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# Parent-offspring conflict over family size in current China

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**Abstract**

**Objectives:** In China, the recent replacement of the one-child policy with a two-child policy could potentially change family ecology—parents may switch investment from exclusively one child to two. The parent-offspring conflict theory provides testable hypotheses concerning possible firstborn opposition toward further reproduction of their mother, and who wins the conflict. We tested the hypotheses that if there is any opposition, it will differ between sexes, weaken with offspring age and family resource availability, and affect maternal reproductive decision-making.

**Methods:** Using survey data of 531 non-pregnant mothers of only one child from Xi'an (China), logistic regression was used to examine effects of age, family income, and sex on the attitudes of firstborn children toward having a sibling; ordinal regression was used to investigate how such attitudes affect maternal intention to reproduce again.

**Results:** Firstborns' unsupportive attitude toward their mothers' further reproduction weakened with age and was overall more frequent in low-income families. Sons' unsupportive tendency displayed a somewhat U-shaped relationship, whereas daughters' weakened with family income; consequently, sons were more likely than daughters to be unsupportive in high-income families, suggesting a tendency to be more demanding. Forty-nine percent of mothers supported by their firstborns intended to reproduce again, whilst only 9% of mothers not supported by firstborns had such an intention.

**Conclusion:** Our study contributes to evolutionary literature on parent-offspring conflict and its influence on female reproductive strategy in modern human societies, and has also important implications for understanding fertility patterns and conducting interventions in family conflict in China.

## 1 | INTRODUCTION

Having been implemented for more than 30 years (Gu, Wang, Guo, & Zhang, 2007; Peng, 2011), China's one-child policy is world-famous. In recent years, China has experienced a series of critical problems brought on by long-term implementation of this policy: a potential low fertility trap (i.e., endless loops of below-replacement fertility rate; see Lutz, Skirbekk, & Testa, 2006), population aging, and shortage of labor force (Zeng, Gu, Liang, & Guo, 2013). The first one especially can cause other problems, as is the case in developed countries (Lee, 2003). To lessen these problems, China began to implement a new fertility policy—the selective two-child policy—in 2014; the policy allowed only-child couples, where either the husband or wife was an only child, to have two children (Bloomberg, 2013; The Standing Committee of the National People's Congress, 2013; Wu, Wu, Su, & Wang, 2015). Since January 2016, the selective policy has been replaced by a universal two-child policy, under which any couple is allowed to have two children. From an evolutionary perspective, the transition from a one-child policy to a two-child policy provides an opportunity to investigate how offspring's attitudes to a potential sibling influence parental reproductive plans.

The parent-offspring conflict theory suggests a firstborn may oppose his/her parents having further offspring, as a

  

sibling only partially related to him/her—for example, to full siblings, the degree of genetic relatedness is 0.5—will share, more or less, an equal portion of parental investment (Schlomer, Giudice, & Ellis, 2011; Trivers, 1974). If there is any opposition, it should weaken with the age of the firstborn offspring, as their inclusive fitness return from parental investment declines as they get older so that the evolutionary interests of offspring and mother converge with respect to further maternal reproduction (Bateson, 1994; Trivers, 1974). Studies on animal foraging support the prediction. For instance, persistence of suckling bouts declined with age in arctic wolves *Canis lupus* (Packard, Mech, & Ream, 1992). As young guinea pigs *Cavia aperea f. porcellus* aged, the relative nutritional value of milk declined with increased self-feeding, such that pups accepted the maternal decision to wean without major squabbling (Rehling & Trillmich, 2007). In humans, Fouts, Hewlett, and Lamb (2005) found weaning fussing was negatively correlated with offspring age in Bofi communities of Central Africa, although the effect was not statistically significant (presumably due to small sample size).

Two other ecological factors are also predicted to affect the occurrence of parent-firstborn conflict over family size. First, conflict may increase with decreasing family income, the major determinant of family wealth or resources in current China. The nature of parent-offspring conflict lies in allocation of limited parental resources, just like that of sibling competition, which occurs more likely in environments with scarce resources and can then lead to an offspring quality-quantity trade-off in a range of species, including humans (Byholm, Rousi, & Sole, 2011; Fey & Trillmich, 2008; Gillespie, Russell, & Lummaa, 2008; Lawson & Mace, 2011; Meij et al., 2009). Indeed, it has been found that parent-offspring conflict increases with environmental deterioration in terms of resource availability, although most relevant studies have been on animal species, rather than humans (Schlomer et al., 2011). Réale, Bousses, and Chapuis (1999) showed the frequency of unsuccessful suckling attempts in lambs of mouflon *Ovis gmelini musimon* was higher—that is, a higher rate of rejection by ewes—when diet quality was poor. Van Dyke, Griffith, and Thompson (2014) found placental nutrition transport was reduced and cannibalism increased in the lizard *Pseudemoia entrecasteauxii* when food was scarce. Barrett and Henzi (2000) indicated tantrums only arose in offspring of chacma baboons *Papio cynocephalus ursinus* when nutritional independence was hard to sustain.

