Does Polygyny Reduce Fertility?

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ABSTRACT Polygyny can increase, decrease, or have no effect on fertility. Understanding how this can occur requires consideration of both the proximate determinants of fertility and the ultimate effects of polygyny as a female reproductive strategy. Several factors reduced the fertility of polygynous women in 19th century Utah, including marrying at an older age, marrying older men, and conflict between co-wives. Sterility did not explain the reduced number of children in polygynous women, nor is there evidence of a "dilution effect" from sharing a husband. If women could anticipate a reduction in their own fertility, why would they still choose polygyny? Evidence suggests that they chose it because the children of polygynous men had increased fertility, high enough to offset the low fertility of polygynous women themselves. Am. J. Hum. Biol. 14:222–232, 2002. © 2002 Wiley-Liss, Inc.

Studies of the relationship between polygynous marriage and fertility have yielded mixed results (Josephson, 2000). Although demographic studies vary greatly in methods and efficacy, they provide some idea of the range of results found in polygynous groups world wide. Of 86 studies reviewed, 64 concluded that monogamous women had higher fertility than polygynous women, a tendency often glossed as the "polygyny–fertility" hypothesis (Anderton and Emigh, 1989; Sichona, 1993; Bean and Mineau, 1986). This hypothesis is often disputed and for good reason: 7 studies concluded that polygynous women had higher fertility than local monogamous women, and 15 studies concluded that polygyny had no effect on fertility.

There are two alternative explanations for this inconsistency. It could be the result of error, as some of the conclusions may be wrong. The demographic studies vary greatly in sample size, quality of information, and effectiveness of analysis. Some authors did not collect quantitative data and based the conclusions on unsupported opinions (Podlewski, 1975; Schwetz, 1923). Other studies reported quantitative information, but did not use statistics to evaluate apparent differences, making it impossible to tell whether the differences were significant (Adewuyi, 1988; Hemerijckx, 1948; Vincent, 1951). Complicating matters further, the studies used a variety of methods to estimate fertility, which makes it difficult to directly compare results. Any of these sources of error could be responsible for the mistaken impression that polygyny has an inconsistent affect on fertility.

On the other hand, the inconsistency may indicate that polygyny has a genuinely variable affect on fertility. This would mean that the argument for or against the polygyny–fertility hypothesis is unlikely to be resolved, because there is no simple pattern that holds everywhere. One impediment is that researchers, with few exceptions, have focused only on the proximate determinants of fertility (Borgerhoff Mulder, 1988; Bongaarts et al., 1984; Low, 1991). These are a necessary component for understanding the relationship between polygyny and fertility, but they are only part of the answer. The purpose of this article is to explain how polygyny could produce such a varied effect on fertility.

Proximate determinants of fertility

Researchers have proposed a number of mechanisms to explain why polygynous women exhibit reduced fertility, only some of which have found support. Culwick and Culwick (1939) and Musham (1956) posed the first detailed explanation: a "dilution effect" from polygynous men sharing their reproductive output among several women. If men have a limited coital budget, having more than one wife should reduce the frequency of intercourse for all. The result could be reduced fertility in polygynous wives, but the evidence for this is mixed (Dorjahn, 1959; Olusanya, 1971; Pebley and Mbungua, 1989; Borgerhoff Mulder, 1990).

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There is little direct evidence for a linear relationship between coital frequency and fertility (Garenne and van de Walle, 1989), or even that polygynous women experience reduced coital frequency (Bhatia, 1985; Sichona, 1993). This does not mean that a dilution effect can be ruled out, for all polygynous groups only that such an effect is not an inevitable result of polygynous marriage.

Another possibility is that sterility is responsible for the reduction in polygynous fertility. Sterility can result in several ways, and be either permanent or temporary. Primary sterility might cause polygynous marriage when men married to sterile women take additional wives in order to have children (Pebley and Mbungua, 1989). This idea finds support in cross-cultural studies that show a correlation between polygynous marriage and the intensity of pathogen load (Low, 1988). Temporary sterility can result from abstinence or contraceptive use, both of which may be more prevalent in polygynous women (Sichona, 1993; Shaikh et al., 1987; see also Kabera and Ntozi, 1988). Even so, the influence of sterility is likely to vary between groups, as the prevalence of both primary and secondary sterility varies considerably.

