originally coded data and for the recoded data in Table I.2. In the following sections a comparison is made of the net and gross errors for various characteristics of the re-interviewed women and examine the implications for the analysis of fertility is examined.

Table 4.2 Characteristics with Net Cramer Measure Exceeding 0.1, Original and Recoded Data

Original Data (Table I.1)		Recoded Data (Table I.2)	
Characteristic	Net Cramer	Characteristic	Net Cramer
If first child died after infancy, years alive	.124		
Heard of and used the injection	.115	Know of injection	.115
Heard of and used lactation	.258	Know of breast-feeding	.258
Heard of and used abstinence	.186	Know of abstinence	.183
Heard of and used the foam tablet	.144	Know of other female methods	.140
Heard of and used withdrawal	.174	Know of withdrawal	.148
Heard of and used vasectomy	.111	Know of vasectomy	.111
Heard of and used rhythm method	.177	Ever used rythm	.145
Heard of and used any other method	.115	Know of other methods	.101
Current method used	.111	Number of methods known	.306
		Number of modern methods known	.269
		Number of methods used	.107
Want a child later or no more children	.115	Want another child	.103
Number of children wanted (lower limit)	.102	Additional children wanted	.118
Number of children wanted (upper limit)	.106	Total children wanted	.148
Husband wants another child	.103	Husband wants another child	.119
		Want no more children	.115
Age of youngest child at next live birth (lower limit)	.120		
Age of youngest child at next live birth (upper limit)	.126		
Whether couple fecund	.132		

4.2 NET ERRORS

As discussed in Chapter 2, the net error is a measure of the overall variation between the means, ratios, rates or distributions obtained from the main and post-enumeration responses. Mutually cancelling errors are disregarded so that the reliability of the mean (or the distribution) is measured by the net error. This aspect is examined first before taking up the reliability of the relationship between two variables. A symmetric model has been used where neither the first interview nor the re-interview is regarded as giving a more precise answer. The two error measures calculated are the net dissimilarity and the net Cramer measure. Both are suitable for nominal measurements and hence also for higher levels of measurement – ordinal, and discrete and continuous variables. As mentioned in Appendix I, while the net dissimilarity is adjusted for the number of categories, only the Cramer measure is adjusted for both the number of categories and the marginal distribution. Moreover, the Cramer measure does not assume a simple response error model. Since characteristics with differing marginal distributions and/or number of categories are being compared, the net Cramer measure only will be used. This measure is given for a wide variety of characteristics in Appendix I.

A perusal of the net Cramer measure presented in Appendix I shows that it is large (over 0.1) for knowledge (and use) of contraceptives, whether more children wanted or not, number of children wanted in all, additional children wanted, whether husband wants another child, spacing preference for the next child and whether the couple is fecund. These characteristics are listed in Table 4.2 along with the Cramer measure.

Regarding knowledge of contraceptives, it should be noted that the conditions in the two interviews were not identical. When questions on knowledge were asked in the first interview, the respondents were sensitized to the various forms of contraception and some information about them was imparted. For instance, asking a question such as:

> Some women feed at the breast for many months, in the belief that this will help them not to become pregnant too soon again. Have you ever heard of this method?

In the first interview made, the women aware of this possibility, if she did not know about it already. Thus in the second interview it can be expected that some of the women, who said no in the first interview, will answer yes. Hence the conditions of the re-interview were not identical

to the extent that the first interview increased the knowledge of the women about contraception.
As an illustration, the marginal distribution of answers to the question on breastfeeding is shown below:

Know About Breastfeeding	Main Survey		Post-enumeration Survey	
	Number	Per cent	Number	Per cent
Yes	183	49.3	276	74.4
No	188	50.7	95	25.6
Total	371	100.0	371	100.0

As might be suspected from these marginal distributions, there were a number of women who did not know at the time of the first interview, that breastfeeding might reduce the chances of conception; some had learnt about it during the first interview and had claimed such knowledge in the re-interview. Similar diffusion effect may be present in varying degrees in the answer to other knowledge questions about contraceptives. This would explain why such questions have large net errors.
As indicated later, answers to questions on contraceptive knowledge also carry a large gross error. It is inappropriate to use a symmetric model when the situation is being changed during the first interview. An attempt is made later to adjust the gross error to this asymmetrical situation.
The other questions which carry large net errors relate to family size expections and fecundity status. Expectations are anticipations for the future and should normally carry a large variability in response. Expectations are affected both by the ability of the respondents to anticipate such events and by the stability over time of their expectations. Hence it is not surprising that the net errors regarding the expected number of children are large. Perhaps, for the same reason, spacing of the next child is also subject to a large net error.
Fecundity status was determined in answer to the question:

> Some couples are unable to have any (more) children, because the wife has reached the menopause, or because one of them has been sterilized, or because of some physical or medical problem. Are you and your husband able to have another child?

There may be various social reasons for not being absolutely frank with the interviewer in answering this question. Moreover, "physical or medical problem" can be determined definitely only on the basis of a medical examination of the couple. These are reasons for expecting large response variations between the answers given on the two occasions.
Having highlighted the characteristics with large net errors, we next examine the gross errors in various characteristics after selecting a suitable error measure.

4.3 RELATIONSHIP AMONG GROSS ERROR MEASURES

As described earlier, several measures of gross error have been calculated for each characteristic. They are given in Appendix I. First, an attempt is made to find the most suitable measure for comparing the gross errors in various characteristics.
The off-diagonal proportion, though the easiest gross error measure to interpret, is affected both by the number of categories and the marginal distribution and is, therefore, the least suitable for comparison of characteristics. The diagonal error measure, though adjusted for the number of categories, can still be influenced by the marginal distribution. Ordinal measures are meaningful only for ordinal characteristics. Thus the choice is narrowed down between nominal gross error measures of Cramer and game-theoretic. Moreover, neither of these two measures assumes a simple response error model.
In order to examine the inter-relationship among various error measures, their rank correlations were obtained. Rank correlations were used instead of product moment correlations to minimize the contribution of extreme values. The characteristics given in Appendix I, Table I.1 were ranked on each error measure, tied measures being allotted tied ranks.
The rank correlation and the linear regression intercept and slope of y on x for pairs of gross error measures were calculated. These parameters for selected pairs are shown below:

x	y	Number of Characteristics	Rank Correlation	Regression of y on x Intercept	Slope
Somers	Tau B	17	.70	2.68	.70
Gamma	Somers	17	.81	1.74	.81
Gamma	Tau B	17	.71	2.60	.71
Gross Cramer	Gamma	17	.71	2.60	.71
Gross Cramer	Tau B	17	.95	0.45	.95
Game	Tau B	17	.94	0.53	.94
Gross Cramer	Game	76	.95	1.96	.95
Diagonal	Gross Cramer	76	.29	27.25	.29
Net Cramer	Gross Cramer	76	.61	14.94	.61

Examinations of the rank correlations reveals that, among ordinal measures, Gamma and Somers are most closely related. The correlation between the two preferred nominal measures – Cramer and game – is high, being .95 (The product moment correlation between these two measures is slightly higher, .97.) Either could be used for comparing the gross errors among characteristics and the overall ranking of characteristics based on the two measures cannot be far different. This means that for interpretative purposes both measures may serve equally well. By contrast, the diagonal measure has a low correlation with the gross Cramer measure and conclusions based on the two measures may be at variance. The ordinal measure Tau B is closely related to the nominal Cramer and game measures, with rank correlations of .95 and .94, respectively.
These results suggest that, for all practical purposes, the gross Cramer measure can be used in comparing characteristics. It is easy to calculate. It has a standard formula and is based on the contingency-X^2, which is usually calculated. It is a measure which takes account of the number of categories and the marginal distribution. It does not assume a simple response error model. It is closely related to the game-theoretic measure which also shares the last three properties. Moreover, the gross Cramer measure is also closely related to the ordinal measure Tau *B*. Hence conclusions based on the gross Cramer measure cannot be far different from those based on the game-theoretic or, where appro-

Table 4.3 Seventy-six Characteristics Ranked By Gross Cramer Measure*

Rank on Gross Cramer Measure		Characteristic	Rank on Game-theoretic Measure	
1	(.067)	Sex of third live birth	2	(.069)
2	(.078)	Currently have a husband	3	(.081)
3	(.084)	Sex of second live birth	5.5	(.100)
4	(.090)	Number of daughters with respondent	9	(.121)
5	(.097)	Sex of first live birth	5.5	(.100)
6	(.108)	Has respondent been married before?	8	(.116)
7	(.109)	Is third child still living?	1	(.038)
8	(.120)	If third child died in infancy months alive	23	(.255)
9	(.121)	Number of sons living with respondent	10	(.125)
10	(.134)	Is first child still living?	11	(.138)
11	(.152)	Number of births	13	(.144)
12	(.162)	Is second child still living	4	(.086)
13	(.184)	Number of daughters away from respondent	21	(.238)
14	(.187)	Is respondent pregnant?	7	(.106)
15	(.193)	Are any children dead?	16	(.197)
16	(.205)	Whether pregnant since last birth	14	(.161)
17	(.244)	Whether pregnant before first child	17	(.204)
18	(.272)	Number of children dead	19	(.230)
19	(.290)	Heard of and used tubectomy	15	(.180)
20	(.291)	Pregnant respondent prefers boy or girl?	22	(.244)
21	(.292)	Number of marriages in all	12	(.142)
22	(.297)	Number of pregnancies since last birth	27	(.297)
23	(.298)	Couple currently using a method	30	(.320)
24	(.299)	Whether couple fecund	26	(.289)
25	(.329)	Ever worked for money	31	(.332)
26	(.347)	Prefer next child as soon as possible	34	(.344)
27	(.358)	If first child died in infancy, months alive	24	(.280)
28	(.359)	Wants a child after current pregnancy	29	(.318)
29	(.368)	If third child died after infancy, years alive	56	(.575)
30	(.370)	Ever used the pill	18	(.214)
31	(.374)	How did the first marriage terminate?	32	(.333)
32	(.375)	Want a child in future after current pregnancy?	28	(.316)
33	(.380)	Heard of and used IUD	20	(.235)
34	(.396)	Does husband want another child?	35	(.346)
35	(.401)	Prefer boy or girl as next child?	40	(.375)
36	(.416)	Want another child in the future?	36.5	(.358)
37	(.425)	Method intended to be used by husband	42	(.445)
38	(.429)	Did respondent work before marriage?	38.5	(.362)
39	(.440)	Does husband want another child after current pregnancy?	36.5	(.358)
40	(.443)	Number of sons living away from respondent	38.5	(.362)
41	(.456)	Method currently used	25	(.285)
42	(.459)	Heard of and used condom	47	(.523)
43	(.466)	Age of the youngest child at next birth (upper limit)	49	(.537)
44	(.470)	Age of the youngest child at next birth (lower limit)	50	(.546)
45	(.491)	If second child died in infancy, months alive	43	(.491)
46	(.493)	Duration of first pregnancy before first child	52	(.559)
47.5	(.500)	If second child died after infancy, years alive	63	(.719)
47.5	(.500)	If first child died after infancy, years alive	58	(.633)
49	(.513)	Worked between marriage and first birth?	44	(.504)
50	(.521)	Does husband intend to use any method?	33	(.335)
51	(.524)	Number of pregnancies between first and last birth	53	(.564)
52	(.533)	Worked after first birth?	45	(.513)
53	(.544)	How many children wanted in all now? (lower limit)	55	(.566)

Table 4.3 (Cont.)

Rank on Gross Cramer Measure		Characteristic	Rank on Game-theoretic Measure	
54	(.554)	How many children wanted in all now? (upper limit)	41	(.431)
55	(.556)	Any pregnancies between first and last birth?	51	(.556)
56	(.558)	How many children in all wanted	54	(.565)
57	(.564)	Number of pregnancies before first birth	48	(.538)
58.5	(.581)	How many children in all wanted by husband after current pregnancy (upper limit)	59.5	(.636)
58.5	(.581)	How many children in all wanted by husband after current pregnancy (lower limit)	59.5	(.636)
60	(.622)	Number of children wanted in all by husband	46	(.514)
61	(.658)	Worked in last 12 months	57	(.598)
62	(.663)	Heard of and used the injection	68	(.768)
63	(.668)	Number of children wanted in all in the interval between the two most recent pregnancies (upper limit)	65.5	(.753)
64	(.670)	Ever heard of the pill	71.5	(.811)
65.5	(.672)	Did the first pregnancy end in a live birth?	61.5	(.672)
65.5	(.672)	If first pregnancy ended in a live birth, sex of that live birth	61.5	(.672)
67	(.702)	Heard of and used rythm method	69	(.770)
68	(.723)	Respondent and/or husband disapproves of contraception	71.5	(.811)
69	(.726)	Heard of and used the foam tablet	67	(.762)
70	(.732)	Number of children wanted in all in the interval between the two most recent pregnancies (lower limit)	65.5	(.753)
71	(.733)	Heard of and used withdrawal	70	(.775)
72	(.753)	In the interval between the two most recent pregnancies, wanted a child later or no more children?	64	(.748)
73	(.808)	Heard of and used lactation for contraception	75	(.902)
74	(.816)	Heard of and used vasectomy	73	(.833)
75	(.838)	Heard of and used abstinence	74	(.898)
76	(.966)	Heard of and used any other method	76	(.975)

Source: Appendix Table I.1
* Gross error measure shown in parentheses.

priate, the Tau *B* measures. Further analysis is continued mainly on the basis of the gross Cramer measure.

4.4 COMPARISON OF GROSS ERRORS IN VARIOUS CHARACTERISTICS

As mentioned earlier in this report, this analysis is conducted in terms of summary error measures. Since a gross error measure cannot be assigned direct quantitative significance, it can be interpreted only in comparative terms. Thus certain types of characteristics may carry more gross errors than others. For instance, factual data may be subject to smaller gross errors than answers relating to future expectations. Among retrospective data, recent events may be recollected with less memory lapse than distant events. Knowledge about contraceptives may be subject to a larger gross error than usage. We proceed to compare different types of characteristics mainly on the basis of the gross Cramer measure. This measure as pointed out in the last section, is closely related to the game measure and would yield essentially similar conclusions.

Another way of comparing gross errors is between surveys. We shall comment later on the level and pattern of gross errors in the Fiji Survey compared to the Turkish Social Survey (1968).

In Table 4.3, have been ranked, in increasing order of gross Cramer measure, 76 characteristics coded for the analysis for which gross error measures are presented in Appendix Table I.1. On the right-hand side are shown the ranks on the game-theoretic measure. Within parentheses, following the ranks, are given the actual error measures.

Inspection of Table 4.3 shows that current and recent factual data have the least errors. These are followed by retrospective factual data relating to distant periods, expectations for the future and, finally, knowledge and use of contraceptive methods other than sterilization.

To examine further the comparative gross errors, 86 recoded characteristics which were widely used in the Principal Report (1976) are grouped in Table 4.4 into 23 groups of related characteristics. For instance, the first six characteristics of this table relate to "children ever born". The average rank for this group, based on the Cramer measure, is 22.8 while that based on the game measure is 21.5. The gross error measures for the characteristics given in this table are taken from Appendix Table I.2. Perusal of this table generally confirms the results of Table 4.2. "Children still alive" is subject to less error (average rank 11.3) than "children deceased" (average rank 38.0) while "children ever born", which is the sum of these two characteristics, has an intermediate level of error (average rank 22.8). "Live births in the five years after the first marriage" has more gross error (average rank 60.0) than "live births in the past five years" (average rank 41.0).

Knowledge about contraception as the largest error (average rank 76.9). Ever use of contraceptives other than

Table 4.4 Eighty-six Recoded Characteristics* Grouped into Twenty-three Groups of Related Characteristics, with Average Errors and Ranks

		Gross Cramer		Game	
	Characteristic	Value	Rank	Value	Rank
1	Children ever born	.152	24	.114	25
2	Children ever born (9+, open interval)	.122	21	.118	21
3	Children ever born (5+, open interval)	.089	18	.084	18
4	Children ever born (< 3, 5+, open interval)	.076	15	.058	16
5	Sons ever born	.180	30	.152	26
6	Daughters ever born	.173	29	.135	23
	Average	.132	22.8	.115	21.5
7	Children still alive	.105	19	.066	17
8	Children still alive (9+, open interval)	.059	12	.061	14.5
9	Children still alive (5+, open interval)	.060	13	.051	13
10	Children still alive + current pregnancy	.088	17	.042	11
11	Children still alive (≤ 3, 4, 5+)	.031	7	.023	7
12	Children still alive (< 4, 4+)	.016	6	.016	6
13	Children still alive + current pregnancy (5+, open interval)	.032	8	.028	8
14	Sons still alive	.050	11	.043	12
15	Sons still alive (3+, open interval)	.035	9	.033	9
	Average	.053	11.3	.040	10.8
16	Children deceased	.272	38.0	.230	38.0
17	Live births in first 5 years of marriage	.526	60.0	.418	56.0
18	Live births in past 5 years	.289	41	.191	35
19	Sons in past 5 years	.299	43	.156	29
20	Daughters in past 5 years	.273	39	.142	24
	Average	.287	41.0	.163	29.3
21	Know of the pill	.670	70	.811	29
22	Know of the loop	.778	80.5	.830	80
23	Know of the injection	.758	79	.774	76
24	Know of breast-feeding	.841	84	.920	83
25	Know of female sterilization	.639	67	.673	65.5
26	Know of abstinence	.878	85	.916	82
27	Know of other female methods	.719	73	.744	71
28	Know of condom	.668	69	.671	64
29	Know of withdrawal	.730	74	.759	74
30	Know of vasectomy	.818	83	.833	81
31	Know of rhythm	.713	72	.718	67
32	Know of other methods	.916	86	.976	86
	Average	.761	76.9	.802	75.7
33	Ever used the pill	.172	28	.172	32
34	Ever used the loop	.153	25	.154	27.5
	Average	.162	26.5	.163	29.8
35	Ever used the injection	.596	66	604	63
36	Ever used breast-feeding as contraception	.778	80.5	784	77
37	Ever used any other female method	.735	75	735	70
38	Ever used abstinence	.805	82	805	78
39	Husband ever used condom	.302	44.5	307	44
40	Husband ever used withdrawal	.749	76	.753	73
41	Ever used rhythm	.676	71	.725	68
42	Summary of use of methods	.415	57	.366	54
	Average	.637	69.4	639	65.9

Table 4.4 (Cont.)