Second, the frequency and intensity of disagreement between mother and firstborn over the mother's future reproduction could vary according to sex of the firstborn. Theoretical works suggest parent-offspring conflict increases with an increasing discrepancy between the optima of parental investment in parental and offspring's eyes, with optimum investment generally depicted by the fitness-investment curve (Godfray, 1995; Redondo, Gomendio, & Medina, 1992; Trivers, 1974). In humans, sons are generally more demanding and thus, more costly to raise (Helle, Lummaa, & Jokela, 2002; Hurt, Ronsmans, & Quigley, 2006; Lummaa, 2001; Rickard, Russell, & Lummaa, 2007). Moreover, reproductive success of sons is more constrained by resource availability than that of daughters, just as in other mammals: Marginal fitness returns are greater in human males than in females as resource availability increases, when taking marital failure and childlessness into account (Clutton-Brock, Albon, & Guinness, 1985; Fieder & Huber, 2007; Hopcroft, 2006; Nettle & Pollet, 2008; Trivers, 1985). These observations, based on data from America and European countries, are also seen in present day China, where it is very difficult for men with low income to find a partner due to high bride price and cost of housing (Jiang & Sanchez-Barricarte, 2012; Mu & Xie, 2014). Thus, in humans, disagreement in the mother-son dyad could be greater than that in the mother-daughter dyad when the mother wants to produce another offspring and needs to cut current investment in current offspring. Although the issue of sex-linked parent-offspring conflict was raised more than 20 years ago (Redondo et al., 1992), there have been few studies on humans compared to other animals.

In the light that children are "psychologically sophisticated" organisms (Trivers, 1974), it can be predicted that the firstborn's attitude could at least partly affect parental intention and plan regarding future reproduction (for resolution of parent-offspring conflict, see Godfray, 1995; Schlomer et al., 2011). This prediction applies especially to current Chinese families, which have become child-centered and where the interests of the only child are above those of other family members (Goh & Kuczynski, 2009); if the only child (i.e., firstborn) does not support a family plan, its odds of succeeding will be significantly reduced (e.g., McNeal & Mindy, 1996). A reported extreme example was that of a 13 year old girl who forced her mother to abort the fetus of the second child by threatening to commit suicide if her parents proceeded with having another child [Liu (2015); for a review of offspring leveraging or blackmail in parent-offspring conflict, see Trivers (1985), Godfray (1995) and Andrews (2006)]. It is worth noting that although extreme selfish acts as described here may be uncommon in other cultures, firstborns elsewhere are still generally more selfish than children born at higher birth orders (Courtiol, Raymond, & Faurie, 2009). Understanding how firstborns may influence the future fertility of their parents is of interest in the current attempts to understand demographic shifts worldwide, but very few studies have to date examined how parental reproductive decision-making in humans is affected by the support or objection that they may receive from their current offspring.

In this study, we investigate the potential parent-firstborn conflict over family size in China, using survey data from a

Chinese city. First, we test the hypothesis that offspring's unsupportive attitude toward the idea of having a sibling weakens with age and family income, and that it is more frequent in mother-son dyads than in mother-daughter dyads. Second, we test the hypothesis that the attitude of the firstborn significantly affects maternal reproductive decision-making. We then discuss the implication of the study for intervening in serious parent-offspring conflict in China (for a review of an evolutionary perspective on public policy, see Nettle, Gibson, Lawson, & Sear, 2013; Tucker & Taylor, 2007).

## 2 | MATERIAL & METHODS

### 2.1 | Background and study population

At the time of conducting the research, the universal two-child policy had not been implemented and we tested our hypotheses in the context of the selective two-child policy. According to the selective policy, any couple with either the husband or wife being an only child was allowed to have two children. We hereafter call such couples only-child couples. Shaanxi Province, a province in west China, began to implement the policy from March 1st, 2014. The government of Xi'an, the capital of Shaanxi Province, requested a research team with the first author as the principal investigator to investigate fertility desires, intentions, and plans among reproductive-aged (roughly 20–44 years) wives of only-child couples with one child in Xi'an City, to assess the population and social impacts of the new policy, for example, whether there would be a quick population growth in the near future. The conduct of the non-experimental investigation was approved by Biomedical Ethics Committee at the first author's institute (Approval No. 2015-368); additionally, informed consent was obtained from each interviewed subject.

