Effects of Kin and Birth Order on Male Child Mortality: An East Asian Comparison of Three Historical Populations

Hao Dong,*[a] Satomi Kurosu,[b] Wen-shan Yang,[c] James Z. Lee[ad]

ABSTRACT: Human child survival, like many mammals, depends on parental supervision and support. In spite of the recent advances in research on the effects of parents and grandparents on infant and child mortality, studies that directly examine sibling mortality difference according to the presence or absence of specific kin by birth order are still rare. This paper attempts to supplement this literature by using individual level panel data from three East Asian historical populations from northeast China, northeast Japan, and northern Taiwan comprising 2.1 million observations of 0.3 million individuals to examine and compare male infant and child mortality by presence/absence of parents and other kin and their interaction effects with birth order. We apply discrete-time event-history methods on 141,373 observations of 64,734 boys 0.5 – 8.5 years-old. We find that in all three populations while presence of parents is important to child survival on average, both presence of parents and presence of grandmothers favor the survival of the early-born over the later-born. These findings underline the importance of birth order in understanding differential parental and grandmother effects on sibling mortality difference.

* ***Corresponding Author.*** Hao Dong, Division of Social Science, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong SAR, China. Email: sohdong@ust.hk

Authors' affiliations: a. The Hong Kong University of Science and Technology, Hong Kong SAR, China; b. Shanghai Jiao Tong University, Shanghai, China; c. Reitaku University, Chiba, Japan.

Human child survival, like many mammals, depends on maternal supervision and support. Many studies of contemporary and historical populations have confirmed and reconfirmed the relative unimportance of the presence of male relatives, even fathers, on infant and child mortality, and the importance of the presence of mothers and other female relatives such as grandmothers. But while such maternal instincts may be universal in all mammals, in some human populations they appear almost selective. As a result, while sibling differences in early age mortality are interpreted for most mammals as a consequence of sibling rivalry (e.g. Sulloway 2007; Mock & Parker 1997; Trivers 1985), they are typically explained for some human populations as a consequence of social, often parental, preferences about the number, gender composition, timing, and even sequencing of children resulting in different sex ratios at birth by parity (Lee & Wang 2001; Voland 1998; Das Gupta 1987). However, in spite of the recent development of research using human population data on parents' and grandparents' effect on mortality, studies that directly examine the interplay between such social preferences and presence-of-kin effects are still rare.

This paper attempts to supplement this literature by using individual level panel data from three East Asian historical populations from northeast China, northeast Japan, and northern Taiwan comprising 2.1 million observations of 0.3 million individuals to examine and compare male infant and child mortality, net of any possible male infanticide, by presence / absence of parents and other kin and their interaction effects with birth order. By restricting our analysis to infants and young children 0.5 – 8.5 years-old,[1] we avoid some of the bias from sibling rivalry, especially in infancy, given that the differences in mortality between very young children are unlikely to be the product of overt competition. By excluding females because of the well-known problem of 'missing girls,' we also ensure, given the equally well-known East Asian preference for sons (Lee, Wang, & Campbell 1994), that our results should not be a product of differential birth registration. Moreover by eliminating the influence of infanticide, given that infanticide which was prevalent in at least one if not two of these populations, usually occurs soon after birth, we focus on the effect of parental

[1] As such original registers record age in traditional Asian *sui*, which is about 1.5 years larger than the current recording method of age, our age restriction refers to 2-10 *sui* in the data.

preferences on what demographers commonly call neglect (Bengtsson, Campbell, and Lee 2004; Lee & Wang 2001). This is especially important, as our study is one of the first to use individual-level methods to understand better social preferences for child survival by birth order, net of infanticide, yet another example of the primacy of culture over biology, even for own children.

We organize the remainder of this paper into five substantive sections. The first briefly summarizes the relevant human biology, demography, and social scientific historical literature. The second describes our study populations and data. The third introduces our analytical methods. The fourth reports the estimated results. The fifth discusses their implications.