	Characteristic	Gross Cramer Value	Gross Cramer Rank	Game Value	Game Rank
43	Sterilized	.061	14	.061	14.5
44	Husband vasectomized	.000	3	.000	3
	Average	.030	8.5	.030	8.8
45	Ever used any other method	.000	3	.000	3
46	Know any method	.000	3	.000	3
47	Know any modern method	.000	3	.000	3
48	Summary of knowledge of methods	.000	3	.000	3
	Average	.000	3.0	.000	3.0
49	Number of methods known	.647	68	.956	85
50	Number of modern methods known	.560	64	.943	84
	Average	.604	66.0	.950	84.5
51	Used any method	.402	55	.402	55
52	Used any modern method	.185	32	.186	34
53	Number of methods used	.534	61	.673	65.5
	Average	.374	49.3	.420	51.5
54	Currently pregnant	.218	33.0	.222	36.0
55	Want another child	.394	52	.351	52
56	Want another child (Yes + undecided)	.302	44.5	.306	43
57	Want no more children or want later	.753	77	.748	72
58	Last pregnancy wanted	.754	78	.766	75
59	Husband wants another child	.386	51	.348	51
	Average	518	60.5	504	58.6
60	Additional children wanted	.548	63.3	.473	58
61	Total children wanted	.540	62	.568	62
62	Total children wanted (5+, open interval)	.578	65	.518	61
	Average	.555	63.3	.520	60.3
63	Sex preference	.442	58.0	.334	50.0
64	Currently using any method	.306	46	.323	48
65	Currently using any modern method	.267	37	.282	41
66	Method currently using	.325	48	.273	40
67	Summary of current method	.343	49	.324	49
	Average	.310	45.0	.300	44.5
68	Work status before first marriage	.291	42	.293	42
69	Work status between marriage and first birth	.278	40	.365	53
	Average	.284	41.0	.329	47.5
70	Age in 5-year intervals	.139	23	.154	27.5
71	Age interval (mixed)	.125	22	.128	22
72	Age in 10-year intervals	.110	20	.116	20
73	Age interval (10 and 5)	.082	16	.085	19
74	Age in 20-year intervals	.039	10	.039	10
	Average	.099	18.2	.104	19.7
75	Number of times married	.397	53.0	.168	31.0

Table 4.4 (Cont.)

	Characteristic	Gross Cramer		Game	
		Value	Rank	Value	Rank
76	Duration since first marriage (5-year intervals)	.260	35	.250	39
77	Duration since first marriage (mixed)	.226	34	.234	38
78	Duration since first marriage (10-year intervals)	.162	27	.174	33
79	Duration since first marriage (10-year intervals with 20+, open)	.154	26	.160	30
	Average	.200	30.5	.204	35.0
80	Type of dissolution of first marriage	.524	59.0	.733	69.0
81	Age at first marriage (2-year intervals)	.382	50	.482	60
82	Age at first marriage (2-year intervals with 25+ open)	.404	56	.475	59
83	Age at first marriage (5-year intervals)	.400	54	.439	57
84	Age at first marriage (17, 18, 21, 22+)	.265	36	.315	46
85	Age at first marriage (20, 20+)	.308	47	.309	45
	Average	.352	48.6	404	53.4
86	Age at first birth (5-year intervals)	.183	31.0	.321	47.0

* Source: Appendix Table I.2.

sterilization, the pill and loop has the next largest gross error (averages rank 69.4) exceeding that for current use of contraceptives (average rank 45.0)

Age intervals have less gross error (average rank 18.2) than duration since first marriage (average rank 30.5) and age at birth of first child (average rank 31.0). "Want another child", with average rank 60.5, and "number of children wanted", with average rank 63.3, have much higher gross errors than factual data.

In Table 4.5, these comparisons are facilitated by rearranging the 23 groups of related characteristics in ascending order of average ranks based on the gross Cramer measure. Further comparisons among groups of characteristics can be made from this table. The conclusions, especially those for groups which include several characteristics, are similar whether we use the gross Cramer or the game measure. The overall pattern that emerges is one in which factual data are more precise than future expectations and contraceptive knowledge. Factual data for current and recent period are more precise than data relating to the less recent and remote past. Knowledge questions are subject to most error. Ever-usage of hard contraceptive methods like sterilization and loop is subject to fewer gross errors than ever-usage of soft methods, such as lactation and abstinence. Current usage of contraceptives is subject to fewer errors than ever-usage. Thus the gross error depends on whether the characteristic is factual or an expectation for the future, whether it is current or retrospective, whether it is changed by the interview process and whether it is episodic (e.g. sterilization operation) or common place (e.g. abstinence).

A variable by variable comparison is not possible between the Turkish and Fiji Surveys because their objectives, variables, classifications and cultural contexts are different. However, Srikantan (1977) has found a similar pattern of errors in the Turkish Social Survey, 1968. "Objective questions relating to facts generally have less errors than subjective ones". It is the author's impression that the levels of errors in roughly similar groups of characteristics may generally be higher in the Turkish Survey compared to the Fiji Survey for various reasons. It is hoped that the World Fertility Survey post-enumeration surveys, now being undertaken in a few countries, would provide similar results for a comparative evaluation of non-sampling errors across countries.

The gross errors presented in this chapter reflect not merely response and interviewer errors but also other sources of variation. In the period lapsed between the interview and the re-interview, events such as births and deaths could have occured so that some change is legitimate between the responses. Knowledge questions asked on two successive occasions are, by nature, asymmetrical and a symmetric model is not appropriate for the assessment of gross error. All characteristics have been treated as nominal categories in this chapter. It is necessary to examine the errors in continuous variables, especially in the dating of events. In the next chapter, we try to eliminate these other sources of errors so that the gross error measure would more closely reflect, for some selected characteristics, the response and interviewer variations.

Table 4.5 Twenty-three Groups of Related Characteristics Ordered by Average Gross Cramer Ranks

	Characteristics Related to (Number)	Gross Cramer Value	Gross Cramer Rank	Game Value	Game Rank
1	No knowledge of contraception (4)	.000	3.0	.000	3.0
2	Sterilized (2)	.030	8.5	.030	8.8
2	Children still alive (9)	.053	11.3	.040	10.8
3	Age intervals (5)	.099	18.2	.104	19.7
4	Children ever born (6)	.132	22.8	.115	21.5
5	Ever used pills, loop (2)	.162	26.5	.163	29.8
6	Duration since first marriage, intervals (4)	.200	30.5	.204	35.0
7	Age at first birth, 5-year intervals (1)	.183	31.0	.321	47.0
8	Currently pregnant (1)	.218	33.0	.222	36.0
9	Children deceased (1)	.272	38.0	.230	38.0
10	Live births in past five years (3)	.287	41.0	.163	29.3
11	Work status (2)	.284	41.0	.329	47.5
12	Currently using contraception (4)	.310	45.0	.300	44.5
13	Age at first marriage, intervals (5)	.352	48.6	.404	53.4
14	Number of methods used (3)	.374	49.3	.420	51.5
15	Number of times married (1)	.397	53.0	.168	31.0
16	Sex preference for child (1)	.442	58.0	.334	50.0
17	Dissolution of first marriage (1)	.524	59.0	.733	69.0
18	Live births in first 5 years of marriage (1)	.526	60.0	.418	56.0
19	Want another child (5)	.518	60.5	.504	58.6
20	Number of children wanted (3)	.555	63.3	.520	60.3
21	Number of methods known (2)	.604	66.0	.950	84.5
22	Used method other than IUD, pill and sterilization (8)	.637	69.4	.639	65.9
23	Knowledge of contraceptive methods (12)	.761	76.9	.802	75.7

Source: Table 4.4.
The number of characteristics in each group is shown in parentheses.

5 Adjustments on Net and Gross Errors for Eliminating Sourses Other than Response Errors.

In this chapter various adjustments are carried out on the net and gross errors in order to eliminate sources other than response variations and to obtain closer measures of response errors. First, the gross error for births intervening between the two interviews is adjusted, for diffusion of knowledge about contraceptive methods and for natural aging between the two interviews. Next, the gross errors in the dating of events are calculated, using measures appropriate for a continuous variable. Finally, the adequacy of the net Cramer measure for testing marginal homogeneity in a contingency table is examined.
In each instance, the adjusted measure is compared with the unadjusted measure to see how important are the effects of sources other than response variation and whether conclusions drawn in Chapter 4 could be valid after the elimination of extraneous sources of variation. Since these adjustments are necessarily complex and difficult to carry out for each individual respondent, the comparison is limited to certain key characteristics.

5.1 INTERVENING EVENTS

In order to see the impact of intervening events on the gross error, the gross error measures for relevant characteristics were recalculated after adjustment for births in the period between the dual interviews. Twelve women reported a live birth between the main and post-enumeration interviews. Their responses in the re-interview were adjusted to reflect the situation as at the date of the first interview. The gross error based on the adjusted re-interview characteristic and the corresponding main survey characteristic should be free of changes due to intervening births.

The adjusted and unadjusted measures may be compared from Table 5.1. Except for pregnancy status, no adjusted measure exceeds the unadjusted measure. "Not pregnant" status at re-interview was adjusted to "pregnant" status, if a woman had a birth between the two interviews. Thus doubtful pregnancy status at first interview was corrected to "pregnant" status in the adjusted re-interview response if there had been a birth between the two interviews. This would explain why the adjusted gross error for pregnancy status is more than the unadjusted figure.
Some characteristics are not affected by the adjustment. Where there is a decrease in the gross Cramer or game measure, it is slight. The same finding would hold for rarer events like deaths in infancy and marriage. Thus the conclusions drawn in Chapter 4 appear to hold true even after eliminating the effect of intervening events.

5.2 DIFFUSION OF CONTRACEPTIVE KNOWLEDGE

In Chapter 4, it was found that one source of variation contributing to the gross error is the diffusion of contraceptive knowledge in the course of the initial interview. The gross error based on the assumption that each respondent's knowledge about contraception was identical in both interviews is inappropriate. Hence the gross error has been adjusted to allow for the contingency that women who did not know about a contraceptive method might have learnt about it during or after the first interview. Thus a no-yes answer in the dual interviews is legitimate even though the woman does not give the identical answers. In calculating the off-diagonal proportion, this category has, therefore, to be excluded. The procedure for making suitable adjustments on the off-diagonal proportion and the game measure is illustrated in the next paragraph.
The dual answers to the question whether the woman had heard of or used the injection were classified into the

Table 5.1 Comparison of Adjusted Net and Gross Errors: 371 Matched Cases of the Main Survey and Post-Enumeration Survey Adjusted and Unadjusted for Intervening Births.

Characteristic	No. of Classes	Net Error Measures		Gross Error Measures							X^2	
				Nominal				Ordinal				
		Dissimilarity[1]	Cramer[2]	Off.-diag. Proportion[3]	Diagonal[4]	Cramer[5]	Game[6]	Gamma[7]	Somers[8]	Tau B[9]	Value[10]	D.F.[11]
Sons with respondent, adjusted	9	.004	.026	.089	.020	.103	.111	.016	.046	.048	2386.12	64
Sons with respondent, unadjusted	9	.005	.025	.100	.022	.121	.125	.016	.050	.052	2295.20	64
Sons away from respondent, adjusted	5	.014	.064	.097	.039	.443	.362	.045	.346	.282	460.71	16
Sons away from respondent, unadjusted	5	.014	.064	.097	.039	.443	.362	.045	.346	.282	460.71	16

Table 5.1 (Cont.)

Characteristic	No. of Classes	Net Error Measures		Gross Error Measures							X^2	
				Nominal				Ordinal				
		Dissimilarity[1]	Cramer[2]	Off.-diag. Proportion[3]	Diagonal[4]	Cramer[5]	Game[6]	Gamma[7]	Somers[8]	Tau B[9]	Value[10]	D.F.[11]
Daughters with respondent, adjusted	8	.002	.019	.075	.019	.080	.097	.021	.057	.057	2197.02	49
Daughters with respondent, unadjusted	8	.005	.025	.094	.024	.090	.121	.022	.069	.069	2148.50	49
Daughters away from respondent, adjusted	5	.003	.019	.073	.029	.184	.238	.032	.211	.200	987.61	16
Daughters away from respondent, unadjusted	5	.003	.019	.073	.029	.184	.238	.032	.211	.200	987.61	16
Any children dead, adjusted	2	.030	.035	.067	.067	.187	.190				245.28	1
Any children dead, unadjusted	2	.032	.038	.070	.070	.193	.197				241.52	1
Number of children dead, adjusted	5	.014	.072	.084	.033	.266	.224	.045	.239	.200	799.68	16
Number of children dead, unadjusted	5	.015	.076	.086	.035	.272	.230	.046	.248	.205	787.55	16
Number of live births, adjusted	15	.003	.051	.102	.014	.132	.114	.011	.028	.027	3911.90	196
Number of live births, unadjusted	15	.005	.060	.129	.017	.152	.144	.013	.035	.034	3733.52	196
Respondent pregnant, adjusted	3	.014	.057	.027	.018	.148	.117				538.26	4
Respondent pregnant, unadjusted	3	.009	.038	.022	.014	.187	.106				490.04	4
First live birth by sex, adjusted	3	.000	.000	.046	.031	.060	.077				656.03	4
First live birth by sex, unadjusted	3	.009	.022	.059	.040	.097	.100				605.03	4
First child living, adjusted	3	.007	.020	.032	.022	.098	.094				603.82	4
First child living, unadjusted	3	.009	.027	.046	.031	.134	.138				556.71	4
First child, if died in infancy, duration in months, adjusted	6	.008	.088	.032	.011	.358	.280				763.98	25
First child, if died in infancy, duration in months, unadjusted	6	.008	.088	.032	.011	.358	.280				763.98	25
First child, if dead after infancy, duration in years, adjusted	11	.003	.124	.027	.005	.500	.633				926.33	100
First child, if dead after infancy, duration in years, unadjusted	11	.003	.124	.027	.005	.500	.633				926.33	100

For 12 women, each of whom reported a live birth between the main survey and the post-enumeration survey, the responses in the re-interview were adjusted to reflect the situation as at the date of the main survey.

1–9 See Appendix I for definitions of these measures.

categories, "heard of and used", "heard of but not used" and "not heard of" with the following results:

First interview	Re-interview			
	1	2	3	Total
1 Heard of and used	1	1	0	2
2 Heard of but not used	0	143	49	192
3 Not heard of	2	89	86	177
Total	3	233	135	371

To allow for diffusion of contraceptive information during the first interview, the cell, "not heard of" in the first interview and "heard of but not used" in the re-interview should not be regarded as inconsistent. Thus the off-diagonal proportion of inconsistent dual answers would now be

$$(0 + 2 + 1 + 0 + 49) / 371 = .140$$

whereas the symmetric model would give an off-diagonal proportion of .380. Similarly, following the method given in Appendix I, the game measure on the basis of the asymmetrical assumption would be

$$(.140) / 1 - (.007)^2 - (.573)^2 - (.420)^2 - (.573)$$

$$(420) = .552.$$

Table 5.2 Measures of Gross Error* Adjusted** for Diffusion of Knowledge about Contraceptive Methods between the Main Survey and the Post-Enumeration Study

Ever heard of and used	Unadjusted		Adjusted	
	Off-diag. Proportion	Game Measure	Off-diag. Proportion	Game Measure
IUD	.059	.235	.038	.157
The injection	.380	.768	.140	.552
Lactation	.480	.920	.154	.509
Tubectomy	.057	.180	.025	.085
Abstention	.507	.898	.243	.654
Foam tablet	.402	.762	.157	.537
Condom	.237	.523	.143	.403
Withdrawal	.456	.775	.251	.628
Vasectomy	.412	.833	.151	.610
Rhythm	.450	770	.264	.673

* The measures of gross error used are explained in the footnotes to Appendix Table I.1 and the text.

** The adjustment consisted in regarding not only the diagonal categories but also the category "not heard of" at the main survey and "heard of but not used" at the post-enumeration survey as consistent. The latter category would, of course, include respondents who have acquired such knowledge either at the first or between the two interviews.

Similar adjustments were made on these two measures for several questions on contraceptive knowledge and use. The adjusted and unadjusted measures are shown in Table 5.2. The adjustment substantially reduces the off-diagonal proportion and the game measure. For instance, for the question on the knowledge and use of lactation as a contraceptive method, the off-diagonal proportion goes down from .480 to .154 and the game measure from .920 to .509. However, even the adjusted measures are large so that the diffusion effect, by itself, would not account for the gross error. Response variation still appears to be important and the findings of Chapter 4 broadly hold good for the adjusted gross error measures also. Contraceptive knowledge remains subject to large gross errors, if not the largest.

