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ABSTRACT: Fertility measurement in small preindustrial societies is hampered by small numbers and the lack of some essential data. Most measures of fertility are collective and require large enough populations to permit grouped data analysis. Existing individual measures of fertility are often unsatisfactory. This paper presents a new measure of individual fertility, the Individual Fertility Rate (IFR), which is constructed by dividing parity by reproductive span in years and multiplying the product by 100. The result is a number which may be used as a dependent individual or cumulative variable to study the effects of health and socioeconomic factors on fertility.

Fertility measurement in small preindustrial societies is constrained by many factors, among which are small numbers and lack of some essential data. Ages are sometimes unknown or approximate, particularly for older individuals. Large aggregates of demographic data of the type easily available in urban societies do not exist. Data for demographic analyses are collected by ethnographic techniques including household interviews and narratives (Caldwell, et al., 1988; Hull et al., 1988; Vlassoff, 1988; Das Gupta, 1988). Data thus collected in the only manner possible are often spectacularly untidy. Birth records are sometimes available, but they are not always reliable. In preliterate societies, the ethnographer must make estimates of age (Howell, 1979, p. 123). These are sometimes quite accurate if they are the result of extended observations, but even then, age groupings are often broader than are usually acceptable for demographic analysis (Chagnon et al., 1985, p. 196). The "own-child" method of fertility estimation requires assumptions that are not likely to be true in small populations: a moderately low proportion of "other than own" children in the household; infant and maternal mortality are insignificant; the number of children not living with their mothers is negligible; and low rates of migration during the estimation period (Rindfuss and Sweet, 1977, p. 11; Retherford and Cho, 1978, p. 568; Cho et al., 1986, pp. 6–7).

In gathering data in Peru for the purpose of studying the effects of cultural change on Shipibo Indian fertility, I found that I could make reasonably accurate age estimates of offspring and thereby calculate birth intervals for each reproductive age woman. I also found that I could ascertain, through consultations with interviewees and family members, the number of reproductive events such as live births, stillbirths, and spontaneous abortions. These data were often more ascertainable than actual ages of reproductive age women or their ages at first or later marriage.

A key part of the research objective

was to correlate individual fertility with certain demographic and cultural classifications such as age, residence, and type of marriage. Part of the reason for this was to control for confounding effects on community fertility as measured by standard fertility indices such as General Fertility Rate and Total Fertility Rate. Completed Fertility was not useful since most women in the study were premenopausal. Parity alone did not convey the fertility experience of an individual woman since she may have had few or many pregnancies over a given period of time. There were no standard demographic or reproductive health indices of individual fertility which were available or suitable for my purpose (Shryok, 1976, p. 274; Spiegelman, 1968, p. 254). This paper reports the construction of a new method for measuring individual fertility, the Individual Fertility Rate.

The specific hypothesis which I wished to test in my research was whether a declining prevalence of polygyny resulted in higher individual and community fertility among the Shipibo Indians of Peru, a group which I have studied since 1964 (Hern, 1977).

MATERIALS AND METHODS

The Shipibo Indians of eastern Peruvian Amazon area are a riverine Panoan group with settlements along a 600-kilometer portion of the Ucayali River from Atalaya to Contamana (Lathrap, 1970; Bergman, 1980). Earlier studies indicated that, in spite of the knowledge and use of herbal contraceptives, they were experiencing exceedingly high fertility (Hern, 1976, 1977). Studies done in 1964 and 1969 indicated that the Shipibo in one village experienced a General Fertility Rate of 0.305, Total Fertility Rate of 9.935, and a Gross Reproduction Rate of 4.933 (Hern, 1977). The annual Rate of Natural Increase was 4.89 per cent. The current study focused on causes of this high fertility with particular attention drawn to the declining role of polygyny in fertility control.

Methods

Data were collected over a 14-month period in 1983 and 1984 by universal household survey of eight Shipibo Indian villages on the Ucayali and Pisqui Rivers of eastern Peru. The head of each household was interviewed to obtain basic demographic data, and a reproductive history was obtained for each female age 13 years or more. Exact ages were recorded wherever possible through the use of birth registration and baptism certificates and by family reckoning where documents were not available.

In analyzing my data, I constructed three individual variables for use in data analysis. MEANINT is an arithmetic mean of birth interval lengths experienced by each woman. PROPOLY is the "proportion of polygynous birth intervals" for each woman, a value ranging from 0.0 to 1.0. A woman who has been monogamously married throughout her reproductive experience would have a PROPOLY value of 0.0. A senior wife in a polygynous marriage might have a PROPOLY of 0.9 or 0.8 if she experienced term births prior to arrival of the junior wives. A junior wife is likely to have a PROPOLY of 1.0.

