Is Polygyny a Risk Factor for Poor Growth Performance Among Tanzanian Agropastoralists?

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KEY WORDS East Africa; Sukuma; seasonal variation; nutritional status; marital status; mixed models

ABSTRACT Anthropologists and demographers have devoted considerable attention to testing the fertility-polygyny hypothesis, which posits that polygynously married women have lower fertility than their monogamously married counterparts. Much less attention has been paid to the potential impact of polygynous marriages on the health and well-being of children. The objective of this paper was to assess whether polygynous marital status is a risk factor for poor nutritional status and growth performance among a cohort of young Tanzanian children. Using data collected from both wet and dry season periods, we tested for an association from both cross-sectional and longitudinal perspectives. Despite relatively high nutritional status compared to other agropastoralists and horticultural populations, as well as the presence of various socioecological factors that were expected to mitigate any “costs” to polygynous marriage, we found that among our target population, polygynous marital status is a risk factor for poor growth performance. This association is most pronounced in the wet season, and maintains even after allowing for the potential influences of child age and sex, and household characteristics. These results counter our original expectation, and suggest that polygyny is costly to children in this population; this does not appear to be the result of difference in early child environment or household wealth. Am J Phys Anthropol 126:471–480, 2005. © 2004 Wiley-Liss, Inc.

Considerable research by demographers and anthropologists has been devoted to testing the “polygyny-fertility hypothesis,” which posits that polygynously married women have lower fertility than their monogamously married counterparts. Anthropological interest in this hypothesis lies primarily in identifying any fitness costs to polygyny in the hopes of understanding something about reproductive decision-making within societies, and more broadly, about the marked cross-cultural diversity in marriage systems (Borgerhoff Mulder, 1988; Chisholm and Burbank, 1991; Heath and Hadley, 1998; Josephson, 2002; Sellen, 1999; Strassmann, 1997). The results from both demographical and anthropological studies are mixed, with many but not all studies showing a fitness cost to polygynously married women. (Josephson, 2002). Curiously, in spite of these groups’ considerable interest in the subject of polygyny, very few studies investigated the association between polygynous marital status and children’s nutritional status. This is especially surprising, given the large numbers of children who may be at an elevated risk of poor nutritional status because of the high prevalence of polygyny in sub-Saharan Africa countries (Timaeus and Reynar, 1998). In addition to the public health implications, knowledge of the links between polygyny and children’s nutritional status is imperative to understanding the processes that may underlie any association between fertility and polygyny, and critical to the testing of many hypotheses derived from evolutionary theory.

The objective of this paper, therefore, is to assess whether polygynous marital status is a risk factor for poor nutritional status and growth performance among a cohort of young Tanzanian children. The study subjects are Sukuma agropastoralists living in the land-rich Rukwa region of Tanzania. The data are presented for both the wet and dry seasons, periods roughly corresponding to the maxima and minima of household food security and morbidity.

In general, it is hypothesized that polygyny leads to deleterious health outcomes because, holding resources constant, an additional wife leads to fewer resources for everyone in the family (Brabin, 1984). If true, this “resource dilution” should first manifest itself in terms of lower nutritional status and then higher mortality among children with currently polygynously married mothers (Brabin, 1984). How-
ever, like life-history tradeoffs in general (Lessells, 1991; Tracer, 1991), any “cost” to children with polygynously married mothers may only be detectable in particularly marginal environments, or during particularly stressful periods of the year such as the preharvest “hunger” periods. Thus, failure to identify any costs in any one population may be due in part to different overall levels of nutritional status between populations, or within populations, to sampling during periods of high food security and low prevalence of morbidity.

Despite the sound theoretical and public health reasons for studying the relationship between polygyny and child health, very few studies have actually explored this topic. This may be due to the fact that studies seeking to explore the relationship between polygyny and maternal and child health with a prospective study design are often at a disadvantage, as prospective studies are expensive and time-consuming, and require large sample sizes. Anthropologists interested in the relationship between polygyny and child health have thus relied on retrospective data collection or family records, neither of which is entirely satisfactory. Besides issues of data quality, if a relationship is identified, often little or no evidence exists to understand the processes that may underlie it.