5.3 GROSS ERROR IN DATING OF EVENTS

In Chapter 4, the analysis of errors has been mainly in terms of nominal classifications. For instance, age groups and duration groups since first marriage have been treated as nominal categories and no weightage has been given to misclassifications according to how far apart the dual responses are. For instance, the nominal measures would treat alike a deviation of one or ten years between the ages reported in the two interviews. However, when assessing the gross error in a discrete or continuous variable, small deviations between dual responses should be less serious than large deviations. Hence it is necessary to calculate the gross error measure for such characteristics using the measures developed for continuous variables in Appendix I. In this section, the consistency in the dating of events is examined following this procedure. First the calculation of the gross error in the date of birth is illustrated.

The year and month of birth were asked from respondents. If both the main survey and the post-enumeration interviews gave the year of birth, the difference was taken and multiplied by 12. If both interviews also reported the month of birth, their difference was added to the above value. The total thus obtained was regarded as the discrepancy, in months, in the date of birth. Respondents, for whom the year of birth was unavailable at either or both interviews, were excluded from the comparison. For respondents who did not provide the month of birth at either or both interviews, only the year of birth was considered.

The distribution of the discrepancy (in months) in the date of birth was as follows:

Discrepancy in months (main survey post-enumeration)	Respondents		
	Number	Per Cent	Cumulative Per Cent
– 48 and below	6	1.71	1.71
– 36	5	1.43	3.14
– 30	1	0.29	3.43
– 24	8	2.29	5.71
– 14	1	0.29	6.00
– 12	33	9.43	15.43

– 11	1	0.29	15.71
– 4	2	0.57	16.29
– 3	2	0.57	16.86
– 2	1	0.29	17.14
– 1	4	1.14	18.29
0	209	59.71	78.00
2	1	0.29	78.29
3	1	0.29	78.57
5	1	0.29	78.86
7	1	0.29	79.14
9	2	0.57	79.71
10	3	0.86	80.57
12	40	11.43	92.00
13	1	0.29	92.29
16	1	0.29	92.57
23	1	0.29	92.86
24	9	2.57	95.43
25	1	0.29	95.71
36	4	1.14	96.86
47	1	0.29	97.14
48 and above	10	2.86	100.00
Total	350	100.00	100.00
Year of birth not stated at either or both interviews	21		

The bunching of discrepancies around 12, 24 and 36 months arises mostly from those women who failed to state the month of birth at either or both interviews. 209 women out of 350 who answered this question, or 59.7 per cent, gave precisely the same answer on both occasions. A nominal measure would take cognisance of only this fact. On the other hand, although 40.3 per cent of the women answering did not give the same date in both interviews, for 86 per cent of the women, the deviation did not exceed a year on either side (including those with no deviation) and for 92 per cent it did not exceed two years. This peaked distribution of deviations around zero is important in the assessment of gross error. Using the measures for continuous variables developed in Appendix I, the net error in the date of birth was calculated as .062 and the gross error as .120. These measures take account not only of the inconsistency between dual responses, but also of the magnitudes of discrepancy.

The correlation between the dual dates is high, .985. This is also the attenuation factor for this variable due to gross errors. Thus when date of birth is correlated with other characteristics, the true correlation will get attenuated by a factor of $\sqrt{.985}$ or .992.

In Table 5.3, the gross errors in dating several events are shown. The deviations are converted into months and the net and gross errors are obtained in the same way. The net and gross errors are generally low except for "date of first marriage if other than current marriage". Larger recall lapse and fluid and informal arrangements for living together as husband and wife may account for the large net and gross errors in this variable. The correlations are .95 or over. It appears that, although women may not give precisely the same dates in the two interviews, the deviations may not be large for those women who respond on both occasions. Hence relationships of these dates with other characteristics are unlikely to be attenuated much.

5.4 NATURAL AGING

The age reported for a woman in the post-enumeration interview would be a year higher than her age reported at the time of the main survey, if her birthday fell between the two interviews. The contribution, to the gross error, of this source of natural aging was eliminated to obtain a closer measure of other sources of variation.

The age at the time of the first interview was adjusted to the re-interview date. The latter reference point was chosen since the post-enumeration work was compressed into two weeks compared to the main survey duration of eight weeks.

Table 5.3 Comparison of the Dating of Events in Dual Interviews: Main and Post-Enumeration Surveys (371 Matched Cases)

Event	No. of Event	Net Error		Gross Error		
		F-ratio*	Measure*	*F*-ratio*	Measure*	Correlation**
Date of birth	350	1.35	.062	2.55	.120	.985
Age	371	7.58	.142	5.65	.172	.983
Date of current marriage	350	0.00	.003	1.38	.089	.975
Date of first marriage	368	0.70	.044	1.00	.074	.977
Date of first marriage (other than current)	38	0.87	.152	0.98	.228	.975
Date of first birth	326	1.22	.061	2.54	.124	.988
Date of second birth	290	2.94	.100	4.73	.178	.988
Date of third birth	246	2.38	.098	1.94	.125	.980
Date of fourth birth	194	2.83	.120	1.50	.124	.970
Date of fifth birth	143	2.19	.123	2.90	.199	.948
Date of sixth birth	112	1.80	.126	0.89	.127	.969

If month and year of occurrence of the event were available for both interviews, they were compared. If years were available for both, but not months, the years were compared.

* See Appendix I for formulation of statistic.

** Product moment correlation.

If the woman was born in February, March or April (main survey months), the main survey age was adjusted to the post-enumeration date of interview as:

(74 –birth year).

If the woman was born in May (post-enumeration month), the age was calculated again as

(74 – birth year)

and compared with the re-interview age. If the latter was a year less, the main survey age was also made a year less. This adjustment would correct for natural aging between the two interviews.

The error measures for the actual age and the adjusted age are given below:

	Net error		Gross error			
	F-ratio	Measure	*F*-ratio	Measure	Correlation	Number of cases
Age	7.58	.142	5.65	.172	.983	371
Adjusted age	4.18	.106	3.70	.140	.983	371

The age adjustment reduces slightly, but not substantially, the net and gross errors. Natural aging is not an important source of change in responses between the two interviews since the post-enumeration survey was carried out soon after the main survey and the durations of both surveys were short.

5.5 NET CRAMER MEASURE

The Cramer measure for net errors is based on the X^2-value for two parallel samples, each of size 371, drawn from the same population on the assumption of stochastic independence of samples. However, dual responses should generally be highly correlated so that the assumption of independence breaks down. Alan Stuart (1955) has proposed a different X^2-test for the hypothesis of marginal homogeneity in a ν x ν contingency table.
The net Cramer measure based on the parallel sample test and that based on the homogeneity test X^2 are compared for five characteristics in Table 5.4. It is found that the measure based on the homogeneity test is over twice as large as the net Cramer measure when the net measure is under 0.1. However, the rank orders of characteristics are similar when ranked by either measure. Because of ease of calculation, we have used only the net Cramer measure in this analysis.

5.6 EFFECT OF ADJUSTMENTS ON GROSS ERROR

While every effort should be made to reproduce identical conditions between the main and post-enumeration surveys, there are several practical obstacles to this. Obviously both surveys cannot be run concurrently or close together although the time lapse between the two interviews should be reduced to a reasonable minimum. Again, random assignment of interviewers might not be possible either in the main or in the post-enumeration surveys, with the result that the interviewer effect cannot be separated. Asking questions about contraceptive knowledge does change its status at the re-interview, and hence the conditions of response to such questions cannot be regarded as identical in both interviews. In practice, some of these extraneous sources of change in dual responses can be controlled while designing the surveys and/or adjusted at the stage of analysis as shown in this report.

In this chapter various adjustments on the gross error have been carried out in order to eliminate the effect of external factors and to get a closer measure of response and interviewer variations. It is difficult to carry out such adjustments for all the characteristics of the respondents and, therefore, we have examined only a few selected characteristics. Since the post-enumeration survey was carried out soon after the main survey and both surveys were

Table 5.4 Comparison of Cramer Measures of Net Error Based on the Parallel Sample Test and the Homogeneity-of-Marginals Test, and Cramer Measure of Gross Error

Character	Number of Classes	Net Cramer		Homogeneity of Marginals Test		Gross Cramer
		Measure*	Rank	Measure**	Rank	Measure***
Sons with respondent	9	.025	2.5	.097	3	.121
Sons away from respondent	5	.064	4	.116	4	.443
Daughters with repondent	8	.025	2.5	.085	2	.090
Daughters away from respondent	5	.019	1	.064	1	.184
Number of children dead	5	.076	5	.150	5	.272

* $\sqrt{X^2/742}$ where the X^2 is the parallel sample test value.
** $\sqrt{X^2/371}$ where the X^2 is the homogeneity-of-marginals test value developed by A. Stuart (1955).
*** $\sqrt{X^2/371, (K-1)}$ where the X^2 is the independence test value for the two-way classification with K categories each way.

conducted within a short period of time, the effect on gross errors, of intervening events like births, was found to be small. The gross error in the dating of events was small since the dates given in the dual interviews did not differ much, if at all. Natural aging was found to have no important effect on the gross error due to closeness of the two interview dates. We found that the net Cramer measure based on parallel-sample led essentially to the same rank order of characteristics as the one based on homogeneity of marginals X^2.

Only diffusion appeared to have a substantial effect on questions about contraceptive knowledge. The adjusted gross errors, for these characteristics, were still large, if not the largest any more. But for this exception, the findings of Chapter 4 appear to be valid, by and large, after adjusting for extraneous sources of errors, other than response and interviewer variations, in dual interviews.

6 Sampling and Non-Sampling Variability of Estimates

As shown in Appendix I, every survey estimate has two components of variation, one arising from the process of sampling and the other from non-sampling sources. The conventional estimates of sampling error (the standard error) include a component arising from non-sampling error. Although not all non-sampling errors are included, it is useful and important to separate the sampling from the non-sampling components where this is possible. Such a separation would be valuable both in evaluating the results and in improving the survey procedures and estimates.

Reduction of the sampling variance would depend on better sampling design and augmentation of the sample size. Reduction of the non-sampling variance, by contrast, should be brought about by better construction of the questionnaire, careful recruitment and training of the interviewers, improvement in their conditions of work and so on. However, since ultimately the information is to be given by the respondents, there are limits to the reduction in non-sampling variance in terms of the co-operation, level of education and the perceived relevance of the survey to the respondents.

In this chapter an attempt is made to separate the sampling from the non-sampling variance in 12 selected estimates. Table 6.1 lists the 12 characteristics along with the number of cases, the estimate and its standard error from the main survey. For the post-enumeration subsample, the number of cases and the estimates based on the first and second interviews are also shown. It is seen that, for all characteristics, the estimates based on the first interview is very close to that based on the second. This is to be expected since the data relate to the same set of women. What is more interesting is that the subsample estimates, in spite of the small subsample size, are close enough to the main sample estimate for all the characteristics considered.

The total variance of each estimate is broken up into the sampling and non-sampling components in Table 6.2. For instance, the estimate of the number of children ever born per woman has a total variance of .002401 of which the non-sampling variance is .000024. The total variance is the square of the standard error presented in the Principal Report (1976). The non-sampling variance is estimated by the formula developed in Appendix I. The non-sampling variance is about one per cent of the total variance. The non-sampling standard deviation, on the other hand, is about 10 per cent of the sampling standard deviation. Thus for the estimate of the number of children ever born per woman, for Fiji as a whole, the non-sampling variance is not large compared to the sampling variance. The same is true for the estimate of the number of children living per woman, the non-sampling percentages being slightly less.

In making these component calculations, two limitations should be noted. The square of the standard error of an estimate has been calculated in the Principal Report (1976) by a procedure different from but closely approximating the formula set forth in Appendix I for the estimation of the total error. Secondly, the estimate of the non-sampling component of error is based on a simple response error model which may be liable to some underestimation, since the dual data were obtained only for a small sample of 371 women. While this would yield moderate and cautious estimates of the non-sampling error, the relative ordering of various characteristics, by the indices of non-sampling error, would be none-the-less reliable,

Almost all women in reproductive ages in Fiji appear to know at least one method of contraception (Table 6.1). There is no non-sampling variance for this characteristic. Characteristics other than the three mentioned above appear to have substantial non-sampling variation compared to sampling variation. For estimates of the proportion of women who claimed to have never used contraception and

Table 6.1 Characteristics Selected for Calculation of Total Error: Comparison of Estimates from Main Survey Respondents and Subsample Respondents of the Main and Post-Enumeration Surveys

		Main Survey*			Subsample Estimate**		
	Characteristic	Number	Estimate	S.E.	Number	Main Survey	Post-enumeration
1	Number of children ever born	4,930	3.8	.049	371	4.1	4.2
2	Number of living children	4,930	3.5	.036	371	3.9	3.9
3	Number of additional children wanted	3,900	0.82	.026	252	0.80	0.79
4	Total number of children desired	4,030	4.2	.036	273	4.3	4.3
5	Proportion currently married	4,930	0.94	.0035	371	0.94	0.95
6	Proportion currently pregnant	4,930	0.11	.0057	371	0.11	0.09
7	Age at first marriage	4,930	18.1	.089	368		
8	Proportion who know of no method	4,160	0.001	.0006	371	0.003	0.003
9	Proportion who never used contraception	4,930	0.32	.0095	371	0.34	0.34
10	Proportion currently using contraception	4,120	0.46	.011	263	0.42	0.40
11	Proportion who want no more children	4,160	0.50	.013	308	0.50	0.50
12	Births in last 5 years	3,540	0.91	.017	371	0.90	0.91

* Taken from the Fiji Principal Report (1976).

** Calculated from the dual responses.

Table 6.2 Non-Sampling Variance (NV) in Relation to Total Variance (TV) and Sampling Variance (SV) and Attenuation ($\sqrt{\ }$) for Selected Characteristics

	Characteristic	Dual Response Variance ($S^2/_2$)	Total Variance (TV)	Non-sampling Variance ($NV = S^2/_2$ *no*)	100 NV/TV	100 $\sqrt{(NV/SV)}$	Attenuation (r)
1	Number of children ever born	0.1163	.002401	.000024	0.98	9.96	.988
2	Number of living children	0.0474	.001296	.000010	0.74	8.65	.984
3	Number of additional children wanted	0.1891	.000676	.000049	7.17	27.80	.832
4	Total number of children desired	0.8398	.001296	.000208	16.08	43.77	.789
5	Proportion currently married	0.0040	.000012	.000001	6.62	26.63	.922
6	Proportion currently pregnant	0.0201	.000032	.000004	12.55	37.88	.782
7	Age at first marriage	1.8685	.007921	.000379	4.78	22.42	.977
8	Proportion who know of no method	0.0	.000004	.0	0.0	0.0	1.000
9	Proportion who never used contraception	0.0905	.000090	.000018	20.35	50.55	.598
10	Proportion currently using contraception	0.0524	.000121	.000013	10.51	34.27	.721
11	Proportion who want more children	0.0701	.000169	.000017	9.96	33.27	.930
12	Births in last 5 years	0.0688	.000289	.000019	6.73	26.86	.783

See Appendix I for method of calculation of the non-sampling variance and indices.
Estimate of total variance is taken from the Principal Report (1976).

the total number of children desired per woman, the non-sampling standard deviation is over 40 per cent of the sampling standard deviation. This index is between 30 per cent to 40 per cent for estimates of the proportion who want no more children, proportion currently using contraception and proportion currently pregnant. It is between 20 per cent and 30 per cent for estimates of average age at first marriage, proportion currently married, births in the last five years and number of additional children wanted. The last column of Table 6.2 shows the attenuation due to non-sampling variation. It is much below unity for characteristics with large non-sampling variation index.

As mentioned earlier, the simple response error model tends to underestimate the non-sampling variation. The larger non-sampling component arises partly from the survey procedures and partly from response errors. While there may be scope for greater control of the first source, the second one is inherent in the population surveyed and beyond the control survey operations. It is interesting to note that the characteristics with larger indices of non-sampling variation and also characteristics which were found to have large gross errors in Chapter 4, e.g. total number of children desired. Further, these characteristics are subject to large attenuation. The conclusions drawn above would be essentially the same if, instead of looking at the index, the non-sampling standard deviation as a percentage of the sampling standard deviation, we had looked at the other index, the non-sampling variance as a percentage of the total variance.

While in Table 6.2 the estimates relate to all women in reproductive ages, in Table 6.3 the non-sampling indices are examined for age subgroups of women. A major feature of Table 6.3. is that, for age subgroups of the population, the two indices of non-sampling variation are generally larger than for women of all reproductive ages. However, the relationship is not simply the result of the sample size. For different characteristics, the pattern among the age groups, in these indices, is complex, depending on the variability in that characteristic among women in the particular age group and the non-sampling variation to which the characteristic is subject.

For the estimated number of children ever born per woman, the indices of non-sampling variation are largest for the 15-19 age group and decline steadily with age. This may be due to less variability in this characteristic among the younger women just beginning to build their families. Number of living children exhibits a similar pattern for the same reason. The indices for the estimate of the number of additional children wanted, on the other hand, increases with age, perhaps because it is subject to less variability among older women nearing completion of their family size. For total number of children desired, the indices of non-sampling variation decrease rapidly with age groups as the non-sampling error in this characteristic may be larger for younger women whose expectations about completed family size are yet to be crystallized.

The largest indices of non-sampling error for the proportion currently married are for the youngest age group due to less variability in this characteristic among the young ever-married women. The age at first marriage has large indices for the youngest age group due to a truncation effect on this characteristic which has a ceiling at age 19. The proportion currently pregnant has higher indices for age groups 30-34 and 35-39 where women with declining fecundity may cast greater doubts about their pregnancy status. The remaining five characteristics do not show wide variations in the indices of non-sampling variation among the age-groups.