The formula for the specific variable constructed to measure individual fertility, the Individual Fertility Rate (IFR), is:

$$\frac{P}{RS_y} * 100$$

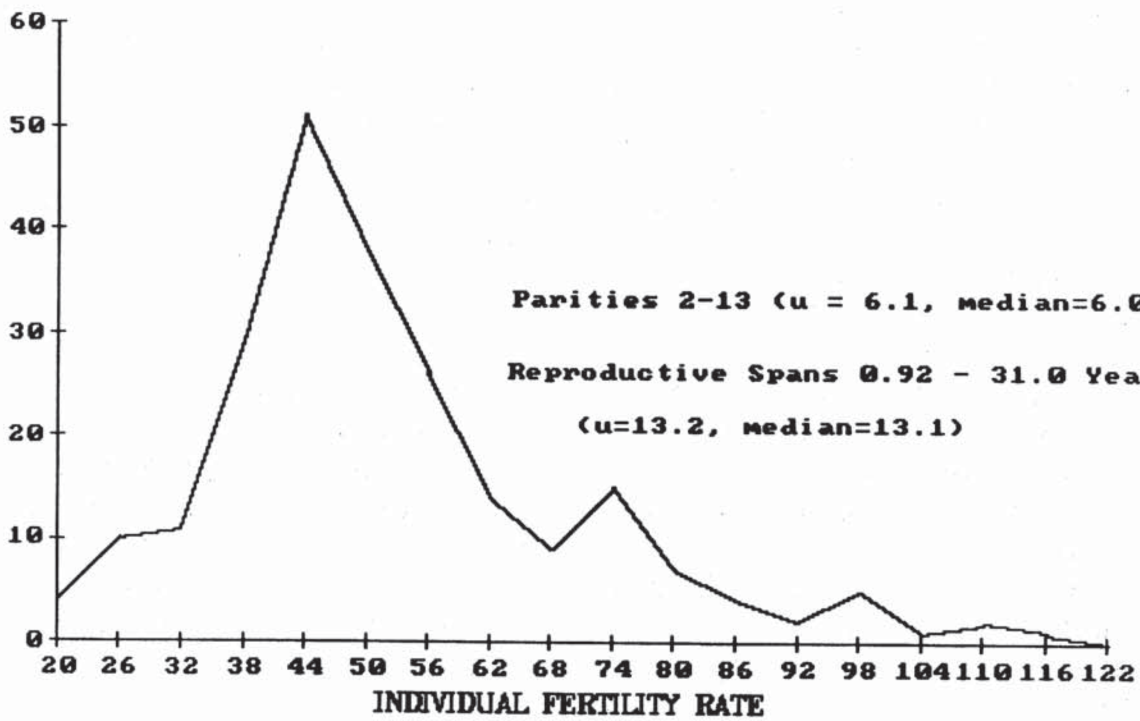

FIG. 1.—Shipibo population, 1984.

where
P = parity
RS = months of reproductive span in years.

Parity is defined as the number of term births and reproductive span is defined as the time in months, divided by 12, from the first birth to the last.[1,2]

A woman having three children in three years would have an IFR of 100; a woman having three children over a period of eight years would have an IFR of 37.5.

[1]"Term births" is used here to mean that a term or near-term delivery of a viable fetus has occurred whether the birth was live or stillborn.

[2]This formula is empirically derived in order to arrive at a range of values that are meaningful and can be manipulated in mathematical equations. The denominator, for example, is in years, because using reproductive span in months would result in extremely small products (0.03, for example) that would be distorted by a large multiplicand.

TABLE 1

INDIVIDUAL FERTILITY RATES BY VILLAGE

VILLAGE	INDIVIDUAL FERTILITY RATE	
	Mean	N
SITE		
CHARASHMANAN	61.00	33
VENCEDOR	47.44	21
TUPAC AMARU	56.71	21
IRAZOLA	44.97	12
SANTAROSA	63.75	24
9 DE OCTUBRE	44.80	7
PAOCOCHA	60.04	34
PAOYHAN	56.78	85
TOTAL	56.75	237

RESULTS

Of 1,445 individuals enumerated in *de jure* censuses of eight villages, 237 were reproductive-age women with sufficient reproductive histories to permit data analysis (Hern, 1988). The mean of all Individual Fertility Rates was 56.8