We conducted a sampling survey covering all 15 districts/counties of Xi'an City in August and September of 2014. First, sample size in each district/county was proportional to the total number of only-child couples with one child in that district/county (for administrative divisions in China, see National Bureau of Statistics of the People's Republic of China, 2013). Second, within a given district/county, 2–4 sub-districts (or "streets") were randomly sampled by PPS—probability proportional to size—sampling (Snedecor & Cochran, 1989), with the probability of each sub-district being sampled proportional to number of only-child couples with one child in it. Third, two communities or villages were sampled within a selected sub-district using simple random sampling. Finally, within each selected community or village, about five wives of only-child couples with one child were selected by random sampling to the best of local authorities' ability (note: post-hoc check of raw data did not indicate concentration of sampling in specific strata of occupation, income or education; see Supporting Information Table S1). At this final stage of sampling, maternal ages were considered: number of selected mothers in a given 5 year age group (e.g., 20–24 years) roughly corresponded to age distribution of wives of only-child couples with one child in the sub-district covering the community or village surveyed. In total, 562 wives of only-child couples with one child from 47 sub-districts were sampled to fill out a questionnaire about fertility desire and intention in a self-administered approach. Response rate was 94.5%: questionnaires of 531 mothers were taken as effective; none of them were pregnant or had a second child at the time of the survey.

In the questionnaire, the two key questions relevant to this study were: (1) "Do you intend to have another child?" and (2) "Does your first child support you to have another child?" The available answers to question 1 were "intending to have," "uncertain," and "intending not to have." The available answers to question 2 were "supportive," "unsupportive," and "we have not asked or considered the attitude of our first child" (according to our survey experience, the third answer—that is, unasked—was mainly driven by the fact that some firstborns were too young to express their attitudes). One merit of inquiring about mothers' perception of their offspring's attitude instead of asking offspring directly is that it was such a perception that directly affected maternal reproductive decision-making (Ajzen, 1991; Billari, Philipov, & Testa, 2009); offspring opposition to having a sibling would not affect parental decision making if the parents were unaware of this opposition. Both questions were single choice questions, that is, a mother could select only one of the options available to these questions. Further questions were about mother's age, ideal family size or lifetime number of children, education, occupation and number of siblings; firstborn's age, sex and education; husband's education, occupation, attitude toward having another child and number of siblings; childcare help from grandmothers/grandfathers; family annual income; and family settlement. Supporting Information Table S1 shows the descriptive statistics of all variables.

### 2.2 | Statistical methods

We conducted the following two statistical analyses: (1) the effects of a firstborn's age, family annual income, and sex on his/her attitude toward having a sibling, among those firstborns who were asked by their mothers about their attitudes and were old enough to express their attitudes; and (2) the effect of a firstborn's attitude on his/her mother's intention to have a second child, among all firstborns.

In the analysis of the effects of three factors on firstborn's attitude toward having a sibling, those firstborns not asked

**TABLE 1** Estimates (log-odds ratios) of regression coefficients of explanatory variables in the logistic regression analysis of attitudes of firstborns

| Explanatory variable | Estimate | SE | *Z* | *P* |
|---|---|---|---|---|
| Firstborn's age | −0.29 | 0.089 | −3.31 | <.001 |
| **Firstborn's sex (ref.=son)** | | | | |
| Daughter | 0.73 | 0.61 | 1.21 | .23 |
| Mother's age | 0.30 | 0.077 | 3.91 | <.001 |
| **Family income (ref.=low income)** | | | | |
| Middle income | −0.71 | 0.56 | −1.27 | .20 |
| High income | 0.009 | 0.64 | 0.014 | .99 |
| **Family settlement (ref.=rural)** | | | | |
| Urban | −2.13 | 0.68 | −3.13 | <.01 |
| Daughter × middle income | −0.22 | 0.79 | −0.28 | .78 |
| Daughter × high income | −3.22 | 1.15 | −2.81 | <.01 |