These results have important operational consequences for the control of the total variance. At sub-domain level, augmentation of the sample size can reduce the total error only if the sampling variability of the characteristic in that sub-domain is large. Otherwise, control of the non-sampling sources of variation assumes importance.

Table 6.3 Non-Sampling Variance (*NV*) Relative to the Total Variance (*TV*) and the Sampling Variance (*SV*) for Selected Characteristics by Age Groups

	Characteristics	% Index	Age Group 15-19	20-24	25-29	30-34	35-39	40-44	45-49	15-49
1	Number of children ever born	NV/TV	21.24	7.29	3.53	1.81	1.86	1.22	1.10	0.98
		$\sqrt{(NV/SV)}$	51.94	28.05	19.13	13.59	13.77	11.11	10.52	9.96
2	Number of living children	NV/TV	10.28	3.45	1.49	0.91	0.93	0.61	0.50	0.74
		$\sqrt{(NV/SV)}$	33.84	18.91	12.31	9.57	9.71	7.83	7.11	8.65
3	Number of additional children wanted	NV/TV	14.66	8.27	12.23	26.13	39.11	49.45	75.91	7.17
		$\sqrt{(NV/SV)}$	41.46	30.03	37.33	59.74	80.15	98.91	177.54	27.80
4	Total number of children desired	NV/TV	95.80	50.82	42.95	20.67	22.02	20.21	13.06	16.08
		$\sqrt{(NV/SV)}$	477.73	101.65	86.77	51.04	53.13	50.32	38.76	43.77
5	Proportion currently married	NV/TV	18.27	8.08	7.77	8.82	7.68	5.40	4.60	6.6.2
		$\sqrt{(NV/SV)}$	47.28	29.65	29.03	30.12	28.85	23.94	22.00	26.63
6	Proportion currently pregnant	NV/TV	8.10	8.69	11.33	22.39	58.90	170.20	–	12.55
		$\sqrt{(NV/SV)}$	29.68	30.84	35.74	53.72	119.71	–	–	37.88
7	Age at first marriage	NV/TV	103.46	31.50	17.80	5.72	9.19	10.12	6.60	4.78
		$\sqrt{(NV/SV)}$	–	67.82	46.53	24.64	31.81	33.55	26.59	22.42
8	Proportion who know of no method	NV/TV	0.0		0.0		0.0			0.0
		$\sqrt{(NV/SV)}$	0.0		0.0		0.0			0.0
9	Proportion who never used contraception	NV/TV	24.76		46.91		34.22			20.35
		$\sqrt{(NV/SV)}$	57.32		93.99		72.13			50.55
10	Proportion currently using contraception	NV/TV	13.08		13.95		19.09			10.51
		$\sqrt{(NV/SV)}$	38.78		40.26		38.57			34.27
11	Proportion who want no more children	NV/TV	38.38		13.03		26.31			9.96
		$\sqrt{(NV/SV)}$	78.92		38.71		59.75			33.27
12	Births in last 5 years	NV/TV	6.17		7.75		9.03			6.73
		$\sqrt{(NV/SV)}$	25.65		28.98		31.51			26.86

The two indices for non-sampling variation are described in Appendix I.

7 Conclusions and Findings

7.1 THE PURPOSE OF THE POST–ENUMERATION SURVEY

Assessment of the quality of survey data and estimates is an essential step in the analysis and utilization of survey findings. There are several aspects to the assessment and several ways in which each of these could be made. Examination of the internal consistency of the data and comparison with external sources of information are two principal means for assessing data quality. Another method which has yet to gain common currency is the re-interview of a subsample of respondents.

In the disciplines of psychology and education, test and retest procedures are extensively used for checking the reliability of response. In demo-social surveys using the questionnaire method, there is need for such a dual interview procedure in order to determine the response and interviewer variations. Where the information is obtained by oral response rather than by using more "objective" measurements, it is essential to ascertain the variation in response under identical conditions and to assess the reliability of the answers given. A post-enumeration survey of a subsample of respondents undertaken soon after the main survey would serve this purpose well.

7.2 PROBLEMS OF THE POST–ENUMERATION SURVEY

Notwithstanding the importance of assessing the reliability of response by using a post-enumeration survey, there are various limitations to such a survey which are discussed below. For practical reasons, while it is not possible to avoid such limitations altogether, the analysis of dual responses could be carried out with proper choice of methods and the findings could be interpreted carefully taking account of the limitations.

Since the main objective of a post-enumeration survey is to examine the reliability of response and not to obtain new information, it would generally be cost-effective to have a small rather than a large subsample.

The post-enumeration check would be undertaken after the completion of a large-scale survey, involving major organizational and logistal efforts. Hence it would be compressed to a short period of field work. Repeated call-back of respondents is not feasible in such a survey. Moreover, identification and contact of the respondents for interview might not always be possible. There might also be problems of matching the respondent in the dual interviews. There might be respondent resistance and interviewer fatigue in the post-enumeration survey. For all these reasons, the failure rate of re-interviews might be high.

To measure the reliability of oral answers, the dual interviews have to be carried out under identical conditions. However, there are practical difficulties in establishing complete identity of conditions at the two interviews. First there is a time lapse between the interviews during which some events of interest to us could have occurred. By reducing the lapsed time, the effect of intervening events could be minimized. The post-enumeration check comes after a major survey effort and so the selection of interviewers by objective criteria and their random assignment might not be adhered to because of the non-availability and fatigue of interviewers and the involvement of the supervisory staff in processing the survey data. The first interview itself might change the condition of the respondent, especially his/her knowledge or attitude on particular matters.

While it is practically impossible to eliminate all these extraneous factors from the dual interview situation, it is none the less possible to recognize such factors and eliminate their effect in a careful analysis of the data. Thus the methods of analysis have to be well chosen and the findings have to be interpreted with due caution while using the method of dual surveys to assess the reliability of oral answers.

The development of methods of analysis of responses from dual interviews is still in an incipient stage and, therefore, we have devoted much attention to the methodological aspect in the present report.

It is the author's personal view that despite various limitations of data obtained by the dual interview procedure, it provides an unique opportunity to assess the reliability of oral answers and should be used whenever information is obtained by questions and answers. It is therefore hoped that the present report will stimulate interest in this procedure and provide some useful tools for analysing data so obtained. In the following sections, are summarized the main findings of the analysis of dual responses from the main and post-enumeration surveys of the Fiji Fertility Survey, 1974. Where appropriate methods and measures suitable for analysing similar data are recommended.

7.3 METHODOLOGICAL AND SUBSTANTIVE FINDINGS

This report evaluates, from dual responses, the quality of data obtained in the Fiji Fertility Survey, 1974. The dual interviews conducted in the main and post-enumeration surveys were utilized in the analysis. Although not the only method available for evaluating data quality, yet the dual interviewer procedure provides an unique opportunity to assess response and interviewer variations. Thus analysis of dual interviews forms an essential part of the evaluation procedure, especially when data are collected by oral questions and answers. It has to be combined with other evaluation procedures to arrive at a comprehensive assessment of the quality of data.

There are a few concepts which have to be clarified in the analysis of dual responses. Most often it is the reliability of response which is being assessed. Ideally the dual interviews should take place under identical conditions although actually this is not possible. However, the operational procedures could be controlled to minimize differences in the interview conditions and, at the stage of analysis, disturbing factors could be identified and accommodated. Net and gross errors should be distinctly measured and interpreted. While net errors affect the means, rates, ratios and proportions of any one characteristic, gross errors affect multivariate analysis of the relationships among characteristics. The error measure should be appropriate to the level of measurement whether nominal, ordinal, discrete or continuous. For comparison between characteristics, the measure used should not be unduly affected by the number of categories nor by the marginal distribution over the categories. From the operational point of view, it is essential to distinguish in the total error, the sampling from the non-sampling varia-

tion. These concepts are discussed in Chapter 2 and suitable measures are developed in Appendix I.

This study is analytical rather than descriptive. Its main objective is to compare the magnitudes and sources of non-sampling errors in dual responses obtained under similar conditions. Hence the author relies principally on summary measures of gross and net errors. Basic tabulations are given only for illustrative purposes. While no summary error measure can be completely satisfactory, the examination of results based on several measures is intended to free the results from the effects of any particular method and to add to the reliability of the findings. A more descriptive presentation of the reliability of dual responses to a few key questions is given in the Principal Report (1976).

The success rate in the post-enumeration surveys was only 76.2 per cent of the subsample for several reasons. This is not atypical of other post-enumeration surveys, where the matched subsample size may be less than 80 per cent of the designed subsample size. Hence it is of great importance to assess the representativeness of the re-interviewed cases as a sample of all respondents and of the population from which they are drawn. At least three comparisons are crucial in examining representativeness: 1) between the women interviewed in the main survey and the subsample of women selected for the post-enumeration check, 2) between the women interviewed in the main survey and those re-interviewed in the post-enumeration survey, and 3) between thewomen re-interviewed and those not re-interviewed in the post-enumeration subsample. The first comparison shows how far the subsample women depart from the main survey women simply due to random selection and provides the basis for interpreting the other two comparisons. The second comparison shows whether the re-interviewed women were representative of the main sample while the third comparison reveals the selectivity of the re-interviewed women as against women not re-interviewed. Before taking up the analysis of dual responses, it is vital to establish the representativeness of the re-interviewed women.

The detailed analysis is carried out in Chapter 3 suggests that the post-enumeration survey might be unrepresentative in a few characteristics – place of residence, religion and husband's occupation – due to sampling fluctuations and the deletion of nine inaccessible women. In fact, compared to the main sample, the post-enumeration subsample women had a larger percentage of rural residents both at the time of interview and during the women's childhood; had a higher percentage of Hindus; and had a larger percentage of husbands engaged in farming or agricultural labour. This is also true of the re-interviewed women. Thus the subsample over-represented rural women and, to a lesser extent, Hindus and wives of farmers, farm managers and agricultural labourers. These characteristics are themselves interrelated. More caution is, therefore, called for in extending, to the main sample, conclusions regarding the errors in these characteristics as revealed by the present study of dual responses.

Self-selection by a few characteristics might also be involved among the subsample women who were re-interviewed compared to those not re-interviewed. The 113 women of the subsample who were not re-interviewed, compared to 371 re-interviewed women, were over-represented in the Western region; among the 113 women a higher percentage was of Indian origin; a higher percentage was illiterate; and a higher percentage of their husbands had more than eight years education. These characteristics are themselves interrelated and suggest some degree of self-selection among women not re-interviewed, by Western region, Indian origin, illiteracy and more educated husbands. Therefore greater caution is necessary in generalizing, to the universe, the results of our dual response analysis for these characteristics. The characteristics by which re-interviewed women were self-selected are themselves closely related to the characteristics for which the subsample of page 86 tended to over-represent Hindu women with husbands working as farm managers, farmers and agricultural workers, the re-interviewed women were selected for Fijian women with less educated husbands. The net result of these opposite effects was to slightly improve the group of re-interviewed women as representative of the main sample for these characteristics.

Though the failure rate was large (23.8%), it may be concluded that the 371 re-interviewed women were not self-selected for most characteristics associated with better response and correlated to fertility and its concomitants. Therefore, it is meaningful to analyse the non-sampling variations of the women with dual interviews and it is valid to generalize, to the main sample and the population it represents, the results obtained from the subsample of 371 re-interviewed women. However, there is evidence of some departure from representativeness of women by residence, religion and husband's occupation and some degree of selectivity of re-interviewed women by such background characteristics as residence, ethnicity, literacy and husband's education, although the combined effect of unrepresentativeness and self-selection is moderated slightly on the re-interviewed women. Hence, in extending to the universe, the conclusions of the dual response study relating to these characteristics, greater caution should be exercised.

The net and gross errors were calculated using several measures in order to arrive at reliable conclusions, to find the interrelations among the error measures and to recommend error measures suitable for adoption in similar studies. These calculations were made for a large set of characteristics that were given in the Principal Report (1976) of the Fiji Fertility Survey, 1974.

Among the two net error measures, the net Cramer measure is preferred as it is less affected by the number of categories and their marginal distribution and, therefore, more suitable for comparison between characteristics. Moreover, the Cramer measure does not assume a simple response error model. The net Cramer measure was large for "knowledge and use of contraceptives", "whether more children are wanted or not", "number of children wanted in all", "additional children wanted", "whether husband wants another child", "spacing of the next child" and "whether the couple is fecund".

Asking questions on knowledge of contraceptives in the first interview seems to affect the response in the re-interview. Responses relating to knowledge of contraceptives also carry large gross errors and are examined further in that context. Expectations are anticipations for the future and carry a large variability in response as they are affected both by the stability of the respondents to anticipate such events and by the ability over time of their expectations. Answers to the question on spacing of the next child are also subject to similar variations. Fecundity status is a somewhat delicate and partly ambivalent question which may account for its large error.

Rank order correlation shows that the gross error measures are closely related. The rank correlations among the gross Cramer measure, game-theoretic measure and Tau B are over .94. Our preference, in comparing the gross error among characteristics, is for the Cramer measure which is based on the contingency – Chi square and it not greatly affected by the number and distribution of the marginal categories. Nor does it assume a simple response error model.

The gross error which has been compared for a large set of

characteristics used in the Principal Report (1976) of the Fiji Fertility Survey reveals a definite pattern. "Children still alive" is subject to less error than "children deceased", while "children ever born", which is the sum of these two characteristics, has an intermediate level of error. "Live births in the five years after first marriage" has more gross error than "live births in the past five years". Knowledge about contraception has the largest error. Ever-use of contraceptives other than sterilization, the pill and loop has the next largest gross error exceeding that for current usage of contraceptives. Age intervals have less gross error than duration since first marriage and age at birth of first child. "Want another child" and "number of children wanted" have much higher gross errors than factual data.

The overall pattern that emerges is one in which factual data are more precise than future expectations and contraceptive knowledge. Factual data for current and recent periods are more precise than data relating to the less recent and remote past. Knowledge questions are subject to most error. Ever-use of hard contraceptive methods like sterilization and loop are subject to fewer gross errors than ever-use of soft methods, such as lactation and abstinence. Current use of contraceptives is subject to fewer errors than ever-use. Thus the gross error depends on whether the characteristic is factual or relates to anticipations for the future, whether it is current or retrospective, whether it is changed by the interview process (e.g. questions on knowledge) and whether it is episodic (e.g. sterilization operation) or common place (e.g. abstinence).

This pattern of gross errors confirms the findings from a similar analysis of the Turkish Social Survey, 1968 carried out by Srikantan (1977). The levels of gross error are, however, generally lower in the Fiji Fertility Survey compared to the Turkish Social Survey. Post-enumeration studies similar to the Fiji Survey, now being conducted in a few countries under the auspices of the World Fertility Survey, should yield data for undertaking a comparative analysis of gross and net non-sampling errors between countries.

Since exigencies of the situation led to some differences between the conditions of the initial interview and the re-interview, it was found necessary to identify such extraneous sources of deviation between the two responses and to assess their impact on the error measures for selected characteristics. Adjustments were made to the gross error for births intervening between the two interviews, for diffusion of knowledge about contraception and for natural aging between the two interviews. The gross error in the dating of events was calculated using measures appropriate for a continuous variable. The adequacy of the net Cramer measure for testing marginal homogeneity in a contingency table was examined.

The gross error measures for relevant characteristics were re-calculated after adjusting for births in the period between the two interviews. The adjusted values were the same or only slightly below the unadjusted values.

To allow for diffusion of contraceptive knowledge during or after the first interview, an asymmetric model for error measures was used. This model substantially reduced the off-diagonal proportion and the game measure. For instance, for the question on the knowledge and use of lactation as a contraceptive method, the off-diagonal proportion fell from .480 to .154 and the game measure from .920 to .509. However, even the adjusted measures were large, so that the diffusion effect, by itself, would not account for the gross error. Response variation was still important and the findings of Chapter 4 broadly hold good for the adjusted gross errors also. Contraceptive knowledge remains subject to a large gross error if not the largest.

The net and gross errors in dating events were obtained by formulae appropriate for a continuous variable. Such formulae take account of the magnitude of deviation between the dual dates. The errors were generally low except for "date of first marriage if other than current marriage". The correlations were over .95 and the attenuation factors over .97. It appears that although women might not give precisely the same date in the two interviews, the deviations might not be large for those women who respond on both occasions. Hence relationships of these dates with other characteristics may not get much attenuated.

The age reported at the main interview was adjusted to the re-interview date. This adjustment reduced slightly the net and gross errors. Natural aging was not an important sources of change between the responses given at the dual interviews since the post-enumeration survey was carried out soon after the main survey and the duration of both surveys was short.

It was found that the homogeneity net Cramer measure was over twice as large as the parallel sample net Cramer measure when the net error was small. However, the rankings of characteristics based on either measure were similar and only the parallel sample net Cramer measure has been used in this analysis.

To sum up, the net Cramer measure based on the parallel sample test is adequate for this analysis. Intervening events like births and deaths and natural aging had little effect on the gross error. The gross error in dating of events was small since the dates given in the dual interviews did not differ much. Only diffusion of information appeared to have a substantial effect on the gross error in questions about contraceptive knowledge. But for this exception, for a wide variety of characteristics, the findings on gross errors given earlier appear to be valid and, by and large, extraneous sources of errors in dual interviews, other than response and interviewer variations, do not seem to be important.