Other research has suggested the importance of age, both in women and their husbands. Women who marry polygynously are often older than women who marry monogamously (Bean and Mineau, 1986; Bongaarts et al., 1984; Bhatia, 1985), and there is evidence that older women are less fecund (Wood, 1994; Hill and Hurtado, 1996). Men also experience reduced fecundity with age, so women marrying older men polygynously are marrying men who are probably less fecund than available bachelors. Men are usually a decade or more older when they marry for the second time, a serious consideration for second and later wives (Josephson, 2000; Sichona, 1993; Bean and Mineau, 1986; Anderson, 1975; Ukaegubu, 1977; Bhatia, 1985).

Conflict between co-wives may also reduce the fertility of polygynous women. This explanation has received comparatively little attention and even less support, but there are reasons for anticipating such conflict (Borgerhoff Mulder, 1988; Garenne and van de Walle, 1989; Strassman, 1997; Ward, 1937; Bongaarts et al., 1984). Ethnographic and historic evidence suggests that conflict between co-wives can be intense and enduring, not surprising given that co-wives are often unrelated to each other (Clinget, 1970; Ware, 1979). From the perspective of each co-wife, her husband's other children are unrelated to her and are, in fact, competitors for her own children. It should not be surprising then that polygynous co-wives attempt to interfere with each other's reproductive efforts (Garenne and van de Walle, 1989), and simply being a polygynous co-wife may reduce fertility even when other factors are controlled (Josephson, 2000).

Although important in and of themselves, the influence of these proximate determinants of fertility cannot be understood without considering how they affect, and are affected by, a woman's choice of husband (see Low, 1991). Whether or not these factors will come to bear depends on whether women are willing to marry polygynously. For polygynous marriages to occur, men must either coerce women into becoming second and later wives or entice them into choosing polygyny. Where coercion by men is possible, there is little reason to expect polygyny to represent the reproductive interests of women (Chisholm and Burbank, 1991; Chagnon, 1983). Far more often women choose to marry polygynously, and if they can anticipate that this will lower their fertility, the question becomes why they are willing to do so.

Choosing polygyny

Where women can choose between polygyny and monogamy, the proximate mechanisms of fertility are only part of the story. If women are aware that choosing polygyny will expose them to factors that reduce their fitness, there may not be any polygynous marriages for us to observe. This assumes that polygynous women actually choose polygyny, and on this basis, we can distinguish two types of polygynous co-wives.

Polygynous first wives are different from second and later wives in that they did not choose polygyny, at least, not at first. First wives face two decisions in their reproductive careers. They originally chose to marry monogamously but later chose to become polygynous by staying with their husband when he remarried (Bongaarts et al., 1984). Only second and later wives truly choose polygyny, in that they willingly marry men who already have a wife or wives. The distinction between these types of polygynous wives is important because first wives do not choose polygyny so much as have it thrust on them. Staying with their now-polygynous husband may be the better of two bad alternatives. However, because it is not known if first wives are free to choose, there is little reason to expect polygyny to represent their reproductive interests. Second and later wives, on the other hand, could have chosen monogamy but married polygynously. For them, exposure to the fertility-reducing factors of polygyny was a matter of choice rather than a dilemma forced on them by their husband.

There are also empirical reasons for discriminating between first wives and second and later wives. There is evidence that the fertility of first wives is often different from that of second and later wives. Sixteen of the studies reviewed in Josephson (2000, in prep.) include information about the fertility of polygynous women by wife order, and most indicate substantial differences, although not always in the same direction. The majority of studies indicate that first wives have higher fertility than their cowives not surprising given that first wives may avoid many of the factors that second and later wives are subject to throughout their reproductive careers. A dilution effect, for example, could affect second and later wives disproportionately, because first wives spend much of their reproductive careers as monogamous women (Josephson, 2000). Such issues could present methodological problems because simply lumping first wives and second and later wives together may obscure the differences between them.

For these reasons, polygynous first wives were omitted in this analysis. This should permit a clearer examination of the effects of polygynous marriage, because second and later wives spent their entire reproductive careers as polygynous women. This will also make it possible to examine the process by which women choose between reproductive strategies, as each of these women chose between monogamy and polygyny and experienced the outcome of their choise.