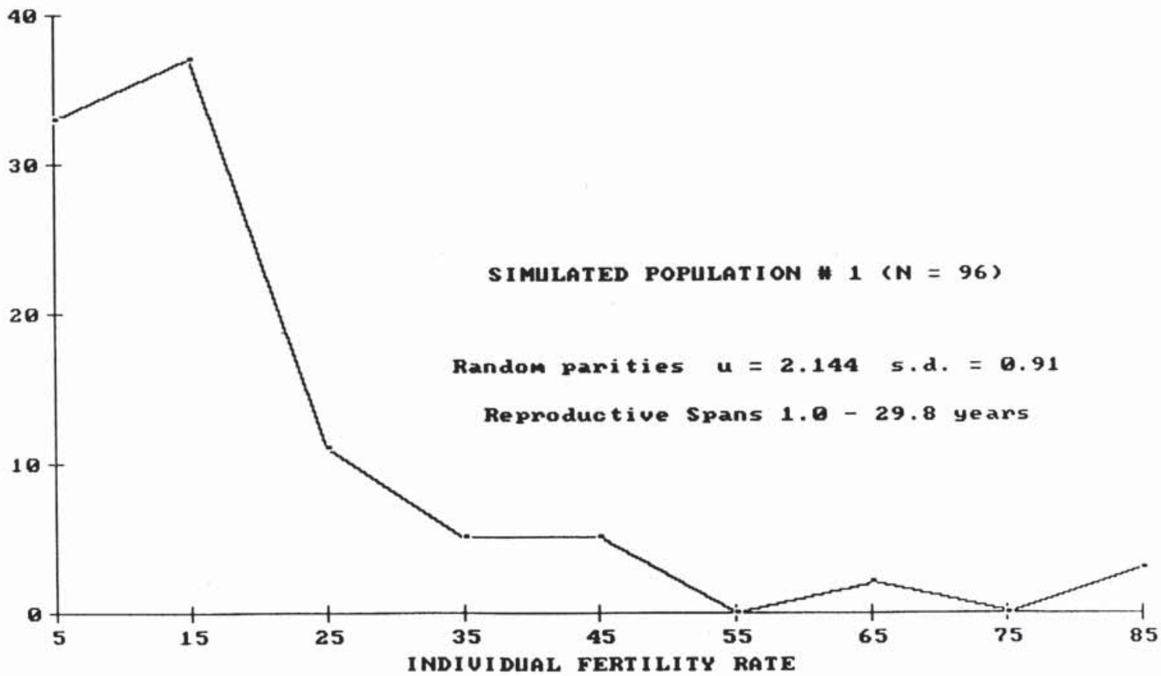

FIG. 2.—Simulated population #1 (N = 96).

with a median of 49.1 (Figure 1). The cumulative IFR for all the women of each village was calculated and ranged from 44.80 to 63.75 (Table 1). IFR is a continuous variable, but it may be made dichotomous by computation of a secondary variable, FERTCAT, which separates those categorized as Low Fertility (IFR = 0 − 45) from those with High Fertility (IFR = 45+).

The arbitrary FERTCAT classification permitted, in this case, discriminant analysis which yielded 86 members of FERTCAT = 1 and 149 members of FERTCAT = 2. The classification used resulted in correct classification of 72.1 per cent of Group 1 and 93.3 per cent of Group 2 with an overall correct classification of 85.5 per cent (Table 2).

To test further the characteristics and usefulness of the Individual Fertility Rate, I have constructed two simulated populations of 100 individuals, each with the same randomly selected repro-

TABLE 2

DISCRIMINANT ANALYSIS: GROUP CLASSIFICATION[a]

Actual Group	No. of Cases	Predicted Group Membership 1	2
Group 1	86	62 (72.1%)	24 (27.9%)
Group 2	149	10 (6.7%)	139 (93.3%)

[a] "Grouped" cases correctly classified = 85.53%.

