

Report

Dimensions of Fatherhood in a Congo Basin Village

A Multimethod Analysis of Intracultural Variation in Men's Parenting and Its Relevance for Child Health

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Fathers' direct care (e.g., carrying, sensitive caregiving, cultural transmission) can potentially improve children's health, well-being, and social development. However, between- and within-culture variation in fathers' roles in these domains remains understudied, particularly in work on small-scale societies, and we know relatively little about how these roles intersect with indirect paternal care (e.g., provisioning, resource defense) to shape child health outcomes. We use data from Bondongo fisher-farmers of the Republic of the Congo to test the relationship between a man's relative fit to a local cultural model of fatherhood and his children's health as measured by local perceptions, anthropometrics, and biomarkers of psychosocial stress (Epstein-Barr virus [EBV] antibodies) and immune activation (C-reactive protein; CRP). Results indicate that Bondongo fatherhood is multidimensional and that higher-quality direct care is associated with better child health and growth, whereas the association with indirect care is less clear. Additionally, paternal care was unrelated to CRP or EBV, but marital disputes correlated with elevated EBV antibody titers, suggesting that psychosocial stress is related to these family dynamics. Thus, Bondongo fathers' care helps shape children's health, consistent with the local cultural model and evolutionary frameworks suggesting a broad and flexible role for hominin fatherhood.

Study Background

Models of the evolution of human life history that include a focus on male parental care often emphasize specific aspects of men's indirect care, such as provisioning or resource defense (Kaplan et al. 2000; Lancaster and Lancaster 1983). However, although highly variable, men also provide direct care to their offspring, including early care behavior such as infant carrying (Gettler 2010), which reduces physical demands on the mother. Fathers also engage in other forms of direct care throughout the life span, such as cultural transmission or contributions to offspring's social status, that improve outcomes for children in complex human social contexts (Dira and Hewlett 2016; Hewlett and Cavalli-Sforza 1986; Scelza 2010; Shenk and Scelza 2012). There is also growing evidence that men's physiology responds to the demands of parenting in ways that overlap with and diverge from that of mothers (Gettler 2014, 2016; Gray and Crittenden 2014), supporting a model of the evolution of paternal care in humans that includes a role for direct care by fathers (Gettler 2010). Altogether, there is good reason to hypothesize that diverse forms of indirect and direct paternal care affect the fitness of human fathers, including through influences on the growth, development, and health of their offspring.

In that vein, there is enormous diversity in men's roles in human family systems. The form those roles take at any particular point, and whether a father is likely to provide direct or indirect care to his children, varies based on ecology, culture, family dynamics (e.g., marital quality), and the individual, leading to substantial cross-cultural (B. S. Hewlett 1992; Gray and Anderson 2010; Shwalb, Shwalb, and Lamb 2013) and intracultural (e.g., B. S. Hewlett 1991) variation. Attention to intracultural variation among fathers is relatively rare in studies of fatherhood in small-scale societies, which typically examine culture-level differences, compare fathers with mothers, or both (Fouts 2008; Hames 1992; Harkness and Super 1992; Morelli and Tronick 1992; Munroe 2002). Theoretical and empirical work has also focused on effects of father absence (Belsky, Steinberg, and Draper 1991; Lawson et al. 2017; Sear and Mace 2008; Shenk et al. 2013), but we know little about how variation between men, as present fathers and husbands, contributes to differences in child physical growth and health in small-scale societies (Winking and Koster 2015).

Drawing on data collected among Bondongo fisher-farmers of the Republic of the Congo, we aim to help advance the field of fatherhood research by (1) mapping intracultural variation in men's status as fathers and marriage partners relative to local cultural models of fatherhood and family life in a small-scale society and (2) investigating the association between men's "fit" to the cultural model of fatherhood and their children's health. We begin by establishing what makes a good father, as understood by our informants—their cultural model of fatherhood (Harkness and Super 1992; B. S. Hewlett 1991). We then examine the association between individual men's fit

to the cultural model as established through peer-ranking and measures of children's relative growth and energetic status as well as biomarkers of immune function. Studies have found that "cultural consonance"—relative perceived fit to a cultural model—can have significant impacts on individuals' health and well-being (Dressler 2005; Gravlee, Dressler, and Bernard 2005). Relative fit to cultural models of parenthood and the association between parents' fit and child health have not previously been examined.