Notes. (1) All estimates refer to log-odds ratios and are not transformed into odds ratio. (2) SE—standard error of estimate. (3) Ref.—reference level of the explanatory variable in model. (4) Low income—an income below 40 thousand Yuan (roughly 6,300 US$) a year; middle income—an income between 40 and 80 thousand Yuan (roughly 12,600 US$) a year; high income—an income above 80 thousand Yuan a year. (5) Rural—living in a rural area. (6) Daughter × middle income—the interaction effect between firstborn's sex (level = daughter) and middle income. (7) The following variables were not significant in predicting firstborn's attitude and are not listed in the table: mother's ($\chi^2_7 = 3.85$, $P = .80$) and father's ($\chi^2_8 = 9.83$, $P = .28$) occupations (9 levels; see Supporting Information Table S1); mother's ($\chi^2_1 = 0.42$, $P = .52$) and father's education ($\chi^2_1 = 0.16$, $P = .68$). Mother's education refers to number of years of education the mother received. (8) The model explains 16.31% of deviance in the null model.

by their mothers or under age 2—that is, those too young to express their attitudes well—were excluded from the analysis, because there was no attitude to analyze in such cases. The sample used in the analysis (221 firstborns), therefore, was only a part of the full sample. The response variable was firstborn's attitude, which was a binary variable (0 for "supportive" and 1 for "unsupportive"). The explanatory variables included firstborn's age (continuous variable) and sex (binary variable: 0 for son and 1 for daughter); maternal age (continuous variable); family socio-economic indicators, that is, family income (3 levels), husband and wife occupations based on national classification (9 levels), and husband and wife education (continuous variable in terms of years of education); family settlement (binary variables: 0 for rural and 1 for urban) and specific geographic location (47 sub-districts or streets). Supporting Information Table S1 and Table 1 give more details about these variables. We conducted a mixed-effects logistic regression model using the statistical package "lme4" (Bates, Maechler, Bolker, & Walker, 2014) run on *R* (R Core Team, 2014). The model had the form: $\text{logit}(P) = \theta + \sum_{i=1}^{k} \beta_i x_i + \varepsilon(\text{sub-district})$. Here, $P$ was the probability of occurrence of an unsupportive attitude; $\theta$ was the intercept; $\beta_i$ was fixed effect of the $i$th explanatory variable; $\varepsilon(\text{sub-district})$ represented the random effect of sub-districts or streets.

In the analysis of the effect of a firstborn's attitude on his/her mother's reproductive decision-making, the sample used was the full sample with a size of 531. Those firstborns not asked were also included in the analysis—they represented a third category where maternal fertility intention was reported in the context of having not heard firstborn's attitude, in contrast to two alternative cases where fertility intention was reported in the context of firstborn's attitude being either supportive or unsupportive. The response variable was maternal reproductive/fertility intention regarding having a second child. The explanatory variables of interest were maternal age (a continuous variable), ideal family size or lifetime number of children (3 levels), education and occupation; firstborn's age, sex and attitude toward having another child (3 levels); husband's attitude toward having another child (2 levels), and his education and occupation; family annual income (3 levels); the numbers of siblings of both the husband and the wife (continuous variables), two variables included to control for family genetic background of fertility (e.g., Kirk et al., 2001; Pettay, Kruuk, Jokela, & Lummaa, 2005); childcare help from grandmothers/fathers (binary

**TABLE 2** Estimates (log-odds ratios) of regression coefficients of explanatory variables in the ordinal regression analysis of maternal fertility intention

| Explanatory variable | Estimate | SE | *Z* | *P* |
|---|---|---|---|---|
| **Ideal number of offspring (ref.=below 2)** | | | | |
| Equal to 2 | −2.48 | 0.32 | −7.83 | <.001 |
| Above 2 | −2.06 | 0.65 | −3.19 | <.01 |
| **Husband's attitude (ref.=desiring)** | | | | |
| Not desiring | 1.66 | 0.22 | 7.53 | <.001 |
| **Firstborn's attitude (ref.=supportive)** | | | | |
| Unasked | 0.87 | 0.43 | 2.01 | <.05 |
| Unsupportive | 1.95 | 0.56 | 3.50 | <.001 |
| **Family annual income (ref.=low income)** | | | | |
| Middle income | 0.43 | 0.44 | 0.98 | .33 |
| High income | −0.90 | 0.52 | −1.75 | <.10 |
| Number of siblings | 0.20 | 0.12 | 1.68 | <.10 |
| Number of husband siblings | 0.29 | 0.12 | 2.44 | <.05 |
| Middle income × unasked | −0.75 | 0.53 | −1.41 | .16 |
| High income × unasked | 0.92 | 0.61 | 1.50 | .13 |
| Middle income × unsupportive | −0.91 | 0.71 | −1.28 | .20 |
| High income × unsupportive | 0.76 | 0.85 | 0.89 | .38 |