In contrast to the difficulties inherent in prospective studies of child mortality, cross-sectional and longitudinal designs using anthropometry offer relatively efficient and powerful means to investigate the relationship between polygyny and child health. A large number of children can be measured in a single field season, and the measures are informative about the different living conditions of the children being measured. That is, anthropometric measurements, although nonspecific (Gibson, 1990), are sensitive to variation in parental care (Panter-Brick, 1998). Children can also be measured in different seasons to assess how their nutritional status changes with varying levels of food security and morbidity (Tomkins, 1993; Ulijaszek and Strickland, 1993a,b). Importantly, recent work suggests that mortality, morbidity, fertility, and children’s nutritional status are all intimately interlinked phenomena, and thus derived anthropometric indices of children’s nutritional status can serve as a proxy measure for risk of mortality (Pelletier, 1994; Schroeder and Brown, 1994; Tomkins and Watson, 1989).

To date, two studies have empirically assessed the association between polygyny and the nutritional status of children, both of which identified health costs to polygynously married women and their children. The prospective study by Strassman (1997) investigating child mortality also included some secondary data on children’s nutritional status. The data from the Dogon suggest a weak relationship between children’s nutritional status and their mother’s marital status. Although the nutritional status of children living in compounds with a high ratio of married women to married men was slightly lower than that of children of monogamous mothers, the association was only marginally significant, and prompted Strassmann (1997, p. 693) to conclude that “the mechanisms causing low child survivorship in polygynous families were probably not nutritional.” Measuring children’s nutritional status was not the primary objective of this study, and she used only one measure of nutritional status, weight-for-height, which when low is a signal of short-term nutritional stress (WHO, 1998). Further, only a portion of the complete sample was measured, thereby introducing a potential bias. The anthropometric data were also collected during the dry season, and thus may not represent the lowest point of children’s nutritional status.

Using data collected in a cross-sectional survey of Datoga mothers and their children in Tanzania, Sellen (1999) showed that even after controlling for the influence of wealth, age, and maternal characteristics, Datoga children born to polygynously married first wives present with particularly poor nutritional status, and this is especially pronounced among children associated with poorer households. Compared to monogamous women, first and second wives also presented with significantly lower measures of energy balance (body mass index; BMI). This was a surprising result, given that Datoga women appear to have considerable control over the household herd, and Sellen (1999; see also Sellen et al., 2000) concluded that contrary to expectation, polygynous marriage is costly for some Datoga women. The results of Sellen (1999) pertain to a politically and geographically marginalized and increasingly impoverished segment of Tanzania (Sieff, 1999), and therefore polygyny may exacerbate the already low levels of nutritional status. For these reasons, it is important to assess the external validity of the Datoga results.

Here we ask whether polygyny is associated with diminished nutritional status in a population where average levels of nutritional status are relatively high. That is, does polygyny affect nutritional status regardless of overall levels of nutritional status, or is it only in particularly impoverished areas that polygyny is “costly” to women and children? To illustrate the generally higher levels of nutritional status, in a recent study of Datoga pastoralists, Sellen (2000, p. 767) noted that 45% of all women measured presented with BMI below the 18.5 cutoff, the currently accepted cutoff for being “at risk of chronic energy deficiency” (Ferro-Luzzi et al., 1992). In marked contrast to the Datoga, previous work among the Sukuma subjects of this paper showed that less than 5% of the women presented with a BMI less than 18.5. Of course, such interethnic group comparisons should be used cautiously because of possible genetic differences between groups. However, further evidence of the relatively high nutritional status of the Sukuma subjects of this paper comes from an analysis of a cross-sectional study,
which showed that Sukuma children enjoy much greater nutritional status than the Pimbwe, a group of horticulturalists who also occupy the study area (Hadley, 2002). This may be because, compared to their horticultural neighbors, the Sukuma appear to enjoy high levels of household food security that buffers them through wet seasons (Brockington, no date; Hadley, 2002).