As illustrated in Chapter 6, the conventional estimate of sampling error includes a component due to non-sampling error. It is important to sift out the non-sampling component in the estimate of variance both to evaluate the results and to help in improving the survey procedures and estimates. Reduction of the sampling variance would depend on better sampling design and augmentation of the sample size while reduction of the non-sampling variance should be brought about by better construction of the questionnaires, careful recruitment and training of the interviewers, improvement in their work conditions and so on.

A simple response error model was used to separate the non-sampling from the sampling errors in estimates of key characteristics. Although adequate for our purposes, the model tends to underestimate the non-sampling variation. Hence the estimate of this component is conservative but it may not significantly affect the relative ordering of characteristics by indices of non-sampling errors.

For the estimate of the number of children ever born per woman, for Fiji as a whole, the non-sampling variance was not large compared to the sampling variance. The same was true for the estimate of the number of children living per woman. There was no non-sampling variance in "whether the woman knows any form of contraception", since almost all women in reproductive ages in Fiji knew at least one method of contraception. Nine other characteristics had substantial non-sampling variability compared to sampling variability. The comparative index is largest for the proportion of women who claimed to have never used any contraceptive and next largest for the total number of children desired per woman. The attenuation due to non-sampling is large for characteristics with large non-sampling variation index.

The larger non-sampling component arises partly from the

survey procedures and partly from response errors. While there may be scope for greater control of the first source, the second one is inherent in the population surveyed. The estimates with larger indices of non-sampling variation are also the characteristics which were earlier found to have large gross errors. Further these characteristics are subject to large attenuation.

For subgroups of the population, such as age groups, the two indices of non-sampling variation are generally larger than for women of all reproductive ages. However, the relationship is not simply the result of the sample size, but is more complex, depending also on the sampling variability for the characteristic in that particular age group and the non-sampling variability to which it is subject. For instance, the indices for the estimated number of children ever born per woman decline steadily with age group, which may be due to less variability in this characteristic among the younger women just beginning to build their families. By contrast, the proportion currently pregnant has higher indices for age groups 30-34 and 35-39 where women with declining fecundity may have greater doubts about their pregnancy status.

These results have important operational consequences for the control of the total variance. At sub-domain level, augmentation of the sample size can reduce the total error only if the sampling variability of the characteristic in that sub-domain is large. Otherwise, control of the non-sampling sources of variation assumes importance.

7.4 GENERALIZATION OF THE FINDINGS

In generalizing the results of this dual response study to the universe, it should be borne in mind that rural Hindu women with husbands working as agricultural managers, farmers or agricultural labourers were over represented in the subsample and literate Fijian women with less educated husbands were self-selected among the re-interviewed women. Also the overall failure rate for the re-interview was as large as 23.8 per cent. This resulted in the net over-representation, among those re-interviewed, of rural Hindu women with husbands engaged in agriculture. Examination of the vital registration data shows that, in the Fiji islands, there is more age-heaping and digital preference among Indian women than among Fijian women. Also the marital relationships of Indian women seem to be more stable than among Fijian women. Taking all these facts into account, it may be surmised that the age-reporting and dating of events may be a little worse for the re-interviewed women than may be expected for the main sample women and, at the same time, information on marital status may be slightly better for the re-interviewed women. Therefore, in generalizing the results of the dual response study to the universe of ever married women aged 15 to 49 years in Fiji, we must caution that the non-sampling errors may be slightly more for marital status and history than revealed by the present study of dual responses. However, the non-sampling errors may be slightly less for data on age and dating of events.

While the methods used in this study are more readily transferable to other studies of dual responses, the results on non-sampling errors and their interpretations are strictly limited to similar surveys conducted in socio-cultural contexts not far different from the Fiji islands. The World Fertility Survey has developed and applied standardized fertility survey techniques in the developing countries as also in the developed countries in order to increase the inter-country comparability of the results within the two groups of countries. Nevertheless, there could be wide variations in socio-cultural contexts which have to be examined carefully before generalizing the conclusions of this dual response study in Fiji to other developing countries.

Higher levels of literacy and education of the respondents tend to reduce the response error since they are able to better articulate attitudes, have clearer expectations for the future and recall vital events with less memory lapse. In comparisons between countries, the cultural homogeneity has also to be taken into account. For instance, in Fiji, there are two major ethno-cultural groups, of Indian and Fijian origins, following different religions and marriage customs and practices. Finally, the continuous operation of a vital registration system with adequate coverage over a long period of time, as in Fiji, should tend to improve the age reporting and the dating of vital events in surveys and censuses. Before generalizing the conclusions of the Fiji study to any other developing country, such major social and cultural factors should be carefully assessed for similarity.

Appendix I
Measures of Errors in Dual Comparisons

This technical appendix describes the various measures of error used in the paper. The earlier work of Srikantan (1977) provides the basis for development of error measures.

Notation and Model

Let x_o and x_R be the values of a characteristic for particular sample unit as recorded in the main and post-enumeration interviews.

We assume the model:

$$x_o = X_o + e_o$$
and $$x_R = X_R + e_R$$

where X_o and X_R are the "real" values for the responses on the two occasions and e_o and e_R are variable errors of measurement or response with zero expectation. Where the two interviews are carried out under identical conditions it is further assumed that x_o and x_R are equal. Also it is assumed that each of the three pairs of variables, (X_o, e_o), (X_R, e_R) and (e_o, e_R) are independent. When $x_o = x_R$, let its sampling variance be σ_x^2 and the variance of e_o as well as e_R be σ_E^2.

When the measurement is nominal, i.e., the response is classified into unordered categories, the proportion in the k categories of the main survey are denoted by

$\hat{P_{io}}, i = 1\ (1)\ k$

and for the post-enumeration response by

$\hat{P_{iR}}, i = 1\ (1)\ k.$

The assumptions underlying the model are valid only if the effect of common factors, like that due to the interviewer, are negligible because they are standardized, balanced, randomized, or eliminated in the design.

NET ERROR MEASURE FOR NOMINAL CLASSES

Net dissimilarity: As developed by Srikantan (1977), a measure of the net error for a polytomy with k categories is:

$$\sum_{i=1}^{k} \left| P_{io} - P_{iR} \right| /k.$$

This measure is adjusted for the number of categories but not for the marginal distribution. Moreover, Hansen, Hurwitz and Bershad (1961) have shown that the simple response error model can introduce a bias in this measure when applied to a polytomy.

Net Cramer measure: Another measure which takes account of the marginal distributions is:

$$\sqrt{x^2/2n}$$

where n is the number of cases for which dual responses are available and x^2 is the parallel sample test statistic,

$$x^2 = n \sum_{i=1}^{n} (P_{io} - P_{iR})^2 / (P_{io} + P_{iR})$$

This is similar to Cramer's formulation of a x^2-based measure of association (1946) and, unlike net dissimilarity, does not assume a simple response error model.

Net difference: Even if the measurement is not repeated for each unit but only two (independent) aggregate estimates or distributions are available – such as from a census and a survey – net error measures similar to those defined in the preceding subsection can still be used as indicators of the net difference between the two distributions. These measures reflect, however, all sources of deviation between the two distributions and are, therefore, conceptually distinct from the net error measures.

GROSS ERROR MEASURES FOR NOMINAL CLASSES

Off-diagonal proportion: This is the proportion of dual responses which are not identical. While it can be readily interpreted, it does not make allowance for the number of categories nor for differences in the marginal proportions of two characteristics. For this reason, it is inappropriate to compare this measure for two characteristics with different numbers of categories or marginal distributions.

Diagonal measure: As developed by Srikantan (1977), this measure adjusts the off-diagonal proportion for the number of categories by the formula:

$$\text{(Off-diagonal proportion)} \ /k.$$

but not for the marginal distribution. This measure is based on a simple response error model.

Gross Cramer measure: This is calculated from contingency x^2 of the main survey response cross-tabulated by the post-enumeration response and is given by:

$$1 - \sqrt{(x^2 / k - 1)}.$$

It is the unit's complement of a measure of association between the dual responses. This measure of association was first formulated by Cramer (1946) and is shown by Srikantan (1970) to be the root mean square canonical correlation. The measure takes account of the number of categories and the marginal distribution and can be more readily compared for nominal characteristics with different numbers of classes and/or marginal distributions. Neither this nor the following measure assumes a simple response error model.

Game-theoretic measure: This measure, like the Cramer measure, can be readily compared between characteristics with different numbers of classes and/or marginal distributions. In the symmetric form, in which it is used here, the marginal distribution is estimated as $(P_{io} + P_{iR}) / 2$, $i = 1\ (1) k$. If the responses on the two occasions are stochastically independent, then the proportion of dual answers expected to be identical is:

$$P_e = \sum_{i=1}^{k} (P_{io} + P_{iR})^2 / 4.$$

If the observed proportion of identical responses is P_d, then a game-theoretic measure of association is:

$$(P_d - P_e) / (1 - P_e)$$

and the corresponding measure of error is:

$$(1 - P_d) / (1 - P_e).$$

This measure is developed along lines proposed by Goodman and Kruskal (1954).

GROSS ERROR MEASURES FOR ORDINAL VARIABLES

Various measures of association have been proposed between two ordinal variables, i.e. characteristics which can be classified into ordered categories. Usually these measures of association are scaled so as to range between 0 and 1. The unit's complement of any of these measures would, therefore, serve as a gross error measure. Three such error measures are used here:

1. (1 – Gamma) where Gamma is defined by Goodman and Kruskal (1954);
2. (1 – Somers) where Somers (1962) defines the measure;
3. (1 – Tau B) where Tau B is defined by Kendall (1955).

These measures can be expressed in the following notation: For units 1 and 2, let

$X(1)$ and $X(2)$ be the X-values and
$Y(1)$ and $Y(2)$ be the Y-values.

Then define:

Like order as: $X(1) > X(2)$ and $Y(1) > Y(2)$

or

$X(1) < X(2)$ and $Y(1) < Y(2)$;

Unlike order as: $X(1) > X(2)$ and $Y(1) < Y(2)$

or

$X(1) < X(2)$ and $Y(1) < Y(2)$;

Tied on X only as: $X(1) = X(2)$ and $Y(1) \neq Y(2)$;

and

Tied on Y only as: $X(1) \neq X(2)$ and $Y(1) = Y(2)$.

Let P, Q, TX and TY be the counts of like order, unlike order, tied on X only and tied on Y only of all pairs of units.
Then the ordinal measures can be expressed as:

Gamma $= (P - Q) / (P + Q)$,
Somer's D $= (P - Q) / (P + Q + TY)$ and
Tau $B = (P - Q) / \sqrt{((P + Q + TX)(P + Q + TY))}$.

The first two ordinal measures are symmetric while Somers' is asymmetric. All three measures take account of the marginal distributions. Since all three measures make use of the ordinal property of the classes, they should contain more information and hence should provide, where applicable, better error measures than the nominal measures discussed earlier.

ERROR MEASURES FOR CONTINUOUS AND DISCRETE VARIABLES

Net error: We use the test statistic for testing the two sample hypothesis

$$\mu_0 = \mu_R$$

namely,

$$n(n-1)(\bar{x}_o - \bar{x}_R)^2 / \left\{ \sum_{i=1}^{n} (x_o - x_R)^2 - n(\bar{x}_o - \bar{x}_R)^2 \right\}$$

where n is the number of dual responses. This is distributed as the F-ratio with 1 and n-1 degree of freedom. The measure of association is the proportion of the sum of squares explained:

$$1 - \left\{ n(\bar{x}_o - \bar{x}_R)^2 / \sum_{i=1}^{n} (x_o - x_R)^2 \right\}$$

and the corresponding net error measure is:

$$\sqrt{\left\{ n(\bar{x}_o - \bar{x}_R)^2 / \sum_{i=1}^{n} (x_o - x_R)^2 \right\}}.$$

This is a symmetric measure with regard to the main and post-enumeration responses.

Gross Error: The regression of x_o on x_R or vice-versa does not lead to symmetric relationships. Hence we use the first principal component given by Kendall and Stuart (1966).

The minimum sum of squared perpendicular squared deviations from the fitted line

$$a + b_o x_o + b_R x_R = 0$$

is given by the lesser root of the quadratic equation

$$Z^2 - Z(S_o^2 + S_R^2) + S_o^2 S_R^2 (1 - r^2) = 0$$

where S_o^2 and S_R^2 are the corrected sums of squares of x_o and x_R and r their product moment correlation. In regression analysis, this is the "least square estimation without restrictions on parameters" specified by C. Radhakrishna Rao (1965). The sum of squared perpendicular deviations from the line

$$x_o - x_R = 0$$

is given by $\sum_{i=1}^{n} (x_o - x_R)^2/2$. This line is obtained by setting $a = 0$ and $b_o = b_R$ and is called the "least squares estimation with restrictions on parameters" by C. Radhakrishna Rao (1965). The proportion of explained sum of squares is $1 - \left\{ 2Z / \sum_{i=1}^{n} (x_o - x_R)^2 \right\}$ and a corresponding measure of the gross error is:

$$\sqrt{\left\{1 - [2Z / \sum_{i=1}^{n} (x_o - x_R)^2]\right\}}.$$

To test its significance,

$$(n-2)\left\{[\sum_{i=1}^{n} (x_o - x_R)^2/2\,Z] - 1\right\}\ /2$$

can be used as the F-ratio with 2 and $(n-2)$ degrees of freedom.

ATTENUATION OF VARIABLES

Attenuation due to errors of measurement: It can be shown that for the simple response error model presented earlier in this appendix, the product moment correlation between x_o and x_R is equal to ${\sigma_x}^2 / ({\sigma_x}^2 + {\sigma_E}^2)$. The ratio of the variability of the "real" value X to that of the measured value x is called the attenuation factor and it tends to reduce the association of x with other variables as shown in the next sub-section.
The U.S. Bureau of the Census (1964) defines the index of inconsistency as the ratio of the gross error (the mean square error) to the value of the mean square error when x_o and x_R are stochastically independent. This index is

$${\sigma_E}^2 / ({\sigma_x}^2 + {\sigma_E}^2)$$

for the model used here. Hence it is equal to

$$(1 - r)$$

where r is the correlation between x_o and x_R, i.e., the attenuation factor.

Attenuation in correlation: Let x and y be the measurements in two variables whose "real" values are X and Y, with errors in measurement of e_x and e_y.

Thus $x = X + e_x$
and $y = Y + e_y$.

Assuming that the errors of measurement have zero expectation, are independent and they are also independent of their "real" values, Yule (1968) shows that the product moment correlation between x and y is attenuated from that between X and Y.

$$r_{xy} = r_{xy} \sqrt{\left\{[{\sigma_x}^2 / ({\sigma_x}^2 + {\sigma_{Ex}}^2)]\ [{\sigma_y}^2 / ({\sigma_y}^2 + {\sigma_{Ey}}^2)]\right\}}.$$

As stated in the preceding sub-section, the last two factors within square brackets on the right-hand side of this equation can be estimated by the correlation between x_o and x_R and between y_o and y_R. Thus the correlation between the "real" values, X and Y, tends to be attenuated by the square-root of the product of the corresponding attenuation factors of the two variables.
It should be noted that the gross Cramer error measure for a dichotomy (regarded as a nominal measurement) and its index of inconsistency defined earlier (regarded as a discrete variable) are equal. This follows from Srikantan's demonstration (1970) that the Cramer measure of association is also the root mean square canonical correlation. Thus a link is established between a gross error measure proposed in this appendix for a nominal classification with an error measure for a continuous (or discrete) variable through a dichotomy.

TABULATION OF VARIOUS MEASURES OF NET AND GROSS ERRORS

Appendix Table I.1 presents the net error measures:

1) dissimilarity,
2) Cramer,

and the gross error measures:

1) off-diagonal proportion,
2) diagonal,
3) Cramer,
4) game

and in addition error measures based on:

5) Gamma,
6) Somers,
7) Tau B

for ordinal variables. A wide variety of characteristics were drawn from the data as coded originally. The comparison is between the 371 (or fewer) dual responses obtained in the main and in the post-enumeration surveys. Table I.2 provides the same measures for another list of characteristics drawn from the data as recoded for the analysis presented in the Principal Report (1976). The relative utility and consistency of the several measures of net and gross errors and their magnitudes are examined in Chapter 4.

SAMPLING VARIABILITY AND NON-SAMPLING VARIABILITY

The simple response error model formulated earlier is used for separating the sampling from the non-sampling variability.

Let $x = X + e$

where x is the observed value for a unit of the population, x the corresponding "real" value, and e the variable error. It is first assumed that x and e are uncorrelated and e has zero mean and variance σ^2.

To draw sampling expectation and variance, the following notation is used. Σ represents summation over the sample set of indices S or the population set of indices P. The stochastic variable d represents the number of times a particular unit is included in the sample and suffix "i" is the index denoting a particular unit of the population. In drawing expectations (E) and variances (V), the method given by Srikantan and Subramanian (1972) is used.

The estimate

$$t = \sum_{p\ni i} d_i X_i / [E(d_i).\, N]$$

is unbiased for

$\sum_{p\ni i} X_i/N$ where N is the number of ultimate units in the population.

Let

$$T = \sum_{p\ni i} d_i X_i / [E(d_i).\, N]$$

so that T is similar to t except that the observed value x is

replaced by the "real" value X. This would be the estimate if there were no errors in measurement.