Ethnographic Context

Fieldwork for this study was conducted during June and July 2016 among the Bondongo people living along the Motaba river in Likouala Province, Republic of the Congo. The Bondongo traditionally speak a Bantu C-10 language, though Lingala is universal. They practice shifting cultivation, growing manioc (cassava), plantains, maize, and a number of minor crops. They also rely extensively on fishing. Men prepare the gardens for planting by clearing a plot out of the primary forest, burning and removing trees and larger foliage. Women then maintain the garden and harvest all foods. Men fish all year round either using baskets or, during the dry season, by bail fishing (Komatsu 1998). Palm wine, or *molenge*, cultivation is a major activity for men, who commonly visit as many as eight trees two to three times a day to harvest. Men also hunt by shotgun or traps. Children perform household labor, run errands in the village, and help their mother in the gardens. After around 12 years of age, boys may accompany their fathers or other related men on hunting expeditions. Part of the year, children 5–12 years old attend public primary school in the village. Market integration in the region is minimal. The families who participated in this study come from one village with a single one-room store. A monthly traveling market also arrives by dugout canoe, selling regional foods (e.g., dried fish) and non-food items (e.g., clothes).

Methods

Sample

Consent for conducting the study was obtained from the village council during a prior trip in 2015, and recruitment of families was conducted in 2016. All married couples with at least one child younger than 18 years old were eligible. More selective inclusion criteria (e.g., specific age range of children) would have significantly reduced the sample size, as only 20–25 households in the village meet these criteria at any one time.

Twenty families agreed to participate, which represented all eligible participants in the village at the time (table 1). Individual consent from adults and assent from the children were obtained independently. One participating man was visiting from a nearby village where his wife and children were living during the study period. He was from the study village, and his family was well-known to the community. Two other participating men left on business trips during the study period and

Table 1. Sample details

	<i>n</i>	Age (years)			
		Mean	SD	Min	Max
Adults:					
Female	21	32.6	8.3	18	48
Male	20	37.1	7.9	24	50
Children:					
Female	41	7.5	4.3	<1	16
Male	42	6.8	4.8	<1	17

did not perform the peer-ranking task, and some of their anthropometric data were not collected. Two participating men each had only one infant child, and they each lived with other family members in a multifamily household. Overall mean household size was 8.1 persons (SD = 2.9). The largest household in the sample included 14 people and spanned four generations. This household included the participating couple's 19-year-old daughter and her breastfeeding infant. They are included in the data set in counts of household members and dependents. However, the adult daughter was excluded from analyses because of her age (>18 years) and breastfeeding status, which can affect energetic status and immune function—two of the core domains in which we measured child outcomes. No measures were taken of her infant, and the infant's father did not live in the village. Three participating men were polygynous, two of whose two wives cohabited in the village and were included in the study along with their children. Parents in the final sample ranged from 18 to 50 years old (mean = 35.18, SD = 8.0), and children ranged from a few months to 17 years old (mean = 7.2, SD = 4.5). All ages were known and reported by participating adults.

Cultural Models of Fatherhood

Informal interviews. Two types of data were collected to understand the local cultural model of fathering and healthy child development. First, we conducted a series of informal interviews about the responsibilities of a father, marital dynamics, and child development. Second, interview responses were used to develop a ranking task to assess men's perceptions of each other's qualities as fathers on positively valued dimensions of fatherhood and on the health of one another's children.

Informal interviews were conducted with nine men and five women directly by our team in French or in Lingala via a translator. Responses showed strong consistency across the four domains of interest. When asked about a "father's responsibilities" or the characteristics of a "good father," informants invariably first mentioned that a man must bring home food. He also must buy clothes for his children, and several informants mentioned that if he travels, a good father buys gifts for his children to bring home. These responses were taken as collectively referring to indirect forms of paternal care. Some

informants also mentioned that men are responsible for caring for sick children by bringing them medicine, but specific stories were also recounted of men staying by their sick child's side. Fathers' responsibility for the social education of children was also frequently mentioned, commonly including descriptions using the French term *encadrer* (literally, "to frame"), suggesting "guiding" or "attending to" the children's behavior. For example, informants explained that fathers should make sure children act appropriately around others, and they must guide adolescents, specifically, toward being responsible and working for the good of the family. These responses were taken as indicators that fathers' direct care for the health and social education of their children was valued in the village.

