Research

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Mother's social status is associated with child health in a horticulturalist population

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High social status is often associated with greater mating opportunities and fertility for men, but do women also obtain fitness benefits of high status? Greater resource access and child survivorship may be principal pathways through which social status increases women's fitness. Here, we examine whether peer-rankings of women's social status (indicated by political influence, project leadership, and respect) positively covaries with child nutritional status and health in a community of Amazonian horticulturalists. We find that maternal political influence is associated with improved child health outcomes in models adjusting for maternal age, parental height and weight, level of schooling, household income, family size, and number of kin in the community. Children of politically influential women have higher weight-for-age ($B = 0.33$; 95% CI = 0.12–0.54), height-for-age ($B = 0.32$; 95% CI = 0.10–0.54), and weight-for-height ($B = 0.24$; 95% CI = 0.04–0.44), and they are less likely to be diagnosed with common illnesses (OR = 0.48; 95% CI = 0.31–0.76). These results are consistent with women leveraging their social status to enhance reproductive success through improvements in child health. We discuss these results in light of parental investment theory and the implications for the evolution of female social status in humans.

1. Introduction

Positive relationships between dominance rank and measures of reproductive success have been found in numerous social species [1,2]. In non-human primates, male dominance rank is associated with preferential access to females and greater fertility, particularly in non-monogamous species [1]. Female dominance has weaker associations with fertility [3], but often associates with higher fecundity and infant survival, due to greater access to resources relative to lower-ranked peers and lower vulnerability to aggression and social stress [1,2,4].

In humans, studies in diverse settings show positive relationships between reproductive success and the proxies of social standing for men [3]. This relationship tends to be stronger in polygynous societies where high-status men can reproduce relatively quickly with multiple mates contemporaneously [3,5]. Regardless of subsistence type and marital practices, the high status appears to enhance male reproductive success through fertility gains rather than improved child survivorship, although there is suggestive evidence of the latter in the few societies where this question has been explored [3].

Less is known about whether and how social status imparts fitness benefits for women. Large, parallel bodies of research in psychology and behavioural
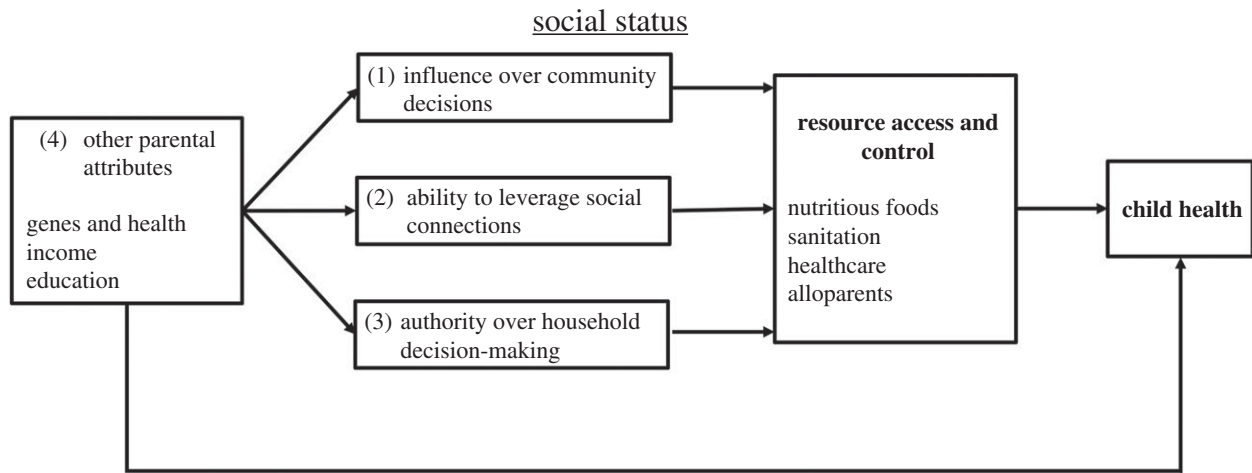
Figure 1. Conceptual pathways from parental social status to child health outcomes.

economics find that women tend to be more risk averse than men [6,7], and consequently less assertive in competitive (as opposed to cooperative) situations [8,9]. These preferences and corresponding behaviours have been put forward to help explain gender disparities in earnings and representation in high-ranking political or corporate positions [10]. Although the root causes of sex differences in status-enhancing behaviours are often attributed to differences in socialization [11,12], a classic evolutionary explanation has linked men's willingness to take greater risks and behave more assertively in competitive contexts to their greater reproductive potential [13]. Males in mammalian species typically have greater reproductive variance than females, who invest more heavily in their offspring via pregnancy and lactation, which limits their total potential number of offspring [14]. As a result, mammalian males tend to be 'competitive', aggressively taking risks to maximize their chances of reproducing, while females are 'choosy' or selective, opting rather to mate with males who can maximize offspring survival [14].