In addition to the relatively high nutritional status among the Sukuma, the presence of several socioecological factors is also expected to mitigate any negative effects of polygyny on children’s health. Brabin (1984) pointed out that polygyny is expected to be associated with poor nutritional status when land and resources are scarce, and this will be exacerbated when there are few alternative economic activities available for women. For the Sukuma, the latter is certainly true. Women have exceedingly few alternative options, and stories abound about women stealing from their husbands to purchase household goods like soap. Land, however, is not scarce in this frontier area of Tanzania’s Rukwa region, and therefore is not likely to be a limiting factor. There is also evidence that women have considerable control over their choice of husband. Polygyny is the preferred marital form and is highly prevalent, but women appear to have considerable freedom in their choice of husband (although the actual arrangements are done through their parents). One indication of the freedom women have in choosing their husbands is the practice of chagulaga. Chagulaga occurs after dance competitions and other large gatherings, when a number of young males surround a young woman and chase her until she chooses a young man to discuss a possible romantic meeting in the future. The process continues, and other young men are chosen until finally one male is guaranteed a meeting with the young woman. Traditionally, this has been a formal marriage market for parents searching for husbands for their daughters.

Thus, Sukuma agropastoralists in this area enjoy high mean levels of nutritional status, and land for herding and farming is abundant. Moreover, ethnographic data and household surveys show an abundance of food and few problems with seasonal food insecurity, a result of their reliance on both agriculture and livestock. Lastly, women have considerable freedom of choice in who they marry. For all these reasons, we expected there to be no difference in the nutritional status of children of monogamously married and polygynously married mothers.

STUDY SITE AND SUKUMA ETHNOGRAPHY

The study site in the Rukwa region of southwestern Tanzania (Fig. 1). The region is considered one of the more remote regions of the country in terms of state infrastructure. Throughout the Rukwa region, roads are dirt and villages have no electricity, and few have running water. In the main village at the study site there are a few small stores, a health clinic, and some government offices for the district. The area is marked by heavy rains (600–900 mm/year), beginning in November and culminating in March. Malaria is endemic in the area.

The Sukuma, the largest ethnic group in Tanzania, are a group of Bantu speakers who in recent years have moved from Shinyanga throughout Tanzania and, within the last 30 years, into the study area (Brockington, 2001; Galaty, 1988). The Sukuma in the study area are sedentary and practice a mixed economy, herding cattle and cultivating large plots of maize and rice (Coppolillo, 2000). Herd sizes range from 1–200, and approximately half of the households who participated in this research had at least some cattle. This means that many households had very few cattle, and about half had none; the Sukuma in this area rely heavily on agriculture. Harvest of maize begins in June, but new maize is available as early as late March.

Households are widely scattered in the area surrounding settled villages. Sukuma households in the study area are extended patrilocal and patrilineal, and modal household size is 8 people, but can be as large as 45. Women move into to their husband’s compound upon marriage. Marriages come with a bride wealth payment, usually in cattle, and divorce is extremely rare in this population. A typical settlement (Swahili: mji, compound/settlement) consists of a number of small buildings, constructed of poles and mud, which are organized in clusters near acacia thorn-enclosed livestock corrals. Livestock such as goats and chickens often roam freely throughout the compounds. Individuals occupying
the same compounds work together and share fields and other household duties. Men are primarily responsible for rice farming and the sale of any crops; women and older girls are responsible for childcare, household chores, and agriculture work; and small boys (and to a lesser extent girls) are responsible for tending cattle and small stock. Among polygynous households, cowives reside in the same compound, often sharing the same house, and all women and children eat together from a common pot. After about 1 year, children’s diets are dominated by maize, spinach and other wild greens, milk, and some meat.

**DATA COLLECTION AND ANALYSIS**

A cross-sectional anthropometric survey was conducted in the late wet-early dry season of 2001 (April, survey 1) in the village of Kibaoni to collect baseline data on children’s nutritional status as part of a study comparing the growth of horticulturalist and agropastoralist children. In the wet season of 2002 (February, survey 2), these children were measured again. Similar protocols were used in each season, except that in 2001, weighing was done at a central location. The central location was used to reduce time in transport and setup. Village leaders were asked to assist, and they called people to a central location on a prespecified day for weighing and measuring. Because of weather (muddy trails, heavy rain) in the wet season (February 2002, survey 2), many people were unwilling to walk to a central location and, to avoid sampling bias, households were visited individually.