Background

To date, most relevant literature focuses on the effects of parents, grandparents and older siblings in increasing child survival. While a number of studies have noted differential sibling mortality in species other than human, the standard explanation – sibling rivalry and even siblicide – do not seem applicable to humans, especially in the first years of life (Mock et al 1990).

Most studies of differential sibling mortality for human populations focus instead on gender differences in survival and link such findings to parental preference. In many historical and contemporary populations, especially those from Asia, girls are found more vulnerable than boys. In particular, the higher the birth order, the higher mortality of girls. One common explanation is that parents often attempt to adjust the size and sex composition of offspring by deliberate spacing, sequencing, ignorance, infanticide, or selective abortion (Lee & Wang 2001; Campbell & Lee 1996; Muhuri & Preston 1991; Das Gupta 1987). However due to the problem of missing girls, many such studies have to rely on sex ratios instead of explicit individual level mortality (e.g. Park & Cho 1995; Zeng et al 1993). Moreover, because lopsided sex ratios typically are more the product of perinatal infant mortality than later infant and early child mortality, such studies largely overlook any effects of "neglect" or differential treatments on sibling difference in early child mortality. Studies of the effect of birth

order in more completely recorded populations deal largely with Western populations where parental preferences are less obvious and gender discrimination is largely unknown. [2]

Our paper, by focusing exclusively on male infant and early child mortality for three Asian populations *after* the first six months of life, is one of the first for any Asian population to discuss the effects of kin and birth order as well as the first to link parental preferences to explain a possible pattern of neglect. Unlike infanticide where parental preference is easy to identify by sharply different sex ratios at birth in historical populations, it is technically hard to distinguish parental preference from dilution of household resources, dilution of parental time and care, sibling competition, or other alternative explanations to account for sibling difference in infant and child mortality (Hertwig, Davis, Sulloway 2002). However, given that we focus on the mortality of dependent infants and children in three "natural fertility" populations that share similar cultural values of son preference and birth order favoritism, we expect social preferences to play an important role in the mortality regime, reflected in the presence and differential treatment by parents and other kin, to produce sibling difference in infant and child mortality.

Data

Our study takes advantage of three datasets from historical household registers: the China Multi-Generational Panel Dataset - Liaoning (CMGPD-LN),[3] the Colonial Taiwan

[2] In fact, other than mortality, birth order has been found negatively associated with other individual outcomes like intellectual development (Kristensen, Petter & Tor Bjerkedal 2007; Zajonc and Markus 1975) and educational and socio-economic attainment (e.g. Black, Devereux, & Salvanes 2005; Behrman & Taubman 1986). While findings on the direct linkage of birth order and fertility are inconsistent (Murphy & Knudsen 2002; Draper & Hames 2000), there is nonetheless evidence on parental birth order preference in their wealth distribution among offspring (Mace 1996), which influences the chance and pattern of marriage and reproduction (Low and Clarke 1993; Low 1990). We didn't include such large literature on general birth order effects since it is not relevant to our current study on mortality.

[3] For detailed information on the background, construction, and characteristics of the China Multi-Generational Panel Dataset – Liaoning, see Lee et al (2010). The CMGPD-LN data are publicly available at Inter-university Consortium for Political and Social Research: http://www.icpsr.umich.edu/icpsrweb/CMGPD/.

Household Register Database (CTHRD),[4] and the Japanese NAC (*ninbetsu-aratame-cho*) register database (NAC-SN).[5] These datasets were transcribed from historical population registers from northeast China, northeast Japan, and north Taiwan, in total covering 2.1 million observations of 310000 individuals in around 700 villages between 18th, 19th and early 20th century. Such East Asian population registration systems in general were products of civilian administration, taxation and military.

Map 1 here

All these data are panels that record individual demographic events longitudinally and prospectively. Such data are especially valuable for studies of kin and community effects because they not only include detailed information on kinship but also record all members in the household and a large proportion if not all of residents in the community. All three sets of population registers record detailed relationship to the household head of each household member, which enables us to reconstruct relationship between any pair of individuals in the household. In addition to such recorded relationship, the relatively complete parent-child linkage in all three datasets provides additional information to identify grandparents, uncles and aunts, brothers, and other kin within and even beyond household. Moreover, because these household registers were designed to cover the whole community and update regularly, in addition to longitudinal information of individual demographic and social events, these data provide time-variant information on presence and absence of specific kin in almost all households in the community.