It can be shown that

$$V(T) = (1/N^2) \sum_{p \ni i} \sum_{p \ni j} \mathrm{Cov}(d_i, d_j) X_i X_j / [E(d_i) \cdot E(d_j)]$$

and

$$V(t) = V(T) + (\sigma^2/N^2) \sum_{p \ni i} \sum_{p \ni j} E(d_i d_j) r_{ij} / [E(d_i) \cdot E(d_j)]$$

where r_{ij} is the correlation between e_i and e_j.
In this equation, V (t) represents the total variation (TV) arising from sampling and non-sampling sources; $V(T)$ the variation due to sampling (SV) since it is unaffected by the errors of measurements; and the second component on the right hand side, therefore, shows the variation arising from non-sampling sources (NV). Thus it is seen that,

$$TV = SV + NV.$$

Estimation of TV, SV and NV
Consider the estimate for V (t):

$$v = (1/N^2) \sum_{p \ni i} \sum_{p \ni j} [Cov(d_i, d_j) d_i d_j x_i x_j] / [E(d_i d_j) E(d_i) E(d_j)].$$

It can be shown that

$$E(v) = V(t) - (1/N + \bar{r})\, \sigma^2$$

where $\bar{r}$ is the average correlation of e_i and e_j over all distinct pairs of units in the population. Hence $E(v)$ is an under-estimate of $V(t)$ by the quantity $(1/N + \bar{r})\, \sigma^2$. In this analysis σ^2/N was found to be negligible since N was about 83,000 and this component was ignored in the actual calculations. The second component, $\bar{r}\, \sigma^2$ depends on the average intercorrelation among the error terms (e's) in the main survey responses. We expect this to be relatively small for most characteristics since the main survey sample was large and a large staff was employed in conducting the interviews, and in editing, coding and punching the data.
In developing expressions for the sampling and non-sampling variations, we make the simplifying assumptions that the e's are uncorrelated. As seen in the preceding paragraph, the effect of this assumption is to underestimate, to a small degree, the total and the sampling variations, since the non-sampling variation is estimated independently on the basis of the dual responses. With this assumption of a simple response model, therefore,

$$V(t) = V(T) + (\sigma^2/N^2) \sum E(d_i^2)/E^2(d_i)$$
and $$E(v) = V(t) - (\sigma^2/N).$$

For the Fiji Survey sample design, since each household could be chosen not more than once in the sample.

$d_i = 0$ or 1 with non-zero probabilities
= other values with zero probability.

Hence $E(d_i^2) = E(d_i)$.

Also, as the design was self-weighted,

$$E(d_i) = n_o/N,$$

where n_o was the ultimate sample size.

Thus $\sum_{p \ni i} E(d_i^2)/E^2(d_i) = N^2/n_o$
so that

$$V(t) = V(T) + \sigma^2/n_o$$

and $$E(v) = V(T) + \sigma^2(1/n_o - 1/N).$$

Now σ^2 can be estimated from the dual response model set forth earlier in this Appendix. We do not assume the error terms, e's, to be independent, except for each pair of dual interviews which was done by two different interviewers. With n dual responses, let

$$s^2 = \left\{ \sum_{s \ni i} (x_o - x_R)^2 - [\sum_{s \ni i} (x_o - x_R)]^2/n \right\} /(n-1).$$

Then

$$E(s^2) = E(u)/(n-1) + 2\sigma^2 [1 - E(\bar{r}_1) + E(\bar{r}_2) /2 + E(\bar{r}_3)]$$

where

$$u = \sum_{s \ni i} (X_o - X_R)^2 - (1/n) \left[\sum_{s \ni i} (X_o - X_R) \right]^2$$

and $\bar{r}_1$ is the average correlation of e_i and e_j over $n(n-1)$ responses from distinct pairs of women occuring in $(\sum_{s\ i} e_o)^2$ and $\bar{r}_2$ and $\bar{r}_3$ are similar averages over distinct pairs in $(\sum_{s \ni i} e_R)^2$ and $(\sum_{s \ni i} e_o)(\sum_{s \ni i} e_R)$.

If the dual responses are obtained under identical conditions,
$X_o = X_R$
and $u = o$.
Hence
$E(s^2/2) = \sigma^2 [1 - \{ E(\bar{r}_1) + E(\bar{r}_2) \} /2 + E(\bar{r}_3)]$.

Even though two different interviewers conducted each pair of dual interviews, still, the other error terms (e's) in s^2 may be correlated, especially as a small number of interviewers, coders and punchers did the post-enumeration survey work. For this reason, we expect $E(\bar{r}_2)$, based on the post-enumeration survey responses, to be the largest average correlation, and $E(\bar{r}_1)$ and $E(\bar{r}_3)$ to be smaller and roughly equal. Therefore, $E(s^2/2)$ would be an underestimate of σ^2 and the extent of underestimation would be somewhat larger for the subsample compared to the main sample. In this simple response error model no account is taken of the underestimation.

In summary, TV, SV and NV were estimated, ignoring σ^2/N, as follows:

Source	Symbol	Variability	Estimate
Total	TV	$V(t) = V(T) + \sigma^2/n_o$	v
Non-sampling	NV	σ^2/n_o	$s^2/2\, n_o$
Sampling	SV	$V(T)$	$v - s^2/2\, n_o$.

Index of non-sampling errors
Two indices showing the relative importance of the non-sampling variation compared to the total and sampling variations have been compiled. The non-sampling variation as a percentage of the total variation is given by

$$I_1 = 100\,(s^2/2\,n_o)/\,V.$$

The non-sampling standard deviation as a percentage of the sampling standard deviation is given by

$$I_2 = 100\sqrt{\left\{(s^2/2\,n_o)/\,[V - (s^2/2\,n_o)]\right\}}.$$

These two indices have been calculated for key characteristics for which the sampling errors are given in the Principal Report (1976) and are presented in Chapter 6.

Table I.1 Comparison of the Dual Responses in the Main and the Post-Enumeration Surveys (371 Pairs of Matched Interviews): Measures of Net and Gross Errors

Characteristic	No. of Classes	Net Error Measures		Gross Error Measures							X^2	
				Nominal				Ordinal				
		Dissimilarity[1]	Cramer[2]	Off.-diag. Proportion[3]	Diagonal[4]	Cramer[5]	Game[6]	Gamma[7]	Somers[8]	TauB[9]	Value[10]	D.F.[11]
Sons with respondent	9	.005	.025	.100	.022	.121	.125	.016	.050	.052	2295.20	64
Sons away from respondent	5	.014	.064	.097	.039	.443	.362	.045	.346	.282	460.71	16
Daughters with respondent	8	.005	.025	.094	.024	.090	.121	022	.069	.069	2148.50	49
Daughters away from respondent	5	.003	.019	.073	.029	.184	.238	.032	.211	.200	987.61	16
Are any children dead	2	.032	.038	.070	.070	.193	.197				241.52	1
Number of children dead	5	.015	.076	.086	.035	.272	.230	046	.248	.205	787.55	16
Number of live births	15	.005	.060	.129	.017	.152	.144	.013	.035	.034	3733.52	196
Is respondent pregnant	3	.009	.038	.022	.014	.187	.106				490.04	4
Sex of first live births	3	;009	.022	.059	.040	.097	.100				604.55	4
Is first child still living	3	.009	.027	.046	.031	.134	.138				556.71	4
If infant death, months alive	6	.008	.088	.032	.011	.358	.280				763.98	25
If other death, years alive	10	.003	.124	.027	.005	.500	.633				926.33	81
Sex of second live birth	3	.013	.020	.065	.043	.084	.100				622.44	4
Is second child still living	3	.005	.019	.035	.023	.162	.086				521.42	4
If infant child death, months alive	6	.003	.064	.030	.010	.491	.491				481.00	25
If other death, years alive	5	.005	.082	.013	.005	.500	.719				371.00	16
Sex of third live birth	3	.009	.015	.046	.031	.067	.069				646.49	4
Is third child still living	3	.004	.014	.019	.013	.109	.038				589.36	4
If infant death, months alive	6	.001	.024	.013	.004	.120	.255				1438.12	25
If other death, years alive	6	.002	.064	.011	.004	.368	.575				742.01	25
Whether pregnant before first birth	3	.022	.051	.057	.038	.244	.204				423.91	4
Number of pregnancies before first birth	4	.011	.069	.049	.024	.564	.535	.050	.326	.445	211.86	9
Duration of first pregnancy before first birth	8	.005	.087	.051	.011	.493	.559				764.24	64
Did the first pregnancy end in a live birth	2	.000	.000	.011	.011	.672	.672				39.89	1

Table I.1 (Cont.)

Characteristic	No. of classes	Net Error measures		Gross Error Measures							X^2	
				Nominal				Ordinal				
		Dissimi-milarity[1]	Cramer[2]	Off.-diag. Propor-tion[3]	Diagonal[4]	Cramer[5]	Game[6]	Gamma[7]	Somers[8]	TauB[9]	Value[10]	D.F.[11]
Sex of that live birth	2	.000	.000	.011	.011	.672	.672				39.89	1
Pregnant respondent prefers boy or girl	4	.009	.032	.046	.023	.291	.244				559.29	9
Whether pregnant since last birth	3	.014	.028	.059	.040	.205	.161				468.98	4
Number of pregnancies since last birth	2	.000	.000	.022	.022	.297	.297	.009	.297	.297	183.39	1
Any other pregnancies	2	.008	.014	.089	.089	.556	.556				73.22	1
Number of such pregnancies	4	.008	.061	.092	.046	.524	.564				252.39	9
Ever heard of the pill	2	.022	.094	.022	.022	.670	.811				40.33	1
Ever used the pill	3	.020	.095	.094	.063	.370	.214				294.23	4
Heard (and used) IUD	3	.022	.082	.059	.040	.380	.235				285.40	4
Heard (and used) of the injection	3	.075	.115	.380	.253	.663	.768				84.47	4
Heard (and used) lactation	3	.167	.258	.480	.320	.808	.902				27.34	4
Heard (and used) tubectomy	3	.016	.070	.057	.038	.290	.180				374.34	4
Heard (and used) abstinence	3	.117	.186	.507	.338	.838	.898				19.55	4
Heard (and used) the foam tablet	3	.095	.144	.402	.268	.726	.762				55.71	4
Heard (and used) condom	3	.038	.062	.237	.158	.459	.523				217.12	4
Heard (and used) withdrawal	3	.115	.174	.456	.304	.733	.775				52.90	4
Heard (and used) vasectomy	2	.111	.111	.412	.412	.818	.833				12.29	4
Heard (and used) rhythm method	3	.099	.177	.450	.300	.702	.770				65.85	4
Heard (and used) any other method	3	.029	.115	.078	.052	.966	.975				0.87	4
Wanted a child later or no more children	3	.049	.115	.283	.189	.753	.748				45.44	4
Number of children wanted in all then (Lower limit)	11	.006	.102	.202	.037	.732	.753	.356	.684	.697	266.54	100
Number of children wanted in all then (Upper limit)	11	.006	.106	.202	.037	.668	.753	.357	.684	.697	409.97	100
Currently have a husband	2	.008	.018	.008	.008	.078	.081				315.30	1
Whether couple fecund	4	.036	.132	.183	.092	.299	.289				546.28	9
Couple currently using a method	3	.040	.062	.210	.140	.298	.320				366.08	4
Current method used	13	.006	.111	.124	.019	.456	.285				1319.66	144
Want another child in the future	4	.023	.082	.248	.124	.416	.358				379.21	9

Table I.1 (Cont.)

Characteristic	No. of classes	Net Error measures		Gross Error Measures							X^2	
				Nominal				Ordinal				
		Dissimilarity[1]	Cramer[2]	Off.-diag. Proportion[3]	Diagonal[4]	Cramer[5]	Game[6]	Gamma[7]	Somers[8]	TauB[9]	Value[10]	D.F.[11]
Prefer boy or girl as next child	4	.005	.016	.184	.092	.401	.375				397.77	9
Prefer next child as soon as possible	3	.009	.015	.164	.110	.347	.344				316.70	4
Age of youngest child at next birth (Lower limit)	14	.005	.120	.164	.023	.470	.546				1357.11	169
Age of youngest child at next birth (Upper limit)	14	.006	.126	.162	.023	.466	.537				1374.88	169
Number of children wanted in all now (Upper limit)	9	.005	.076	.218	.049	.554	.431	.133	.290	.300	589.42	64
Husband wants another child	9	.026	.103	.240	.120	.396	.346				406.21	64
Number of children wanted in all by husband (Upper limit)	9	.007	.083	.235	.052	.622	.514	.186	.373	.391	423.42	64
Wants a baby after current pregnancy	3	.013	.034	.059	.040	.359	.318				304.94	4
Husband intends to use any method	4	.011	.045	.062	.031	.521	.335				255.28	9
Method intended	8	.007	.084	.067	.017	.425	.445				860.12	49
Respondent and/or husband disapproves	5	.002	.056	.032	.013	.723	.811				114.24	16
Want another child in the future after current pregnancy	4	.016	.088	.059	.030	.375	.316				434.21	64
How many children in all wanted (Lower limit)	6	.007	.079	.043	.014	.544	.566	.038	.212	.381	386.31	25
How many children in all wanted (Upper limit)	6	.007	.085	.043	.014	.558	.565	.037	.211	.380	363.19	25
Does husband want another child after current pregnancy	4	.016	.094	.067	.034	.440	.358				349.04	9
How many children in all wanted by husband after current pregnancy (Lower limit)	6	.010	.094	.049	.016	.581	.636	.032	.143	.420	325.24	25
How many children in all wanted by husband after current pregnancy (Upper limit)	6	.010	.094	.049	.016	.581	.636	.032	.143	.420	325.24	25
Ever worked for money	2	.038	.040	.151	.151	.329	.332				167.17	1
Did you work before marriage	3	.025	.040	.181	.120	.429	.362				241.69	4
Worked between marriage and first birth	3	.025	.054	.240	.160	.513	.504				175.85	4

Table I.1 (Cont.)

Characteristic	No. of classes	Net Error measures		Gross Error Measures							X^2	
				Nominal				Ordinal				
		Dissimi-milarity[1]	Cramer[2]	Off.-diag. Proportion[3]	Diagonal[4]	Cramer[5]	Game[6]	Gamma[7]	Somers[8]	TauB[9]	Value[10]	D.F.[11]
Worked after first birth	3	.031	.058	.243	.162	.533	.513				161.60	4
Worked in last 12 months	3	.031	.059	.224	.149	.658	.598				86.72	4
Have you been married before	3	.005	.018	.024	.016	.108	.116				589.81	4
Number of marriages in all	4	.004	.039	.030	.015	.292	.142	.019	.092	.125	558.677	9
How did the first marriage terminate	4	.011	.073	.070	.035	.374	.333					9

1. $\sum_{i=1}^{k} P_{io} - P_{ir} \; /k$
(see text of this Appendix).

2. Cramer measure used is $\sqrt{(X^2/371)}$ where the X^2 is the test of statistic for 2 parallel samples.

3. This is the proportion of responses which are not identical on both occasions.

4. This is twice the off-diagonal proportion divided by the number of classes (see text of this Appendix).

5. The Cramer measure of gross error used is $1 - \sqrt{\{X^2/[(k-1).371]\}}$ where k is the number of classes and the X^2 is the contingency X^2 for the response to the question in the main survey cross tabulated by that given in the post-enumeration study.

6. This is obtained from the formula: (Off-diagonal proportion)/$(1 - \sum_{i=1}^{k} P_i^2)$ where $\hat{P}_i = (\hat{P}_{io} + \hat{P}_{iR})/2$.
(See text of this Appendix for explanation.)

7. 8. 9. These are the unit's complement of the corresponding ordinal measures of association for a two-way classification.

