COOPERATIVE BREEDING IN HUMANS – WHICH KIN HELP AND WHY?

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Poster Presentation for the XXV IUSSP, Tours, July 2005.
DRAFT – Introduction and Discussion incomplete

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INTRODUCTION

There is growing interest among evolutionary anthropologists in the role of kin in subsidizing the costs of reproduction. The theoretical challenge lies in explaining our species' relatively (controlling for body size) late maturity, small size at weaning, and high fertility in comparison with other primates. The idea, reviewed recently in Hrdy (in press), is that women rely on close kin to assist them in defraying the high costs associated with rapid reproduction. To date focus has been primarily on the role of grandparents, specifically the "grandmother" hypothesis (Hawkes, et al. 1998). According to this hypothesis the postreproductive lifespan of human females evolved in response to the benefits elderly women could provide to their daughters, particularly with respect to acquiring labour-intensive food sources such as tubers and roots. There is now considerable evidence showing how children can benefit from living with their grandmothers (Sear, et al. 2002; Lahdenpera, et al. 2004; Jamison, et al. 2002; Leonetti, et al. 2005). Other studies have looked beyond postreproductive kin, focusing on reproductive and pre-reproductive aged individuals. In some cases the presence of mother's siblings is associated with greater fertility (Flinn 1989; Bereczkei 1998), in other cases a mother's previous offspring, particularly daughters, appear to enhance a woman's production of surviving offspring (Crognier, et al. 2001; Bereczkei and Dunbar 2002; Flinn 1989; Turke 1989).

Impressive as some of these studies are, there are many troubling methodological issues. First, rarely are confounding factors controlled; this is surprising given all that is known about the effects of age, birth order, length preceding interbirth interval, education, and marital status on fertility and child survival. There are many ways in which such variables might confound the association between the number and availability of kin and reproductive outcomes. Second, kin effects are rarely examined in conjunction with one another; for example in determining whether or not maternal grandmothers enhance offspring survival we need to control for the survival status of parents. Third, studies are generally very lose about defining whether kin are living at a location where they can indeed assist a mother – the fact that they are alive may not bear in any sense on the help that they can provide. Fourth, frequently studies fail to make use of event-history analysis which can deal with two common features of longitudinal even histories – right-censored observations and time-varying variables (Allison 1984). Fifth, most studies fail to recognize that observations on children born to the same mother and father are not independent of each other. There is considerable evidence that mortality risks run in families, perhaps due to behavioral, genetic or socioeconomic factors. Such lack of independence among data points needs to be addressed statistically. Finally and perhaps most important, factors like wealth, status or family circumstances, are rarely taken into consideration; this is troublesome because correlations between fertility and survival across generations may reflect heritable differences in extrasomatic (or human) capital, such as wealth, status or education) or even genetic differences affecting health and survival.

In these analyses I use event history methods, specifically survival analyses, to determine the multiple factors that affect survival in a rural Kenyan population, Kipsigis agropastoralists who live on the boundaries of Kericho and Narok Districts on the southern edge of Kenya's White Highlands. I analyze child survival prior to the fifth birthday as a function of a set of biodemographic, socioeconomic and familial variables, retaining in the model all variables that reach statistical significance. I do not focus on a single relative, for example a maternal grandmother or a first born female offspring, but rather examine at the same time the full set of relatives. I incorporate household wealth into the analysis, with the expectation that kin effects may be wealth dependent. We already know that wealth is an important determinant of offspring survival in this population (Borgerhoff Mulder 1987b), that there can be intense competition among brothers over inheritances, and that there are strong advantages from having siblings of the opposite sex with respect to marriage (Borgerhoff Mulder 1998).

Kipsigis are originally cattle and goat herders who farmed small plots of millet (Manners 1967; Peristiany 1939). They were patrilineal, polygynous and largely patrilocal in residence patterns. During the colonial period they increasingly settled on permanent plots of land, on which they grazed their livestock and cultivated maize. Rates of polygynous marriage appear to have increased in the colonial period. After Independence Kipsigis began to seek title to their plots of land, with the entitlement process gaining momentum in the 1980s due to World Bank support. On account of escalating land shortages in highland Kenya patrilocal residence patterns were crystallized, with sons inheriting (in equal shares) the land of their father, following the inheritance pattern for livestock (Borgerhoff Mulder 1989). Wealth differences escalated as a function of the size of the original plot settled, polygyny and fertility differentials, and access to limited but lucrative sources of off-farm employment (including cattle raiding) – the product of which is occasionally used to purchase new land. Marriage is patrilocal, with women settling on the farm of their husband, often adjacent to his brothers and his parents; accordingly household wealth is measured in this study as the land to which a woman has access in her marital home.