We also wanted to assess whether marital conflict was perceived to affect child well-being. Informants mentioned that marital conflict was typically caused by sexual jealousy, aggressive behavior related to excessive drinking, or, for men, wives not adequately performing housework or childcare. Eleven of the 14 informants (79%) agreed that spousal disputes were bad for the children, remarking that children cry and "hold it in their hearts." We took this general consensus to indicate that marital conflict is a possible factor impacting fathers' contributions to child health.

Finally, informants were very consistent about what constituted healthy child development. Invariably, we were told that if an infant nursed well and did not cry too much, he or she was in good health, and, past infancy, if a child ate well, was robust in form (*na monene*), and played well with others, he or she was in good health. Often, informants referred to healthy children as having, in French, "*les vitamines*," indicating the children were adequately nourished.

Ranking task. The responses to the informal interviews were used to construct a peer-ranking task using the set of questions shown in table 2. Questions 1–4 were intended to assess individual men's performance in relation to a cultural model of fatherhood. Question 5 was intended to measure relative "emic" perceptions of other men's children's health and to compare local knowledge of child health to anthropometric measures of health. Reliability statistics were computed on the rankings to measure the overall agreement among informants on the "correct" ranking of the 20 fathers (Weller 2007). Cronbach's alpha coefficients indicate strong consensus for each question (table 2).

The ranking task was conducted as follows. Each available man ranked photographs of the remaining 19 participating men (i.e., excluding themselves) from first to last in relation to the five questions. Informants were urged to uniquely rank all of the men, but ties were allowed, with the last position always coded as 1 and the first (highest) position as the sum of the number of positions. An average rank was then calculated for each of the 20 fathers for each question.

Because we allowed for ties in the rankings, the range of scores reveals the relative ease our informants had in distinguishing finer-grain variations in each quality among their peers. For example, if all men were laid out individually, the maximum score would be 19. As seen in table 3, the "provider" question yielded the most individual rankings across rankers. Indeed, men would describe each other man in terms of the number of important subsistence activities he performed on a regular basis (e.g., hunting, fishing, gardening, *molenge* cultivation). Men were ranked more similarly to each other for the other qualities.

Average rankings for children's health were highly correlated with both the indirect care measure (provider) and the two direct care measures ("stay" and "attend"; table 4). Additionally, stay and attend were strongly correlated. "Dispute" was not correlated with any other rankings (table 4). An exploratory factor analysis of the four fatherhood quality rankings excluding "health" (which pertains to the men's children, not directly to the men as fathers) indicates two major dimensions of fatherhood in these data, with provider loading highly on one factor and stay and attend loading together on the second factor. Therefore, we averaged stay and attend scores for each father to create a combined variable for overall direct care ("direct").

Anthropometrics and Biomarkers

Physical health was measured by two approaches. First, for all available participants, we measured height using a Seca stadiometer, weight using an electronic bathroom scale, and triceps skinfold thickness (SFT) using Lange skinfold calipers, by standard techniques (Lohman, Roche, and Martorell 1988). We first calculated z-scores for weight-for-height (WFH), body mass index (BMI), and triceps SFT using World Health Organization (WHO) standardization methods, which control for var-

Table 2. Questions asked in the peer-ranking task

Question	Dimension	Cronbach's α
Whose children are the healthiest?	Perception of children's health [Health]	.89
Who works the hardest?	Indirect investment [Provider]	.95
Who is most likely to stay home/sacrifice other activities when their children are sick to care for them?	Direct investment, health [Stay]	.85
Who "attends to" their children the most?	Direct investment, social [Attend]	.97
Who disputes with their wife/wives the most?	Marital harmony [Dispute]	.84