10. This is the contingency X^2.

11. The degree of freedom is given by $(k-1)^2$, where k is the number of classes.

Table I.2 Comparison of Recoded Data from the Dual Responses in the Main and the Post-Enumeration Survey (371 Pairs of Matched Interviews): Measures of Net and Gross Errors

Characteristic	No. of Classes	Net Error measures		Gross Error Measures							X^2	
				Nominal				Ordinal				
		Dissimi-milarity[1]	Cramer[2]	Off.-diag. Proportion[3]	Diagonal[4]	Cramer[5]	Game[6]	Gamma[7]	Somers[8]	Tau B[9]	Value[10]	D.F.[11]
Children ever born	15	.005	.060	.129	.017	.152	.144	.013	.035	.034	3733.52	196
Children ever born(9)	10	.006	.046	.105	.021	.122	.118	.012	.034	.033	2571.42	81
Children ever born(5)	6	.008	.031	.065	.022	.089	.084	.008	.031	.035	1539.78	25
Children ever born(2)	4	.007	.016	.040	.020	.076	.058	.007	.027	.031	950.21	9
Children still alivve	14	.004	.051	.059	.008	.105	.066	.004	.016	.015	3866.10	169
Children still alive(9)	10	.005	.031	.054	.011	.059	.061	.003	.015	.015	2959.25	81
Children still alive(5)	6	.004	.024	.040	.013	.060	.051	.000	.014	.014	1638.18	25
Children still alive & pregnancy	14	.002	.043	.038	.005	.088	.042	.005	.012	.012	4014.23	169
Children still alive(2)	4	.001	.004	.016	.008	.031	.023	.000	.010	.009	1045.30	9
Sons still alive	9	.004	.021	.035	.008	.050	.043	.007	.021	.021	2677.13	64
Sons still alive (3)	4	.005	.014	.024	.012	.035	.033	.006	.021	.021	1037.50	9
Children deceased	5	.015	.076	.086	.035	.272	.230	.039	.243	.200	787.55	16
Currently pregnant	2	.019	.031	.040	.040	.218	.222				226.85	1
Know the pill	2	.022	.094	.022	.022	.670	.811				40.33	1
Know the loop	2	.019	.078	.024	.024	.778	.830				19.23	1
Know of the injection	2	.113	.115	.377	.377	.758	.774				21.76	1
Know of breast-feeding	2	.251	.258	.434	.434	.841	.920				9.36	1
Know of female sterilization	2	.024	.070	.040	.040	.639	.673				48.25	1
Know of abstinence	2	.175	.183	.418	.418	.878	.916				5.57	1
Know of other female methods	2	.140	.140	.372	.372	.719	.744				29.33	1
Know of condom	2	.027	.039	.162	.162	.668	.671				40.92	1
Know of withdrawal	2	.143	.148	.353	.353	.730	.759				26.96	1
Know of vasectomy	2	.111	.111	.412	.412	.818	.833				12.29	1
Know of rhythm	2	.057	.058	.337	.337	713	.718				30.46	1
Know of other methods	2	.040	.101	.078	.078	.961	.976				0.56	1
Ever used the pill	2	.008	.009	.073	.073	.172	.172				254.32	1
Ever used the loop	2	.013	.020	.035	.035	.153	154				266.40	1
Ever used the injection	2	.003	.016	.008	.008	.596	.604				60.66	1
Ever used breastfeeding as contraceptive	2	.016	.040	.065	.065	.778	.784				18.24	1
Sterilized	2	.005	.007	.016	.016	.061	.061				327.04	1
Abstention	2	.008	.014	.143	.143	.805	.805				14.12	1
Other female method	2	.003	.008	.040	.040	.735	.735				26.11	1
Husband ever used condom	2	.030	.042	.078	.078	.302	.307				180.78	1
Husband ever used withdrawal	2	.030	.046	.159	.159	.749	.753				23.33	1
Husband vasectomized	2	.000	.000	.000	.000	.000	.000				371.00	1
Ever used rhythm	2	.092	.145	.146	.146	.676	.725				38.98	1
Ever used any other method	2	.000	.000	.000	.000	.000	.000				371.00	1
Know any method	2	.000	.000	.000	.000	.000	.000				371.00	1
Know any modern method	2	.000	.000	.000	.000	.000	.000				371.00	1

Table I.2 (Cont.)

Characteristic	No. of Classes	Net Error measures		Gross Error Measures							X^2	
				Nominal				Ordinal				
		Dissimilarity[1]	Cramer[2]	Off.-diag. Proportion[3]	Diagonal[4]	Cramer[5]	Game[6]	Gamma[7]	Somers[8]	Tau B[9]	Value[10]	D.F.[11]
Number of methods known	13	.036	.306	.838	.129	.647	.956	.669	.708	.711	553.74	144
Number of modern methods known	8	.053	.269	.736	.184	.560	.943	.634	.715	.716	503.89	49
Summary of knowledge of methods	2	.000	.000	.000	.000	.000	.000				371.00	1
Used any method	2	.003	.003	.181	.181	.402	.402				132.75	1
Used any modern method	2	.022	.022	.092	.092	.185	.186				246.33	1
Number of methods used	8	.012	.107	.482	.121	.534	.673	.325	.465	.474	(563.30	49
Summary of use of methods	3	.014	.033	.205	.137	.415	.366				254.24	4
Number of times married	3	.002	.037	.022	.014	.397	.168	.003	.131	.148	270.21	4
Want another child	4	.028	.103	.232	.116	.394	.351				408.36	9
Want another child (2)	3	.014	.032	.186	.124	.302	.306				361.16	4
Additional children wanted	8	.016	.118	.350	.088	.548	.473	.388	.471	.472	531.38	49
Total children wanted	16	.013	.148	.496	.062	.540	.568	.400	.459	.459	1178.75	225
Total children wanted (5)	9	.015	.111	.415	.092	.578	.518	.362	.455	.450	528.79	64
Sex preference	5	.014	.062	.199	.080	.442	.344				462.06	16
Husband wants another child	4	.032	.119	.232	.116	.386	.348				419.69	9
Last pregnancy wanted	2	.080	.092	.288	.288	.754	.766				20.40	1
Currently using any method	3	.040	.066	.210	.140	.306	.323				357.73	4
Currently using any modern method	3	.032	.057	.183	.122	.267	.282				399.15	4
Method currently using	7	.008	.040	.119	.034	.325	.273				1014.66	36
Work status before first marriage	2	.030	.033	.116	.116	.291	.293				186.45	1
Work between marriage and 1st birth	3	.025	.054	.154	.102	.278	.365				386.45	4
Age in 5-year intervals	7	.008	.036	.129	.037	.139	.154				1649.44	36
Age interval (mixed)	5	.005	.015	.102	.041	.125	.128				1135.94	16
Age in 10-year intervals	4	.008	.029	.081	.040	.110	.116				882.38	9
Age interval (10 and 5)	4	.007	.015	.062	.031	.082	.085				937.30	9
Age in 20-year intervals	2	.013	.014	.019	.019	.039	.039				342.86	1
Duration since first marriage (5)	8	.007	.046	.210	.053	.260	.250				1422.46	49
Duration since first marriage	6	.005	.022	.194	.065	.226	.234				1109.94	25

Table I.2 (Cont.)

Characteristic	No. of classes	Net Error measures		Gross Error Measures							X^2	
				Nominal				Ordinal				
		Dissimi-milarity[1]	Cramer[2]	Off.-diag. Propor-tion[3]	Diagonal[4]	Cramer[5]	Game[6]	Gamma[7]	Somers[8]	Tau B[9]	Value[10]	D.F.[11]
Duration since first marriage (10)	4	.013	.036	.119	.059	.162	.174				782.17	9
Duration since first marriage	3	.011	.018	.105	.070	.154	.160				531.51	4
Age at first marriage (2)	7	.020	.080	.377	.108	.382	.482				849.87	36
Age at first marriage	6	.023	.080	.372	.124	.404	.475				659.10	25
Age at first marriage (5)	4	.022	.054	.261	.131	.400	.439				401.07	9
Age at first marriage (3)	3	.032	.053	.194	.129	.265	.315				401.31	4
Age at first birth (5)	7	.013	.055	.224	.064	.183	.321				1486.77	36
Live births in first 5 years	8	.013	.083	.315	.079	.526	.418	.156	.279	284	584.54	49
Live births in past 5 years	5	.008	.020	.129	.052	.289	.191	.009	.089	.086	749.76	16
Sons in past 5 years	4	.005	.023	.078	.039	.299	.156	.011	.092	.092	547.62	9
Daughters in past 5 years	5	.009	.046	.073	.029	.273	.142	.004	.102	.091	785.28	16
Age at first marriage (2)	2	.005	.006	.129	.129	.308	309				177.42	1
Sons ever born	11	.007	.069	.127	.023	.180	.152	.011	.050	.049	2494.72	100
Dissolution of first marriage	3	.123	.222	.447	.298	.524	.733				17.20	4
Children still alive	2	.003	.003	.008	.008	.016	.016				359.11	1
Children alive and pregnancy	5	.002	.010	.022	.007	.032	.028	.002	.010	.010	1738.99	16
Daughters ever born	11	.003	.056	.111	.020	.173	.135	.012	.053	.051	2537.91	100
Want no more children	3	.049	.115	.283	.189	.753	.748				45.44	4
Summary of current method	4	.030	.069	.224	.112	.343	.324				480.88	9

Footnotes as in Table I.1.

Appendix II
Net Difference Measures

As described in Appendix I, the net error measures could also be used as measures of net differences for comparing two independent distributions. In this Appendix two such measures – dissimilarity and Cramer net difference – are calculated for a large set of characteristics from the main survey of the Fiji Fertility Survey, 1974.
As explained in Chapter 3, comparisons were made between the following four groups of women:

A 4928 women interviewed in the main survey;
B 484 women selected as the subsample for the post enumeration survey;
C 371 women re-interviewed in the post-enumeration survey; and
D 113 women not re-interviewed in the post-enumeration survey.

Three comparisons were chosen as relevant for examining the representativeness of the 371 re-interviewed women as a sample of the 4,928 women interviewed in the main survey:

a) group *B* with group *A* (table II.1);
b) group *C* with group *A* (table II.2); and
c) group *D* with group *C* (table II.3).

The dissimilarity measure is the same for all three comparisons and is given by:

$$\sum_{i=1}^{k} | P_{i1} - P_{i2}/k$$

where P_{i1} and P_{i2} are the proportions in the i^{th} category of the first and second groups and k is the number of categories.
The formula for contingency–x^2 varies for each comparison. For comparison (a), the *A* group is the population (main sample respondents) and the *B* group is a sample of 484 women. Hence the contingency –x^2 test for parallel samples is:

$$x^2 = 484 \sum_{i=1}^{k} |(P_{iB} - P_{iA})^2| P_{iA}$$

and the Cramer measure is:

$$\sqrt{(x^2/484)}.$$

For comparison (b), the *A* group is the population and the *C* group is a sample of 371 women. The contingency –x^2 test for parallel samples is:

$$x^2 = 371 \sum_{i=1}^{k} (P_{ic} - P_{iA})^2 / P_{iA}$$

and the Cramer measure of association is:

$$\sqrt{(x^2/371)}.$$

Finally for comparison (c), both *C* and *D* groups are samples of sizes 371 and 113 from a common population. The contingency –x^2 test for parallel samples is, in this instance:

$$x^2 = 371.\,113\,[\sum_{i=1}^{k} (P_{ic} - P_{iD})^2/(371\,P_{ic} + 113P_{iD})]$$

and the Cramer measure of association is:

$$\sqrt{(x^2/484)}.$$

For a large list of characteristics from the recoded data of the main survey, Table II.1 presents for the comparison (a) the net difference measures, the x^2 – value and its significance level. Table II.2 presents the same measures for comparison (b) and table II.3 for comparison (c). The significant characteristics in these comparisons are summarized in Chapter 3, and the representativeness of the 371 re-interviewed women as a sample of the 4,928 women interviewed in the main survey and the selectivity of women re-interviewed compared to those not re-interviewed in the post-enumeration sample are discussed.

Table II.1 Representativeness of the Post-Enumeration Sample: Comparison of the Main Survey Respondents (4,928) with the Post-Enumeration Sample (484), Main Survey Data

Characteristics	No. of Classes	Net Difference		X^2	
		Dissimilarity (1)	Cramer Measure (2)	Value (3)	Significance (4)
Region of residence	5	.022	.152	11.26	*
Type of place of residence	4	.101	.492	89.19	**
Childhood type of place of residence	3	.061	.264	33.71	**
Ethnicity	3	.047	.194	18.13	**
Respondent's years of education	19	.008	.205	20.31	
Literacy	4	.027	.131	8.29	*
Religion	5	.031	.204	20.24	**
Number of children ever born	18	.009	.223	24.04	
Number of children ever born (9)	10	.016	.198	19.06	*
Number of children ever born (5)	6	.019	.138	9.26	
Number of children ever born (2)	4	.029	.125	7.57	
Number of children still alive	17	.009	.215	22.46	
Number of children still alive (9)	10	.014	.183	16.21	
Number of children still alive (5)	6	.020	.143	9.89	
Total children alive plus pregnancy	17	.008	.214	22.18	
Number of children still alive (2)	4	.030	.127	7.83	*
Number of sons still alive	11	.012	.219	23.17	*
Number of sons still alive (3)	4	.032	.149	10.81	*
Number of children deceased	8	.009	.122	7.20	
Currently pregnant	3	.003	.042	0.84	
Currently breastfeeding	4	.013	.076	2.77	
Know of the pill	2	.011	.086	3.60	
Know of the loop	2	.002	.011	0.06	
Know of the injection	2	.034	.068	2.24	
Know of breastfeeding	2	.027	.055	1.46	
Know of female sterilization	2	.001	.003	0.00	
Know of abstinence	2	.012	.023	0.27	
Know of other female methods	2	.002	.005	0.01	
Know of the condom	2	.017	.046	1.02	
Know of withdrawal	2	.005	.010	0.05	
Know of vasectomy	2	.004	.008	0.03	
Know of rhythm	2	.015	.030	0.45	
Know of any other method	2	.026	.120	6.97	**
Ever used the pill	2	.003	.007	0.02	
Ever used the loop	2	.023	.064	1.51	
Ever used the injection	2	.016	.044	0.95	
Ever used breast-feeding as contraceptive	2	.033	.131	8.25	**
Have you been sterilized	2	.003	.008	0.03	
Have you ever abstained as contraceptive	2	.001	.002	0.00	
Ever used any other female method	2	.008	.043	0.89	
Has husband ever used condom	2	.017	.047	1.06	
Has husband ever used withdrawal	2	.028	.078	2.91	
Has husband been vasectomized	2	.001	.029	0.39	
Have you ever used rhythm	2	.004	.012	0.07	
Have you ever used any other method	2	.006	.067	2.20	
Know of any other method	2	.001	.017	0.14	
Know of any modern method	2	.000	.006	0.02	
Number of methods known	13	.008	.188	17.07	
Number of modern methods known	8	.021	.181	15.93	*
Summarized knowledge of methods	3	.000	.026	0.34	
Ever used any method	2	.008	.018	0.15	
Ever used any modern method	2	.011	.023	0.25	

Table II.1 (Cont.)

Characteristics	No. of Classes	Net Difference		X^2	
		Dissimilarity (1)	Cramer Measure (2)	Value (3)	Significance (4)
Number of methods used	9	.006	.083	3.31	
Number of modern methods used	6	.009	.092	4.06	
Summarized use of methods	3	.013	.063	1.91	
Current marital status	3	.004	.025	0.31	
Number of times married	4	.007	.063	1.94	
Exposure status	6	.004	.046	1.04	
Want another child	4	.010	.042	0.85	
Want another method (2)	3	.026	.098	4.64	
Additional number of children wanted	8	.008	.093	4.21	
Additional number of children wanted (5)	9	.007	.097	4.51	
Total number of children wanted (retrospective and prospective)	20	.005	.198	18.90	
Total number of children wanted (retrospective and prospective) (5)	9	.007	.079	3.01	
Sex preference	5	.010	.060	1.75	
Does husband want another child	4	.019	.087	3.64	
Spacing preference	22	.005	.242	28.24	
Spacing preference (5)	7	.011	.135	8.80	
Preferred waiting time before next child	5	.007	.061	1.82	
Was last pregnancy wanted	4	.004	.037	0.67	
Was any method used in last closed interval	3	.017	.061	1.82	
Was a modern method used in last closed interval	4	.013	.070	2.38	
Currently using any method	3	.020	.070	2.38	
Currently using any modern method	3	.019	.067	2.19	
What method currently using	7	.011	.117	6.63	
Intend to use a method in the future	4	.016	.067	2.18	
What method is it intended to use in the future	9	.004	.109	5.74	
Have you or your husband been sterilized	2	.002	.006	0.02	
Pattern of contraceptive use	6	.014	.102	4.99	
Work status before first marriage	3	.034	.111	6.00	*
Did you work between marriage and first birth	4	.009	.050	1.22	
Have you worked before and after marriage	4	.025	.128	7.87	*
Have you worked away from home before and after marriage	5	.020	.130	8.18	
Current husband's years of education	23	.008	.298	43.01	**
Current husband's occupation	7	.038	.282	38.61	**
First husband's occupation	7	.030	.227	24.97	**
Respondent's age in 5-year intervals	7	.011	.090	3.94	
Respondent's age in a mixture of 5- and 10-year intervals	5	.011	.077	2.90	
Respondent's age in 10-year intervals	4	.016	.072	2.54	
Respondent's age in 10-year intervals with one 5-year interval	4	.007	.031	0.47	
Respondent's age in 20-year intervals	2	.013	.027	0.35	
Completed years since first marriage in 5-year intervals	8	.012	.108	5.69	
Completed years since first marriage in 5-year intervals with longer terminal interval	6	.016	.106	5.42	
Completed years since first marriage in 10-year intervals	4	.010	.043	0.91	
Completed years since first marriage in 10-year intervals with longer terminal interval	3	.013	.042	0.84	

Table II.1 (Cont.)

Characteristics	No. of Classes	Net Difference		X^2	
		Dissimilarity (1)	Cramer Measure (2)	Value (3)	Significance (4)
Age at first marriage in 2-year intervals	7	.013	.102	5.07	
Age at first marriage in 2-year intervals with longer terminal interval	6	.015	.101	4.93	
Age at first marriage in 5-year intervals	4	.007	.053	1.38	
Age at first marriage grouped in 3 intervals	3	.028	.086	3.59	
Age at first birth in 5-year intervals	8	.015	.149	10.74	
Number of live births in first 5 years of marriage	10	.008	.149	10.79	
Number of live births in past 5 years	6	.017	.140	9.50	
Number of sons in past 5 years	5	.004	.063	1.93	
Number of daughters in past 5 years	5	.013	.129	8.10	
Age at first marriage grouped into two intervals	2	.008	.016	0.13	
Number of sons ever born	13	.010	.225	24.61	*
Dissolution of first marriage	4	.010	.085	3.47	
Total number of children still alive	2	.051	.102	5.03	*
Total number of children still alive including current pregnancy (5)	6	.019	.135	8.79	
Number of daughters ever born	12	.011	.180	15.66	
Number of live births in past 5 years	5	.026	.139	9.29	
Want child later or want no more children	4	.008	.076	2.79	
Summary of current methods used	4	.015	.072	2.48	
What method used in last closed pregnancy interval	7	.008	.104	5.19	

1 Dissimilarity measure: $\sum_{i=1}^{k}[P_{iA} - P_{iB}]/k$, where P_{iA} and P_{iB} are the proportions in class i for the main survey respondents (A) and for the post-enumeration sample (B) according to the main survey data, and k is the number of classes.