Children’s height and weight were measured using standard procedures (Frisancho, 1990; Gibson, 1990; Shorr, 1986). Unfortunately, very young children frequently were not measured for length during the April 2001 study because of the mother’s reluctance to lay their children on the measuring board. In contrast, nearly all of these children were measured for length in the 2002 study because of the mother’s willingness to assist, and they called people to a central location. The anthropometric data were converted to z-scores using Epi-Info, the CDC’s free program that represents standardized deviations from the reference median that is constructed by measuring healthy age- and sex-matched children whose growth has been largely unaffected by undernutrition and frequent bouts of infection. The reference is not a standard per se, but allows comparisons to be made across a range of study sites and ethnic groups. Low values of HAZ, or stunting, are indicative of slightly shorter-term nutritional stress. Low WHZ, or wasting, is also indicative of short-term nutritional stress (Gibson, 1990). Following standard public health protocols used when the...
relationships between anthropometric measurements and functional impairment and mortality are unknown for a specific population, children presenting with weight-for-age z-scores less than −2 WAZ are considered underweight, children with −2 HAZ are considered stunted, and children with a WHZ less than −2 are considered wasted (WHO, 1998).

Two-tailed t-tests are used to explore differences between mothers, and children’s anthropometric indicators by women’s marital status (and the non-parametric Wilcoxon test when sample sizes are below 20 per group). Chi-square tests are used to explore differences in percent prevalence of stunting, wasting, and underweight among children. Multivariate regression models are fit to control for the potential influence of children’s age, sex, and household wealth. In addition to ordinary least squares (OLS) regression models, hierarchical level models (using the MIXED procedure in SAS; Littell, 1996) were also used to assess the influence of mother’s marital status on children’s nutritional status while controlling for children’s age, sex, and other covariates. These models accommodate the clustering that is inherent in the data because multiple children from one mother were weighed, as were multiple mothers from a single compound. This is necessary, because children of the same mother (and mothers from the same compound) are not truly independent, and thus potentially violate an important assumption of OLS regression; ignoring this issue increases the probability of rejecting the null hypothesis when it is in fact true (Singer, 1998). Maternal and compound effects are neither presumed nor ignored, but rather treated as a hypothesis to be tested. All non-significant interactions were dropped from the models. Results are considered significant at the 0.05 level and marginally significant at or below the 0.10 level.

RESULTS

Mothers were first compared to assess whether polygynously married women differed from monogamously married women in ways that may affect their children’s nutritional status. To test this, t-tests were used to compare mothers with regard to their age, education, height at survey 1, weight in surveys 1 and 2, household wealth (aggregate measure of livestock, land, and material wealth), and parity and number of children who died. Monogamously married women were statistically indistinguishable from their polygynously married counterparts on each of these variables (Table 1). It is notable that monogamously married women and polygynously married women also had access to similar numbers of cattle and goats (Cattle Polygynous 31 ± 65 Range 200, monogamous 34 ± 67 range 200; Goats: Polygynous 12 ± 11 range 40, monogamous 13 ± 12 range 40). This is not surprising, given that many compounds housed both monogamous and polygynously married women, all of whom shared the compounds’ resources.

Complete weight series were available for 105 children (47 with monogamous mothers) from 29 polygynously and 21 monogamously married women who lived in 32 different compounds. Completed height series were only available for 54 children, 29 with monogamous mothers. At baseline, the sample of children with polygynously married mothers did not differ in age and sex (Table 2). Nor did the number of children younger than 3 years differ between the polygynous (poly) and the monogamous (mono) sample (51% poly vs. 53% mono, $\chi^2 = 0.02$, $P = 0.88$); this is important because most growth faltering occurs prior to age 3 (Table 2). Considerably more girls than boys were weighed and measured (62% girls, binomial $P = 0.008$), but there was no age difference between boys and girls (boys, 38.21 ± 40; girls, 38.21 ± 32.0; t-test, $P = 0.14$). Because of the small sample sizes and because the age and sex distributions of the monogamous and polygynous samples are statistically indistinguishable, all analyses were conducted on the full sample.