Although second and later wives chose polygyny, this does not mean that polygynous marriage necessarily represented their reproductive interests. Even when men can not force women into polygyny, they may be able to deceive them about their already-married status. Women can be fooled into marrying polygynously, although this is likely more common in other species, where the mating status of males is more difficult to verify (Davies, 1992; Josephson, 2000). It is also possible that second and later wives simply made a poor choice, either because they could not anticipate the factors that would reduce their fertility, or because they were unable to gauge their effects (Symons, 1989; Borgerhoff Mulder, 1991).

Because there is evidence that choosing polygyny can have an effect on reproductive success, it is reasonable to suggest that this decision has been exposed to and shaped by natural selection (Boyd and Richerson, 1985; Cashdan, 1993). This article, therefore, entertains the hypothesis that second and later polygynous wives behave adaptively and that polygyny reflects their reproductive interests. This has direct implications for understanding the proximate determinants of fertility, because women choosing polygyny should be able to anticipate and evaluate the factors that will affect their fertility. Otherwise, they should avoid problems by marrying monogamously. They should be willing to marry polygynously only if it offers them at least as high a fitness payoff as monogamy (Orians, 1969; Becker, 1981; Davies, 1992). These predictions can be tested by examining the proximate mechanisms that affect fertility and the fitness outcomes of female strategies in a group that allows both polygynocess and monogambud marriages.

METHODS

The sample

The sample was composed of the reproductive histories of 201 women, all 19th century members of the Church of Jesus Christ of Latter-day Saints (Mormons). Mormonism originated in upstate New York in the 1830s and grew to several thousand members within a decade (O'Dea, 1957; Young, 1954; Brodie, 1945). By the 1860s, this population had grown larger than 50,000, although it is very difficult to estimate how many of these people were married polygynously (May, 1992; Josephson, 2000). The highest-ranking members began to secretly practice polygyny in the 1840s, then openly after the church moved to Salt Lake City in 1847 (May, 1992; Logue, 1985). Polygyny persisted until the 1890s when the church abolished the practice under pressure from the federal government (Brodie, 1945; Campbell and Campbell, 1992).

This group is ideal for studying the relationship between polygyny and fertility for several reasons. Previous studies indicate that this group had natural fertility, with little evidence for the use of contraceptives or deliberate fertility control (Anderton and Emigh, 1989; Bean et al., 1978; Mineau et al., 1979). They also had fairly simple and well-defined marriage customs, obviating the methodological problems that arise when studying groups that have a more gradual marriage process (Pebley and Mbungua, 1989; Borgerhoff mulder, 1989). There is also little credible evidence that women were coerced into polygynous marriages, or that polygynous men attempted to conceal their already-married status (Kunz, 1980; O'Dea, 1957; Embry, 1987).

As in most polygynous cultures, the majority of marriages were monogamous. Polygynous marriages were by no means rare in this group even though the practice was widely denounced by non-Mormons (Brodie, 1945; Ivins, 1956). It is difficult to know what proportion of marriages were polygynous because they were usually not officially recorded, but estimates range between 2% and 25% (Essholm, 1913; Berrett, 1973; Lever, 1898; May, 1992). This is comparable to other polygynous cultures where polygyny is legal and has a long history (Flinn, 1981). Census records from this period show a slight male bias, so there is no reason to suspect that women were forced into polygynous marriage because of a lack of single men (May, 1992).

This sample was gathered using methods designed to avoid ascertainment bias from the female perspective. A list of women who married between 1840 and 1865 was generated by examining announcements in a period newspaper, the *Deseret News*, and from records identifying polygynous men (Essholm, 1913; K. Heath, personal communication). This was done to avoid a problem common to retrospective studies: women who had few or no offspring tend to be under-represented in samples ascertained via their descendants (Pennington and Harpending, 1992). Each woman's reproductive history was researched for two complete generations at the Family History Library in Salt Lake City, Utah (Bean et al., 1980).

Although the sample is not biased from the perspective of wives, the same is not true from the perspective of husbands. The sample included the reproductive histories of 83 men, 43 monogamous and 40 polygynous. The average number of wives for polygynous men was 5.3, which seems a bit high compared to other, larger studies of this population (e.g., 3.9 in Bean and Mineau, 1986). The distribution of number of wives suggests that highly polygynous men were over-represented (Fig. 1), which was not surprising given that these men were ascertained via their wives. Men with many wives are more likely to appear in this sample. Indeed, an unbiased estimate of the average number of wives in this sample (using the harmonic mean, see Josephson, 2000, Appendix 1) yields an estimate of 3.9, much closer to previous estimates. Although this sample might overestimate the average reproductive success of polygynous men, this should not present a problem for the present analysis because the focus is on the reproductive success of women.