2 Cramer measure: $\sqrt{(x^2/484)}$.

3 $X^2 = 484. \sum_{i=1}^{k} (P_{iA} - P_{iB})^2/P_{iA}$.

4 Significance at the 5 per cent and the 1 per cent levels are shown by * and **, respectively.

Table II.2 Representativeness of the Post-Enumeration Respondents: Comparison of the Main Survey Respondents (4,928) with the Post-Enumeration Respondents (371), Main Survey Data

Characteristic	No. of Classes	Net difference		X^2	
		Dissimilarity (1)	Cramer measure (2)	Value (3)	Significance (4)
Region of residence	5	.014	.178	11.69	*
Type of place of residence	4	.107	.456	77.10	**
Childhood type of place of residence	3	.064	.275	27.99	**
Ethnicity	3	.025	.179	11.88	**
Respondent's years of education	19	.007	.190	13.43	
Literacy	4	.011	.083	2.58	
Religion	5	.020	.171	10.90	
Number of children ever born	18	.009	.220	18.02	
Number of children ever born (9)	10	.015	.201	14.95	
Number of children ever born (5)	6	.020	.154	8.76	
Number of children ever born (2)	4	.028	.130	6.28	
Number of children still alive	17	.010	.223	18.43	
Number of children still alive (9)	10	.016	.192	13.61	
Number of children still alive (5)	6	.024	.167	10.35	
Total children alive plus pregnancy	17	.010	.232	20.04	
Number of children still alive (2)	4	.034	.144	7.67	
Number of sons still alive	11	.012	.222	18.27	
Number of sons still alive (3)	4	.031	.143	7.59	
Number of children deceased	8	.005	.095	3.36	
Currently pregnant	3	.001	.041	0.62	
Currently breast-feeding	4	.015	.091	3.10	
Know of the pill	2	.008	.066	1.59	
Know of the loop	2	.007	.038	0.54	
Know of the injection	2	.026	.052	1.00	
Know of breast-feeding	2	.009	.019	0.13	
Know of female sterilization	2	.002	.012	0.05	
Know of abstinence	2	.005	.009	0.03	
Know of other female methods	2	.023	.047	0.81	
Know of the condom	2	.014	.038	0.55	
Know of withdrawal	2	.004	.007	0.02	
Know of vasectomy	2	.001	.001	0.00	
Know of rhythm	2	.028	.057	1.19	
Know of any other method	2	.027	.125	5.83	*
Ever used the pill	2	.001	.001	0.01	
Ever used the loop	2	.023	.064	1.51	
Ever used the injection	2	.001	.009	0.03	
Ever used breast-feeding as contraceptive	2	.033	.131	6.35	*
Have you been sterilized	2	.001	.004	0.01	
Have you ever abstained as contraceptive	2	.002	.008	0.02	
Ever used any other female method	2	.005	.028	0.28	
Has husband ever used condom	2	.004	.011	0.04	
Has husband ever used withdrawal	2	.017	.047	0.83	
Has husband been vastectomized	1	.001	.029	0.30	
Have you ever used rhythm	2	.004	.010	0.41	
Have you ever used any other method	2	.005	.060	1.35	
Know of any other method	2	.001	.034	0.43	
Know of any modern method	2	.001	.020	0.15	
Number of methods known	13	.010	.204	15.43	
Number of modern methods known	8	.024	.198	14.61	*
Summarized knowledge of methods	3	.001	.039	0.58	

Table II.2 (Cont.)

Characteristic	No. of Classes	Net difference		X^2	
		Dissimilarity (1)	Cramer measure (2)	Value (3)	Significance (4)
Ever used any method	2	.015	.033	0.40	
Ever used any modern method	2	.006	.013	0.06	
Number of methods used	9	.009	.106	4.18	
Number of modern methods used	6	.008	.096	3.39	
Summarized use of methods	3	.014	.071	1.87	
Current marital status	3	.000	.001	0.00	
Number of times married	4	.004	.044	0.73	
Exposure status	6	.007	.055	1.13	
Want another child	4	.007	.034	0.43	
Want another child (2)	4	.007	.034	0.43	
Additional number of children wanted	8	.010	.093	3.18	
Additional number of children wanted (5)	9	.009	.096	3.40	
Total number of children wanted (retrospective and prospective)	20	.009	.256	24.30	
Total number of children wanted (retrospective and prospective) (5)	9	.013	.128	6.05	
Sex preference	5	.008	.071	1.87	
Does husband want another child	4	.020	.094	3.25	
Spacing preference	22	.006	.323	38.66	*
Spacing preference (5)	7	.012	.154	8.77	
Preferred waiting time before next child	5	.007	.058	1.24	
Was last pregnancy wanted	4	.010	.066	1.59	
Was any method used in last closed interval	3	.021	.083	2.54	
Was a modern method used in last closed interval	4	.015	.083	2.55	
Currently using any method	3	.020	.063	1.49	
Currently using any modern method	3	.015	.048	0.85	
What method currently using	7	.011	.129	6.15	
Intend to use a method in the future	4	.013	.062	1.43	
What method is it intended to use in the future	9	.004	.109	4.40	
Have you or your husband been sterilized	2	.001	.002	0.00	
Pattern of contraceptive use	6	.017	.130	6.25	
Work status before first marriage	3	.025	.085	2.66	
Did you work between marriage and first birth	4	.004	.034	0.42	
Have you worked before and after marriage	4	.020	.123	5.57	
Have you worked away from home before and after marriage	5	.021	.145	7.75	
Current husband's years of education	23	.010	.325	39.10	*
Current husband's occupation	7	.039	.301	33.54	**
First husband's occupation	7	.031	.053	23.71	**
Respondent's age in 5-year intervals	7	.020	.178	11.70	
Respondent's age in a mixture of 5- and 10-year intervals	5	.020	.143	7.56	
Respondent's age in 10-year intervals	4	.029	.133	6.54	
Respondent's age in 10-year intervals with one 5-year interval	4	.014	.073	1.96	
Respondent's age in 20-year intervals	2	.028	.057	1.19	
Completed years since first marriage in 5-year intervals	8	.013	.132	6.49	
Completed years since first marriage in 5-year intervals with longer terminal interval	6	.018	.132	6.42	
Completed years since first marriage in 10-year intervals	4	.018	.076	2.16	

Table II.2 (Cont.)

Characteristic	No. of classes	Net difference		X^2	
		Dissimilarity (1)	Cramer measure (2)	Value (3)	Significance (4)
Completed years since first marriage in 10-year intervals with longer terminal interval	3	.021	.074	2.03	
Age at first marriage in 2-year intervals	7	.014	.110	4.46	
Age at first marriage in 2-year intervals with longer terminal interval	6	.017	.108	4.35	
Age at first marriage in 5-year intervals	4	.008	.041	0.61	
Age at first marriage grouped in 3 intervals	3	.029	.090	3.02	
Age at first birth in 5-year intervals	8	.012	.156	9.12	
Number of live births in first 5-years of marriage	10	.009	.148	8.11	
Number of live births in past 5 years	6	.011	.079	2.30	
Number of sons in past 5 years	5	.005	.045	0.77	
Number of daughters in past 5 years	5	.007	.123	5.65	
Age at first marriage grouped into 2 intervals	2	.001	.002	0.00	
Number of sons ever born	13	.010	.208	16.13	
Dissolution of first marriage	4	.009	.071	1.89	
Total number of children still alive	2	.055	.112	4.63	
Total number of children still alive including current pregnancy (5)	6	.025	.170	10.67	
Number of daughters ever born	12	.009	.175	11.31	
Number of live births in past 5 years	5	.035	.180	12.03	*
Want child later or want no more children	4	.012	.084	2.61	
Summary of current methods used	4	.015	.066	1.60	
What method used in last closed pregnancy interval	7	.011	.127	5.94	

(1) Dissimilarity measure: $\sum_{i=1}^{k} [p_{iA} - p_{iC}]/k$, where p_{iA} and p_{iC} are the proportions in class i for the main survey respondents (A) and for the post-enumeration respondents (C) according to the main survey data and k is the number of classes.

(2) Cramer measure: $\sqrt{(x^2/371)}$.

(3) $x^2 = 371 \cdot \sum_{i=1}^{k} (p_{iA} - p_{iC})^2 / p_{iA}$.

(4) Significance at the 5 per cent and the 1 per cent levels are shown by * and **, respectively.

Table II.3 Selectivity of the Post-Enumeration Survey Respondents: Comparison of Respondents Re-Interviewed in the Post-Enumeration Survey (371) with Those not Re-Interviewed (113), Main Survey Data

Characteristic	No. of Classes	Net Difference		X^2	
		Dissimilarity (1)	Cramer Measure (2)	Value (3)	Significance (4)
Region of residence	4	.073	.153	11.26	*
Type of place of residence	3	.037	.095	4.38	
Childhood type of place of residence	2	.016	.031	0.48	
Ethnicity	3	.104	.144	10.07	**
Respondent's years of education	15	.018	.193	18.08	
Literacy	4	.068	.135	8.88	*
Religion	5	.050	.123	7.34	
Number of children ever born	16	.018	.174	14.65	
Number of children ever born (9)	10	.024	.118	6.76	
Number of children ever born (5)	6	.027	.085	3.51	
Number of children ever born (2)	4	.026	.064	1.97	
Number of children still alive	14	.013	.121	7.04	
Number of children still alive (9)	10	.017	.090	3.89	
Number of children still alive (5)	6	.021	.069	2.31	
Total children alive plus pregnancy	14	.014	.124	7.50	
Number of children still alive (2)	4	.022	.041	0.80	
Number of sons still alive	9	.016	.081	3.14	
Number of sons still alive (3)	4	.029	.049	1.18	
Number of children deceased	5	.037	.158	12.15	
Currently pregnant	2	.022	.030	0.45	
Currently breast-feeding	3	.026	.065	2.04	
Know of the pill	2	.011	.029	0.41	
Know of the loop	2	.020	.050	1.23	
Know of the injection	2	.035	.029	0.42	
Know of breast-feeding	2	.077	.066	2.08	
Know of female sterilization	2	.008	.016	0.13	
Know of abstinence	2	.030	.025	0.31	
Know of other female methods	2	.089	.076	2.82	
Know of the condom	2	.012	.014	0.10	
Know of withdrawal	2	.016	.014	0.09	
Know of vasectomy	2	.016	.014	0.09	
Know of rhythm	2	.056	.048	1.11	
Know of any other method	2	.005	.014	0.10	
Ever used the pill	2	.002	.002	0.00	
Ever used the loop	2	.031	.037	0.66	
Ever used the injection	2	.003	.019	0.17	
Ever used breast-feeding as contraceptive	2	.000	.001	0.00	
Have you been sterilized	2	.006	.007	0.02	
Have you ever abstained as contraceptive	2	.012	.017	0.14	
Ever used any other female method	2	.012	.031	0.47	
Has husband ever used condom	2	.057	.063	1.91	
Has husband ever used withdrawal	2	.046	.059	1.71	
Has husband been vasectomized	1	.000	.000	0.00	
Have you ever used rhythm	2	.035	.042	0.83	
Have you ever used any other method	2	.003	.025	0.31	
Know of any other method	2	.003	.025	0.31	
Know of any modern method	2	.003	.025	0.31	
Number of methods known	13	.021	.161	12.49	
Number of modern methods known	8	.020	.097	4.52	
Summarized knowledge of methods	2	.003	.025	0.31	

Table II.3 (Cont.)

Characteristic	No. of Classes	Net Difference		X^2	
		Dissimilarity (1)	Cramer Measure (2)	Value (3)	Significance (4)
Ever used any method	2	.030	.027	0.35	
Ever used any modern method	2	.021	.018	0.16	
Number of methods used	8	.022	.100	4.86	
Number of modern methods used	5	.021	.058	1.62	
Summarized use of methods	3	.020	.028	0.37	
Current marital status	3	.015	.042	0.86	
Number of times married	3	.017	.048	1.11	
Exposure status	6	.023	.068	2.26	
Want another child	4	.035	.071	2.46	
Want another child (2)	3	.046	.071	2.43	
Additional number of children wanted	8	.019	.127	7.75	
Additional number of children wanted (5)	8	.019	.127	7.75	
Total number of children wanted (retrospective and prospective)	16	.026	.211	21.45	
Total number of children wanted (retrospective and prospective) (5)	9	.037	.175	14.87	
Sex preference	4	.043	.079	3.03	
Does husband want another child	4	.030	.065	2.04	
Spacing preference	17	.011	.165	13.26	
Spacing preference (5)	7	.015	.102	5.07	
Preferred waiting time before next child	4	.046	.116	6.56	
Was last pregnancy wanted	3	.035	.070	2.39	
Was any method used in last closed interval	3	.028	.068	2.22	
Was a modern method used in last closed interval	4	.032	.090	3.91	
Currently using any method	3	.019	.031	0.45	
Currently using any modern method	3	.036	.048	1.11	
What method currently using	7	.013	.083	3.35	
Intend to use a method in the future	3	.047	.072	2.52	
What method intend to use in the future	9	.017	.098	4.69	
Have you or your husband been sterilized	2	.006	.007	0.02	
Pattern of contraceptive use	6	.020	.077	2.85	
Work status before first marriage	2	.053	.052	1.30	
Did you work between marriage and first birth	3	.043	.066	2.14	
Have you worked before and after marriage	4	.024	.054	1.40	
Have you worked away from home before and after marriage	5	.033	.108	5.67	
Current husband's years of education	20	.020	.254	31.14	*
Current husband's occupation	7	.038	.150	10.92	At 10%
First husband's occupation	7	.041	.132	8.41	
Respondent's age in 5-year intervals	7	.044	.161	12.58	Just below 5%
Respondent's age in a mixture of 5- and 10-year intervals	5	.041	.117	6.61	
Respondent's age in 10-year intervals	4	.055	.110	5.89	
Respondent's age in 10-year intervals with one 5-year interval	4	.036	.078	2.97	
Respondent's age in 20-year intervals	2	.063	.054	1.39	
Completed years since first marriage in 5-year intervals	8	.020	.089	3.89	
Completed years since first marriage in 5-year intervals with longer terminal interval	6	.026	.083	3.35	
Completed years since first marriage in 10-year intervals	4	.036	.064	1.99	

Table II.3 (Cont.)

Characteristic	No. of Classes	Net Difference		X^2	
		Dissimilarity (1)	Cramer Measure (2)	Value (3)	Significance (4)
Completed years since first marriage in 10-year intervals with longer terminal interval	3	.048	.063	1.92	
Age at first marriage in 2-year intervals	7	.017	.080	3.09	
Age at first marriage in 2-year intervals with longer terminal interval	6	.020	.080	3.09	
Age at first marriage in 5-year intervals	4	.018	.041	0.80	
Age at first marriage grouped in 3 intervals	3	.039	.072	2.50	
Age at first birth in 5-year intervals	7	.023	.112	6.04	
Number of live births in first 5 years of marriage	6	.030	.087	3.71	
Number of live births in past 5 years	6	.044	.147	10.47	
Number of sons in past 5 years	5	.037	.128	7.92	
Number of daughters in past 5 years	5	.029	.084	3.42	
Age at first marriage grouped into 2 intervals	2	.036	.034	0.55	
Number of sons ever born	10	.018	.104	5.22	
Dissolution of first marriage	4	.008	.034	0.57	
Total number of children still alive	2	.021	.018	0.15	
Total number of children still alive including current pregnancy (5)	6	.026	.081	3.17	
Number of daughters ever born	11	.018	.133	8.51	
Number of live births in past 5 years	5	.037	.095	4.34	
Want child later or want no more children	4	.022	.101	4.90	
Summary of current methods used	4	.027	.060	1.73	
What method used in last closed pregnancy interval	7	.014	.108	5.66	

1 Dissimilarity measure: $\sum_{i=1}^{k} [p_{iC} - p_{iD}] / k$, where p_{iC} and p_{iD} are the proportions in class i among the 371 women who were re-interviewed (C) and the 113 women not re-interviewed (D) according to the main survey data and k is the number of classes.

2 Cramer measure: $\sqrt{\{(x^2/(371 + 113)\}}$.

3 $x^2 = 371 \cdot 113 \cdot \left[\sum_{i=1}^{k} (p_{iC} - p_{iD})^2 / (p_{iC} \cdot 371 + p_{iD} \cdot 113\right]$

4 Significance at the 5 per cent and the 1 per cent levels are shown by * and **, respectively.

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8.	Community-Level Data in Fertility Surveys	Ronald Freedman
9.	Examples of Community-Level Questionnaires	Ronald Freedman
10.	A Selected Bibliography of Works on Fertility	György T. Acsádi
11.	Economic Data for Fertility Analysis	Deborah S. Freedman (with Eva Mueller)
12.	Economic Modules for use in Fertility Surveys in Less Developed Countries	Deborah S. Freedman and Eva Mueller
13.	Ideal Family Size	Helen Ware
14.	Modernism	David Goldberg
15.	The Fiji Fertility Survey: A Critical Commentary	M. A. Sahib *et al*
16.	The Fiji Fertility Survey: A Critical Commentary–Appendices	M. A. Sahib *et al*
17.	Sampling Errors for Fertility Surveys	L. Kish *et al*
18.	The Dominican Republic Fertility Survey: An Assessment	N. Ramírez *et al*
19.	WFS Modules: Abortion · Factors other than Contraception Affecting Fertility · Family Planning · General Mortality	WFS Central Staff

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