This framework, which has been advanced as an explanation for observed behavioural differences between men and women [15], may have limitations for the study of human behavioural variability [16,17]. Unlike most mammals, humans are characterized by long-term pair bonds and biparental care, yielding opportunities for women to benefit from competitiveness both when choosing a partner (in societies where they can exercise mate choice) and when seeking to maximize fitness for themselves and their children [18,19]. Accordingly, gender differences in competitiveness and risk-taking may be context-dependent, and women may adopt behaviours stereotypically associated with men in situations where there are clear benefits to themselves or their children [20,21]. While measures of social status may not be associated with higher fertility for women to the same extent that they are for men, they might be expected to associate with other fitness proxies, such as offspring survivorship [22], which mothers are uniquely positioned to impact given their role as primary carer of children in most human societies [23,24]. Humans occupy a particular ecological niche where parental care of offspring extends throughout childhood and adolescence, including heavy investment in 'embodied' capital, in the form of knowledge, skills, and social ties [25,26]. Parental investment during this period is vital to the development and survival of children [25,26].

Maternal embodied capital, in particular, is predicted to have a larger impact on offspring phenotype than paternal capital, and to have a stronger effect for younger offspring [27]. A few studies in small-scale societies indicate women who are preferred as social partners have more surviving offspring compared to less desirable social partners [28,29]. However, no study to our knowledge has explored whether high-status women are better able to leverage their social position within a community to obtain benefits for their children.

To assess potential fitness benefits to women of higher social status, we examined links between women's social status and proxies of offspring survivorship including child nutritional and health status, among Tsimane forager-horticulturalists of Amazonian Bolivia. We asked Tsimane villagers to assess the social status of their peers according to three criteria: verbal influence during community meetings (hereafter political influence), engagement in community project management (project leadership), and more broadly, the respect accorded by other community members (respect).

There are several possible pathways by which maternal and paternal social status might associate with resource access, and subsequently child health (figure 1). High-status individuals, by definition, shape community decision-making (figure 1: path 1) or leverage social connections (figure 1: path 2) which may yield preferential access to resources. These resources can, in turn, be converted into fitness gains by improving child health and nutrition in ways that increase child survivorship. Status within the community-at-large and social connections may also increase influence over decision-making within one's household (figure 1: path 3), which in turn, can increase resources available to children. This is particularly true for women who are, on average, more likely to favour investments in children's needs [30]. Finally, social status and child health could be related without any direct causal relationship. Parents who are themselves healthy may have both higher social status and healthier children. Or parental income and education may increase parents' status and, independently, child health via knowledge or purchasing power (figure 1: path 4).

To better understand potential fitness consequences of women's status motivations in a small-scale subsistence population, we examined the association between parental social status and child health (proxied by child anthropometrics and clinical diagnoses). We predict women's social

status is positively associated with their children's health, and more strongly associated with children's health than the status of fathers [23,24,27,31]. A previous study among Tsimane found that influential men have more surviving offspring due to higher fertility and lower offspring mortality [32], but that study only focused on men's status.

2. Material and methods

(a) Ethnographic setting

Tsimane reside in lowland Bolivia, Beni department, in more than 90 villages ranging in size from approximately 50 to approximately 500 residents. Their economy depends heavily on swidden horticulture, hunting, fishing, and gathering but they increasingly rely on income from wage earnings and sales of horticultural produce [33]. Women have on average nine children [31]. Men are responsible for hunting, but both men and women fish and work in horticultural fields [31]. Most marriages are monogamous and post-marital residence is often but not exclusively matrilocal, followed by patrilocal residence after the birth of one or two children [31]. Tsimane experience a high pathogen burden and have relatively little access to modern medical care over most of their territory [34]. A high prevalence of stunting is evident at all ages in childhood, as is a moderately high prevalence of wasting under age 2 years [35]. Previous studies have shown that proximity to market towns is associated with better statural growth in Tsimane children [36]. Proximity to town and greater household wealth are also associated with lower concentrations of C-reactive protein (CRP), a biomarker of immune activation [37]. School attendance and maternal literacy, however, show positive associations with higher CRP concentrations [37]. Other studies have shown that higher rates of helminth infection among Tsimane children are associated with low household income and traditional wealth, less parental knowledge about traditional medicine, as well as reduced access to clean water sources, latrines, and household items that improve hygiene (e.g. shoes) [38]. The death of a parent, especially the mother, strongly increases the risk of child mortality [39].