The records for these women were unusually complete for a historic population.

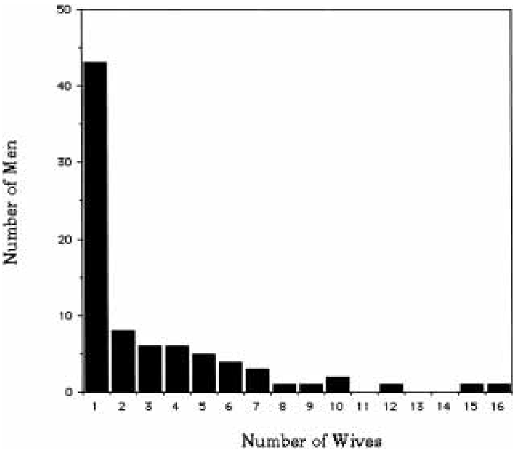

Fig. 1. Men in the sample and their number of wives. There are 83 men total, 43 monogamous and 40 polygynous.

For most individuals, the records included dates for birth, death, marriage, and the birth of all children. Fifty women in the sample married a single man who never remarried while still married to them, while 151 women married men who already had a wife or wives. Although the majority of children in this sample were born to polygynous second and later wives (Fig. 2), this is not a problem if we use methods that are not affected by disproportionate representation.

At the simplest level, there is evidence that women who chose polygyny had reduced fertility. Second and later polygynous wives averaged significantly fewer children than monogamous women (3.84 ± 0.578, n = 151, vs. 6.30 ± 1.38, n = 50, P = 0.0001),[1] a result seen in other studies of this population (Bean and Mineau, 1986; Smith and Kunz, 1976; Kunz and Smith, 1974; Ivins, 1956). This is consistent with the majority of polygynous groups for whom there is information. By itself, however, the number of children cannot be taken as evidence that polygyny reduces fertility. The problem is that completed fertility is subject to many different factors, including issues of divorce and remarriage, or even the question of what constitutes a marriage (Dorjahn, 1959; Sembajwe, 1979; Johnson and Elmi, 1989). Number of children may also be too crude a measure to discern the proximate mechanisms that underlie it. Nevertheless, several possibilities can already be ruled out.

Sterility does not seem to decrease the fertility of polygynous women in this sample. Although sterility lowers the average fertility in this group, there is little evidence that sterile women are more likely to marry as second and later polygynous wives. It is true that more second and later wives than monogamous women in this sample had no children; 23% (35 of 150), compared to 12% (6 of 49) for monogamous women. Then again, this difference may reflect the influence of factors other than sterility. It is interesting to note that 17% (25 of 150) of second and later wives were older than 30 when they married, compared to only 6% (3 of 50) of monogamous women. If older women are more likely to be childless than younger women, then age at marriage could explain the apparent difference in childlessness. More significantly, fertility differences remain even when childless women were eliminated from the sample. If only women who had at least one child are considered, monogamous women still averaged more children than second and later polygynous women (7.31 ± 1.38, n = 44, vs. 4.95 ± 0.571, n = 115, P = 0.0002).

Duration of exposure to risk of pregnancy can also be eliminated as an explanation for the lower fertility in polygynous women. If we assume that exposure to risk of pregnancy begins when women marry and ends when they die, their husband dies, they divorce, or they pass the age of 50, then women with longer reproductive careers should be able to have more children (Wood, 1994; Bongaarts, 1983). Duration of exposure sums many of the factors that could differentially lower the completed fertility of polygynous women, including an increased likelihood of becoming widows or divorcing (Dorjahn, 1959; Sembajwe, 1979). Yet monogamous women and second and later polygynous wives in this sample were very similar in the duration of their reproductive careers. Monogamous women averaged 19.95 (±2.89, n = 49) years, whereas second and later polygynous wives averaged 17.69 (±1.72, n = 140) years; these values are statistically indistinguishable (P = 0.1830). The durations of the two types of women were limited by different factors (Josephson, 2000), but it is clear that duration in and of itself cannot account for the differences in completed fertility.

