



Original Article

Kin and birth order effects on male child mortality: three East Asian populations, 1716–1945^{☆,☆☆}Hao Dong^{a,*}, Matteo Manfredini^b, Satomi Kurosu^c, Wenshan Yang^d, James Z. Lee^e^a Princeton University, Princeton, USA^b University of Parma, Parma, Italy^c Reitaku University, Kashiwa, Japan^d Academia Sinica, Taipei, Taiwan^e The Hong Kong University of Science and Technology, Hong Kong, China

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ABSTRACT

Human child survival depends on adult investment, typically from parents. However, in spite of recent research advances on kin influence and birth order effects on human infant and child mortality, studies that directly examine the interaction of kin context and birth order on sibling differences in child mortality are still rare. Our study supplements this literature with new findings from large-scale individual-level panel data for three East Asian historical populations from northeast China (1789–1909), northeast Japan (1716–1870), and north Taiwan (1906–1945), where preference for sons and first-borns is common. We examine and compare male child mortality risks by presence/absence of co-resident parents, grandparents, and other kin, as well as their interaction effects with birth order. We apply discrete-time event-history analysis on over 172,000 observations of 69,125 boys aged 1–9 years old. We find that in all three populations, while the presence of parents is important for child survival, it is more beneficial to first/early-borns than to later-borns. Effects of other co-resident kin are however null or inconsistent between populations. Our findings underscore the importance of birth order in understanding how differential parental investment may produce child survival differentials between siblings.

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That parents, especially mothers, are important for infant and child survival is a truism for humans and indeed almost all mammals (Clutton-Brock, 1991; Sear & Coall, 2011; Sear & Mace, 2008). According to classical kin selection theory (Hamilton, 1964a, 1964b), other things being equal, such universal maternal effect should be similar between siblings.

[☆] Author's contribution: Hao Dong designed the study, was responsible for the analysis, including the production of the harmonized data as well as all statistical calculations, wrote the first draft of this manuscript, and collaborated closely in the manuscript revisions; Matteo Manfredini assisted in much of the evolutionary biological framework; Satomi Kurosu manages the Japanese data, helped prepare the analytical file, and commented on the draft manuscript; Wenshan Yang manages the Taiwanese data, helped prepare the analytical file, and reviewed the draft manuscript; James Z. Lee conceived and coordinated this study, led the effort to create the Chinese data, participated in the study design, and revised the manuscript. All authors gave final approval for publication.

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Differential parental investment, however, is evident in many species. According to Trivers (1972), any parent investment in an offspring increases his/her chances of survival and reproductive success at the expense of the parent's ability to invest in other offspring. From an evolutionary point of view, natural selection would have favored specific parental behavioral strategies aimed at increasing fitness by investing more in those children with greater reproductive value (Geary & Flinn, 2001). In other words, differential parental investment may be a product of natural selection, which favors those better able to take advantage of the differential chances of survival and reproductive success of offspring (Clarke & Low, 2001; Clutton-Brock, 1991; Daly & Wilson, 1995; Trivers, 1972, 1974).

Parental favoritism would then be based on an evolutionary mechanism making parents able to judge the reproductive value of each of their offspring and invest in proportion to their expected fitness. Put it differently, “selection will favor the evolution of mechanisms in parents that favor offspring who are likely to provide a higher reproductive return on the investment” (Buss, 2015, 198). Many are the variables and the factors that could play a role in the parental evaluation of the reproductive value, such as offspring sex and age, child health status and individual characteristics of offspring phenotypic quality (with particular attention to congenital disability), parental age, and,

obviously, available resources (Clutton-Brock, 1991; Daly & Wilson, 1995; Hertwig, Davis, & Sulloway, 2002; Trivers, 1974; Trivers & Willard, 1973).

Multiple studies of human populations document that the mechanisms of such differential parental investment can be quite complex, resulting in child survival differentials that vary greatly between regions, periods, and sub-populations (Hrdy, 1987). Differential parental investment according to offspring sex, exemplified by the Trivers–Willard hypothesis (Trivers & Willard, 1973), is probably the best known example (Boesch, 1997; Bradbury & Blakey, 1998; Cameron & Linklater, 2000; Clutton-Brock & Albon, 1982; Isaac, Krockenberger, & Johnson, 2005; Ligon & Hill, 2010; Svensson & Nilsson, 1996). While such phenomena are atypical for contemporary human European (Kolk & Schnettler, 2016) and North American (Freese & Powell, 1999; Gaulin & Robbins, 1991) populations, there are now a number of well documented cases of explicit sex-selective infanticide, neglect, abuse, and abortion, as well as overwhelming aggregate evidence of highly skewed infant and child sex ratios, for many developing and historical human populations, especially from Africa and Asia (Cronk, 2007; Drixler, 2013; Fujita et al., 2012; Guggenheim, Davis, & Figueredo, 2007; Hrdy, 1987; Lee & Wang, 2001). Much of this literature focuses on sex ratio differences at birth or among infants and children, and suggests that, in contrast to the expectation of relatively equal sex ratio (Fisher, 1930), sex, parity, and sex composition and even sequence of surviving children can bias parental investment (Choe, Hao, & Wang, 1995; Daly & Wilson, 1984; Lee, Wang, & Campbell, 1994; Park & Cho, 1995; Tsuya & Kurosu, 2010; Zeng et al., 1993). Direct comparisons with individual-level longitudinal data on neonatal and perinatal mortality differences further reveal that, such differentials are not only subject to characteristics of offspring, but also shaped by parental and household circumstances (Bengtsson, Campbell, & Lee, 2004; Tsuya, Wang, Alter, & Lee, 2010). And such parental preferences, whether in East and South Asia or elsewhere, are embedded in local cultural and social context (Drixler, 2013; Hrdy, 1999; Lee & Wang, 2001; Muhuri & Preston, 1991).

