Demographic Analysis of Small Populations Using the Own-Children Method

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This article discusses the own-children method, a reverse-survival technique devised by demographers to estimate Total Fertility Rates in the absence of detailed data on reproduction. The method is useful for researchers such as anthropologists since the basic data requirements can be met through a household survey. It can help researchers answer key questions concerning population processes within well-delineated social, cultural, economic, and political contexts. The author uses a historical tax register from Tibet to illustrate the steps taken when using the own-children method.

Keywords: *fertility; own-children method; demography; anthropology; Tibet*

$\mathbf{A}$nthropologists have a long-standing interest in population issues, yet until comparatively recently have lacked many of the tools and interdisciplinary connections to fully exploit their engagement with formal demographic analysis. The rise of microdemographic fieldwork approaches (Caldwell, Hill, and Hull 1988; Axinn, Fricke, and Thornton 1991) and the convergence of anthropology and demography have improved matters considerably, resulting in research that bridges methodological and theoretical chasms (e.g., Greenhalgh 1995; Kertzer and Fricke 1997b; Basu and Aaby 1998). One notable shortcoming of this convergence has been the tendency for demographers to relegate anthropological contributions to the domain of qualitative

fieldwork that is meant to lend a veneer of ethnographic substance to quantitative studies, what Kertzer and Fricke lamented as the "add fieldwork and stir" approach (1997a). Although I concur with this sentiment, I also believe that anthropologists have yet to take full advantage of the quantitative tools that demography has to offer—especially those techniques that have been developed to deal with situations in which data limitations hinder demographic analysis.

The purpose of this article is to discuss applications of the own-children method (henceforth OCM), a reverse-survival technique designed to calculate Total Fertility Rates in the absence of detailed data on reproduction. Reverse-survival, also called reverse-projection, uses a population's current age structure and assumptions about mortality to reconstruct that population's age structure at a previous time. The Total Fertility Rate (TFR) is a standardized measure of the average number of children that would be born to each woman if Age-Specific Fertility Rates (ASFRs, births in a year to women aged x divided by the number of women aged x at midyear) remain constant. The TFR is an estimate of the number of children that would be born to a hypothetical cohort of women, not to an actual cohort of women. Nevertheless, the TFR is a useful way of assessing the level of fertility experienced by a population.

OCM is relatively straightforward to use and can help answer key questions concerning population processes within well-delineated social, cultural, economic, and political contexts. In what follows, I describe methodological issues associated with OCM and illustrate the application of the method through a specific example from my own research on Tibetan historical demography (see Childs 2003). Many of the lessons derived from my application of OCM are relevant to other research projects since the data set that I use is roughly equivalent to the anthropologists' ubiquitous household survey. The ability to calculate TFRs from such a limited data source makes OCM a useful inclusion within a methodological toolkit.

DESCRIPTION OF THE OWN-CHILDREN METHOD

Cho, Retherford, and Choe (1986) are the authors of a manual that describes OCM and provides empirical examples to demonstrate the method's strengths and weaknesses. In brief:

> The own-children method of fertility estimation is a reverse-survival technique for estimating age-specific birth rates for years previous to a census or household survey. . . . The matched (i.e., own) children, classified by their own ages and mother's age, are then reverse-survived to estimate numbers of births

by age of mother in previous years. Reverse-survival is similarly used to estimate numbers of women by age in previous years. After adjustments are made for misenumeration (mainly undercount and age misreporting) and unmatched (i.e., non-own) children, age-specific birth rates are calculated by dividing the number of reverse-survived births by the number of reverse-survived women. Estimates are normally computed for each of the fifteen years or groups of years before the census. Estimates are not usually computed further back than fifteen years because births must then be based on children aged fifteen or more at enumeration, a large proportion of whom do not reside in the same household as their mother and hence cannot be matched. (pp. 1–2)

Data requirements for applying OCM are the following: (1) all children (aged zero–fourteen whose mother is identified) classified by age and mother's age; (2) all children (aged zero–fourteen whose mother is not identified) classified by age; (3) all women (aged fifteen–sixty-four) classified by age; (4) an estimation of child survivorship; and (5) an estimation of female adult mortality.