Bivariate tests

In the dry season of 2001, 14% of 105 children were underweight, 20% of 54 were stunted, and 6% of 54 were wasted. There were no differences in the prevalence of any indicator between sexes. Children of polygynously married mothers presented with a slightly greater prevalence of underweight (18% poly vs. 8% mono mothers), but this difference was not statistically significant. Children of monogamously married mothers and children of polygynously married mothers also did not differ in their WAZ scores, although mean values for children in the polygynous group were about 0.30 WAZ below the monogamous group. No difference was observed in the HAZ scores for all children, although the sample was quite small for this indicator.

In the wet season of 2002, weight data were available for all 105 children. Height data were available for 100 of these children (43 with monogamous mothers). Overall, 17% of children were underweight, 24% were stunted, and 3% were wasted. Again, there were no differences in prevalence between sexes, but there were differences between monogamous and polygynous children (Fig. 2). In this season, children of polygynously married mothers presented with a increased prevalence of under-

### Table 1. Baseline characteristics of study mothers

<table>
<thead>
<tr>
<th>Variable</th>
<th>Monogamous</th>
<th>Polygynous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education (years)</td>
<td>0.86 ± 1.7</td>
<td>0.76 ± 1.7</td>
</tr>
<tr>
<td>Age (years)</td>
<td>25.19 ± 4.1</td>
<td>26.48 ± 6.1</td>
</tr>
<tr>
<td>No. of children born</td>
<td>3.62 ± 1.9</td>
<td>3.59 ± 2.7</td>
</tr>
<tr>
<td>No. of children died</td>
<td>0.67 ± 0.9</td>
<td>0.48 ± 0.8</td>
</tr>
<tr>
<td>Weight in 2002 (kg)</td>
<td>57.9 ± 7.1</td>
<td>55.3 ± 6.8</td>
</tr>
<tr>
<td>Weight in 2001 (kg)</td>
<td>57.77 ± 9.0</td>
<td>55.47 ± 6.6</td>
</tr>
<tr>
<td>Height in 2001 (cm)</td>
<td>161.04 ± 3.8</td>
<td>160.94 ± 3.1</td>
</tr>
<tr>
<td>Household wealth score</td>
<td>0.95 ± 0.6</td>
<td>1.04 ± 0.5</td>
</tr>
</tbody>
</table>

*No differences are statistically significant ($P >> 0.05$). N = 21 monogamous, 29 polygynous.*
weight (24% poly vs. 8% mono, $\chi^2 = 4.46, P = 0.03$) and significantly lower WAZ scores ($-1.37 \pm 1.26$ poly vs. $-0.87 \pm 1.28$ mono, $t$-test $P = 0.05$). Paired $t$-tests comparing the dry season WAZ with the wet season WAZ revealed highly significant declines in WAZ scores among children in the polygynous group ($P < 0.001$) but not among children in the monogamous group ($P = 0.11$). Children with polygynous mothers were also relatively shorter than children with monogamously married mothers (monogamous $-0.86 \pm 1.18$ vs. polygynous $-1.44 \pm 1.13$, $t$-test $t = 2.47, P = 0.01$; Fig. 2).

**Growth velocity**

The results above indicate that a mother’s marital status may be a risk factor for young children, particularly in the wet season survey. One issue that may cloud any clear association between mother’s marital status and children’s nutritional status is that children’s ages may not have been accurately obtained. Focusing the analysis on younger children is one way around this, but a more powerful method is to focus on growth velocity, or the change in weight and height between the two surveys. Such intrasubject comparisons reduce the problem of inaccurate ages, and growth velocity potentially reveals more about nutritional status and growth performance than do the static indices used above. Moreover, this gets around that fact that the static measures may represent events when the mother had a different marital status.

Children’s growth performance between the two surveys was associated with their mother’s marital status. Children with monogamously married mothers gained significantly more weight and height (Fig. 3). For the smaller sample of children with complete height records, children with monogamous mothers also gained more height between the two surveys ($t$-test $t = 3.09, P = 0.003$).