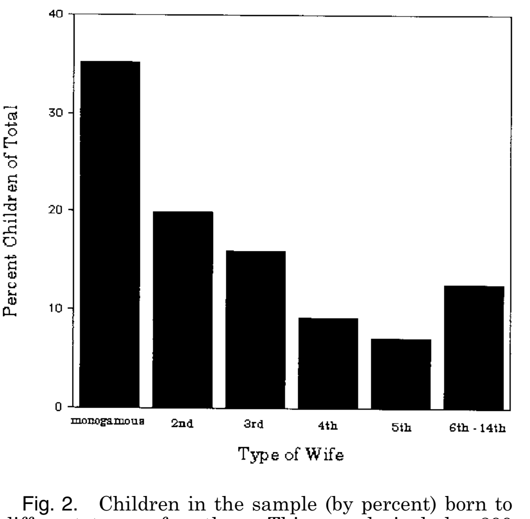

Fig. 2. Children in the sample (by percent) born to different types of mothers. This sample includes 899 children born to monogamous and polygynous 2nd through 14th wives.

[1]All tests two-tailed t-tests with pooled variance.

Polygynous women did differ from monogamous women in ways likely to reduce their fertility. Second and later polygynous wives were significantly older than monogamous women on average when they married (24.17 ± 1.302, n = 140, vs. 20.05 ± 1.375, n = 48, P = 0.0022). This probably reduced the completed fertility of second and later wives somewhat (Ukaegubu, 1977; Ahmed, 1986; Bean and Mineau, 1986), but other factors must also have contributed. Figure 3 shows the age-specific fertility (ASF) of monogamous and second and later polygynous women. It seems that second and later wives had lower ASF at all ages (Josephson, 2000). However, the figure does not show whether the differences are significant (an issue that will be taken up shortly), but it is certain that this is not an artifact of age at marriage. ASF includes only women who were already married and is not affected by the age structure of the population. There is no reason why women who married at an older age should also have lower ASF, so there must be other factors at work (see Bongaarts and Potter, 1983; Bongaarts et al., 1984).

One possible factor is the age of the women's husbands. Second and later polygynous wives often marry men who are much older than the husbands of monogamous women, and this could explain some of the difference in fertility (Sichona, 1993; Ukaegubu, 1977; Bean and Mineau, 1986). The husbands of second and later polygynous men in this sample were much older than the husbands of monogamous women (40.47 ± 0.78, n = 139, vs. 24.89 ± 0.85, n = 48, P < 0.0000). If male fecundity decreases with age, this could help explain the differences in ASF; yet other factors may have contributed to this result.

The number of factors that can decrease fertility highlights the limitations of many of the previous studies of polygyny and fertility. Alternate measures of fertility are sensitive to different factors, which makes it possible to come to different conclusions using different methods in the same group (Pebley and Mbungua, 1989). This problem limits the ability to directly compare different studies (Sichona, 1993). In addition, many studies considered only one or two factors, leaving open the possibility that other factors were also involved. Parceling out the different factors requires a method that permits an independent estimate of the effects of these factors.

Cox regression was used to examine how several covariates affect women's risk of pregnancy. A proportional hazard model is useful for examining the risk of experiencing an event such as a birth as a function of the covariates that condition the underlying risk (Suchindran et al., 1985; St. George et al., 2000). The dependent variable in this case is the interval from marriage to first birth or the interval between births, with

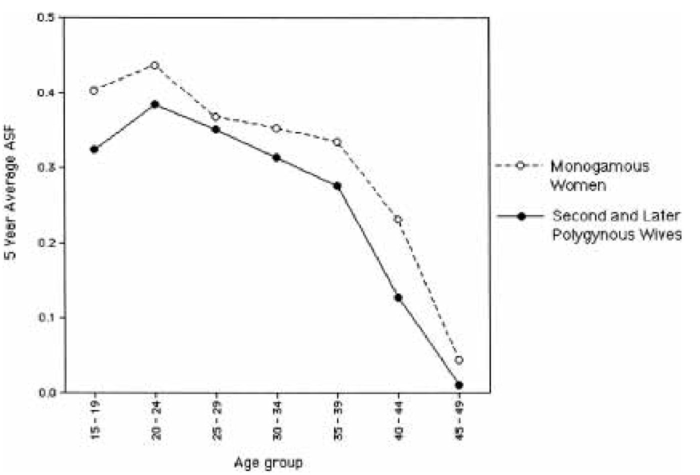

Fig. 3. The age-specific fertility of monogamous women and polygynous second and later wives. On the y-axis are the 5-year average age-specific fertility, and on the x-axis are the women's 5-year age groups. Data are from Josephson (2000).

the null hypothesis that each covariate had no effect on the risk of pregnancy.