The study village is about a 45 min drive from the nearest market town and was home to approximately 380 adults and children in 2014. Reliance on wage labour, market goods, livestock, and Spanish language proficiency is high compared to more isolated Tsimane communities. Villagers live in clusters of closely related families but commonly participate in community-wide projects such as cleaning shared spaces (e.g. trimming soccer field grass), building and maintaining communal infrastructure (e.g. fixing the roof of the village school), or maintaining community trails. Weekly community meetings are held at the village school. They are coordinated by the village representative (corregidor) and other influential villagers and provide a platform for discussing village activity, community project logistics, and participation in government or non-governmental organization (NGO)-sponsored development projects. Community meetings also serve as a venue for resolving conflicts within the community, e.g. over land access for horticulture, the sale of community lumber, or other interpersonal disputes [40]. Interpersonal disputes generally result from conflicts between neighbours over theft and property damage, or disputes related to perceived lack of support from a cooperation partner, child negligence, sexual jealousy, and infidelity [41]. Attending community meetings is voluntary and varies depending in part on availability during the rice harvest season (February–April), and the importance of the meeting agenda. However, even when not attending meetings, villagers may gather around the school to socialize. Meetings typically last a few hours, and men and women of all ages attend and voice opinions. While women tend to speak less than men [42], educated and extraverted women tend to speak more than other women.

(b) Data collection

The sample consists of 342 clinical observations of 142 children (48% female), 47 mothers, and 47 fathers living in a Tsimane village studied since 2005. Measures of parental social status were collected in June 2014, and measures of child health were collected longitudinally between 2012 and 2016 with an average of 2.4 observations per child.

(i) Social status

All resident adults in the village ($n = 72$ women, 80 men) were rated by peers on three dimensions of social status: political influence, project leadership, and respect. Six women and six men from the village were randomly selected as raters and were asked to evaluate photographs of community members, for each of the following questions: (i) 'whose voice carries the most weight during community debates?' (political influence), (ii) 'who knows how to manage community projects?' (project leadership), and (iii) 'who receives more respect in the village?' (respect). Men and women's photographs were included in the same array and evaluated together by each rater. The questions were translated from Spanish into Tsimane and then back-translated by different research assistants from other Tsimane' villages to ensure consistency. The literal translation of the question used to generate the political influence score specifically refers to an individual's effectiveness in generating consensus and swaying opinion when conflicts arise in the community, while the question used to generate the project leadership score refers to an individual's effectiveness in instigating and leading community projects. Previous analysis of these domains of status among Tsimane men using a similar photo-ranking methodology indicate that 'respect' (arajjyedye') tracks traditionally valued skills like hunting ability [40]. Previous studies [43,44], ethnographic experience, and insights from our research assistant suggest that for women, respect may track child-rearing skills, and expertise in food processing, traditional craft-making, and folk medicine.

For each question, each rater evaluated two separate arrays, each containing nine photographs of women and 10 photographs of men. Photographs are Polaroid™ photos of the top-half of each person's body set against a neutral background. Arrays were generated using random sampling without replacement, but we ensured that no one rated themselves. For every array, the 19 selected photos were shuffled, and the order of the photos after shuffling determined the order in which they were placed in front of the rater. The raters (mean age: 33.27; range: 22–48), who represented most extended families within the village were asked to rearrange the photos from the highest (19) to the lowest ranking (1), starting with the highest-ranking individual on the right and lower-ranking photos successively to its left. This procedure meant that, for each question, each individual was ranked by three different raters, each time against a different set of their fellow villagers. Ratings of each participant were summed, yielding a range in possible scores from 3 (lowest score) to 57 (highest score) on each question. Each rater evaluated the photos with no one else present but CVR and SA.

(ii) Child health

From 2012 to 2016, as part of the Tsimane Health and Life History Project's (THLHP) focus on health, growth, and development [33], team physicians collected anthropometric measurements and diagnosed children's illnesses during annual or biannual medical exams. The THLHP's medical team provides medical attention to all individuals in the community who visit the team's encampment, using an updated village census and scheduled visits with each family that is present, to minimize biased sampling. Visits are scheduled during community meetings organized by the THLHP team to discuss protocols with the participants prior to any data collection. Of the men and women whose