To assess whether the differences in nutritional status between these two samples were the result of slight differences in age and sex or household wealth, several multivariate models were fitted to the anthropometric and growth data. These models included mother’s marital status, child’s age at baseline (and an age-squared term), child’s sex, and the wealth score for each compound. Response variables were WAZ in the dry season, WAZ in the wet season,
TABLE 3. Results of regression models

<table>
<thead>
<tr>
<th>Variables</th>
<th>WAZ dry</th>
<th>WAZ wet</th>
<th>HAZ wet</th>
<th>Weight gain (kg/month)</th>
<th>Height change (cm/month)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta \pm SE$</td>
<td>$p$</td>
<td>$\beta \pm SE$</td>
<td>$p$</td>
<td>$\beta \pm SE$</td>
</tr>
<tr>
<td>Moms MS Monogamous</td>
<td>0.31 $\pm$ 0.22</td>
<td>0.16</td>
<td>0.53 $\pm$ 0.27</td>
<td>0.04</td>
<td>0.58 $\pm$ 0.23</td>
</tr>
<tr>
<td>Months</td>
<td>$-0.004 \pm 0.003$</td>
<td>0.12</td>
<td>0.02 $\pm$ 0.01</td>
<td>0.008</td>
<td>$-0.001 \pm 0.003$</td>
</tr>
<tr>
<td>Child sex (F)</td>
<td>0.02 $\pm$ 0.23</td>
<td>0.98</td>
<td>$-0.16 \pm 0.25$</td>
<td>0.53</td>
<td>0.09 $\pm$ 0.24</td>
</tr>
<tr>
<td>Months*</td>
<td>0.0081</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wealth</td>
<td>0.03 $\pm$ 0.009</td>
<td>0.0009</td>
<td>105.0</td>
<td>105.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

1 Impact of mother’s marital status on various measures of nutritional status while controlling for child age, sex, and household.

TABLE 4. Results of mixed models

<table>
<thead>
<tr>
<th>Variables</th>
<th>Parameter estimates (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>$-0.83 (0.22)^{**}$</td>
</tr>
<tr>
<td>Mother’s marital status Monogamous</td>
<td>$-1.9 (0.37)^{**}$</td>
</tr>
<tr>
<td>Child’s age (months)</td>
<td>$-0.005 (0.003)^{**}$</td>
</tr>
<tr>
<td>Child’s sex Female</td>
<td>$-0.00016 (0.00005)^{**}$</td>
</tr>
<tr>
<td>Compound</td>
<td>$0.29 (0.16)^{**}$</td>
</tr>
<tr>
<td>Weight at baseline</td>
<td></td>
</tr>
<tr>
<td>Height at baseline</td>
<td></td>
</tr>
<tr>
<td>Model adjusted mean values Monogamous</td>
<td>$-0.76 (0.20)$</td>
</tr>
<tr>
<td>Polygynous</td>
<td>$-1.04 (0.19)$</td>
</tr>
</tbody>
</table>

$^a = P<0.10$. $^{**}=P<0.05$. —, nonsignificant and removed. 1 Impact of mother’s marital status on various measures of nutritional status while controlling for child age, sex, and household.

HAZ in the wet season, and change in height and weight. The age-squared term and the wealth term were removed from the models when they were insignificant. Other factors such as maternal height and child’s birth order were originally included in the models but were not significantly related to children’s nutritional status in this sample.

In the multivariate models, none of the variables, including mother’s marital status, predicted children’s dry season weight-for-age z-scores (Table 3). The parameter estimate for a mother’s marital status, however, suggested that children of monogamous mothers were heavier for a given age. In contrast, in the wet season, a mother’s marital status was a predictor of WAZ, as were the age and age-squared terms. Children with monogamously married mothers were also taller for their age than were children with polygynously married mothers, and they gained more weight and height in the period between the two anthropometric surveys. The household wealth term was a significant predictor of children’s gain in weight. This may be because wealthy households were less affected by preharvest food insecurity.