For the most part, OCM has been applied to large data sets such as national censuses from various countries (e.g., Retherford, Cho, and Kim 1984; Haines 1989; Retherford and Thapa 1998), yet has been underutilized in anthropological settings even though its potential was demonstrated long ago (Schroeder and Retherford 1979). From an anthropologist's perspective, the advantages of OCM include first and foremost the fact that it can be used in places in which systems of vital registration are absent. All one needs is a single census, preferably a household survey, in which it is possible to link children with their mothers. OCM can be cost effective since it eliminates the need to collect detailed reproductive histories or to conduct censuses at regular intervals. This is not to say that OCM should be considered an automatic substitute for the reproductive history survey, since the latter is indispensable for understanding phenomena such as birth spacing and infant mortality. As with all research, the choice of methods must concord with the questions being asked.

In the following sections, I walk readers through the steps required to apply OCM, with special attention paid to some key technical details. I preface that with an introduction to the data source used in my own study of Tibetan historical demography, since that data will be used to illustrate the methodological procedures associated with OCM.

OCM AND A TIBETAN TAX REGISTER

Kyirong, formerly a district-level administrative unit (*rdzong*) in Tibet, had a land-tenure system wherein all residents were subjects of land-owning

institutions, either a monastery or the government. All those who held a land-lease document were classified as "taxpayers" (*khral-pa*). Fraternal polyan-dry, the normative form of marriage, was practiced by taxpayer families to prevent the partitioning of heritable land leases. Those who held no such leases worked for wages on taxpayer land and were classified as "small householders" (*dud-chung-ba*). They rarely engaged in formal marriages with taxpayer households and almost never practiced polyandry.

Government lands were administered by a district commissioner (*rdzong-dpon*), who was dispatched from Lhasa, Tibet's capital. His duties included conducting periodic censuses of all government taxpayer households. The data source used in my research is one such census, the handwritten manu-script for which was completed, witnessed, and sealed by local officials in July 1958.

In the document, every taxpayer household is listed according to village. The head of the household's name is recorded first, followed by each mem-ber's name as well as his or her age and relationship to the head of household. Small householders are also listed, but not necessarily in conjunction with their families. A total of 2,844 individuals are recorded.

To make sense of this census, I interviewed 180 elderly people from Kyirong, most of who had been listed in the document four decades earlier. My purposes were to reconstruct household structures and histories and to gather pertinent ethnographic data. Household structures in 1958 were rela-tively easy for informants to recall because they could be pegged to the last time when traditional Kyirong society was intact. In 1959, Tibet lost all sem-blances of independence, and shortly thereafter China initiated major politi-cal and economic transformations. Through the interviews, I was able to acquire direct data (i.e., from a member of that household) or indirect data (i.e., from a relative or former neighbor) for 70% of all the households listed in the 1958 census.

DEALING WITH SOURCES OF BIAS

Age misreporting, the inability to accurately link children with their mothers, and migration are three issues that can compromise the validity of OCM fertility estimates. I deal with each of these below in reference to my research using the Kyirong tax document.

Age Misreporting

Age misreporting of children is the most serious threat to the validity of OCM fertility estimates since it can cause overestimates for some years and

underestimates for others (Cho, Retherford, and Choe 1986:48–54). This can be a substantial problem in societies in which a person's precise age is of little concern (e.g., Chagnon 1974), but it can be overcome through diligent ethnographic inquiries to understand how the people being studied "construct notions of time" (Hern 1995).