social status measures were collected in 2014, 47 women and 47 men had children aged 0–16 years who had been evaluated by the THLHP between 2012 and 2016, and who were included in our dataset, resulting in 342 clinical observations of 142 children (48% female) in the community of study. Children's standing and sitting height were measured without shoes to the nearest millimetre with a portable Seca 213 stadiometer. Weight was measured with a Tanita BF-572 scale in light clothing without shoes. Anthropometric measurements were used to assess population-specific z-scores (sensu [35]; `localgrowth` R package: https://github.com/adblackwell/localgrowth) for (i) weight-for-age (indicator of low weight), (ii) height-for-age (indicator of stunting), and (iii) weight-for-height (indicator of wasting). Using bilingual (Spanish-Tsimane) research assistants, physicians also diagnosed children's illnesses using the International Classification of Diseases (ICD-10). Clinical diagnoses were binary (disease present or absent) and grouped into three categories reflecting common illnesses: gastrointestinal diseases ([31% prevalence]; e.g. diarrhoea, stomach ache), respiratory infections (33%); e.g. bronchitis, pneumonia, and anaemia (21%). We created another binary variable, 'any illness' (53%), indicating whether a focal child was diagnosed with any of these illnesses during the physical exams (electronic supplementary material, figure S1).

(iii) Socio-demographics

Demographic data used to determine kinship, age, and live births per woman at the time of the child's medical visit come from reproductive histories collected from 2003 to 2005 and updated annually thereafter [45]. In interviews with CVR and SA in 2014, parents also reported their years of schooling and household cash income over the past year. Income was determined by asking about all potential sources of income, including wage labour with loggers and ranchers and sales of different categories of horticultural goods. Income events tend to be sporadic, which facilitated recall.

(iv) Intra-household bargaining power

A subset of men in the present study ($n = 21$) were surveyed in 2010 in a separate study about: (i) the degree to which they themselves dominate household decision-making relative to their wives across various domains (e.g. use of household income, residential decisions) and (ii) men's patriarchal attitudes towards their wives. These questions are used in the present study to examine associations between women's social status and their bargaining power as reported by their husbands. Unfortunately, the sample of children for these couples is too small to test whether bargaining power has any impact on child health.

(c) Data analysis

Analyses were conducted using R v. 3.6. To test for associations between parental social status and children's health, we performed linear mixed model regressions (`MASS` package) and conducted separate regressions for each of the three parental status measures and each of the seven child health outcomes. Child and family IDs are clustered to adjust for sibling effects (all children in our sample who share the same mother also share the same father). All models were estimated using penalized quasi-likelihood (`glmmPQL`) to avoid boundary problems associated with small variance components, and the small sample of families per cluster [46]. For each health outcome, we ran a model with maternal and paternal social status adjusting for child age and sex, mother's age at the time of the medical visit, parents' heights and weights to adjust for potential genetic correlations and parental health effects, household income, mother's and father's years of schooling, number of live births at the time of the medical visit to adjust for number of siblings, and mother's and father's number of close kin living in the community. Close kin include parents, siblings,

parent's siblings, nieces, and nephews (i.e. where coefficient of relatedness with ego is greater than or equal to 0.25). Cousins were excluded due to the common practice of cross-cousin marriage among Tsimane [31], and the subsequent overlap of kin between spouses. Household income was logged and all variables were standardized. We used this procedure when modelling each health outcome, including as a primary predictor each of the three measures of parental social status.

Infant and child mortality is high among Tsimane [47] and in our sample morbidity was higher for younger children (electronic supplementary material, figure S1); this suggests that any effects of parental social status on child health are greater earlier in the child's life. Therefore, we also ran all models with subsamples, first with children aged 0–5 years, and then with children aged 6–16 years.

3. Results

(a) Descriptives

Within sexes, political influence, project leadership, and respect are intercorrelated (Pearson's r range = 0.54–0.68) (electronic supplementary material, figure S2). Tsimane fathers score higher than mothers on each of the three measures (table 1), but ranges overlap (electronic supplementary material, figure S3) and social status score are correlated between spouses (Pearson's $r = 0.37$–0.65; electronic supplementary material, figure S2). Median household income is 4500 Bolivianos (Bs) in the past year (range = 0–34 680 Bs; 1B = 0.14 USD) and the average number of years of schooling is 3.8 years for women and 6.0 years for men (table 1). Mothers and fathers have, on average, 12 and 11 kin members living in the community, respectively (table 1). Significant correlates of maternal status measures include income and schooling (electronic supplementary material, figure S4). Significant correlates of paternal status measures include height, income, schooling, and number of children adjusted for age (electronic supplementary material, figure S5). A previous study conducted on the full sample of men ($n = 80$) and women ($n = 72$) also found that a composite measure of political influence and project leadership was associated with weight and number of cooperation partners for both sexes [42]. Unlike the status–fertility relationships reported among men [32], we found no relationship between any maternal status measure and parity-for-age (electronic supplementary material, figure S4).

