Title: Reproductive decision-making in the Bolivian Amazon: Why do preferences not match outcomes?
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Introduction

For many South Amerindian and other rural indigenous populations in the developing world mortality remains high and birth rates are *increasing*, despite observations that women's preferred family size has been declining over time (Bremner et al., 2009; Perez et al., 2008; Terborgh et al., 1995). In spite of development efforts aimed to improve health and nutrition, the growing discrepancy between women's preferred family size and fertility can negatively impact maternal and child health and survival, and women's socioeconomic status and reproductive autonomy (McSweeney & Arps, 2005). Many South Amerindian groups are currently experiencing rapid population growth rates of 3-5% (with associated population doubling times of 14-23 years) (Bremner et al., 2009; McSweeney & Arps 2005; Perz et al. 2008), which are particularly problematic, given that many groups have limited land rights and territory, are often subject to discrimination, and face limited upward socioeconomic mobility (Bremner et al. 2009). This unsustainably high fertility, and the discrepancy between fertility preferences and observed fertility are therefore of practical and theoretical interest.

Market integration and urbanization are often believed to increase indigenous peoples' access to modern forms of human capital and socioeconomic resources (Blackwell et al., 2008; Kaplan, 1996; Lu, 2007). Women with greater resource access and body size may be better able to afford the costs of gestation, lactation and childcare and should therefore also display higher fertility. Comparative analyses suggest that the general female mammalian pattern is for greater resource access to lead to higher fertility (Charnov & Berrigan, 1993; Valeggia & Ellison, 2003). This pattern of improved resource access leading to higher fertility is currently observed in numerous South Amerindian, and possibly other, rural indigenous populations. However, such a pattern contradicts the standard fertility transition observed around the world, where economic changes and increased access to resources leads to marked fertility declines, and where the wealthiest members are often first to reduce their fertility (Borgerhoff Mulder, 1998; Kaplan, 1996; Vining, 1986). Such deviations from the commonly observed demographic transition pattern raise key questions about how selection has shaped women's fertility preferences and behavior that are best addressed from an evolutionary perspective. Pretransition rises in fertility are not rare (Dyson and Murphy 1985; Hirschman 1994), but have not been extensively explored.

In this paper, we examine the impact of market integration and modernization on women's fertility preferences and outcomes. We test predictions underlying three hypotheses for why a discrepancy exists between women's stated fertility preferences and their achieved fertility using data collected among the Tsimane, South Amerindian forager-horticulturists living in Bolivia. The Tsimane are an ideal population for study because they are currently undergoing rapid integration into the local market economy, with increasing spatiotemporal and socioeconomic heterogeneity expected to have concurrent impacts on fertility.

H1. Female Reproductive Autonomy: women are unable to achieve their fertility preferences due to social pressures by husbands or kin to have many children;

H2. Improvements in Maternal Condition: women with better nutrition and health are more fecund but, unable to effectively control their fertility without concurrent improvements in access to contraception, they consequently have higher fertility than desired;

H3. Low Returns on Embodied Capital: the benefits of investing heavily in offspring quality and self are perceived to be low amongst indigenous people who are only moderately integrated into the market economy, and so opportunity costs of high fertility may be low; in this case, somatic wealth and large kinship networks remain the most important determinants of social status and prestige.

The novelty of our approach is to present a framework that links fertility goals and perceptions with behavior, incorporating ideas from behavioral ecology, household economics, reproductive ecology and cultural transmission theory to best understand fertility-related decision-making at the initial stages of the demographic transition to small family size. It expands upon standard treatments of the demographic transition among rural, indigenous populations by use of individual-level data in ethnographic context.

Methodology

Study Population: We test the above hypotheses among Tsimane living in the Bolivian Amazon. The Tsimane have been studied since 2002 as part of the Tsimane Health and Life History Project (www.unm.edu/~tsimane) (Gurven et al., 2007). The Tsimane are lowland South Amerindian forager-horticulturists living in the Beni Department of Bolivia. Market integration and modernization is a mosaic experience, depending on access to formal education, contact with outsiders, and Spanish fluency, all of which increase with proximity to the local town, San Borja (2010 population, 24,610).

While infant mortality and fertility rates are both very high among Tsimane (13% infant mortality rate (IMR), total fertility rate (TFR)=9.7), each co-varies with travel distance to San Borja (Gurven et al., 2007). IMR is roughly 25% in communities far from town and the TFR is 8.4, compared to an IMR of 10% and TFR of 10.5 in communities near town (unpublished data).

Data collection: Fertility preferences and behaviors of 305 Tsimane women and 216 of their husbands' were investigated during extensive demographic interviews by MG between 2002 and 2005. Follow-up fertility outcomes for these women were analyzed in 2008 based on censuses and interviews during medical checkups. This study population constitutes 19% of all Tsimane women of reproductive age. Our subjects come from 22 villages spanning the traditional Tsimane territory that we group into "near town", "riverine", "forest" and "Mission" based on their ease of access to town and outside influences, and dietary differences.

Methods used to gather reproductive histories and to ascribe ages to living and dead individuals have been previously described (Gurven et al., 2007). Demographic interviews also measured IFS, educational experience and Spanish fluency. IFS was queried as: "What number of children do you think is the best number of children for you to have so that you can live well? Think about your own experience, life and wishes."

Additional interviews conducted by LM focused on women's views on mate choice, parenting and social aspirations. The questions were designed to help understand how status and cultural success are viewed by Tsimane and to assess the lifestyle options that Tsimane women believe are available to them.