METHODS

1. Sample

Analyses are based on 785 births to 129 women and 107 men between 1945 and 1990, collected from retrospective interviews with families living in four neighbourhoods (*kokwetinik*) intensively studied in 1982-1983 and 1990-91. In each household reproductive interviews were made of all individuals who had produced one or more children. These individuals were household heads, their wife (or wives), their married sons, and their daughters-in-law; daughters will only appear in the data set if the daughter married into one of the 4 *kokwetinik* forming the focus of the 1982-83 and 1990-91 study. Births to individuals deceased at the time of the interview were recorded (10 men [9.3% of sample] and 12 women [9.3% of sample]) women, by means of questions with a living spouse who fell in the sample.

2. Variables

Survival status or age at death, was determined for each birth. Of special interest were the survival status and residence of mother's mother (MM) and father (MF), and the number of the mother's brothers (MB), and the same for paternal kin – father's mother (FM), father's father (FF) and father's brothers (FB). The number and/or status of kin in these categories was determined from the full demographic sample (Borgerhoff Mulder 1987a; Borgerhoff Mulder 1987b). It was particularly straightforward for paternal kin, given the strong patrilineal residence patterns among the Kipsigis, with men and their brothers very commonly living on the same or adjacent plots of land. Fortuitously systematic data on wives' relatives had been collected as part of a bridewealth study (Borgerhoff Mulder 1988; Borgerhoff Mulder 1995). Additional kin effects considered in the model are the survival status of the focal child's mother (MALIVE) and father (DALIVE). A child's mother, father, maternal grandmother, maternal grandfather, paternal grandmother and paternal grandfather was coded as dead if this individual had died within the focal child's first five years of life. Because year of the specified relative's death could not always be narrowed down to month and year, this approximation seemed most appropriate. The number of a child's mother's brothers (MB) or father's brothers (FB) was determined simply on the basis of a question regarding the number of currently living (1982-83) brothers of the mother and father; it is therefore fixed for a sibset and can be considered only an approximation for any given child. For this reason, and for clarity of exposition, these variables are treated as categorical variables (MBCAT, FBCAT). For MF, MM, FM and FF it was possible to determine whether this relative lived in the same set of adjacent *kokwetinik* as the child (generally within a 15 km range, an easy day's walk), or at a further distance (generally more than a day's walk); even where relatives lived beyond the adjacent *kokwetinik* that constituted the sample of this study, the distance rarely exceeded 25 kms. Unless other information was available, it was assumed that residence patterns observed in 1982-1983 and confirmed in 1991 had been constant. Very infrequent land sales and minimal labour migration justify such an assumption.

To understand better the independent effects of kin factors on survival, and their interactions, these demographic files were linked to the full demographic and socioeconomic records for each family. Wealth is measured as land ownership, because of the significance of this factor in previous analyses of this population (Borgerhoff Mulder 1987a; Borgerhoff Mulder 1987b). Used as control variables were data on year of birth (for secular changes in survival), gender, twin status, mother's age, previous birth interval, polygynous status of mother, education, and household wealth (measured as the land to which a woman has access in her marital home).

3. Analysis

Cox's regression analysis was used to determine probability of survival within the first 60 months of life. This method is appropriate in that it allows for the inclusion of censored cases, in this case children who have survived to various ages but not yet reached their fifth birthday. Four analytical steps were taken. First, to identify unobserved variability between households all independent variables were investigated for shared frailty using the STATA share command, and entering the mother's ID as a covariate. Theta values (a single variance parameter that measures heterogeneity in survival times across the children of different mothers) were consistently very small (0.00 – 0.086) and never significant, indicating there is no inter-household variance in frailty; in other words that all families have the same unobserved frailty (Gutierrez 2002). This results in part because many of the covariates of interest, such wealth, status of grandparents, number of siblings, etc., vary much less within families than between families. The shared mother effect was also investigated in the full model, and again was observed to be very small, reflecting the fact that multiple independent variables capture much of the variation and leave little residue to be explained as unobserved heterogeneity. Since shared frailty parameters never contributed significantly to any of the models, they were dropped from the presentation of the final analyses.