(b) Associations between parental social status and child health

Maternal political influence had a consistent effect on all measures of child anthropometrics and clinical diagnoses, both when considered alone in the model, and in models including maternal project leadership and respect, with the exception of weight-for-height and respiratory infections, for which the effect is no longer significant when adjusting for the other measures of maternal status (electronic supplementary material, table S1). By contrast, project leadership and respect were only associated with better child outcomes for respiratory infections, and not at all when maternal political influence is included in the model (electronic supplementary material, table S1). In order to reduce collinearity (electronic supplementary material, figure S2 and table S2), models including only maternal and paternal political influence were retained in subsequent analyses.
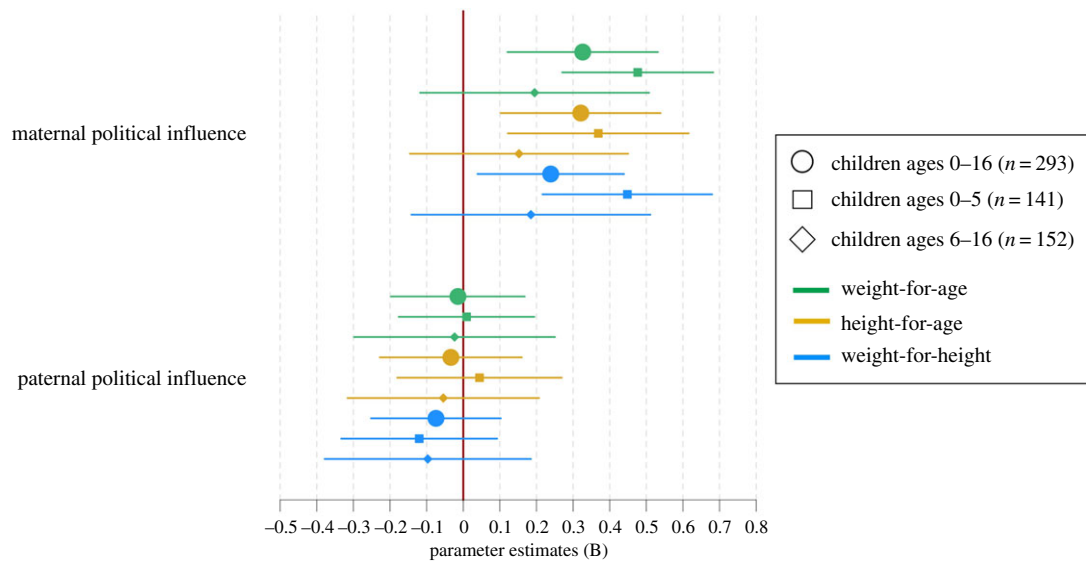
Figure 2. Parental political influence and child nutritional status. Standardized estimates from linear mixed models of the relationship between parental political influence and children's anthropometrics (population-specific z-scores) indicated by circles for all children, squares for children ages 0–5, and diamonds for children ages 6–16; size of the shapes is proportional to sample size; bars denote 95% CIs; models adjusting for age, sex, mother's age, both parents' height and weight, household income, years of schooling, and number of co-resident kin in the community. See electronic supplementary material, tables S3 and S4, for parameter estimates. (Online version in colour.)

Table 1. Descriptive statistics for mothers ($n = 47$) and fathers ($n = 47$) in the study.

time range		mothers ($n = 47$) mean (s.d.)	fathers ($n = 47$) mean (s.d.)
2014	political influence score	25.3 (11.0)	40.7 (13.4)
2014	project leadership score	25.6 (10.4)	40.8 (12.6)
2014	respect score	25.9 (10.6)	38.3 (12.7)
2012–2016	age	31.1 (9.7)	34.7 (10.1)
2014	height (cm)	150.6 (3.4)	163.8 (5.4)
2014	weight (kg)	59.2 (10.4)	66.0 (9.6)
2014	years of schooling	3.8 (4.0)	6.0 (4.5)
2014	number of kin in community	11.6 (10.0)	10.9 (10.0)
2012–2016	number of live births	6.1 (3.5)	

Maternal political influence is consistently associated with child health in the predicted directions (figures 2 and 3; table 2; electronic supplementary material, tables S3–S11). It is moderately associated with children's weight-for-age ($B = 0.33$; 95% CI = 0.12–0.54), height-for-age ($B = 0.32$; 95% CI = 0.10–0.54), and weight-for-height ($B = 0.24$; 95% CI = 0.04–0.44) (figure 2, electronic supplementary material, table S3). Our model predicts that the children of high influence women (75th percentile) would have higher weight-for-age (0.44 s.d.), higher height-for-age (0.43 s.d.), and higher weight-for-height (0.32 s.d.) than the children of low influence women (25th percentile). These associations between maternal political influence and child anthropometrics are stronger for younger children (i.e. aged 0–5 years) compared to older children (i.e. aged 6–16 years) (figure 2, electronic supplementary material, tables S3, S4); among the latter, associations are in the same direction but of lower magnitude, with the 95% CI overlapping 0 (figure 2). By contrast, paternal political influence is not associated with child anthropometrics, irrespective of the addition of maternal political influence and control variables in the models (figure 2, electronic supplementary material, tables S3–S5).