We restrict our data to observations of live male children who are 0.5 – 8.5 years-old (2 – 10 *sui*) and who continue under observation in the subsequent register. The actual final study population therefore includes 64,734 boys for whom there are 86,925 triennial observations, including 3,838 recorded deaths in the CMGPD-LN,

[4] The Colonial Taiwan Household Register Database includes data from 19 townships. The availability and accessibility of data however vary by townships. Our current study includes data from three townships from north part of Taiwan: Beipu, Chupei, and Ermei. Data information and application can be found on the website of Program for Historical Demography:
http://www.demography.sinica.edu.tw/EN/en_achievement_b.htm

[5] For detailed introduction on the history and institutional settings of these Japanese household registers and the two villages, see Hayami (1979) and Narimitsu (1992).

45,130 annual observations including 648 recorded deaths in the CTHRD, and 9,318 annual observations including 286 recorded deaths in the NAC-SN, that is 141,373 observations all together including 4,772 deaths.

Methods

We apply discrete-time event-history methods (Allison 1984). Because there is likely to be unknown correlations between observations of children living in the same household, we introduce clustered standard errors at household level.

Our outcome variable is a dummy variable indicating whether an individual died either during the next year in the NAC-SN and CTHRD data or during the next three years in the CMGPD-LN. In terms of kin measures, we construct a categorical variable to measure different status of parental presence: both parents, only mother, only father, or none present in the household. Two dummy variables indicate the presence of paternal grandmothers and grandfathers. We use three count variables to measure number of father's sisters, paternal uncles, and their wives. We include birth order among brothers as a continuous variable. To avoid the outlier effect of extremely high birth orders, we code 8th and later births as 8. To control for the effect of maternal age at birth, our estimation also includes two dummies indicating whether maternal age at birth is lower than 20 or higher than 36. There is another dummy variable as control for whether preceding birth interval of the indexed individual is less or equal to 2 years. Other control variables are number of age 0 - 9 brothers living in the same household that measures the potential sibling competition, household size, linear year trend, and regional fixed effects accounting for spatial mortality differences.

We summarize our analytical samples in table 1 based on their distribution according to the variables we employed.

Table 1 here

Our analysis is three fold. We first estimate average effects of kin on boy's possibility of dying in next 1 or 3 years, controlling for other confounding factors. Then,

to examine whether such kin effects vary by birth order, we run four separate sets of regressions, each time introducing an interaction term of birth order and one of such kin as parents, paternal grandmothers, aunts as father's sisters, and aunts as uncle's wives. Except for such interaction terms, specifications of these models are the same as the model specifications for average effects. Finally, we check the robustness of our estimated results by relaxing the linear assumptions of birth order, controlling for period effects with year or period dummies, and comparing our results with estimated results using seniority among live brothers as an alternative measure.

Preliminary Results and Discussion

Based on comparable estimations on three individual-level panel datasets from northeast China, northeast Japan and north Taiwan between 1716 and 1945, our analysis confirms the overall importance of kin in shaping child survival in historical East Asia. Despite differences in household size, household structure and other societal factors, the presence of parents and paternal grandmothers has consistent and substantial effects in reducing male child mortality. Effects of the presence of grandfathers, uncles and aunts in household are however none or inconsistent. All these findings are largely in line with the increasing literature on kin effects worldwide (see, Sear & Coall 2011 and Sear & Mace 2008, for reviews). Especially, our research design ensures that such findings are net from the influence of prevalent infanticide or "missing girls" in Asian populations.

More importantly, our comparison between these three East Asian populations reveals that parental and grandmother effects differ by birth order even between male siblings. The presence of parents and grandmothers tend to favor early births over later births in terms of survival. Such findings coincide with other studies on birth order that demonstrates the difference or advantage of first births over later births in various outcomes, including educational attainment, leadership, personality, etc. According to the existing literature, such birth order effects could be attributed to several reasons. Our findings nonetheless shed light on one perspective to understand the origin of such birth order effects in later outcomes, that is, the differential treatment of kin effects, especially from parents and grandmothers.