Mixed models

As mentioned above, the hierarchical structure of the data introduces the potential for serious bias in OLS regression models and therefore incorrect tests of the significance of the coefficients. To assess and counter this problem, five other models were fitted that initially included compound-specific effects. The models also included the following covariates: child’s age, age-squared, child’s sex, and mother’s marital status. The squared term was dropped when not significant, although all other terms were retained. Children’s weight and height at baseline were also added to the models for growth velocity, although in both cases they were nonsignificant and were removed from the final models. Similarly, in no case was there evidence of maternal effects, so this term was dropped from the models. The models were fit to the 2001 weight-for-age data, and the 2002 wet season weight-for-age and height-for-age data, as well as the dynamic measures of weight and height gain (Table 4).

After accommodating the clustering issues by including the compound-specific random effect, the models showed that a mother’s marital status was still an independent predictor of children’s nutritional status and growth performance, and this effect was greatest among the more robust outcome measures of growth velocity (Table 4). Only the models for weight-for-age failed to show a statistically significant effect of a mother’s marital status, although the mean values were consistently lower among the polygynous group. Children’s weight-for-age, however, was affected by the compound they
lived in, as evidenced by the statistically significant compound term. Both the age and age-squared term were significant, which suggests that older children gained less weight between the two surveys. In the 2002 survey, children with monogamous mothers were taller for their age than were children with polygynous mothers. There was also an independent effect of the compound in which a child lived, as evidenced by the statistically significant compound term. The variables describing growth velocity showed even stronger effects of a mother’s marital status. Mother’s marital status and the compound in which a child lived were independently associated with children’s weight gain, with monogamy being associated with greater weight gain. There was also a significant effect of age, but baseline weight and sex were not associated with children’s weight gain. Children’s gain in height was also associated with their mother’s marital status, but not with compound where they lived. Together, the results from the mixed models highlight the appropriateness of accounting for the dependencies inherent in the data. Most noticeably, P-values for the marital status term in the mixed models are substantially reduced from what they were in the OLS models, suggesting that some unmeasured heterogeneity in compounds is accounting for much of the differences observed between children of monogamous and polygynous children.

Interestingly, including only those children aged 3 years and younger still showed marginally significant effects of mother’s marital status (n = 39, P = 0.10) and compound (P = 0.04) on children’s weight gain, suggesting that the difference between children with monogamous and polygynous children may be set at a very early age. Fitting these models to the WAZ data also showed marginally significant associations between mother’s marital status and children’s WAZ in the dry season (n = 50, P = 0.09) and the wet season (n = 39, P = 0.06). A similar association was observed in the wet season HAZ data; children less than 3 years old with polygynous mothers were shorter (n = 39, P = 0.04) for their age than were similarly aged children of monogamously married women. The effect of compound disappeared in these samples, possibly because of the small sample sizes.

**DISCUSSION**

**Why are children of polygynously married women worse off?**

Contrary to initial expectations, the results show that children of polygynously married mothers have poorer nutritional status and growth performance relative to children of monogamously married women, and these results maintain after controlling for effects of age, compound, wealth, and child sex. Perhaps most surprisingly, given the abundance of studies linking wealth and fitness outcomes (Borghoff Mulder, 1987), there were no differences in wealth scores between monogamously married women and polygynously married women, and monogamously married women were actually more likely to report running out of food early during the rainy season (results not shown). Wealth differentials, apparently, do not underlie the growth differences reported.

There is also some indication that these differences in growth performance appear to be set quite early and become more pronounced during the pre-harvest rainy season. These observations suggest there may be key differences in the early child environment for polygynous women and monogamously married women. In an attempt to understand more about the process that may lead to the results presented above, we assessed this “early environment” hypothesis by exploring six additional variables, all of which are known to be associated with poor growth performance. These were: 1) whether the child was born in a hospital or at home, 2) whether the child received any nonhuman milk item before breastfeeding, 3) where, if the child was fed water, this water came from (well or river), 4) whether the mother self-expressed colostrum before initiating breastfeeding, 5) when the child began consuming uji, a maize-based colostrum before initiating breastfeeding, 5) when the child began consuming uji, a maize-based gruel which is typically the first nonbreastmilk item to be introduced to children, and 6) whether the child was ill at any time during the week prior to the interviews.