Table 3. Descriptive statistics for average peer-ranking scores

	<i>n</i>	Mean	SD	Min	Max
Health	20	5.8	2.2	2.2	9.5
Provider	20	8.0	3.7	1.6	15.4
Stay	20	4.9	2.0	1.5	7.7
Attend	20	4.6	2.4	1.3	9.3
Dispute	20	3.0	1.3	1.1	5.4

iation due to age (de Onis et al. 2007; WHO Multicenter Growth Reference Study Group 2009). However, because of small sample sizes in individual reference age groups, statistical models using WHO *z*-scores were not stable. As an alternative method to account for age-dependent variation in these measures of health, we regressed WFH, BMI, and SFT values on age and added the residuals to the average value for each measure. While losing comparability with WHO standards, this method maximized the use of available data, allowing comparison of health measures within the community independent of age. We then converted these age-adjusted WFH, BMI, and SFT values to *z*-scores.

From finger pricks, we also collected dried blood spots (DBS) on standard filter paper from as many participants as was possible. We were unable to acquire sufficient blood for analysis from a significant number of participants. The lancets used could not puncture the calloused skin of many adult and some child participants, and others, including children, did not produce sufficient blood required for analysis even after hand massage and brief exercises (short jog or dance) to stimulate blood flow before sampling. For these reasons, the sample sizes for biomarkers derived from DBS are smaller than for anthropometrics (table 5). Samples were sent to the Global Health Biomarker Laboratory at the University of Oregon and assayed for levels of Epstein-Barr virus (EBV) antibodies and C-reactive protein (CRP; McDade et al. 2000, 2008).

EBV immunoglobulin G (IgG) antibody levels in DBS were assessed as described by Eick et al. (2016) and are expressed in the arbitrary units of absorbance units per milliliter. CRP levels in DBS (in milligrams per liter) were assayed using a modified version of the CRP assay described in prior work (e.g., McDade et al. 2008) and converted to plasma-equivalent values. Following McDade et al. (2008), we use plasma-equivalent CRP values above 3 mg/L as an indicator of "elevated CRP," encompassing low-grade immune activation as well active acute infection. We log-transformed EBV because of its skewed distribution, and we eliminated one individual based on an EBV value that was ≥ 6 SD above the sample mean. One individual was EBV seronegative. Intra- and interassay coefficients of variation for the CRP ELISAs were 3.6% and 6.3%, respectively; for the EBV IgG ELISAs, they were 7.5% and 13.7%, respectively.

Not every anthropometric or biomarker measure was obtained from every participant. Some were unavailable or unwilling (some young children and one man) to have one measure or more collected. Descriptive statistics of all measures are shown in table 5.

Statistical Analysis

Relationships between our variables of interest were analyzed using either ordinary least squares regression or logistic regression (CRP only). In each case, we utilized robust standard errors clustered at the household level to control for non-independence of children sharing a house (Meehan, Helfrecht, and Quinlan 2014).

The average peer-ranking scores of children's health status (health) and of fatherhood quality (provider, direct, dispute) served as predictor variables, and the standardized anthropometric (WFH, BMI, SFT) measurements of the children were predicted as dependent variables (see table 6). Subsequently, we predicted the children's biomarker profiles (EBV, elevated CRP) from health (only) and the three fatherhood qualities (provider, direct, dispute). Finally, we also predicted children's biomarker profiles (EBV, elevated CRP) from their anthropometrics to explore the interrelationships of these health measures. As noted previously, in all models, we converted the anthropometric and immune (EBV) dependent variables to *z*-scores to aid in comparison across measures.

We hypothesized that a number of variables might be relevant covariates in these models. First, some men lived in households with nonbiological children who they likely cared for (e.g., stepchildren, grandchildren, and cohabiting children of other men), but there is reason to believe men might allocate resources and time preferentially toward biological children. Thus, we included a dichotomous variable indicating whether or not the child was the biological child of a cohabiting father as a covariate. Second, we reasoned that men's experience as fathers might impact their knowledge and skill as parents. To address this possibility, we explored the sum of the ages in years of each man's biological children as a proxy measure of children's fathers' parenting experience. We chose this variable because it reflects both the number of children a man has and their ages independent of his age, though it is also highly correlated with fathers' age. Finally, as a marker of fathers' health and recent energetic condition, biological fathers' SFT was included as a covariate. Table 5 presents descriptive statistics for each covariate used.