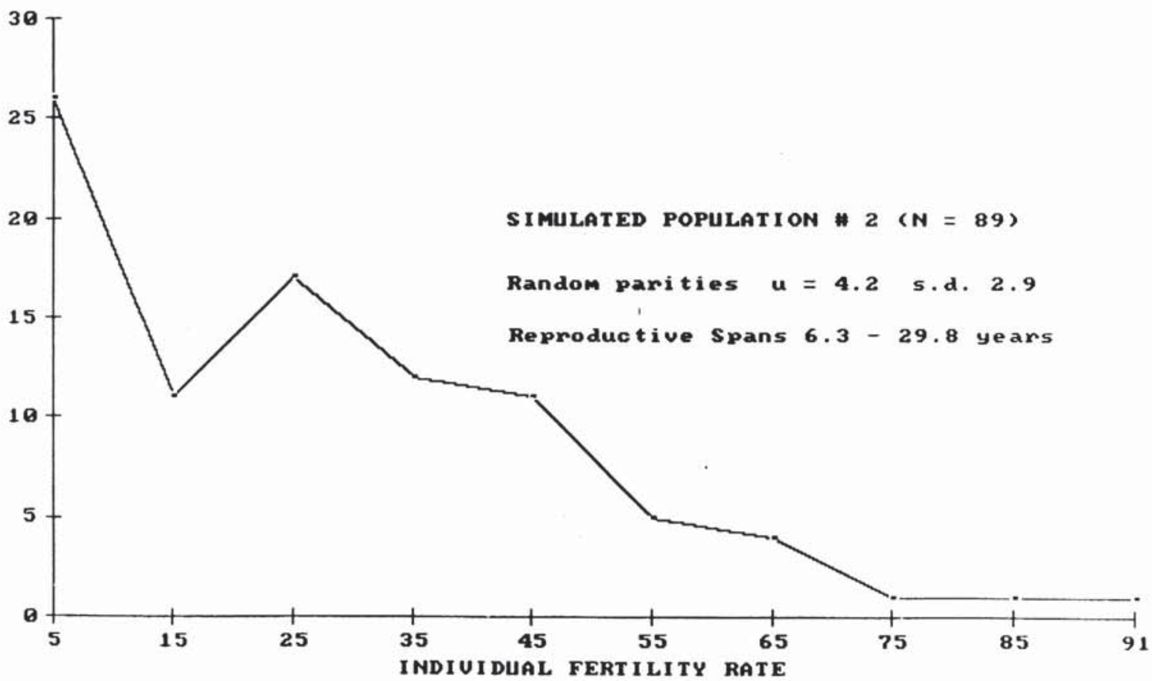

FIG. 3.—Simulated population #2 (N = 89).

ductive spans ranging from 0.75 to 30 years (Remington and Schork, 1970, p. 358). In one population, the parities were drawn from a random table of numbers with a mean of 2 and standard deviation of 1 (Dixon and Massey, 1957, p. 452) in order to approximate a Western industrial population. In the other, the parities were drawn from a random table of numbers ranging from 0 to 9 (Downie and Heath, 1965, p. 316).

In the first population (Figure 2), beginning with a normally distributed mean parity of 2.0, the mean IFR for 96 valid cases was 18.595, the median was 13.001, and the standard deviation was 17.549.[3] IFR values ranged from 1.154 to 90. Standard error was 1.791; kurtosis, 5.822; and skewness, 2.299.

In the second population (valid $N = 89$), with parities ranging from 0 to 9 (Figure 3), the actual mean parity was 4.225 with a median of 4.0 and standard deviation of 2.93.[4] For this group, IFR values ranged from 0 to 90.756 with a mean of 26.929 and median of 24.407; standard deviation was 21.789; standard error, 2.31.

These simulated populations show lower fertility than the real-life study population of Shipibo women, a result consistent with the high recorded community fertility among the Shipibo.

In order to test further the concept of an Individual Fertility Rate, I drew upon the reproductive histories of the first 504 of 1,323 individuals in the Com-

[3]Due to elimination of outliers beyond possible values in a real population, the actual mean parity for this group (valid $N = 96$) was 2.144 with a median of 2.20; mode, 1.4; s.e., 0.93; s.d., 0.910; kurtosis, −0.314; skewness, 0.099; minimum, 0.10; maximum, 4.2. Reproductive span actual mean was 16.568; median, 16.5; mode, 13.417; s.e., 0.772; s.d., 7.566; kurtosis, −0.905; skewness, 0.010.

[4]Mean reproductive span in years for this group was 17.67; median, 16.667; mode, 13.417; s.e., 0.714; s.d., 6.735; kurtosis, −0.107; skewness, 0.212; minimum, 6.33; maximum, 29.837.

