Post-reproductive survival in a polygamous society in rural Africa

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Chapter 8

Socio-economic status determines sex dependent survival of human offspring

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Abstract

In polygamous societies, rich men have high reproductive prospects through the marriage of multiple wives. Evolutionary, rich households would therefore benefit more from sons. In a polygamous African society, men had three times higher fertility rates than women in rich households. As hypothesized, sons had both higher survival and better nutritional status here.

In polygamous societies, richer men can afford to marry multiple wives and consequently increase their reproductive success. From an evolutionary perspective rich households would therefore benefit more from sons. To test this hypothesis we have first studied the effects of socioeconomic status on fertility rate of men and women in a polygamous society of 28,994 individuals in the Upper East Region of Ghana. Second we investigated the sex differences in offspring survival and offspring weight in poor and rich households. The main characteristics and methods are summarized in the supplementary information and table. General fertility and mortality patterns have previously been described in more detail[1].

Figure 1a shows the age specific fertility rates in poor and rich households. The people in the research area are polygamous and the man must pay a bride price of four cows to arrange a marriage. Consequently, richer men are able to increase their number of offspring. From the area under the curve, we found that in poor households men can expect 5.5 offspring and women can expect 3.1 offspring. In rich households men had much higher reproductive prospects; they can expect 9.2 offspring, while women can expect only 3.5 offspring.

Studies have shown a strong heritability of socioeconomic status in pre-transitional societies[2]. This seems applicable to this population also, since income is generated largely through agriculture and sons inherit the land of their fathers. If offspring inherits the socioeconomic status from their parents and rich men have better reproductive prospects, one could hypothesize that rich households would benefit more from sons, which would create an opportunity for selection on sex specific survival dependent on socioeconomic status. We tested this and compared the offspring survival and weights of offspring in poor and rich households.

First, we studied survival of 16,632 offspring up to reproductive age (≤18 years) (figure 1b). In poor households sons had much higher mortality risk compared to daughters (hazard ratio 1.45 [95%CI 1.08-1.95]; p=0.01) In rich households, however, mortality risk of sons was similar to that of daughters (hazard ratio 1.05 [95%CI 0.82-1.34]; p=0.71). These ratio's were significantly different (p for interaction = 0.028).

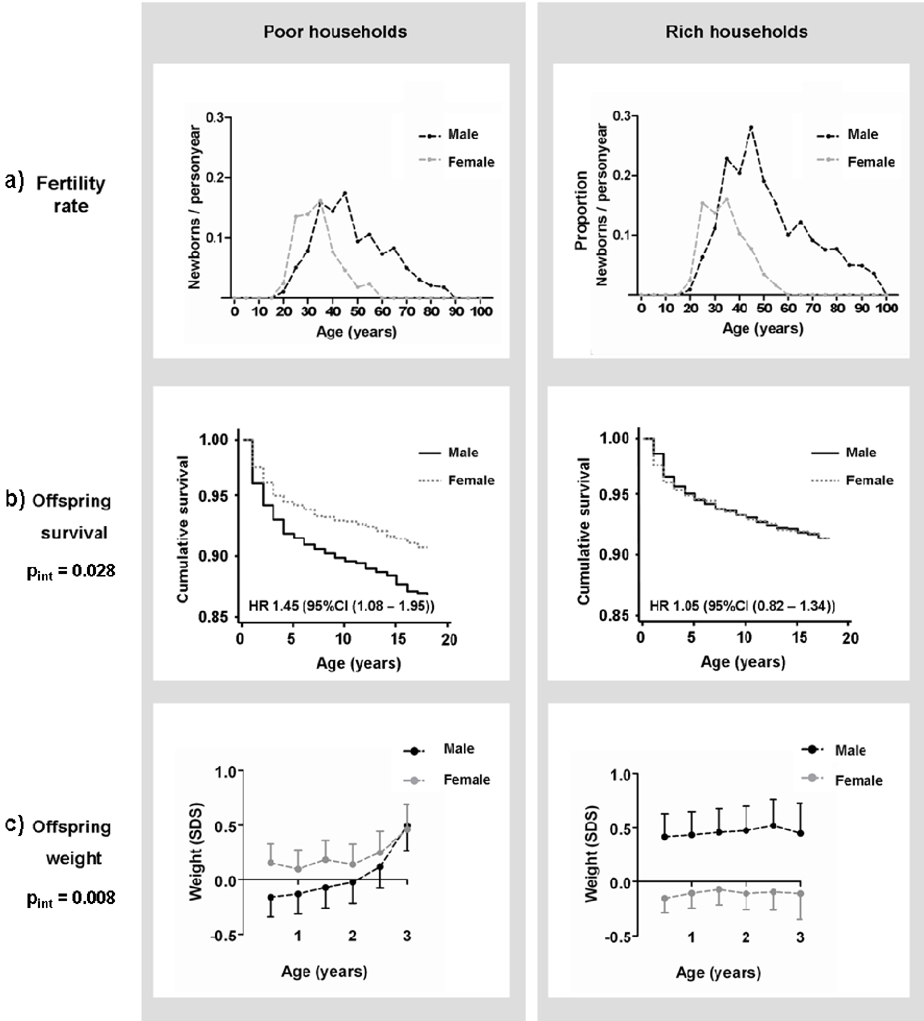

Figure 1. Fertility rate, offspring survival and offspring weight in poor and rich households. Error bars indicate standard errors.