The second step entailed the determination of the effects of a range of control variables, defined as variables expected to affect survival times but not of primary interest in the current analysis. This was done through model fitting. Models were fit using the Stepwise Forward entry method within SPSS (see Table 1). Model A drops individuals for whom there is missing data, whereas Model B uses the full sample, dropping variables for which there is not complete information. The results are largely congruent. Children with a later birth year are less likely to die (Table 1, panel 1, B only), and twins have higher mortality than single births (panel 3); mortality declines with the length of the preceding birth interval (panel 5, A only), among children of middle parities (panel 6; statistical trend in A only), among children born to women with no cowives (panel 7, B only), with each year of paternal education (panel 8; statistical trend A only), and among the wealthier half of the population (panel 9). These are all well-established and commonly observed effects found previously both in this population and in many other developing nation populations (ADD REFERENCES) and receive no further discussion here.

The third step entailed single variate analyses of kin effects for the full sample of births (Table 2, Model C), split by the mother's household wealth (Table 3, Model D), and with wealth interactions (Table 3, Model E). The fourth step examined a multivariate model with control and kin variables considered together (Table 4, Model F), split by wealth (Model G) and with interactions (Model H). These latter two steps are presented in the results section below.

RESULTS

1. Parents

As shown in the 1st panel of Table 2 a child is more likely to survive if its mother is alive during the first year of its life than if the mother dies during this period (see Fig 1). Living fathers have no such effect; if anything, there is a slightly increased probability of mortality when the father is alive. These mother and father effects are retained in the full model (Table 4, Model F), and show no interaction effects with wealth. In other words their pattern does not change across the poorer and richer halves of the population (Table 3, Model D) and no significant interaction terms are observed in either the single variate analyses (Table 3, Model E) or the fully controlled analysis (Table 4 Model H).

2. Paternal kin

Raw effects of paternal kin on survival are shown in the 2nd panel of Table 2 (see Fig. 2). Single variate analyses (Model C) show children with a living father's mother, a living father's father, and a large number of father's brothers are less likely to die than those without these paternal kin. These effects are maintained in the full model where all demographic and economic covariates are controlled (Table 4, Model F). In other words paternal kin raise survival chances, independent of wealth effects (see Table 4 note a), of parental survival status, and of a positive effect associated with the number of *mother's* brothers.

The principle paternal grandparental effect lies between those who are deceased, and those who are alive and live either within *or beyond* the neighbourhood (see Figure 2 again). This indicates that for this category of kin distance is not a major factor in providing support, conforming to ethnographic observations: paternal kin amass at times of conflict over land, interfamily conflicts, or family crises in current times, as they did in the early years of the 20th century (Peristiany 1939). Accordingly further analyses of father's mother and father's father effects compare cases where these relatives are alive or dead, irrespective of their residence, a variable labeled (FF5, FM5).

With the exception of father's mother, who status seems to protect against mortality across the wealth spectrum, paternal kin effects are stronger in the richer than in the poorer half of the population (Table 3, Model D); note however that only the number of father's brothers shows a significant interaction with wealth (Table 3, Model E). This same pattern is preserved in the full model (Table 4, Model G) although no significant interactions effects are observed (Model H). The reasons why the father's brothers might enhance survival in wealthy families but not in poor families are examined further in the discussion.

3. Maternal kin

Raw effects of maternal kin on survival are shown in the 3rd panel of Table 2 (Figure 3) and are much less marked than those of paternal kin. Single variate analyses (Model C) show children with a living mother's mother and a large number of mother's brother show no higher survival than those without a mother's mother, or those whose mothers have few brothers; the effect of the mother's father appears as a statistical trend only. In the full model (Table 4, F) when all other significant effects are controlled both the mother's mother and the mother's father show no overall effects on survival, although the number of mother's brothers appears as a significant effect, with survival generally increasing as the number of mother's brothers rises.

Visually (see Figure 3 again) we can ascertain that the marginal effect of MF in the raw data lies between those who are alive but living beyond the neighbourhood and those who are either deceased or alive and present. This suggests an unusual but ethnographically quite plausible maternal kin effect – that a woman benefits if her mother has an intact family living at some distance from her own marital home. This "refuge" effect is examined in the discussion. Accordingly further analyses of the mother's mother and mother's father effects contrast cases where these relatives are either alive and distant to cases where they are either alive and present or dead, a variable labeled (MM6, MF6).