In models including children of all ages, maternal political influence is associated with reduced odds of child illness (any illness; adjusted OR = 0.48; 95% CI = 0.31–0.76) (table 2, electronic supplementary material, table S6), gastrointestinal diseases (adjusted OR = 0.37; 95% CI = 0.22–0.62), respiratory infections (adjusted OR = 0.54; 95% CI = 0.34–0.86), and anaemia (adjusted OR = 0.43; 95% CI = 0.22–0.81) (electronic supplementary material, table S6). Our model predicts that the children of high influence women (75th percentile) are less likely to be diagnosed with any common illnesses (40% versus 64%) including gastrointestinal diseases (15% versus 40%), respiratory infections (23% versus 41%), and anaemia (8% versus 21%), compared to children of low influence women (25th percentile) (figure 3). As with analyses of child anthropometrics, these associations are generally stronger among younger children while 95% CIs include 0 for older children (electronic supplementary material, tables S6, S7).

Paternal political influence is not associated with child morbidity in full models where it is analysed jointly with maternal political influence and control variables (table 2, electronic supplementary material, tables S6, S7). However, it is associated
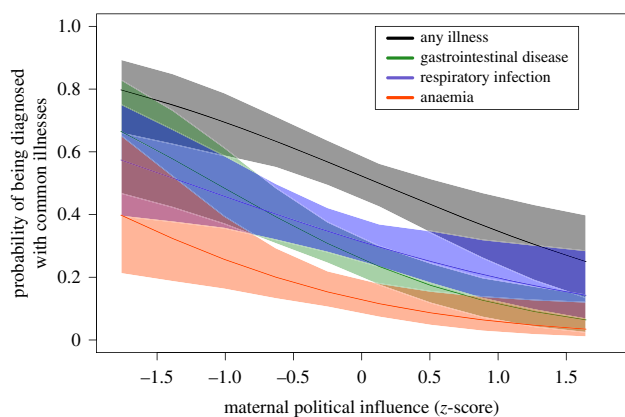
Figure 3. Predicted probabilities of being diagnosed with common illnesses as a function of maternal political influence for children ages 0–16. Models adjusting for maternal age, parental height and weight, household income, years of schooling, live births, and number of co-resident kin in the community ($n = 255$). (Online version in colour.)

with lower odds of children being diagnosed with common illnesses when alone in the models (electronic supplementary material, tables S8–S11). The effect of paternal political influence is reduced or disappears when analysed additively with maternal political influence or with correlates of paternal status (electronic supplementary material, tables S8–S11).

Other variables associated with child health outcomes include mother's height and years of schooling, father's height, and weight, household income, years of schooling, livebirths, number of kin in the community, and the sex of the child, but their effects are inconsistent across models (electronic supplementary material, tables S3–S11).

(c) Maternal political influence and intra-household bargaining power

Maternal political influence is positively correlated with her involvement in household decision-making including the decisions to visit friends and relatives (Pearson's $r = 0.44$), to have sexual intercourse ($r = 0.47$), to travel to town ($r = 0.43$), to choose residence ($r = 0.57$), and for the husband to engage in wage labour ($r = 0.53$). Husbands' attitudes towards their wives' degree of independence, level of schooling, and value of their economic contribution are also positively correlated with their wives' political influence ($r = 0.53$–0.62) (electronic supplementary material, table S12).

4. Discussion

Maternal political influence, as measured by peer evaluations of verbal influence during community meetings, is associated with improved child health among Tsimane forager-farmers. Children of influential women have higher weight-for-age, height-for-age, and weight-for-height (figure 2; electronic supplementary material, tables S3, S4), and are less likely to be diagnosed with common illnesses (figure 3; table 2; electronic supplementary material, tables S5, S6), suggesting that influential women may have healthier children who are more likely to survive. This relationship is evident across all seven measured outcomes. Four of the seven relationships meet a conservative Bonferroni correction criterion of having a p-value $\leq 0.05/7$, and summed together the seven p-values add to $p = 0.052$. The relationship between

Table 2. Multilevel regression models assessing the effects of parental political influence on the likelihood of being diagnosed with any common illness (gastrointestinal disease, and/or respiratory infection, and/or anaemia) for children ages 0–16.