Table 4. Intercorrelation matrix of average peer-ranking scores (Pearson's *r* values)

	Health	Provider	Direct ^a	Stay	Attend	Dispute
Health	1.00					
Provider	.60*	1.00				
Direct	.70**	.13	1.00			
Stay	.72**	.15	.96**	1.00		
Attend	.64*	.11	.97**	.85**	1.00	
Dispute	.16	.0002	.14	.04	.22	1.00

^a Direct is the average of stay and attend and is the measure of direct investment used in analyses.

* $P \leq .005$.

** $P \leq .001$.

Table 5. Descriptive statistics of children’s anthropometric and biomarker variables and covariates used in statistical analyses

	<i>n</i>	Mean	SD	Min	Max
WFH (kg/cm)	74	.19	.05	.09	.36
BMI (kg/m ²)	74	16.00	2.10	11.05	24.36
SFT (mm)	66	9.27	3.05	4.00	19.00
CRP (mg/L)	55	3.07	4.33	0 ^a	16.34
EBV (AU/ml)	52	201.74	213.73	24.6	693.51
Father’s SFT (mm)	72	9.04	4.61	4.00	19.00
Nonbiological child dummy ^b	83	.11	.31	0	1
Sum of children’s ages (years)	83	37.38	27.46	.2	100

^a Not true zero but under the detection limit of the assay.
^b Sample included nine nonbiological children in four households.

To examine the impact of covariates on the major relationships of interest, we compared three sets of models. In each set, the independent variables of core interest were either the peer-ranking of children’s health (health only) or the three peer-rankings of fathering qualities (analyzed together; see table 6). In the first set of models, to maximize the data from the full sample, we predicted children’s WFH, BMI, SFT, CRP, or EBV from the core independent variables with no covariates in the models. If there were significant findings in the first set of models, we ran the models again with only the independent variables of core interest but restricted to those participants for whom we had all covariate data; and finally, we ran a third set of models that included covariates.

Results

The peer-ranking score for men’s children’s health (health) was significantly and positively related to children’s WFH ($B = 0.16, SE = 0.04, P = .002$) and SFT ($B = 0.22, SE = 0.05, P < 0.001$). The model including covariates was not qualitatively different than the basic model. Health score was also positively

related to children’s BMI in the basic model ($B = 0.12, SE = 0.04, P = .01$) but became nonsignificant when covariates were included ($P = .12$).

Table 6 presents model results for fathering qualities on anthropometric outcomes. Men’s provider score was significantly positively related to SFT in the basic model but not in the model when covariates were included. Provider score also showed a modest positive relationship to WFH in the basic model, but this trend was not evident in the model controlling for covariates. Direct score was significantly and positively related to children’s WFH, BMI, and SFT in the basic model and in the model including covariates (WFH: $B = 0.20, SE = 0.05, P = .002$; BMI: $B = 0.19, SE = 0.05, P = .001$; SFT: $B = 0.19, SE = 0.08, P = .04$; fig. 1).

Using logistic regression to predict children’s likelihood of elevated CRP, we found that children’s health peer-ranking scores did not significantly predict their likelihood of elevated CRP ($P > .6$). Similarly, likelihood of elevated CRP did not significantly vary based on any of the rankings of fatherhood quality (all $P > .2$). However, children with greater WFH (odds ratio = 0.38, $SE = 0.14, P = .01$) and BMI (odds ratio = 0.44,

Table 6. Ordinary least squares regression model results predicting children’s anthropometrics from father rankings