Cox regression is especially useful in this case because it enables maximum use of information. Many of these intervals did not end in a birth, but were, instead, terminated by some other factor, such as a woman's death, passing the age of 50, the death of her husband, or divorce. All women in the sample contributed at least one of these "censored" intervals, since all ended their reproductive careers in one of these four ways. Censored intervals did not end in a birth, yet they also contain information about the risk of pregnancy. Simply discarding censored intervals would be wasteful and unwise, because this could introduce bias (Allison, 1984). Fortunately, Cox regression can incorporate both censored and uncensored intervals in the hazard function (Norusis, 1949; Cox, 1972).

The method assumes that each of the intervals is independent, but this is unlikely to be strictly true under most circumstances (Cox and Oakes, 1984; Kalbfleich and Prentice, 1980). This is especially so here, because most of the women in the sample contributed more than one interval. Intervals from an individual woman are unlikely to be independent, but this can be evaluated by including as a covariate the length of the previous interval from each woman (Allison, 1998). This was done for the model below and the length of the previous interval did not have a significant effect on the length of the next interval ($\beta = 0.0001$, β SE = 0.0001, Wald = 1.0129, $P = 0.3142$). The cases will, therefore, be treated as independent and this covariate was excluded from the subsequent analysis.

Five covariates were included in the model to help discriminate between the mechanisms that mediate fertility:

Woman's age: coded as a categorical variable in 5-year age groups (15–19, 20–24, etc.)

Husband's age: also coded into 5-year age groups

Number of wives: a numeric variable that gives the number of wives a man had at the beginning of the interval

Number of previous children: a numeric variable that gives a woman's number of previous children whether they were alive or dead

Polygynous or monogamous: coded as 0 or 1, showing whether the interval came from a monogamous or polygynous woman

Although they are numeric variables, the age of women and men were coded categorically by 5-year intervals. This was done because age may have a nonlinear effect, and a categorical coding allows examination of how the effect of age changes over time.

RESULTS

The 201 women in the sample contributed 1006 intervals, of which 154 (15.3%) were censored. Age of both women and their husbands, number of previous children, and whether or not a woman was polygynous had a significant impact on risk of pregnancy, whereas the total number of wives did not (Table 1).

Age had a profound effect on a woman's risk of pregnancy. The null hypothesis that the effects associated with both husband's age and women's age were equal to 0 can be rejected ($P = 0.0013$ and $P = 0.0000$, respectively). It is also apparent that the effect of age varied over time. The e^{β} column within each variable shows the effect of each age group relative to the final age group, which is not included. Men were vastly more fecund at earlier ages than older. Risk of pregnancy diminishes as men age, but it is interesting to note that the effect of men's age is relatively consistent over much of their lifetime. The effect of women's age is similar: women between the ages of 15 and 19 are 5 times more likely to have a child than women between the ages of 45 to 49, controlling for other variables. The relative risk decreases over time in a way similar to their husbands, but the decrease in risk occurs over a much shorter interval.

A woman's number of previous children also had a significant effect on her risk of pregnancy. As seen in the e^{β} column, a woman's risk of having a child increases 16.7% for each child she has had already. It is not certain whether this affect is linear, but it is highly significant ($P < 0.0000$).

There is also a significant effect of simply being a polygynous second and later wife, which persists even when other covariates are controlled. Expected time to giving birth is 37% shorter for monogamous women than it is for second and later wives, a sig-

TABLE 1. Hazard regression of factors on the inter-birth intervals for monogamous and second and later polygynous wives