Maternal condition was measured by body mass index (BMI) [weight/height^2], using a portable stadiometer and Tanita weighscale, and body fat percentage, based on bioelectric impedance using the same weighscale.

Data Analysis:

(H_1) Female Reproductive Autonomy: Paired t-tests on husbands and wives IFS were run to assess the discrepancy between spousal IFS, and whether IFS discrepancy varies by region. To assess if husbands exert greater influence on fertility outcomes, we correlate IFS discrepancy between husbands and wives with the difference in wives' parity and IFS.

(H_2) Maternal Condition: We assess whether women's BMI and body fat percentage varies with parity, controlling for age, using multiple regression analysis. We test whether women are able to control fertility by considering the predictive power of women's IFS on subsequent fertility.

(H_3) Embodied Capital: To separate H3 and H2, regarding increased discrepancies between IFS and parity, we assess whether this discrepancy varies with distance to town controlling for women's maternal condition using multiple regression analysis. To assess perceptions about the benefits of investing in human capital and greater market integration, we focus on ethnographic interview responses.

Results

(H_1) Female Reproductive Autonomy: Husbands and wives had a mean IFS of 5.52±3.60 and 4.69±2.37, respectively. Both are considerably lower than the mean TFR of 9.7. Moreover, for both men and women the mean IFS was significantly lower near town (Men (ANOVA F (3, 212) = 7.730, $p < 0.001$) and Women (ANOVA F (3, 212) = 5.638, $p = 0.001$)). In general there is a significant difference between husbands' and wives' IFS (Paired t-test $t = -3.682$, $d.f. = 215$, $p < 0.001$). However, this shows regional variation with couples near town showing no significant discrepancy in spousal IFS.

Greater spousal disparity in IFS is positively associated with the extent of excess fertility above IFS (Figure 6, $R^2 = 0.099$, $\beta(1, 212) = 0.320$, $p < 0.001$), controlling for women's age and distance from town. However, men also overshoot their IFS, suggesting that while husbands' preferences may matter, they may not be a large influence on their wives' parity. When both partners' IFS are analyzed simultaneously, for women living near town and the mission their parity is more strongly related to their own IFS than their husbands' IFS; this pattern is reversed for forest and riverine women. This suggests that in the near town and mission communities women have greater reproductive autonomy.

(H_2) Maternal Condition: There was no significant difference between regions in women's BMI (ANOVA F (3, 185) = 1.566, $p = 0.199$) or fat percentage (ANOVA F (3, 161) = 0.657, $p = 0.579$). In addition, BMI (N = 189) and fat percentage (N = 165) at year of interview had no significant relationship with whether a woman had additional children several years post-interview. However, ages at menarche and first birth have declined over the past few decades, and controlling for age, the decline in age at menarche is greatest among women living near town (Partial r = 0.319, $d.f. = 286$, $p < 0.001$), suggesting better nutrition or improved health among these women.

However, despite the absence of effective birth control, Tsimane women have some control over their fertility. Comparing women who had exceeded their IFS (IFS lower than parity) with those who had yet to exceed their IFS (IFS higher than parity) by region shows: (1)

that Mission and riverine women who want more children have a significantly greater relative risk of having another child by 2008 than women who did not want more children; while (2) near town and forest women regardless of whether they have exceeded their IFS or not experience no significant difference in risk of having another child by 2008.

(H_3) Embodied Capital: Controlling for women's age, parity, the age*parity interaction and indicators of maternal condition (women's BMI at interview and age at menarche), distance to town was significantly negatively correlated with women's discrepancies between their IFS and fertility (Partial r = -0.277, $df = 83$, $p = 0.010$). Women near town, regardless of their maternal condition, exceed their IFS more than in other regions ($R^2 = 0.066$, $\beta(1,83) = 0.549$, $p < 0.001$).

However, although ethnographic interviews suggest that small family size is considered beneficial by most Tsimane, when asked to identify the "influential" or "model" woman" in their village, respondents chose women with large families. In addition, when asked whether they thought Bolivian nationals or Tsimane living in various locales had a "better life", more women reported that Tsimane living far from town in the forest had a better life than Tsimane living near or in town, while nationals were believed to have relatively good lives regardless of where they lived (N = 58, $p < 0.005$). Bolivian nationals in town were believed to have significantly better lives than Tsimane living in town (N = 60, p = 0.004). Consistent with their reports about the "good life" women said they would prefer to live far from town rather than in or near town.

Furthermore, human capital, in the form of formal education, Spanish fluency and literacy, did not appear as salient resources to invest in children. For women in both the acculturated and remote village samples, traditional skills such as fishing, hunting and farming were deemed most important.

Conclusions

A lack of reproductive autonomy (H1) does not explain why Tsimane women are exceeding their IFS. The second hypothesis (H2) was only weakly supported. Women living near town reach menarche and start their reproductive lives at earlier ages than women living in other regions. However those women did not have higher BMI or body fat for their age. Moreover, women near town have easiest access to contraceptives and family planning classes, but they did not show evidence of fertility control while Mission and riverine women did.

Preliminary evidence supports H3. There is little overt motivation to pursue education and delay reproduction. Economic returns for educational investment are low, and there is little overt desire to emulate low fertility Bolivian nationals, even among the most acculturated women. Instead, substantial value is placed on maintaining traditional skills and lifestyle.

Women's IFS is a useful measure to bridge between fertility-related beliefs, perceptions and outcomes at the onset of a demographic transition. Many women in developing countries may exceed their IFS due to the low perceived or real benefits of investing novel forms of human capital in self and offspring. Somatic wealth and large kin networks may persist as the most important components of social success, and so fertility remains high.

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