	Model 1			Model 2 ^a			Model 3		
	WFH	BMI	SFT	WFH	BMI	SFT	WFH	BMI	SFT
<i>n</i>	74	74	66	64	64	58	64	64	58
<i>R</i> ²	.10	.06	.25	.13	.10	.29	.17	.14	.32
Provider	.05 (.03) ⁺	.03 (.03)	.09 (.03)**	.06 (.03) ⁺	.02 (.03)	.08 (.03)*	.05 (.05)	-.03 (.06)	.08 (.06)
Direct	.14 (.05)*	.13 (.05)*	.21 (.08)*	.14 (.06)*	.17 (.05)**	.25 (.08)**	.20 (.05)**	.19 (.05)***	.19 (.08)*
Dispute	.12 (.11)	.04 (.10)	.08 (.12)	.10 (.10)	.03 (.11)	.08 (.11)	.08 (.08)	.04 (.08)	.08 (.09)
Biological child							.15 (.32)	.22 (.37)	-.10 (.26)
Sum of children’s ages							.004 (.004)	.01 (.01)	-.003 (.004)
Father’s SFT							-.05 (.03) ⁺	-.04 (.03)	.05 (.03)

^a Sample restricted to participants for whom all covariate data is available.
⁺ $P \leq .10$.
^{*} $P \leq .05$.
^{**} $P \leq .01$.
^{***} $P \leq .005$.

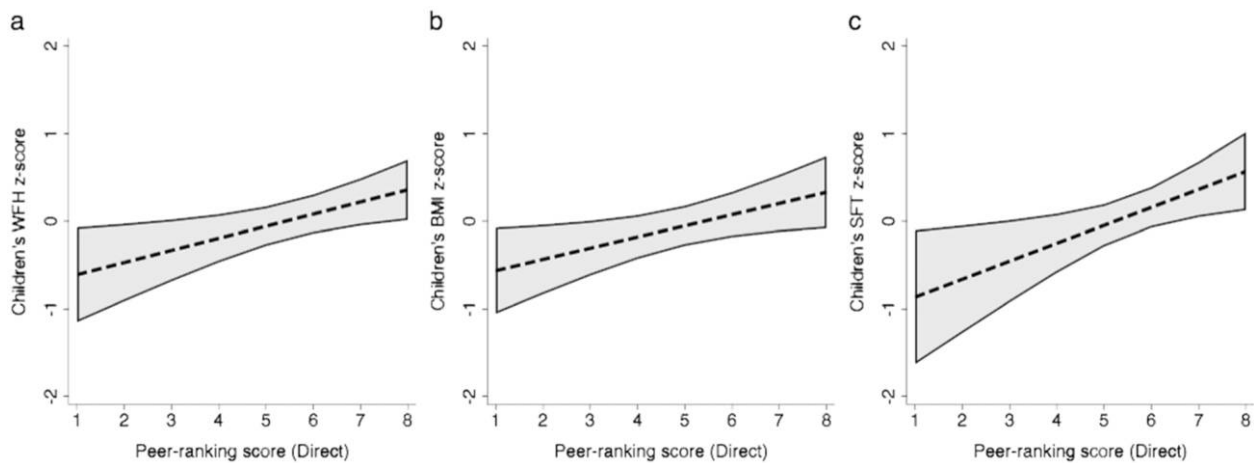


Figure 1. Linear fit plots with 95% confidence intervals (gray area) of direct investment peer-ranking score (direct) on z-scores of weight-for-height (WFH; A), body mass index (BMI; B), and triceps skinfold thickness (SFT; C).

SE = 0.17, $P = .04$) were less likely to have elevated CRP; those findings were largely unchanged after we added covariates (both $P < .05$). Children's EBV did not significantly vary based on their anthropometrics or health rankings (all $P > .3$). EBV also did not differ significantly based on the direct or provider fathering dimensions (both $P > .6$). In contrast, children in families with greater marital disharmony (dispute) had elevated EBV ($B = 0.28$, SE = 0.11, $P = .025$; fig. 2), including after we added covariates ($P = .029$).

Discussion

In this study, Bondongo fatherhood was shown to have multiple dimensions that vary in their degrees of cultural salience, but each dimension relates to aspects of children's physical health and well-being. These findings align with the Bondongo cultural model that holds fathers as essential to the health of their families. Overall, the study is consistent with evolutionary models suggesting a broad and flexible role for hominin fatherhood (Gettler 2010; Gray and Anderson 2010) but one that is responsive to ecological and cultural contexts (Gettler 2016). Notably, fathers' perceived level of direct care was more consistently associated with their children's health than was their perceived indirect care.