Splitting the sample by wealth shows that beneficial maternal kin effects do in fact consistently occur in the poorer half of the population (Table 3, Model D). Women married in poor households experience enhanced child survival if their own mothers and fathers are alive but live outside of the neighbourhood; they also enjoy higher child survival if they have many brothers. In the full model (Table 4, Model G) this pattern is largely replicated, with the mother's mother and mother's father effects showing significant wealth interactions, and the mother's brother effect showing a statistical trend (Table 4, Model H).

DISCUSSION

1. I have shown kin effects on child survival to the fifth birthday in the Kipsigis of Kenya, using longitudinal data on births between 1945 and 1990, making specific methodological improvements to previous studies.
2. Loss of a mother but not of a father is a strong determinant of offspring survival in this population in the Kipsigis. Mother loss is a strong determinant of mortality in the first year of life, and subsequently, in many populations (e.g., Hill and Hurtado 1996). Where a father loss effect has been observed it is often linked to the mother's new marriage (Voland 1988, Daly and Wilson 1985, Sear, et al. 2002). The absence of a father effect in the Kipsigis may reflect the fact that remarriage does not occur. The fact that widowed mothers do not experience enhanced offspring mortality is also likely to reflect the practice of widow inheritance, whereby a widowed woman is effectively incorporated into to the family of one of the husband's surviving brothers.
3. Although paternal kin effects are superficially more apparent than maternal kin effects, analysis of interactions with wealth show that paternal kin are key among the wealthy whereas maternal kin are key among the poor.
4. The mechanisms whereby kin do, or do not, improve child survival are not identified in this study, but are likely to entail provision of food and labour at critical family crises – food shortages, crop loss, cattle disease, political disputes, and acute illness. Given the well-established interactions between nutrition, stress, weight loss, and susceptibility to infection, the social and economic services provided by kin could be critical in influencing both the rate at which children become sick, and subsequent treatment by means of either traditional or western health practitioners (Borgerhoff Mulder 1987b).
5. The fact that paternal kin, and particularly father's brothers, appear to have beneficial effects in richer families but not in poorer families can possibly be

attributed to the extreme fraternal strife that increasingly afflicts smaller landowners. Land pressure is escalating in all of Kenya and the study areas lies in the low fringing hills adjacent to the Maasai plains (or Narok District). Land is not highly productive, and as plots are fragmented to only a few acres in size, brothers see each other as direct competitors over access to resources (which of course they are). It is conceivable that the mechanisms outlined in (4) above are less effective in such situations of conflict.

6. The fact that maternal kin appear to have a protective effect against child mortality only among women who are married into poor households might indicate that women turn strategically to their natal kin in situations where they cannot expect much help from their husband's kin and lineage.

7. The role of maternal kin as helpers is only in evidence when they live at a distance (over a day's walk) from the mother's marital household. In a cultural group where divorce is practically non-existent (Peristiany 1939; Orchardson 1961) women are quite commonly unhappy during at least some period of their marital life, and they do not have divorce as an option (primarily because of the complexities associated with returning bridewealth). In such circumstances, and particularly when violence ensues, women run away (or at least take their children away) to the home of their parents, where their brothers also live. Several such instances were observed during fieldwork. When the natal homestead is near to the marital homestead the husband and his kin arrive in person to demand the wife and her children back. When the natal homestead is at a great distance such delegations demanding the wife's return, to the extent that they occur, are generally less successful. This is primarily because a patrilineage will lack political allies beyond the area where it is localized. I therefore view this effect as evidence of the wife finding safe haven, for herself and her children, with her natal family, and would suggest that this "refuge" hypothesis be tested in other populations.

8. Unlike most studies to date there is no maternal grandmother effect. Generally grandmothers are thought to be the natural caretakers of their daughters' as opposed to their sons' children because of the greater certainty of relatedness. In the Kipsigis, however, it is the paternal grandmother whose presence has a beneficial effect on the survival of small children. This may reflect the strongly patrilineal organization of Kipsigis (see too Leonetti, et al. 2005; Lycett, et al. 2000).