Notes. (1) All estimates refer to log-odds ratios and are not transformed into odds ratio. (2) SE—standard error of estimate. (3) Ref.—reference level of the explanatory variable in model. (4) Below 2—ideal number of offspring is 0 or 1. (5) Low income—an income below 40 thousand Yuan (roughly 6,300 US$) a year; middle income—an income between 40 and 80 thousand Yuan (roughly 12,600 US$) a year; high income—an income above 80 thousand Yuan a year. (6) Number of siblings—number of children of mother's parents minus one. If a mother was an only child, its value was zero. (7) Middle income × unasked—the interaction effect between middle income and firstborn's attitude (level = unasked). (8) The following variables were not significant in predicting maternal fertility intention and are not listed in the table: firstborn's sex ($\chi_1^2$=0.0006, $P = .98$) and age ($\chi_1^2$= 1.79, $P = .18$); mother's age ($\chi_1^2$= 1.05, $P = .31$), education ($\chi_1^2$= 2.46, $P = .12$) and occupation ($\chi_7^2$= 3.41, $P = .84$); father's education ($\chi_1^2$= 0.35, $P = .56$) and occupation ($\chi_8^2$= 11.67, $P = .17$); childcare help from grandmothers/fathers ($\chi_1^2$= 1.24, $P = .27$); family settlement ($\chi_1^2$= 2.51, $P = .11$). (9) The model explains 27.67% of deviance in the null model.

variable: 0 for "no help" and 1 for "help"), a variable to control for effect of cooperative breeding on fertility intentions (e.g., Lahdenperä, Lummaa, Helle, Tremblay, & Russell, 2004); family settlement and geographic location. Supporting Information Table S1 and Table 2 give more details about these variables. We conducted mixed-effects ordinal regression or cumulative link model using the statistical package "ordinal" (Christensen, 2014; Venables & Ripley, 2002) run on R. The model had the form: $\text{logit}(P(Y \le j)) = \theta_j - \sum_{i=1}^{k} \beta_i x_i + \varepsilon(\text{sub-district})$. Here, $j$ took values of 1, 2, 3, representing "intending to have another child," "uncertain about having another child" and "intending not to have another child," respectively. $P(Y \le j)$ was the cumulative probability of occurrences of $Y$ up to $j$. $\theta_j$ was intercept for category $j$ of response variable. $\beta_i$ was the fixed effect of the $i$th controlled variable. As the sign after $\theta_j$ was negative, a higher $\beta$ meant a lower tendency to produce another offspring, that is, a higher tendency to not reproducing again. $\varepsilon(\text{sub-district})$ represented the random effect of sub-districts or streets.

All figures were plotted based on raw data.

## 3 | RESULTS

### 3.1 | Firstborns' attitudes

About 35% of firstborns who were asked about their attitude to a potential sibling and older than 2 years did not support

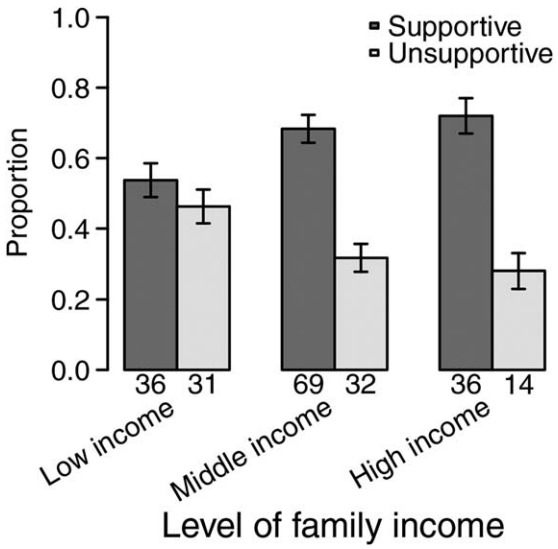


**FIGURE 1** Distribution of firstborns' attitudes toward the plan of producing another child by family income, among those firstborns inquired and older than two years. *x* axis gives family income (three levels: low income; middle income; high income). *y* axis gives proportion of each attitude under each level of family income. The attitudes are represented with bars in different colors: dark gray for "supportive"; light gray for "unsupportive." Error-bar of each bar refers to standard error of proportion. The number at the bottom of each bar refers to sample size

their mothers to reproduce again. A firstborn's unsupportive tendency declined with age: when controlling for other factors, a year increase in the age of the firstborn decreased the odds of having an unsupportive attitude by 1-exp(−0.29) = 25.2% (Table 1; $Z = -3.31$, $P < .001$).