	OR	95% CIs
intercept	0.8	0.5–1.3
social status measures		
political influence mother	**0.5****	**0.3–0.8**
political influence father	0.9	0.6–1.3
controls		
male (0–1)	1.8	1.0–3.3
age at medical visit	**0.6*****	**0.4–0.8**
age at medical visit mother	1.2	0.7–2.0
height mother	1.3	0.9–2.0
height father	0.9	0.6–1.4
weight mother	1.1	0.7–1.5
weight father	0.9	0.6–1.4
log (household income)	1.0	0.6–1.5
years of schooling mother	0.9	0.5–1.5
years of schooling father	1.0	0.6–1.6
live births at medical visit	1.0	0.6–1.8
kin in community mother	0.8	0.5–1.1
kin in community father	1.1	0.8–1.7
summary		
number of observations	255	
groups: child id	118	
groups: family id	37	

Signif. codes: <0.001***; <0.01**.

maternal political influence and child health is stronger for younger children (figure 2, electronic supplementary material, tables S3, S4, S6, S7), who experience greater risk of mortality than older children, which is likely due to the critical resources that mothers provide during early childhood.

Mechanisms underlying the association between maternal political influence and child health are not clear, warranting further study. Community meetings provide an important avenue for discussing the allocation of community resources such as arable land for horticulture, the location of water pumps and wells, and projects and donations from NGOs or governmental organizations [40]. Meetings are also designed to address responsibilities of the local health promotor, petitions for immunization campaigns or periodic visits by municipal physicians and nurses, and issues about transport to town (e.g. fixing bridges that have been washed away by rains). Women who actively participate and are listened to during these meetings may be more likely to extract community resources in a way that benefits their children. For example, J.S. was present during a community meeting that was held to plan for the construction of a clean water well, in collaboration with an established international organization and local construction professionals. During this meeting, which involved the creation of a supervisory five-person committee to oversee well construction and future maintenance, a highly influential woman (political influence score greater than 1.5

s.d.) insisted on being a committee member and provided critical input regarding where in the community the well would be built. Community meetings also serve as a platform for resolving interpersonal conflicts among village residents, for example, over access to arable land or unpaid debts and theft. Like influential men [32], influential women may resolve conflicts in ways that are more favourable to them and their families. Influence during community meetings can also beget resources indirectly, by helping build and maintain networks of potential helpers and supporters [48]. We do not have sufficient social network data for the subsample of women for whom we also have child health data, but we have previously found that influential women have more cooperation partners, including alloparents and other forms of labour and resource-sharing partners [42], all of whom may influence child health through direct and/or indirect pathways.

A woman's political influence may also be associated with her status within marriage. We find that politically influential women are both more involved in household decision-making (as reported by husbands) and married to men who espouse less patriarchal attitudes (electronic supplementary material, table S12). This suggests that women who are assertive during community meetings may also hold more intra-household bargaining power (figure 1: path 3). Tsimane women commonly engage in arguments with their spouse over how to allocate resources within the household [49,50]. This is particularly true for cash earnings from male-dominated wage labour that are sometimes diverted from the household and instead used for alcohol and/or pursuit of extra-marital affairs [49,50]. Stieglitz et al. [51] also found experimental evidence that Tsimane women are willing to sacrifice household production in exchange for greater personal control over cash earnings; for meat, which is also usually acquired by men, but less fungible and more widely shared than cash, women express no such willingness to sacrifice production for personal control. While horticulture and other subsistence practices provide the bulk of Tsimane calories [52], Tsimane women may be more likely than men to purchase market items that buffer against child malnutrition or illness (e.g. pasta, medicine), or save cash for future emergencies. Consistent with studies showing that increasing the share of household income controlled by women changes spending in ways that benefit children [53,54], influential Tsimane women may have a greater ability to negotiate decisions pertaining to the allocation of household resources, and particularly cash earnings, to their children's advantage. In addition, social costs to husbands of actively preventing wives from accessing critical household resources may be higher in households with more influential wives.