Second, we analyzed the weights of offspring using repeated measurements from growth charts of the local health clinics. In an analysis of 9,842 age and sex standardized measurements among 1,470 offspring up to the age of three years, in poor households, daughters had higher weights while in rich households sons had higher weights (figure 1c). These differences in sex specific weight gain were significantly different (p for interaction = 0.008).

There are two possible explanations for the marked sex specific effects of socioeconomic status on life course characteristics. First, they could be a reflection of higher intrinsic vulnerability of sons to poor conditions. Men have higher mortality risks throughout life in almost all countries[3].

Second, our observations are also in line with differences in parental investment as hypothesized by Trivers and Willard[4]. According to their hypothesis parents invest more in offspring of that sex that has the best reproductive prospects. Although Trivers-Willard effects have been found in different mammal species, it is highly debated whether these effects are present in humans[5]. The observed sex differences in weight could reflect differences in parental nursing habits; sex differences in breastfeeding have previously been observed in Poland and the Caribbean[6,7].

Whether the sex differences that we have observed in our study reflect the higher vulnerability of sons to poor conditions, or reflect a sex specific parental investment as proposed by Trivers and Willard, the net result is the same; sons are better off in richer households which maximizes the reproductive prospects of households in this polygamous society.

Supplementary information

This study was conducted in the Garu-Tempane district in the Upper East region of Ghana. General fertility and mortality patterns have been described elsewhere[8]. The people are patriarchal, patrilinial and patrilocal and live in extended families of which 48% are polygamous. During eight years of follow-up from 2002-2010 we followed 28,994 participants for reproduction and survival. The area is currently undergoing an epidemiological transition[9]. The socioeconomic status was assessed for all inhabited households in accordance with the Demographic and Health Survey (DHS) methods[1]. We defined poor and rich as the poorest 50% and the richest 50% divided by the median. Drinking water was assessed on household level, water from bore-holes was considered safe drinking water, water drawn from either open wells or from rivers was considered unsafe drinking water[10]. The survival analysis includes all offspring up to reproductive age (≤18 years) and used a multivariable left-censored Cox regression analysis adjusted for sex, tribe and drinking source. We found no evidence that the assumption of proportionality of hazards was violated. The left-censored plots represent age-specific survival probabilities rather than a prospective eighteen year follow-up. The weights of the offspring were obtained from growth charts of local health clinics in 2008. The clinics use hanging scales to measure the weight and use growth charts from the Ghana Health Service, adapted from the World Health Organisation. We standardized the weights on age and sex and used a linear mixed model adjusted for tribe, drinking source and the month and year of measurement, as weights fluctuated dependent on the season. All analyses were performed with Stata 11.0 (StataCorp LP, Texas USA). This research was supported by the Netherlands Foundation for the advancements of Tropical Research (WOTRO) the Netherlands Organization for Scientific Research (NWO), the EU funded Network of Excellence LifeSpan, an unrestricted grant of the Board of the Leiden University Medical Center and the Association Dioraphte. None of these organizations had any role in the design, analysis, interpretation, or report of the study. Ethical approval was given by the Ethical Review Committee of the Ghana Health Service, the Medical Ethical Committee of the Leiden University Medical Centre in Leiden, the Netherlands and by the local chiefs and elders of the research area.

Supplementary table 1. Characteristics of the study population

Participants (n)	28,994
Male (%)	46%
Female (%)	54%
Tribe	
Bimoba (%)	66%
Kusasi (%)	26%
Other (%)	8%
Households (n)	1,703
Polygamous households (%)	48%
Value of household possessions in US$ (mean (SD))	1,063 (1,021)
Safe drinking water (%)	80%
Reproduction	
Numbers of newborns registered 2002-2010 (n)	3645
socioeconomic status available (n)	3511
Offspring survival	
Offspring ≤18 years (n)	16,632
Follow up (calenderyears)	2002-2010
Person years (n)	91,256
Mean follow up (years)	5.5
Deaths during followup (n)	471
Weights of offspring	
Offspring ≤3 years with growth chart (n)	1,470
Weight measurements (n)	9,842
Average number of measurements per child (n)	7

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