Our data suggest that Bondongo men are attuned to the cultural model of fatherhood, the health of other families in the village, and their peers' qualities as fathers. This can be seen by (1) the high reliability among the participating fathers who ranked their peers' relative fit to the dimensions of fatherhood derived from informal interviews; (2) the strong, significant intercorrelations between the men's rankings of each other's qualities as fathers and their rankings of each other's children's health (table 4); and (3) the significant associations between men's rankings of each other's children's health and the anthropometric measures. Indeed, many men in the study have known

each other all of their lives and at least since they became fathers. Thus, we have confidence that our measures of fathering quality reflect high-quality knowledge of men's behavior.

Past work from industrialized countries, primarily in the West, has shown that aspects of high-quality fathering (e.g., sensitive, nurturant, authoritative behavior) relate to improved child development outcomes in a number of social, behavioral, and cognitive domains (Shwalb et al. 2013). Meanwhile, the smaller literature on fathers' impacts on children in small-scale societies tends to focus rather explicitly on fathers' absence versus presence as well as on child mortality as the sole outcome (e.g., Sear and Mace 2008). Complementing those insights, a full perspective on paternal effects would also include variation in morbidity and health of living children and indicators of the range of investment variation between fathers. Thus, our findings help bridge existing gaps in this literature by showing that children were viewed as healthier and had better anthropometric indicators of long-term (WFH, BMI) and shorter-term (SFT) energetic status when their fathers were ranked highly on direct care. In our sample, Bondongo children's energetic status (SFT, BMI) was qualitatively similar to findings from other resource-constrained, subsistence-level societies in which energy shortfalls and growth stunting are common (e.g., Houck et al. 2013; Magvanjav et al. 2013). Given the ecological and energetic conditions, our results are relevant to applied and evolutionary-oriented perspectives on fathers' effects on children. Specifically, improved childhood energetic status can substantially influence children's ability to stave off disease in highly pathogenic environments (McDade et al. 2008) and also shapes growth and other aspects of somatic development that affect productivity and fitness-relevant aspects of the phenotype later in life.

Conceptions of paternal care related to evolutionary models often emphasize men's indirect care (Kaplan et al. 2000; Lancaster and Lancaster 1983). Here, men's direct roles were

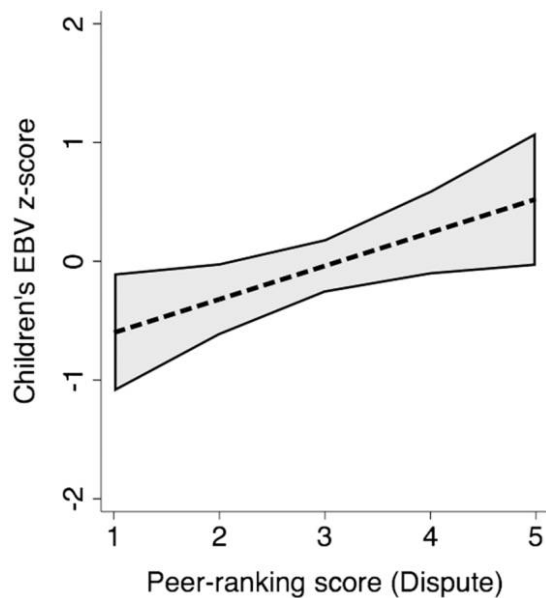


Figure 2. Linear fit plot with 95% confidence intervals (gray area) of marital harmony (dispute) peer-ranking score on z-scores of Epstein-Barr virus (EBV) antibody levels.

stronger and more consistent predictors of all measures of children's health compared with the indirect provider role. The participants' emphasis on fathers as "framers" of appropriate social behavior in particular suggests that conceptualizing paternal care beyond infancy may be critical to a fuller concept of what fathers have to contribute and may have contributed in our evolutionary past. For example, teaching is considered by many to be a critical adaptation that allowed for the evolution of culture (Boyd and Richerson 1985; Kruger and Tomasello 1996). Fathers may have been important contributors to children's cultural education, a process that occurs throughout development (Boyette and Hewlett 2017).