Along with sex, age is the other individual characteristic often evaluated by parents in order to determine offspring contribution to parental fitness. The offspring reproductive value, in fact, increases with age at least until puberty, which makes older offspring much more valued than younger ones by parents. Offspring age is then by definition strictly associated with birth order, which is another way to look at the temporal sequence of offspring. A growing literature emphasizes the potential role of birth order in shaping sibling differentials in survival and reproductive success in humans and non-human primates (Barclay & Kolk, 2015; Draper & Hames, 2000; Faurie, Russell, & Lummaa, 2009; Low, 1990; Low & Clarke, 1992; Mace, 1996a, 1996b; Modin, 2002; Stanton, Lonsdorf, Pusey, Goodall, & Murray, 2009). Compared with laterborns, first-borns survive longer and develop further with less uncertain early defects, reach reproductive maturity earlier, and benefit more from the generational overlap with parents and other older kin for support and care (Daly & Wilson, 1995; Hrdy & Judge, 1993; Jeon, 2008; Stanton et al., 2009; Trivers, 1974). In addition, in societies practicing primogeniture or partible inheritance, to recognize the heir with concomitant early biased parental investment helps to avoid domestic social tension as well as to prepare children for their adult roles (Hrdy & Judge, 1993).

Unequal parental investment however may increase and trigger competitive and rivalry behaviors among offspring as well as parent-offspring conflicts (Daly & Wilson, 1990; Mock & Parker, 1997; Sulloway, 1997). Although parents could be pressed to reduce such conflictual family dynamics by operating an equal distribution of resources among offspring, Hertwig et al. (2002) have demonstrated that an unequal cumulative distribution of parental investment among siblings may occur even in spite of equal parental allocation at each time point.

The intensity of such conflicts among siblings, competing for limited family resources, both material and affective, has been usually claimed to depend on sibship size and offspring composition, especially by

gender. According to the resource dilution hypothesis, the larger the sibship size, “the more the resources are divided and hence, the lower the quality of the output” (Blake, 1981, 421). Compared to siblings from smaller families, many studies have in fact proved that offspring from large families have lower educational attainment (Conley & Glauber, 2006; Hauser & Sewell, 1986; Hill & O’Neill, 1994), lower height (Oberg, 2015) and less chances to achieve higher social status (Davis, 1997). Consequently, large family sizes might induce stronger competition among siblings for finite family resources. In such situation, firstborns tend to be favored over laterborns (Black, Devereux, & Salvanes, 2005), largely due to their period of undiluted parental investment (Salmon, 2003). On the other hand, lastborns and middleborns would preferentially conflict one another, with the latter destined to suffer the most for the fewest resources.

It has been suggested, especially in the field of evolutionary psychology, that offspring would therefore compete with one another “in an effort to secure physical, emotional, and intellectual resources from parents” (Sulloway, 1997, 21), setting up strategies and behaviors, when interacting with parents, so specific and peculiar as to prompt a process of niche differentiation within the family (Rhode et al., 2003; Sulloway, 1997, 2001). Eventually, the occupation of such family niches would make them possible to maximize their differences, in other words, “to make themselves unique in their parents’ eyes” (Saad, Gill, & Natarajan, 2005).

Some authors, especially Sulloway (1997), stress specifically the role of birth order as one of the key determinants of such a niche differentiation and different sibling strategies. The idea is that birth order would be specifically associated with many important individual characteristics such as age, strength, power, and role within the family (Sulloway, 1997). In this respect, siblings would acquire different personality traits according to birth order. In particular, firstborns would be the most conservative, in the attempt to preserve their privileged status and birth prerogatives, laterborns would be more nonconforming and altruistic, whilst middleborns would be the least close to their parents as a consequence of the fact that they were the only offspring who never experienced a period of exclusive parental investment (Rhode et al., 2003; Salmon & Daly, 1998). However, some factors could bias and modulate such a model of family dynamics, namely socio-economic status, sibship size, and birth interval (Emst & Angst, 1983; Sulloway, 1997).

Thus, birth order is a key factor in both parent- and sibling-driven family dynamics. Both parental investment theory and Sulloway’s theory of family niches, in fact, support the idea that offspring’s position in the time sequence of siblings would be strongly associated with resource availability, parental care, inheritance practices, and prospective reproduction. However, a question naturally follows but remains empirically unexamined: Do effects of parents, and possibly other co-resident kin, vary by birth order in shaping child survival differentials? Our premise is that, if the investment of parents, and possibly of other co-resident kin, is biased by birth order, then the influence of presence of such kin on child survival should differ by birth order. While a growing number of studies identify effects of the presence of parents and occasionally other female coresident kin on human child survival, few directly examine their possible interaction with birth order (Sear & Coall, 2011; Sear & Mace, 2008). Similarly, while there are studies of birth order differentials in early-age accidents, health and mortality (Bakketeig & Hoffman, 1979; Bijur, Golding, & Kurzon, 1988; Hobcraft, McDonald, & Rutstein, 1985; Horwitz, Morgenstern, & Berkman, 1985; Nixon & Pearn, 1978), they overlook the possibility that these effects may differ according to the presence or absence of parents and other kin. As we shall see in this article, such expected differential importance of kin presence is especially the case in East Asian societies where birth order favoritism is apparent (Feng, 1937; Hayami, 1983; Lee & Campbell, 1997; Skinner, 1992).

This paper contributes to the literature by examining whether and how birth order and the presence or absence of parents and other kin in the household interact to shape child mortality in East Asia. We do

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