Variable	β	β SE	Wald	df	Significance	e^{β}	Mean
Husband' s age (years)			36.8875	15	0.0013		
15–19	5.1177	19.7885	0.0669	1	0.7959	166.9441	0.0000
20–24	2.3078	19.7666	0.0136	1	0.9071	10.0519	0.0219
25–29	2.1309	19.7659	0.0116	1	0.9141	8.4225	0.0626
30–34	1.9747	19.7656	0.0100	1	0.9204	7.2047	0.0855
35–39	1.6494	19.7654	0.0070	1	0.9335	5.2037	0.1243
40–44	1.5439	19.7653	0.0061	1	0.9377	4.6826	0.1561
45–49	1.3632	19.7653	0.0048	1	0.9450	3.9087	0.1600
50–54	1.3688	19.7654	0.0048	1	0.9448	3.9305	0.1521
55–59	1.2250	19.7655	0.0038	1	0.9506	3.4042	0.0984
60–64	1.1884	19.7657	0.0036	1	0.9521	3.2817	0.0636
65–69	0.8461	19.7666	0.0018	1	0.9659	2.3305	0.0328
70–74	0.7335	19.7684	0.0014	1	0.9704	2.0824	0.0199
75–79	−7.5330	81.9844	0.0084	1	0.9268	0.0005	0.0060
80–84	−0.2984	19.7876	0.0002	1	0.9880	0.7420	0.0010
85–89	−6.8648	216.7830	0.0010	1	0.9747	0.0010	0.0000
90–95	—	—	—	—	—	—	—
Wife's age (years)			181.2718	6	0.0000		
15–19	1.6576	0.1620	104.7115	1	0.0000	5.2466	−0.0775
20–24	1.0024	0.1108	81.8066	1	0.0000	2.7248	0.0517
25–29	0.6828	0.0912	56.0256	1	0.0000	1.9793	0.0785
30–34	0.3478	0.0880	15.6152	1	0.0001	1.4160	0.0746
35–39	0.1326	0.0941	1.9845	1	0.1589	1.1417	0.0547
40–44	−0.3223	0.1269	6.4513	1	0.0111	0.7245	0.0308
45–49	—	—	—	—	—	—	—
Number of previous children	0.1559	0.0218	51.0586	1	0.0000	1.1687	3.6630
Monogamous or polygynous wife	0.3153	0.1295	5.9245	1	0.0149	1.3706	0.6700
Number of co-wives	−0.0160	0.0145	1.2185	1	0.2696	0.9841	4.0805

−2 log likehood = 9842.473

nificant advantage (P = 0.0149). This is consistent with the results of other studies of this population (Bean and Mineau, 1986), and with the decreased ASF in second and later wives that we saw in Figure 3.

Last, a woman's number of co-wives does not have a significant effect on the risk of pregnancy. This does not reflect a lack of variation in this covariate; although each of the intervals from monogamous women had a value of 1, all of the intervals from second and later wives had a value of 2 or more. Second and later wives outnumbered monogamous women in the sample 3:1, which explains why the mean for this variable is just over 4. Most of the intervals in this model came from women who had many co-wives, yet the effect of this covariate is not significant when the effects of simply being polygynous are controlled.

DISCUSSION

The results show that polygyny reduced fertility in this group and how this happened. There is little evidence that a dilution effect, sterility, or deliberate fertility control reduced the fertility of polygynous women. Age and conflict between polygynous co-wives reduced the fertility of second and later wives, but this alone cannot explain why this decrease is there to be observed. This can only be because women chose polygynous marriage despite the decrease in fertility.

There is little indication of a dilution effect in this sample even though many of the women had many co-wives. A dilution effect implies that men divide their time roughly equally among co-wives, which is consistent with observations in many polygynous cultures (O'Dea, 1957; Goody, 1973; although see Pebley and Mbungua, 1989). More wives should mean greater dilution, yet intervals from women with few co-wives were no different than intervals from women with many co-wives. This is consistent with results from other studies of this population, which found that higher-order co-wives in two-wife families experienced similar decreases in fertility as those in larger families (Bean and Mineau, 1986; Josephson, 2000; Smith and Kunz, 1976; Kunz and Smith, 1974).

The results also suggest that the differences in fertility between monogamous and polygynous women are unlikely to be the result of sterility. As seen before, the differences in completed fertility persisted when childless women were removed, but the hazard model used intervals from all women. Childless women contributed only censored intervals to the model, and they were at least partially responsible for the significant effect of the number of previous children. This is because women who had many children likely had them more closely together than women who had few. This factor may highlight the distinction between fecund and sterile women, but it does not eliminate the difference in risk between polygynous and monogamous women.

Consistent with the results from other studies, a woman's age had a significant effect on her risk of pregnancy. Because second and later wives are often older at marriage than monogamous women, this factor explains at least some of their reduced number of children (Ahmed, 1986; Bean and Mineau, 1986; Smith and Kunz, 1976). Second and later wives were several years older on average when they married, and this likely contributed to the difference we saw in number of children. Why older women in this group seem to be more likely to marry polygynously is a question dealt with elsewhere (Josephson, 2000), but age at marriage explains only a small part of the reduction in number of children.