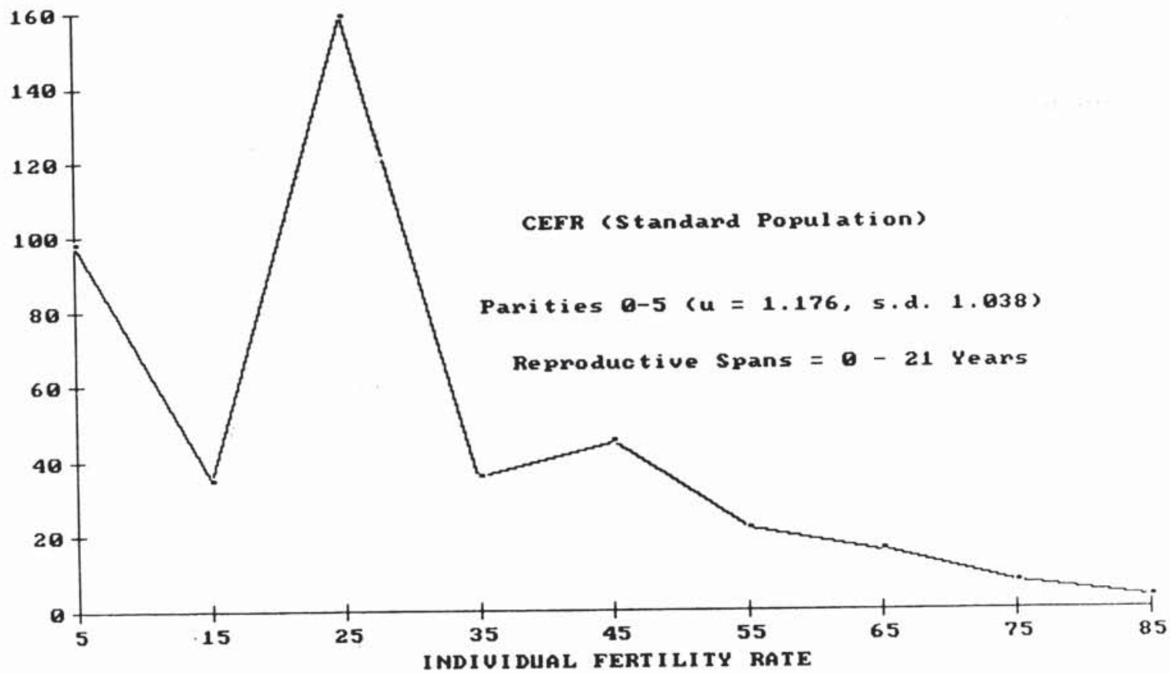

FIG. 4.—CEFR (standard population).

ponents of Effective Fertility Regulation (CEFR) study (Helbig et al., 1987). The IFR as used for the Shipibo population could not be applied because so few CEFR women had experienced more than one term birth. In fact, only 31 per cent of the CEFR women had experienced 2 or more births, while this was true of 74 per cent of the Shipibo women. Also, 54.7 per cent of the CEFR women had experienced one or more induced abortions, whereas only one of the Shipibo women gave a history of induced abortion. The rate of spontaneous abortions was similar for both groups at approximately 13 per cent. Because of these extreme differences in fertility experience, the original IFR formula could only be applied to 31 per cent of the CEFR population.

In order to devise a way of using the concept for both populations, I defined the reproductive span of the CEFR women as being bounded by the first and last "reproductive event": term birth, induced abortion, or miscarriage; and I determined that the mean reproductive span of the CEFR women with a span greater than zero was 61.9 months or 5.13 years. I also determined that the mean reproductive span of those with one or more induced abortions (but no term births) was 27.6 months (2.3 years). All CEFR women with 1 term birth were the assigned reproductive span values of 60 months, and those with 1 or more induced abortions (but no term births) were assigned reproductive spans of 28 months.

The result of this analysis showed the CEFR women (valid $N = 460$) to have a mean IFR of 33.9 and median IFR of 20.0, standard deviation of 38.9 and standard error of 1.8 (Figure 4). The distribution of values was strongly influenced by the large number cases of substituted mean values.

Application of substituted mean values in the same fashion with the Shipibo population did not seriously distort the results since so few of the Shipibo women (8 per cent) had experienced only one term birth.

DISCUSSION

There are several advantages to the Individual Fertility Rate as calculated here. It is independent of age and can be used when the age of the respondent is uncertain. It is independent of age at marriage, which has its own set of uncertainties. It is an incidence-density–type variable since it is a function of time (Miettinen, 1976; Morgenstern et al., 1980). It reflects intensity of fertility experience since it is current and can be used meaningfully for young women who have not completed their reproductive careers. By contrast, Age-Specific and Mean Completed Fertility are most useful for a large population containing a significant proportion of menopausal women with certain age data.

Without exception, measures of fertility used by demographers are aggregates. Debates concerning the use of Crude Birth Rate versus Total Fertility Rate, for example, are valid and interesting, but they do not help in resolving some of the issues faced in research with small populations (Entwisle, 1981). Aggregate measures may conceal important intragroup differences that are sources of confounding or of primary interest. In the study of rapidly changing and modernizing peasant societies, new demographic tools may be necessary to capture the details of change (Caldwell, 1982).

The IFR has similar advantages over another aggregate measure of fertility in populations with limited information, the Fertility Pattern Method (Wishik and Helbig, 1972).

In this study, IFR proved to be an extremely useful device for studying the effect of various independent variables on individual fertility.

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