Tibetan societies are relatively easy to deal with in terms of age reporting. The Tibetan calendar operates according to a sixty-year cycle that consists of five (the number of elements) twelve-year cycles (the number of animal signs). When asked, a Tibetan may not be sure of his precise age. This is because he may consider the number of years that have elapsed since birth to be less important than the animal sign corresponding to his birth year (*lo-rtags*). Furthermore, Tibetans consider themselves to be one year old at birth and do not have birthdays. Everybody advances one year in age on the first day of the new lunar year. Thus, when gathering data for demographic analysis in a Tibetan context, the researcher must inquire about both the respondent's age and birth sign. The former is taken as a relative figure, whereas the letter can be converted more or less precisely into a Western equivalent. For example, one person informed me in 2000 that she was seventy-two years old. Simple arithmetic indicates that she was born in 1928. However, she also stated that she was born in a Snake Year (*sbrul-lo*), which corresponds with 1929. Knowledge of a person's *lo-rtags* and stated age are crucial for establishing that person's actual age (seventy-one) that is used for demographic analysis.

In the case of the Kyirong census, I was able to verify through interviews the ages and *lo-rtags* of roughly 150 people listed in the document. I found the data in the document to be remarkably accurate with respect to the Tibetan system of age reckoning. The data were made amenable to demographic analysis by subtracting one year from each person's recorded age, thereby bringing them into line with our own system of age reckoning.

Linking Children with Their Mothers

The misallocation of children through mismatching or failing to account for those who reside outside of the study area can be a minor source of bias in OCM fertility estimates (Cho, Retherford, and Choe 1986:36–45). Linking children with their mothers in census or survey data is not necessarily a straightforward task since social and biological parenthood are not always the same (Townsend 1997). For example, fosterage results in children living away from their natal households (Bledsoe 1990). Child abandonment has a similar effect. In Italy, before the twentieth century, unwed mothers were forced to give their illegitimate offspring to foundling homes (Kertzer 1993),

and in China today, the one-child policy has prompted parents to abandon millions of children (Johnson 1996). In both contexts, an attempt to apply OCM to census data will result in a low estimate of fertility if the abandoned children are not enumerated. On the other hand, if the children are erroneously matched with adoptive mothers, the fertility estimate will not be affected much, but the age pattern of fertility will be biased upward since the adoptive mothers may tend to be older than the birth mothers. If the children are enumerated in an orphanage or other such institution, then the fertility estimate will not be affected much since they are included in the non-own-children adjustment factor.

Linking children with their mothers in the Kyirong tax register is often straightforward since offspring are generally listed after their mother. The following household exhibits this principle:

Household example 1
Dawa, woman (*dman*), age fifty-nine; Döndrub the son (*bu*), age thirty-three; Tenzin the bride (*mna'-ma*), age thirty-one; Tashi the son (*bu*), age ten; Sangpo the son (*bu*), age four.

Dawa the widower is the mother of Döndrub. Döndrub's wife is Tenzin who gave birth to at least two sons (Tashi and Sangpo). Given the gap in ages between Tashi and Sangpo, it is quite possible that other children had been born but died prior to the census.

In many cases, illegitimate children can be linked with their mothers. Any woman listed as *bu-mo* (daughter) in the document had never been married but may have given birth to children out of wedlock. Consider the following household:

Household example 2
Nyima the head of household (*'dzin-mi*), age seventy; Ngawang the son (*bu*), age fifty-three; Wangdu the son (*bu*), age twenty-nine; Purbu the daughter (*bu-mo*), age twenty; Buti the daughter (*bu-mo*), age thirty-two; her son (*de'i bu*) Rigzen, age seven, Yangzom the daughter (*bu-mo*), age three.

Nyima is Ngawang's uncle (younger brother of Ngawang's deceased father). Ngawang, a widower, is the father of Wangdu and the unmarried sisters Purbu and Buti. Buti had given birth to two illegitimate children, Rigzen and Yangzom, who are listed after their mother. Buti is clearly identified as the mother by the pronoun "her" (*de'i*) that precedes Rigzen's name.

On the other hand, in some instances, illegitimate children were left behind in the mother's natal household when those women subsequently married. For example:

Household example 3
    Gyatso, male head of household *('dzin-mi khyo)*, age sixty-one; Samten the
brother *(spun)*, age fifty-one; Tashi the bride *(mna'-ma)*, age sixty-five;
Puntsok the son *(bu)*, age twenty-seven; Buti the bride *(mna'-ma)*, age forty-
seven; Zangmo the daughter *(bu-mo)*, age fifteen; Lhakpa the son *(bu)*, age
thirteen; Gyalpo the son *(bu)*, age fifteen.