Marrying older men also lowered the fertility of polygynous second and later wives. The effect of husband's age was significant overall, but it varied depending on a man's age. The decrease was less for women marrying men in their 30s than for women marrying men in their 60s, yet the impact on number of children is subtle at best. If men's age had a significant effect on the completed fertility of their later wives, there should be a decreasing number of children with increasing wife-order. There is little evidence of such an effect in this sample, as all second and later polygynous wives averaged a similar number of children (Josephson, 2000). Marrying an older man was not an unimportant issue, but it was not the most important factor decreasing the fertility of polygynous women (Garenne and van de Walle, 1989).

The greatest effect may have come from conflict between polygynous co-wives. As mentioned previously, there are reasons for anticipating such conflict and the results are consistent with this hypothesis. Even after for the effects of other variables are controlled, monogamous women were at a much greater risk of pregnancy than polygynous second and later wives over all intervals. Second and later wives may have been older when they married, but this could only have contributed to their lesser number of children, not their lower ASF. These women also married older men, yet the effect on number of children is small. Only other co-wives stand to gain by this reduced fertility, so it is interesting to note that polygynous first wives seem to suffer far less from polygynous marriage (see Josephson, 2000, for details; also Bean and Mineau, 1986). Exactly how this cost was exacted is beyond the scope of this sample, but this has profound implications for when and where we see polygynous marriages (Josephson, in prep.).

One important implication of these results is that second and later wives were probably aware, (in an evolutionary sense if not consciously) of the risk of reduced fertility when they married polygynously. These women certainly knew their own age and that they were marrying an older, already-married man, but they chose polygyny anyway (Embry, 1987; Young, 1954; see also Ware, 1979). Interestingly, the factors women probably could not assess either do not affect fertility or do not influence a woman's choice of husband. There were childless women in this population, but there is little evidence that these women were more likely to marry monogamously or polygynously (Josephson, 2000). Because there was no evidence of a dilution effect, women considering polygyny did not need to worry about suffering an unforeseen reduction in fertility should their husband take subsequent wives (Bean and Mineau, 1986). Previous wives were a problem, but again, women were no doubt aware when they married of their impending status as a polygynous co-wife.

If these women 'knew' that choosing polygyny meant having reduced fertility, the question becomes why they did not simply choose monogamy. Where women choose between monogamy and polygyny, polygynous marriages should be seen only when women find it acceptable. More often than not, polygyny has a negative effect on fertility, and yet these cases are there to see.

There must be a reason why women in these groups still opt for polygynous marriage.

The answer may lie in the long-term reproductive effect of polygyny for women. It was assumed earlier that women choose reproductive strategies in order to maximize their fitness, but this does not necessarily mean that this will maximize their fertility (Lack, 1968; Borgerhoff Mulder, 1998). In this sample, there were benefits from marrying polygynously as well as costs: the children of polygynous men averaged more offspring than the children of monogamous men (4.84 ± 0.749, n = 116, vs. 3.32 ± 0.975, n = 43, P = 0.0227). The way this happened strongly suggests that men were responsible for this reproductive enhancement (Josephson, 2000), but what is important here is the effect on the reproductive success of polygynous second and later wives. Choosing polygyny meant having fewer children, but it also meant that these children would have high fertility. The cost and the benefit balanced; second and later wives ended up with an equal number of grandchildren as women who chose monogamy (16.97 ± 2.95, n = 151, vs. 20.08 ± 5.95, n = 49, P = 0.3169). In this group at least, second and later wives may have been willing to marry polygynously because it offered them the same long-term result as monogamy.

This may explain why there is no simple relationship between polygyny and fertility cross culturally. This relationship depends on a combination of proximate determinants and women's selection of long-term reproductive strategies. Where polygyny has a positive effect or no effect on fertility, it should be no surprise that women are willing to marry polygynously. Where polygyny has a negative effect on fertility, women might still be willing to choose it if their loss is offset by some benefit. In any case, we must consider not only the proximate determinants of fertility, but how fertility fits into women's long-term reproductive strategies. The relationship between fertility and polygyny is likely genuinely variable and only comprehensible by considering the processes that underlie it.

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