As far as family income was concerned, about 54% of the firstborns from low-income families supported their mothers to reproduce again, whereas the corresponding proportions in middle-income and high-income families were about 68% and 72%, respectively (Figure 1). Therefore, it was more likely for firstborns from low-income families to be unsupportive than those from families in middle ($Z = -1.65$, $P = .10$) or high incomes ($Z = -1.86$, $P < .10$).

On the whole, the unsupportive proportion of firstborn sons was slightly higher than that firstborn daughters, but the difference was not significant ($Z = -0.016$, $P = .99$). Further analysis indicates sons were significantly more likely to hold unsupportive attitudes than daughters in high-income families (interaction income × sex: $\chi^2_2 = 11.50$, $P < .01$). The pattern arose because a son's attitude displayed a somewhat U-shaped relationship with family income—that is, sons in middle income families had the least unsupportive attitude (however, this was not significant; see Table 1)—whereas the likelihood of a daughter's unsupportive attitude declined significantly with improvement in family income (interaction middle-income × daughter, $Z = -0.28$, $P = .78$; high-income × daughter, $Z = -2.81$, $P < .01$; Figure 2; Table 1).

Two other factors that were significant in predicting the firstborn's attitude are worth mentioning. First, after controlling for other factors, maternal age enhanced the firstborn's unsupportive tendency (Table 1). Thus, maternal age and offspring age had contrasting effects on an offspring's unsupportive tendency; without controlling for maternal age, the tendency appeared to be almost constant with offspring age. Second, the firstborns from rural areas were less likely to support their mother's intention to reproduce again than those from urban areas ($Z = -3.13$, $P < .01$; Table 1).

### 3.2 | The effect of firstborn's attitude on maternal fertility intention

When her firstborn did not hold a supportive opinion, a mother had a weaker intention to give birth to another child; log odds in favor of intending not to reproduce again among mothers who did not inquire of their firstborns and who were not supported by their firstborns were, compared to mothers supported by their firstborns, 0.87 ($Z = 2.01$, $P < .05$) and 1.95 ($Z = 3.50$, $P < .001$) higher respectively (Table 2). Figure

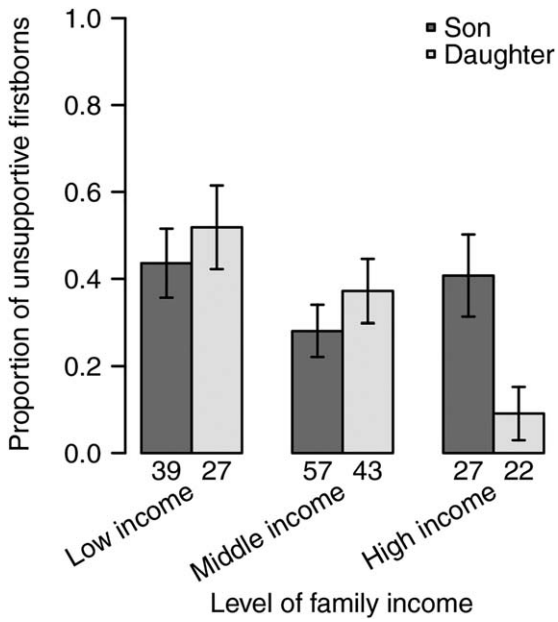


**FIGURE 2** Proportion of firstborns who held unsupportive attitude toward the plan of producing another child by family income and firstborn's sex, among those firstborns inquired and older than two years. *x*-axis gives family income (three levels: low income; middle income; high income). *y*-axis gives proportion of unsupportive attitude under each level of family income. Under each level of family income, unsupportive proportion among firstborn sons (dark gray) is contrasted with that among firstborn daughters (light gray). Error-bar of each column refers to standard error of proportion. The number at the bottom of each bar refers to sample size