Data to test the above predictions were available for 60 women and their youngest child. Overall, 54% of women reported giving birth to their last child at home, 78% reported feeding their child water or cow’s milk before they initiated breastfeeding, 78% reported self-expressing their colostrum because their “milk had not started” or their “milk was dirty,” 87% reported feeding their child water during his/her first week, and 82% of these women fetched this water from the river. Most (81%) women reported boiling the water before feeding their children. Taken together, infant feeding practices among these Sukuma women deviate substantially from current international recommendations (WHO, 1998), but there were no differences between monogamously married and polygynously married in any of these variables.

To assess whether children born to polygynously married mothers began consuming uji, the food that is first introduced to children, earlier than children born to monogamously married women, a mother’s response to the question “How old was your child when s/he began eating uji?” was compared to mother’s marital status. Because some children had not yet begun eating uji, a survival model was used to maximize use of the available data (Allison and SAS Institute, 1995). Although these data are retrospective, there is no reason to think that a mother’s marital status would affect maternal recall of this key event. Moreover, most children were still quite young, and mothers were thus recalling events that
happened in the not-too-distant past, and considerable time was devoted to pinning down the month when supplementation began. Other studies of maternal recall also suggest that mothers in developing nations are able to recall these events with considerable accuracy (Gray, 1995, 1996; Sellen, 1998).

For all mothers combined, the median age of introduction was 4 months (95% CI, 3, 5 months), and monogamously married women reported a significantly earlier age of introduction than polygynous mothers (3 months vs. 4 months, log-rank $\chi^2 = 4.31$, d.f. 1, $P = 0.03$). Given that delayed introduction of complementary foods is often associated with improved growth performance (Dewey, 1998), this finding is initially confusing. Because children of monogamously married women grow better, the expectation is that they are consuming complementary foods later, not earlier. It is possible that mothers are using infant-based cues to assess when they should begin introducing solid foods (Marquis et al., 1997; Simondon et al., 2001).

Infections, which are known to slow growth through a variety of mechanisms (Eveleth and Tanner, 1990; Stephensen, 1999), were assessed at the wet season anthropometric survey by 1-week maternal recall, and showed no differences when disaggregated by mother’s marital status. Of 60 children, 30% were reported to be suffering from some illness (fever, coughing, and diarrhea) during the week prior to weighing and measuring. There were no differences in the percent prevalence of illness by mother’s marital status (30% vs. 27% monogamous mothers), or in the number of days the child had been ill (average = 7 days for each group). Although maternal recall of illness may be a crude measure, there is little evidence of a difference in prevalence by mother’s marital status. More problematic is the relatively small number of children who were reported ill and the small number of days of observation. These are serious limitations which undermine the power of these results.

One of the more striking results is that when the compound variable is allowed to contribute variation to the models, it is a significant predictor of children’s nutritional status in 4 of the 5 models. Only the model predicting children’s gain in height does not show an effect of compound, and this is also the indicator associated with the smallest sample size. It is noteworthy also that with the inclusion of the compound term, a mother’s marital status is still associated with children’s nutritional status. This means that even for mothers living in the same compound and ostensibly sharing the same resources and home environment, children of polygynously married mothers suffer more, particularly during the preharvest wet season. It is therefore likely that subtle asymmetries in the distribution of food and/or differences in maternal time constraints (which may influence breastfeeding schedules and infant care) account for the observed differences in children’s health and well-being. Unfortunately, data on the frequency and duration of feeding and measures of infant care are unavailable.

CONCLUSIONS

Despite the small sample sizes, we can tentatively conclude that polygynous marriage status is a risk factor for poor nutritional status among Sukuma children, and that this is most pronounced during the wet season. Little evidence exists for differences in the young child environment or in prevalence of morbidity between children with mothers of different marital status, although the latter test had extremely low power. There is also little evidence that wealth differentials offset the cost of polygyny; the wealth variables were often not a predictor of children’s nutritional status, and the marital status terms are frequently still significant after accounting for the mother’s compound. Contrary to initial expectations, the results suggest that children of polygynously married women in this sample are at an elevated risk of poor nutritional status. This is a surprising result, given that land and food appear to be abundant, and women are free to choose their husbands. These results imply that the potential costs of polygynous marriage are not offset by differences in wealth, a finding running contrary to some predictions of the polygyny threshold model (Searcy and Yasukawa, 1995).

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