In this household, two women (Tashi and Buti) are listed as brides.
Zangmo, who was interviewed, reveals that Tashi was the initial wife of the
polyandrously married brothers Gyatso and Samten. Later, Samten brought
Buti home to be his own bride, effectively dividing the household. Children
are generally listed beneath their mother in the tax register, and indeed
Puntsok was the son of Tashi. Based on this logic, we could assume that
Zangmo, Lhakpa, and Gyalpo were the children of Buti. However, Zangmo
stated that Gyalpo was not her brother but was the illegitimate son of Lhamo
(aged thirty-seven), Gyatso and Tashi's daughter. Lhamo later married, went
to live with her husband, and left Gyalpo behind in his grandparents' and
maternal uncles' household.
    Maternal mortality and remarriage is another factor to be reckoned with.
For example:

Household example 4
    Kunga, father and head of household *('dzin-mi pha)*, age fifty-eight;
Tsering the son *(bu)*, age fofty-five; Dolma the bride *(mna'-ma)*, age thirty-six;
Pasang the daughter *(bu-mo)*, age eleven; Kunchok the son *(bu)*, age one;
Norbu the son *(bu)*, age fifteen; Gyalmo the daughter *(bu-mo)*, age eighteen.

The relationships seem straightforward. Kunga is Tsering's uncle (youn-
ger brother of Tsering's deceased father). Tsering's wife is Dolma. Children
are generally listed after their mother, so one could assume that all four chil-
dren belong to Dolma. However, a former neighbor revealed in an interview
that Dolma was actually the second wife in the household. The first, Dolma's
elder sister, died after giving birth to Norbu (her second surviving child, the
first being Gyalmo). Only Pasang and Kunchok are Dolma's own children.
Norbu and Gyalmo need to be relegated to the category of non–own-children
in the application of OCM.
    OCM allocates unmatched children in proportion to matched children.
So, for example, if an illegitimate child is left behind in his mother's natal
household (household example 3), and if that child is inadvertently allocated
to a woman who lives in that household and who is older than the child's
actual mother, this would not affect the TFR but would bias ASFRs in favor
of elder women. Conversely, in household example 4 the absence of inter-

view data could have resulted in two children being mistakenly allocated to a woman who was younger than their mother. Doing so would bias ASFRs in favor of younger women. As mentioned above, data were obtained for 70% of all households listed in the document. Since the precise details for the other 30% of households remain unknown, linking children with their mothers depended on making judgments based on relationship terms and the order in which a household's members were listed. As a result, a few errors similar to those that were averted in the above descriptions may have crept into the analysis.

Migration

If migrants are a small proportion of the population, then migration is not a major source of bias in OCM fertility estimates (Cho, Retherford, and Choe 1986:6). However, population mobility is a common phenomenon today. Migration tends to be an age-specific phenomenon that typically adds or removes from a population a disproportionate number of people who are in their prime reproductive years. In general, a high rate of rural to urban migration will result in an elevated fertility estimate for urban areas since the children of migrants who were born in rural areas will be enumerated in their new place of residence. Conversely, fertility in a rural setting will be underestimated since those children born to people who subsequently migrated will not be counted.

Migration was not a major factor in Kyirong before 1958. The household interviews revealed that approximately the same number of people entered the region through marriage and other means as those who exited. Furthermore, as mentioned above, the major landholding institutions in Kyirong were the government and various monasteries. Since the tax document lists only government subjects, mobility between government and monastic estates would in effect be migration. For example, if a taxpayer belonging to a monastery took a bride from a government taxpayer's household, the woman would become a monastery taxpayer on marriage. In the context of this study, such a movement represents out-migration since the woman would no longer appear on the government's tax register. However, the loss of a taxpayer needed to be compensated through a "human exchange" (*mibrjes*), an administrative procedure whereby a person was officially transferred from one estate to another. A document was drafted to formalize the exchange, such as the following one from Kyirong.