Nonetheless, our findings do not suggest that a man's role as provider is unimportant to their children's health, only that this role is intertwined with other factors. Men's status as hard workers did positively predict higher SFT and WFH in their children, although the latter was not statistically significant and the former became nonsignificant after controlling for other factors, such as biological relatedness. Prior work has shown that fathers preferentially provision biological children (Anderson, Kaplan, and Lancaster 1999; Flinn 1988; Marlowe 1999), and nutritional benefits of provisioning would have differential effects on children of different ages, as growth, development, and activity demands change across childhood and adolescence (e.g., Magvanjav et al. 2013). A primary limitation of our study was lack of power to examine the possible mediating or moderating effects of these demographic and household variables on the relationship between men's quality as providers and their children's health. Our statistical results suggest they merit consideration in future, larger studies.

Additionally, some evolutionary models also suggest that it is difficult to differentiate between provisioning as parenting effort versus mating effort (Hawkes 1991), and investment in provisioning may not always benefit children's physical health but rather represent investment in social relationships that may yield benefits for a man's family (B. S. Hewlett 1991). For example, while cultivation of palm wine may be regarded as an essential activity for Bondongo fathers, it is dangerous, involving climbing high in a tree using a liana while carrying tools and a receptacle for sap (wine) collection. Men have been known to fall—a cause of serious injury. Given the risks, its cultivation might be better seen as mating effort. Alternatively, its benefits or attractiveness as a provisioning activity might come from male-male bonding via drinking together—a common sight in the village. Future research that includes explicit measurement of men's allocation of resources (e.g., to step- vs. biological children) and social, status, or reproductive benefits related to indirect care behaviors would help clarify these possibilities.

We did not find associations between marital disputes and children's anthropometrics. This may suggest that, in the Bondongo context, marital harmony does not necessarily indicate or interrelate with poor fathering in domains that affect children's energetic well-being, such as through resources available to children or the children's energetic costs. Indeed, ranking in the dispute domain was also not significantly linked with the other fatherhood quality domains. Alternatively, our measure of marital harmony simply may not capture aspects of conflict that reflect poorly on children's health. However, evidence against this explanation includes our finding that children in families with higher marital conflict have elevated activation of their stress physiology, which aligns with previous research (Flinn et al. 2011). Other studies of neighboring Bantu cultures (B. L. Hewlett 2013) and our own ethnographic experience suggest that men's aggression toward their wives is an acceptable if not expected part of marital life in these cultures, but children may nonetheless be negatively affected by it, given the significance of family life and dynamics in shaping their working models of the world (Flinn et al. 2011). Just as we did not find clear relationships between men's provisioning and physical health, children may receive adequate nutrition despite conflict between their parents. Again, observational data on family life are essential to future research in order to clarify these issues.

We observed that children with higher BMI and WFH were less likely to have elevated CRP. None of the measures of fathering quality or the peer rankings of children's health were significantly associated with heightened CRP production. It would be expected that children with better nutritional status (i.e., with more stored energy available to support costly immune function) would be better positioned to avoid or fight off infection, suggesting that our measure is giving us a reasonable signal of immune activation. Given that we found that greater paternal direct care was linked to better energetic status for children and that children who were perceived to be in better

health by our participating fathers were also in better energetic condition, we suggest that repeated measures over the long term or a larger sample might help reveal any associations between fathers' care and children's costly immune activation and infection risks that we failed to detect here.

Finally, a family systems approach must evaluate the roles of the mother and other nonparental caregivers in children's well-being (Sear and Mace 2008), particularly in light of the increasing emphasis on humans as cooperative breeders (Meehan et al. 2014). For example, because of assortative mating and influences of mothers and fathers on one another, more invested Bondongo fathers may be married to similarly high-quality mothers, and our results could partially reflect maternal effects. Additionally, marriage also links a couple to broader childcare networks through paternal and maternal families. Contributions from these broader networks of caregivers may also be reflected in our results. Future work must include observational measures of fathering to add depth to our understanding of men's roles in the context of wider family systems and as external validation of rankings of fit to the cultural model. While the lack of such data is a limitation of this study, the several significant findings reported here strongly suggest that fathering quality—as defined within a man's cultural context and relative to other men in his cultural group—has significant implications for children's health.

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