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TABLE 1. MULTIVARIATE ANALYSIS OF CONTROL (NON-KIN VARIABLES) AFFECTING SURVIVAL OUTCOMES (data in control4.spo)

	Model A (a)			**Model B (b)**		
Variable	N	Beta	Wald /sig	N	Beta	Wald /sig
1. Birth year (ye) (c)	582	-0.019	1.508 ns	758	-.032	8.963 **
2. Sex			.093 ns			.276 ns
Male	300			404		
Female	282	.071		381	-.100	
3. Twins			8.015**			31.25 ***
Single	568			756		
Twin	14	1.367		29	1.761	
4. Mother's age at birth (d) (*nmagb*)			1.427 ns			1.445 ns
12-20 years	105			253		
21-27 years	249	-.351		286	-.330	
28-47 years	228	-.068		246	-.294	
5. Previous IBI (e) (*previbi4*)			10.179 *			
10-22 months	147					
23-25 months	147	.202				
26-36 months	164	-.475				
37 – 150 months	124	-.944				
6. Birth order (*nbpar1*) (f,g)			5.495 (t)			3.700 ns
1-3	193			366	-.554	
4-6	228	-.841		248	-.102	
7-14	161	-.492		171		
7. Polygyny (d) *Mnwaab2*			1.790 ns			4.755 *
Cowives 0	254			391		
Cowives 1	264	.353		317	.539	
Cowives >1	64	.408		77	.731	
8. Education (e) *(meduc)*			3.287 (t)			
Years of education (c)	582	-.071				
9. Acres *(aa83)*			4.817 *			14.361 ***
Below median	284			400		
Above median	298	-.625		385	-.847	
Full model Chi Square Likelihood statistics	46.080, df = 14, p<0.0001			64.849, df = 10, p < 0.0001		

(a) Individuals dropped with missing data
(b) Variables dropped with missing data
(c) Covariate
(d) Calculated at time of birth of child
(e) Data on *previbi4* missing for 146 observations, and on *meduc* for 87 observations. These two variables are dropped from Model B, leaving an N of 582
(f) Birth orders categorized this way to maximize capture of inverted U shape survival by parity
(g) Number of *surviving* nuclear and extended family brothers and sisters were examined, but were not significant (Borgerhoff Mulder 1998).

TABLE 2 KIN EFFECTS ON CHILD SURVIVAL ACROSS FULL SAMPLE

(output in bivar.spo – comp910)

		MODEL C (a)	
	N	Beta	Wald/sig
1. Parental survival			
Father (dead)	19		0.087 ns
Father (alive)	766	.211	
Mother (dead)	23		19.854 ***
Mother (alive)	762	-1.480	
2. Paternal Kin			
FM (deceased)	117		29.732 ***
FM (alive not in AK) (b)	214	-1.124 ***	
FM (alive in AK)	454	- 1.039 ***	
FF (deceased)	193		6.981 *
FF (alive not in AK)	219	-0.543 *	
FF (alive in AK)	373	- 0.510*	
FBCAT (0-1)	216		9.581 *
FBCAT (2)	190	-.158	
FBCAT (3)	179	-.700 *	
FBCAT (4-7)	200	-.631 *	
3. Maternal kin			
MM (deceased)	119		3.926 ns
MM (alive not in AK)	375	-.540	
MM (alive in AK)	291	.300	
MF (deceased)	147		4.770 (t)
MF (alive not in AK)	342	-0.397	
MF (alive in AK)	296	0.052	
MBCAT2 (0)	112		6.228 ns
MBCAT2 (1-2)	320	-.312	
MBCAT2 (3-4)	292	-.597*	
MBCAT (5-7)	61	-.802 (t)	

(a) Single variate models
(b) AK = adjacent kokwet or neighbourhood, i.e. living over 1 day's walk away

TABLE 3 KIN EFFECTS ON CHILD SURVIVAL WITH DATA SPLIT BY WEALTH (MODEL D), WITH WEALTH INTERACTION TERMS (MODEL E)

(Output in singlevar_w5&6 models_split wealth.spo (D), and singlevar_w5&6 models_wealth-ints.spo (E) – comp910)