Tsering Gyalmo, the sister of the government taxpayer Nyidön from Tsongdu [a village in Kyirong] was exchanged for Dawa, the daughter of Yudön who

belongs to Samtenling [a monastery in Kyirong]. Dated December 10th, 1947. (Schuh 1988:197)

Note that a woman was exchanged for a woman. Informants concur that most human exchanges involved the substitution of one marrying woman for another. The net result was zero migration between government and monastic estates.

Resolving the above issues is an important first step toward applying OCM. The next section will walk readers through data entry procedures.

DATA ENTRY

Usage of OCM is greatly facilitated by a free software program (EASWESPOP—Fertility Estimate Programs version 2.0) that can be downloaded from the East-West Center Program on Population's Web site (www.eastwestcenter.org). The program is easy to use, providing you understand the logic behind the method. Data-entry procedures are dealt with below in both general terms and with respect to my own research using the data from Kyirong.

1. *Survey/census year*: Enter the year that the data were collected, which was 1958 in the case of the Kyirong tax document.
2. *Age of oldest child*: If you are seeking retrospective fertility statistics for the fifteen years preceding the census, then the age of the oldest child will be fourteen since those born in the census year are aged zero. However, if you are seeking fertility statistics for only the previous five years, then the oldest child will be four.
3. *Highest age of women*: Demographers typically include women between the ages of fifteen and forty-nine in fertility calculations. Fertility in age groups younger than fifteen and older than forty-nine is generally negligible. Therefore, if one is seeking fertility statistics for the fifteen years preceding the census, then the age of the oldest woman will be sixty-four (fifteen years prior to the census she would have been forty-nine). If you are seeking statistics for only the previous five years, then the oldest woman will be fifty-four.
4. *Sex ratio at birth*: Generally, you should enter 1.05 as the sex ratio at birth because—all things being equal—more males tend to be born than females. Caution is advised for those working in settings (e.g., China, Korea, and India) in which modern technologies such as ultrasound have been linked with sex-selective abortions that result in skewed sex ratios at birth. The sex ratio of infants (ages zero–one) should not be used as a proxy measure for the sex ratio at birth because a higher or lower than expected sex ratio for infants may be the result of gender-based discriminatory childcare practices that have a postnatal affect on the pattern of mortality (Das Gupta 1987). The

Kyirong data were collected before the advent of prenatal sex-determination technologies, so I used a sex ratio at birth of 1.05.

5-9. *Type of mortality, life table region, and life expectancy at birth*: The OCM software prompts the user to select either a model life table from those generated by Coale and Demeny (1983) or a user-supplied life table, that is, one calculated specifically for the population under study. If you do not have enough age-specific mortality data for the population, then I would advise using the Coale and Demeny model life tables. Model life tables are statistical tools used for analyzing mortality by age and sex. Demographers have developed them to account for a wide range of mortality patterns and levels (for details on life table analysis, see Newell 1988). Remember, most model life tables were constructing using mortality data collected primarily in industrial societies and therefore may not be representative of mortality patterns in many places where anthropologists work. Although OCM fertility estimates are not very sensitive to mortality estimation errors (Cho, Retherford, and Choe 1986:45–47), care must be taken to choose those that best approximate the pattern of mortality in light of what scant information may be available.

If you choose to use the Coale and Demeny model life tables, then it is first necessary to select a regional pattern (North, South, East, or West). A basic understanding of age-specific mortality patterns in the area being studied helps one select the most appropriate pattern. North is characterized by low infant and old age mortality, but high adult mortality. South is characterized by high infant and childhood mortality (under five), low adult mortality, and high old age mortality (over sixty-five). East is characterized by high infant and old-age mortality, but relatively low childhood and adult death rates. The West pattern is considered somewhat of an average, being based on numerous data sets from different places. When in doubt, demographers recommend using the West pattern.