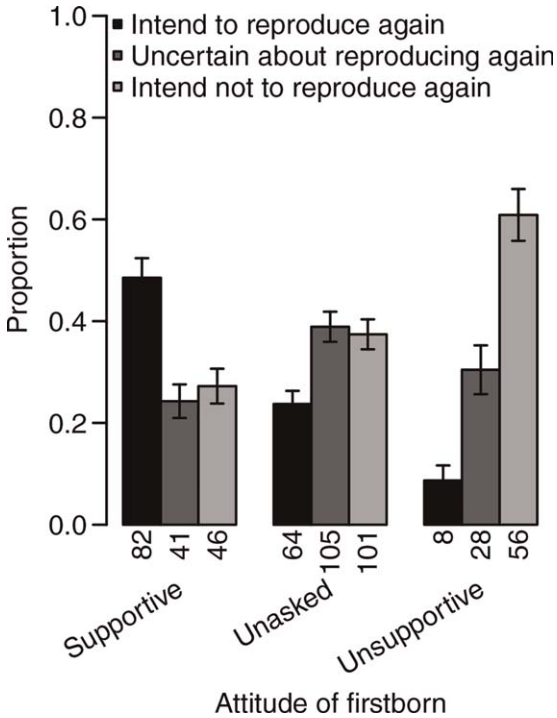


**FIGURE 3** Distribution of maternal fertility intention by firstborn's attitude. *x*-axis gives firstborns' attitudes (three categories: supportive; unasked; unsupportive). *y*-axis gives proportion of each fertility intention under each attitude. Fertility intentions are represented by bars in different colors: black for "intend to reproduce again"; dark gray for "uncertain about reproducing again"; light gray for "intend not to reproduce again." Error-bar of each bar refers to standard error of proportion. The number at the bottom of each bar refers to sample size

3 shows that if a mother's firstborn did not support her to reproduce again, the probability of a mother intending to have another child was just 8.7%; by contrast, the probabilities when the firstborn was not asked or held a supportive attitude were 23.7% and 48.5%, respectively. The corresponding probabilities of intention to not reproduce again in the context of the three attitudes of firstborns were 60.9% (unsupportive), 37.4% (unasked), and 27.2% (supportive). It is worth noting that the proportions of mothers having a fertility ideal of $\geq 2$ children under the three attitudes of firstborns—unsupportive, unasked, and supportive—did not differ much and were 74.7%, 72.3%, and 89.6%, respectively; among all mothers, the average proportion was 78.5%.

Other factors significantly affecting maternal fertility intention included maternal ideal number of children (a higher number predicted a greater intention to reproduce again), husband fertility desire (if a husband desired two children, this promoted maternal intention to have another child), numbers of siblings of the parents (having more siblings promoted a lower intention to have another child), and the interaction effect between family income and firstborn's attitude (Table 2).

## 4 | DISCUSSION

The implementation of a two-child policy in China provides an opportunity to investigate parent-offspring conflict over family size and its influence on maternal reproductive decision-making. Based on a survey of fertility/reproductive intention in Xi'an, a metropolitan city in west China, we found that about one-third of firstborns did not support their parents to reproduce again, at a time before maternal pregnancy when firstborn attitude could affect the reproductive intentions of the parents. The result indicates a conflict between mother and firstborn with respect to family size, as about 75% of mothers of those unsupportive firstborns thought two or more children were better than just one.

Statistical analysis of the survey data supports the hypothesis regarding variation in offspring unsupportive tendency in relation to ecological factors. First, unsupportive attitudes weakened with age of firstborns, a result consistent with the dynamics theory of parent-offspring conflict: with age, evolutionary interests of parents, and offspring gradually converge (Bateson, 1994; Trivers, 1974). This is among the first evidence of significant change in parent-offspring conflict with offspring age in humans. As mentioned in the Results section, this result can only be detected by controlling for maternal age, which had a positive effect on offspring unsupportive tendency. When including both offspring and maternal ages in the statistical model, such a positive effect means that a mother who had her first child at a later age promoted an unsupportive tendency in the child. The reason could be that the later a mother had her first child, the more she would invest in him/her (presumably including emotional investment), that is, she would trade off her current reproduction against her future reproduction (Clutton-Brock, 1984; Creighton, Heflin, & Belk, 2009; Trivers, 1974). Leman (2009) mentioned that old couples invested all they could in their only child (their "special jewel"), and such investment could lead to some spoiling and the development of self-centered characteristics of the only child.

Furthermore, we give one of the first demonstrations in humans that the frequency of the parent-offspring conflict over further reproduction could vary according to resource availability and offspring sex (Figures 1 and 2). Firstborns were more likely to hold an unsupportive attitude toward the production of another child in low-income families, a result in line with studies on the influence of resource availability on parent-offspring conflict in animal species (e.g., Réale et al., 1999; Van Dyke et al., 2014). The influence of family income is more evident when considering its joint effect with offspring sex: a significantly higher proportion of male firstborns than female ones held unsupportive attitude in high-income families. This finding is consistent with the framework of sex-linked parent-offspring conflict (Redondo et al.,

1992), but not with the findings of either Daly and Wilson (1990), who predicted that parent-offspring conflict in humans was blind to offspring sex, or Wu et al. (2015), whose findings were based on a small sample and did not consider the effect of family income.