Our models adjust for potential confounders, including maternal age at the time of the child's medical visit, parental height, weight, education, and household income, mother's total live births at the time of the child's medical visit, and number of maternal and paternal kin in the community. We expected but did not find strong and consistent associations between children's health and household income, maternal education and presence of maternal or paternal kin in the community (electronic supplementary material, tables S3–S11). Women's education is commonly linked with improved child health [54]. In the present study, maternal education is positively correlated with maternal political influence (electronic supplementary material, figure S4), but is not associated with improved child health (table 2; electronic supplementary material, tables S3, S4, S6, S7). While increasing access to novel

forms of capital such as cash earnings and schooling may grant women new ways of seeking and obtaining status, the impact of these novel forms of capital on children's health is contingent on other factors. In particular, the effect of maternal education on child health may remain minimal if living conditions and exposure to unpredictable health hazards remain unchanged [34]. We also expected (sensu [23,55]) but did not find a consistent association between child health and number of maternal or paternal kin residing in the village. Even though post-marital residence tends to be patrilocal after the birth of one or two children among Tsimane, there were no significant differences in the number of kin in the community between men and women in our sample.

Our results reveal no consistent association between child health and project leadership or respect for either mothers or fathers after adjusting for political influence (electronic supplementary material, table S1). Taking on project leadership roles is not always prestigious and is generally considered a matter of civic duty. Perhaps project leadership better reflects one's willingness to participate in collective action rather than the amount of authority they wield in the community, which might be associated with improved child health in other settings. Similarly, our measure of respect may not be associated with improved child health in this setting, because rather than reflect a community-wide consensus, the measure might be more subjective. Unlike verbal influence during community meetings, respect is not explicitly witnessed by a wide audience. Instead, raters might have used their own feelings of respect for a person instead of the respect they command more generally in the community. Consistent with these explanations, inter-rater reliability was lowest for respect scores (electronic supplementary material, table S13).

Paternal political influence is associated with reduced odds of common illnesses when analysed alone in the models (electronic supplementary material, tables S8–S11), consistent with a previous study focusing on child survivorship [32]. This association, however, is reduced or disappears when adjusting for maternal political influence or correlates of paternal status (electronic supplementary material, tables S8–S11), suggesting the effect of paternal influence on child morbidity is exerted through these variables, or that influential men have a lesser impact on their children's health than influential women. Supporting this, there is evidence that Tsimane men leverage their status at least partially towards improving their mating success [3,32]. Women's political influence was unrelated to their parity-for-age in this sample (electronic supplementary material, figure S4). Given women's greater initial parental investment [14] and physiological constraints on fertility, women may have evolved preferences more for improving child survivorship than for increasing their own fertility.

A major concern warranting future longitudinal study is that the cross-sectional design of the present study prevents causal inference and does not preclude reverse causality, or bidirectional causality. For example, having sick children might lower political influence (e.g. because mothers of sick children may miss community meetings more often). Preliminary evidence on attendance for two community meetings held in the same month as when status data were collected (June 2014), however, suggests the limited impact of reverse causality. We found no association between child's odds of being diagnosed with any illness in 2014 and mother's meeting attendance score (0 = absent at both meetings, 1 = present at one meeting, 2 = present at both meetings) (electronic supplementary material, table S14).

We also analysed the relationship between residential proximity to the village school (from global positioning system (GPS) data)—where community meetings are always held—and maternal political influence, and found no relationship (electronic supplementary material, figure S4 and table S15), suggesting that political influence is not shaped by endogenous residence patterns. Furthermore, if having sick children caused lower influence because child morbidity was perceived by raters as an indicator of bad parenting (and perhaps poor decision-making which would extend to broader social relationships), then one would expect an association between child health and measures of status that track parenting skills, such as maternal respect; yet we find no such association.

Another concern is that we did not account for any child deaths in our consideration of parental status effects on child health. We did not have complete data of the total number of children lost for each parent. However, we are confident in the association between maternal political influence and child health given that any bias caused by unobserved infant and childhood mortality would lead to an underestimation of the effect in our model given that we do not observe the children in poor health who did not survive.

Finally, we were unable to test all the hypothesized pathways of figure 1 linking maternal political influence to child health as we had insufficient data on bargaining power and social partners. Kin networks among Tsimane are central for resource access [56] and although we do not have data on the intensity of network connections, we do report that having more close maternal or paternal kin does not mediate the effect of political influence on child health. Future research will include instruments to measure the strength of kin and non-kin networks.

5. Conclusion

At the societal level, women's status bears important consequences for child welfare. Proxies of women's social status such as better schooling and greater autonomy are commonly associated with improvements in children's health [57]; women's political representation [58,59] and suffrage [60] have been shown to lower child morbidity and mortality. Here, we find that Tsimane women's political influence has positive repercussions on child health, suggesting that women's motivation for seeking status may be guided at least in part by gains in offspring welfare. Our results are consistent with a growing body of literature showing that women are more competitive in social contexts where incentives can improve benefits for their children [20,21].

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