Life expectancy at birth (e_0 in life table notation) varies according to the level of mortality in the model life tables (1–20, with 1 being the highest level of mortality and 20 being the lowest). In the absence of direct measurement, selecting the life expectancy at birth requires at least one parameter. The Infant Mortality Rate (IMR; deaths within one year per 1,000 live births) is a good starting point. If you are reasonably confident of the IMR, which corresponds to $_1q_0$ (the probability of dying between birth and age one) in the model life table, then it is possible to figure out e_0 according to the selected mortality pattern. For example, if you are confident that the West pattern best represents mortality in the group under study, and have determined that the IMR is 160/1000, then female mortality Level 10 is the best choice, since $_1q_0$ is 161.93. Reading across the columns, you find the life expectancy at birth (e_0) to be 42.5, the value entered in this step.

I chose to use Coale and Demeny's South pattern (high mortality in infancy, childhood, and over sixty-five, moderate mortality in the middle years). To select the most appropriate level of mortality, I looked at IMRs from ethnically Tibetan communities in the Himalayan borderlands (e.g., Goldstein 1976; Levine 1987; Attenborough 1994; Wiley 1997; Childs 2001). Excluding the outliers, the IMR figures cluster around the 200/1000 mark, which corresponds most closely with female Level 7 of the Coale and Demeny South model life tables ($_1q_0$ is 198.64, e_0 is 35). Because I was unable to directly measure the level of infant mortality for Kyirong, I chose to bracket the most likely scenario (South Level 7) with results using other South model life tables having a range of $_1q_0$ that reflect IMRs between 161/1000 and 246/1000. Thus, I used a range of tables (South Level 4–Level 10), entering the corresponding life expectancies ranging from 27.5 to 42.5 years. A separate calculation was run for each level of mortality.

10. *The number of women at each age (fifteen to sixty-four)*: The maximum age of women entered is sixty-four, since OCM calculates TFRs for each of the past fifteen years. Fertility analysis includes women aged fifteen–forty-nine, so those women who are sixty-four at the time of the survey were forty-nine years old fifteen years ago. All women—regardless of marital status—should be included here.

11. *The number of children at each age (zero–fourteen) by age of mother*: This data entry step only includes those children who have been linked with their mothers. Extending beyond age fourteen is not recommended since older children are more likely to move out of their households and live elsewhere.

12. *Non-own (i.e., nonmatched) children*: Those children who cannot be matched with their mothers (i.e., adopted and foster children who live with another family but whose actual mother cannot be determined; children whose mother died or migrated elsewhere) are entered according to age.

13-14. *Underenumeration factor for children and women*: The user needs to consider whether to include an underenumeration factor for children and women. If you are confident that everybody was counted in the survey, then enter an underenumeration factor of 1. In places where children are sent out of the community they may or may not be recorded on a census or survey. It is then up to the researcher to arrive at an underenumeration factor based on an estimate of the percentage of children at each age who for whatever reason are not covered in the census or survey.

In most Tibetan societies, a significant number of children (more males than females) are sent away from their natal households to reside in monasteries. Kyirong was no exception. Once such children were ordained as monks and nuns, they were no longer classified as government taxpayers, and were not recorded in the tax register. Based on an estimate arrived at

through interviews and data on monastic enrollments, I judged that approximately 5% of children from government taxpayer households in Kyirong were sent to monasteries. However, most children were not sent before their eighth birthday. Therefore, I entered an underenumeration factor of 1 for ages zero–seven (no underenumeration), and of 1.05 for ages eight–fourteen (5% underenumeration).

RESULTS

After the data are entered, the program will calculate TFRs for each of the fifteen years preceding the census. The precise formulas and their derivations, which are too complex to present here, are fully elucidated in Cho, Retherford, and Choe (1986:8–13).

Results are in the form of ASFRs for each five-year cohort of women and the TFR, which is calculated directly from those rates (for ASFR and TFR calculations, see Newell 1988:39–42). Table 1 displays the ASFRs and TFR for Kyirong covering the period from 1944 to 1958 using the Coale and Demeny South Level 7 mortality pattern.