		MODEL D (a)				**MODEL E** (b)
		Poor		Rich		Wealth interaction
	N	Beta	Wald /sig	Beta	Wald /sig	Wald /sig
1. Parental survival						
Father (dead)	19		.099 ns		.131 ns	.015 ns
Father (alive)	766	0.226		3.010		
Mother (dead)	23		4.351 *		19.667 ***	1.473 ns
Mother (alive)	762	-1.078		-1.950		
2. Paternal Kin						
FM5 (deceased)	117		7.995**		23.945***	3.507 (t)
FM5 (alive)	668	-0.753		-1.526		
FF5 (deceased)	193		2.655 ns		6.133*	.560 ns
FF5 (alive)	592	-0.440		-0.743		
FBCAT (0-1)	216		2.852 ns		16.570 ***	12.784 **
FBCAT (2)	190	-0.485		0.210		
FBCAT (3)	179	-0.444		-1.191		
FBCAT (4-7)	200	-0.151		-1.630		
3. Maternal kin						
MM6 (alive not in AK)	410		5.031 *		0.000 ns	2.115 ns
MM6 (alive in AK/deceased)	375	0.560		-0.006		
MF6 (alive not in AK)	342		7.701 **		0.000 ns	3.246 (t)
MF6 (alive in AK/deceased)	443	0.729		0.003		
MBCAT2 (0)	112		9.539 *		0.777 ns	6.681 (t)
MBCAT2 (1-2)	320	-0.315		0.234		
MBCAT2 (3-4)	292	-0.893		0.354		
MBCAT (5-7)	61	-1.625		0.608		

(a) Single variate model, dividing sample into richer and poorer half

(b) Model E is the single variate model (Model C) with wealth and a wealth interaction term added for the specified kin variable.

TABLE 4 KIN EFFECTS ON CHILD SURVIVAL WITH CONTROLS ACROSS FULL SAMPLE (MODEL F), WITH DATA SPLIT BY WEALTH (MODEL G), AND WITH WEALTH INTERACTION TERMS ADDED TO MODEL F (MODEL H)

Output in full model_w5&6.spo (F), in full model_w5&6_splitwealth (G), and inspecific-ints w5&6 (H) – comp910)

		MODEL F (a)		**MODEL G** (b)				**MODEL H** (c)
				Poor		Rich		
	N	Beta	Wald /sig	Beta	Wald /sig	Beta	Wald /sig	Wald /sig
1. Parental survival								
Father (dead)	19		4.189 *		2.234 ns		.001 ns	.008 ns
Father (alive)	766	1.635		1.306		10.215		
Mother (dead)	23		21.509 ***		7.182 **		15.083 ***	.511 ns
Mother (alive)	762	-1.805		-1.547		-2.274		
2. Paternal Kin								
FM5 (deceased)	117		24.680 ***		8.934 **		2.066 ns	.620 ns
FM5 (alive)	668	-1.152		-.987		-.756		
FF5 (deceased)	193		5.680 **		0.400 ns		2.171 ns	.053 ns
FF5 (alive)	592	-.627		-.254		-.666		
FBCAT (0-1)	216		12.728**		4.049 ns		12.422 ***	4.622 ns
FBCAT (2)	190	-.377		-.083		-.585		
FBCAT (3)	179	-.760		-.653		-1.327		
FBCAT (4-7)	200	-1.028		-.582		-2.251		
3. Maternal kin								
MM6 (alive not in AK)	381		0.010 ns		0.957 ns		0.033 ns	4.340 *
MM6 (alive in AK/deceased)	404	0.029		.373		-1.120		
MF6 (alive not in AK)	344		0.862 ns		0.504 ns		0.349 ns	3.898 *
MF6 (alive in AK/deceased)	441	0.283		.280		-416		
MBCAT2 (0)	112		12.753**		10.295 *		5.572 ns	6.313 (t)
MBCAT2 (1-2)	320	0.478		.000		.795		
MBCAT2 (3-4)	292	-0.239		-.955		.752		
MBCAT (5-7)	61	-0.880		-1.871		1.044		
Full model Log Likelihood Chi-square	785	129.21, df=17, p<0.001		59.592, df=16, P<0.001		99.359, df=16, p<0.001		

(a) Full model. Significant variables included in model but not shown in table: mnwaab 7.855, df=2, p=0.020, year 26.783, df=1, p<0.001, twins 26.626, df=1, p<0.001, wealth 19.501, df=1, p<0.001.

(b) Full model with sample split into richer and poorer halves. Significant variables included in model but not shown in table: poor: mnwaab 9.729, df=2, p=0.008, year 6.398, df=1, p<0.011, twins 6.449, df=1, p=0.011; rich: mnwaab 1.497, df=2, ns, year 11.756, df=1, p<0.001, twins 24.089, df=1, p<0.001).

(c) Model H is a rerunning of Model F with a wealth interaction terms added for the specified kin variable.