Evidently, the significant sex difference in unsupportive tendency toward having a sibling between male and female offspring in high-income families arose due to the weakening unsupportive tendency among daughters, but not sons, as family income improved. Largely explained by marital success and childlessness, a son's reproductive success in various human populations is constrained to a larger degree by resource availability than a daughter's (Fieder & Huber, 2007; Liu & Lummaa, 2014; Nettle & Pollet, 2008; Trivers, 1985). As a result, sons may develop a disposition to demand more investment from parents, and thus are more sensitive to any sharing of parental investment with potential future siblings. With the current sample, it is unclear whether the non-significance of the U-shaped relationship between an unsupportive tendency in sons and family income was due to small sample size (note: effective number of observations in model = 213), or if the true relationship was indeed a constant unsupportive tendency with family income—the null hypothesis that our model cannot reject (Table 1). Although the conclusion that difference in unsupportive tendency between sons and daughter will not be affected by the exact relationship, more theoretical and empirical works are needed to further check the sex-linked response of reproductive success of offspring to parental investment and its pathways to sex-linked parent-offspring conflict and sibling competition along a gradient of resource availability.

Third, consistent with the predictions of models on resolution of parent-offspring conflict (e.g., Godfray, 1995), our study indicates firstborn attitudes significantly impacted maternal fertility intention. Figure 3 shows that when the firstborn supported the plan of having another child, the probability of maternal intention to reproduce again was close to 50%, and the probability decreased almost to zero when firstborn held unsupportive attitudes. A few mothers told us explicitly that the objection from their firstborns was one of the major reasons why they did not plan, or were hesitating, to have another child. Among another sample of only-child couples—those who already produced the second offspring at the time of survey—the proportion of unsupportive firstborns among those inquired about their attitudes was just 4.4%, indirectly suggesting that lower resistance from firstborns helped to bring about the intention of having the second child in mothers. Based on these observations, it can be concluded that firstborns played an important and active role in family fertility decision-making through expressing their attitudes, and it was largely the firstborn, not the mother, that won parent-offspring conflict over producing another offspring: Only a small proportion of mothers with an unsupportive firstborn intended to fulfil their own fertility ideal (Figure 3). We have not investigated how firstborns exerted influences on their mothers; such investigations could contribute to our knowledge about the resolution of parent-offspring conflict in humans, which is currently poorly understood (Schlomer et al., 2011). Leveraging could be one of the most likely mechanisms, according to earlier studies on humans and other species with parental care (Andrews, 2006; Thompson et al., 2013).

Our results may have wide implications for understanding the role of parent-offspring conflict in human family constellations and dynamics. First, they shed light on the decrease of family size during the demographic transition. Evolutionary anthropologists have emphasized that in modern competitive societies, parents trade off offspring quality against quantity to achieve an optimal family size (Gibson & Gurmu, 2011; Kaplan, 1996; Lawson & Mace, 2011). Our study suggests that the decision on family size is not made solely by parents, and that parent-offspring conflict may partly contribute to a reduced family size in modern human societies. More generally, in analyzing female reproductive strategy, it is advisable to take close social network members—for example, husband, children, and grandmothers/grandfathers—into account, as suggested by the significant influence of family members on maternal reproductive decision-making (Table 2; see also Borgerhoff Mulder, 2009; Snopkowski & Kaplan, 2014). Second, we analyze here the effect of attitudes of offspring born at a given order on maternal reproductive intention: whether to produce a second child when confronted with the firstborn's unsupportive attitude. Analyzing cases at higher birth orders is important and could further improve our understanding of influence of already born offspring on parental reproductive strategy in humans (see also Charnov, 1982; Godfray & Parker, 1991).

Not only does our study make sense in evolutionary terms but also has some important implication for China's social work system. Wu et al. (2015) mentioned that parents who plan for having another child should foresee a possible unsupportive attitude from firstborns. However, just relying on parents to handle this problem may be insufficient, as implied by reports on undesirable consequences after pregnancy or the birth of a second child (e.g., Liu, 2015). This situation calls for establishing a local family intervention system aiming at family harmony and happiness, which, to our knowledge, almost does not exist in China. Evolutionary theory could shed light on designing such a system, by helping policy-decision makers understand ultimate motivations underlying a conflict and the proximate pathways to this conflict (see also Nettle et al., 2013; Shenk, 2007; Tucker & Taylor, 2007).

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## AUTHOR CONTRIBUTION

JL and CD designed and directed implementation of the survey. JL and VL analyzed data and drafted the manuscript.

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