A TFR of 4.41 lies at the low end of the spectrum for those populations that do not practice deliberate birth control (Wood 1994). Part of the explanation can be seen in the ASFRs that peak among women in the twenty-five–twenty-nine age cohort, reflecting a delayed onset of childbearing. Reasons for the relatively low level of fertility are explored in Childs (2003).

As mentioned above, I feel that South Level 7 is the most reasonable mortality pattern given what we already know about infant mortality in nearby areas. Therefore, the TFR of 4.41 births per woman is my best estimate of fertility, albeit imperfect. In many communities studied by anthropologists, detailed mortality data does not exist, which is why it is advisable to bracket the most likely scenario within a range of possibilities. Table 2 shows TFRs calculated under different mortality assumptions.

If mortality is overestimated, then fertility is also overestimated, since more births are assumed to have occurred through reverse survival. Contrarily, if mortality is underestimated, then fertility is also underestimated, since fewer births are assumed (Cho, Retherford, and Choe 1986:45–47). That is why the estimates in Table 2 differ by one full birth. This variance underscores the importance of starting with the best possible estimate of mortality.

For large populations, the time depth of fifteen years can help identify trends such as a recent onset of fertility decline. Caution is advised when working with small populations because the rates can vary from year to year

TABLE 1
ASFRs and TFR for Kyirong 1944–1958 at South Level 7 Mortality

Women's Age	ASFR	TFR
15–19	31.1	
20–24	141.2	
25–29	208.7	
30–34	193.9	
35–39	183.5	
40–44	99.3	
45–49	23.8	
		4.41

NOTE: ASFR = Age-Specific Fertility Rates. TFR = Total Fertility Rate.

TABLE 2
Kyirong Total Fertility Rates from Different Mortality Levels

South Level	$_1q_0$	e_0	TFR
4	246	27.5	4.99
5	229	30.0	4.77
6	213	32.5	4.57
7	199	35.0	4.41
8	185	37.5	4.26
9	173	40.0	4.14
10	161	42.5	4.02

NOTE: TFR = Total Fertility Rate. $_1q_0$ = probability of dying between birth and age one. e_0 = life expectancy at birth.

due to random factors. Table 3 shows annual TFRs for Kyirong at South Level 7 mortality.

TFRs in Table 3 range from a high of 8.0 (1948) to a low of 1.3 (1955), meaning that any single year may be anomalous. For small populations, the combined figure for all years, rather than any figure for an individual year, is a more reliable estimation of fertility.

RESEARCH APPLICATIONS

OCM can be used as a validity check on a fertility rate calculated through other methods. In Sama, an ethnically Tibetan village in Nepal, I conducted a reproductive history survey and then used the data to calculate a TFR for the

TABLE 3
Kyirong Annual TFRs at South Level 7 Mortality

Year	TFR	Year	TFR	Year	TFR
1944	3.8	1949	4.0	1954	5.4
1945	4.1	1950	3.8	1955	1.3
1946	5.3	1951	5.1	1956	4.3
1947	3.5	1952	3.9	1957	4.1
1948	8.0	1953	5.6	1958	4.3

NOTE: TFR = Total Fertility Rate.

period from 1990 to 1996 (Childs 2001). I subsequently used OCM to esti-
mate fertility from data obtained through a household survey. Using South
Level 6 and 7 model life tables (IMR of 220/1000 in Sama), I obtained TFR
estimates of 5.52 and 5.32, respectively. These figures are only slightly
higher than the TFR of 5.25 calculated directly from the fertility history sur-
vey. In this case, OCM provides a valuable validity check.

Here is an example in which the calculation of TFRs can help clarify theo-
retical connections between population dynamics and resources. According
to one hypothesis, settlers in a frontier area of low population density experi-
ence a higher fertility rate than those in the more densely populated areas that
the settlers left behind (Easterlin 1971). Labor requirements in agricultural
settlements on the frontier increase in response to more extensive economic
strategies. In the context of low population density, a family must depend
first and foremost on its own members to satisfy labor requirements, a situa-
tion that is conducive to high fertility. As more settlers create a correspond-
ing rise in population density, the advantages of large families diminish,
thereby leading to a fertility reduction within a generation or two. Such
trends have been validated in several studies of the American frontier
(Easterlin 1976; Bean, Mineau, and Anderton 1990).

The links between frontier settlement, labor requirements, and household
sizes have been studied extensively by anthropologists working in Nigeria
(Stone, Johnson-Stone, and Netting 1984; Netting, Stone, and Stone 1996;
Stone 1996). In the 1950s, many Kofyar families began migrating from the
densely populated Jos Plateau to the surrounding lowlands, where land was
plentiful and cash-cropping opportunities abundant. In doing so, they altered
their household labor requirements. Once the land constraint was removed,
production became more dependent on the labor that could be mobilized
from within the household. Household expansion became the primary strat-
egy for meeting the new labor requirements, which led to a discernable

increase in the average household sizes of the migrants. To some extent, household sizes increased through the addition of more wives and by the retention of married sons (Stone, Johnson-Stone, and Netting 1984). Still unanswered in this research is whether the new labor demands actually led to changed reproductive strategies.

Detailed household surveys were conducted at both the sending and receiving ends of the migration stream, therefore OCM can be used to determine if there was a significant fertility difference between the densely populated plateau and the sparsely populated frontier. Finding such a difference would provide empirical validation that the move to a frontier was associated with a change in reproductive behavior. Answering this question would then permit an investigation into the factors that led to higher fertility, such as earlier and more universal marriage for women, decreasing birth intervals through a reduction in the duration of breast-feeding, and so forth.

Anthropologists who are concerned with the relevance of demographic processes to their own research questions are often confronted with a dilemma—how to estimate vital rates in places in which systems of vital registration do not exist and in fieldwork settings where conducting reproductive history interviews or other time-consuming survey techniques are impractical or unfeasible. In such cases, OCM holds great potential for providing insights into the dynamics of fertility. All one needs is a household survey, something that many of us do anyway, and proper coding procedures so that children can be linked with their mothers. Fertility can then be calculated according to whatever other characteristics (education, ethnicity) that are also recorded in the survey to better understand the connections between reproduction and other variables.

REFERENCES

Attenborough, R. 1994. The population of Stongde, Zangskar. In *Himayalan Buddhist villages*, edited by J. Crook and H. Osmaston, 295–330. Bristol, UK: University of Bristol.

Axinn, W. G., T. E. Fricke, and A. Thornton. 1991. The microdemographic community study approach. *Sociological Methods & Research* 20 (2): 187–217.

Basu, A. M., and P. Aaby, eds. 1998. *The methods and uses of anthropological demography*. Oxford, UK: Clarendon.

Bean, L. L., G. P. Mineau, and D. L. Anderton. 1990. *Fertility change on the American frontier: Adaptation and innovation*. Berkeley: University of California Press.

Bledsoe, C. 1990. The politics of children: Fosterage and the social management of fertility among the Mende of Sierra Leone. In *Births and power*, edited by W. Penn Handwerker, 81–100. Boulder, CO: Westview.

Caldwell, J. C., A. G. Hill., and V. J. Hull, eds. 1988. *Micro-approaches to demographic research*. London: Kegan Paul.

Stone, G. D. 1996. *Settlement ecology: The social and spatial organization of Kofyar agriculture*. Tucson: University of Arizona Press.

Stone, G. D., P. Johnson-Stone, and R. M. Netting. 1984. Household variability and inequality in Kofyar subsistence and cash-cropping economies. *Journal of Anthropological Research* 40 (1): 90–108.

Townsend, N. 1997. Reproduction in anthropology and demography. In *Anthropological demography*, edited by D. Kertzer and T. Fricke, 96–114. Chicago: University of Chicago Press.

Wiley, A. S. 1997. A role for biology in the cultural ecology of Ladakh. *Human Ecology* 25 (2): 273–95.

Wood, J. W. 1994. *Dynamics of human reproduction: Biology, biometry, demography*. New York: Aldine de Gruyter.

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