Such birth order differences in the effects of the same kin are largely overlooked by existing theory as well as empirical studies. While theories on relatedness of kin and genetic uncertainty are often adopted to explain kin effects of different kin, little is known about the differential effects on offspring of kin with same relatedness and genetic uncertainty. While our findings are suggestive rather than conclusive, this preliminary test nonetheless depicts the interplay between parental and grandmother presence and sibling mortality by birth order, of which preferential care and supervision may serve as one explanation.

References

Allison, P. D. 1984. *Event History Analysis: Regression for Longitudinal Event Data* (No. 46). Beverley Hills: Sage.

Behrman, J. R., & Taubman, P. 1986. Birth order, schooling, and earnings. *Journal of Labor Economics*, S121-S145.

Bengtsson, T., Campbell, C., & Lee, J. Z. 2009. *Life Under Pressure: Mortality And Living Standards In Europe And Asia, 1700-1900*. Cambridge: MIT Press.

Black, S. E., Devereux, P. J., & Salvanes, K. G. 2005. The more the merrier? The effect of family size and birth order on children's education. *The Quarterly Journal of Economics*, *120*(2), 669-700.

Campbell, C., & Lee, J. Z. 1996. A death in the family: Household structure and mortality in rural Liaoning: Life-event and time-series analysis, 1792–1867.*The History of the Family*, *1*(3), 297-328.

Draper, P., & Hames, R. 2000. Birth order, sibling investment, and fertility among Ju/'hoansi (! Kung). *Human Nature*, *11*(2), 117-156.

Gupta, M. D. 1987. Selective discrimination against female children in rural Punjab, India. *Population and Development Review, 13*(1), 77-100.

Hayami, A. 1979. Thank you Francisco Xavier: an essay in the use of micro-data for historical demography of Tokugawa Japan. *Keio Economics Studies, 6,* 65–81.

Hertwig, R., Davis, J. N., & Sulloway, F. J. 2002. Parental investment: how an equity motive can produce inequality. *Psychological Bulletin*, *128*(5), 728.

Kristensen, P., & Bjerkedal, T. 2007. Explaining the relation between birth order and intelligence. Science, 316(5832), 1717-1717.

Lee, J. Z., & Campbell, C. D.. *China Multi-Generational Panel Dataset, Liaoning (CMGPD-LN), 1749-1909* [Computer file]. ICPSR27063-v6. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2011-09-02. doi:10.3886/ICPSR27063.v6

Lee, J. Z., Campbell, C. D. & Chen, S. 2010. *China Multigenerational Panel Dataset, Liaoning (CMGPDLN) 1749–1909 User guide*. Ann Arbor: Inter-university Consortium for Political and Social Research.

Lee, J. Z., & Wang, F. 2001. *One Quarter Of Humanity: Malthusian Mythology And Chinese Realities, 1700-2000*. Harvard University Press.

Lee, J. Z., Wang, F. & Campbell, C. 1994. Infant and child mortality among the Qing nobility: implications for two types of positive check. *Population Studies, 48*(3), 1-17.

Low, B. S. 1990. Occupational Status, Landownership, and Reproductive Behavior in 19th-century Sweden: Tuna Parish. *American Anthropologist*, *92*(2), 457-468.

Low, B. S., & Clarke, A. L. 1992. Resources and the life course: Patterns through the demographic transition. *Ethology and Sociobiology*, *13*(5), 463-494.

Mace, R. 1996. When to have another baby: a dynamic model of reproductive decision-making and evidence from Gabbra pastoralists. *Ethology and Sociobiology*, *17*(4), 263-273.

Mock, D. W., & Parker, G. A. 1997. *The Evolution of Sibling Rivalry*. Oxford: Oxford University Press.

Mock, D. W., Drummond, H., & Stinson, C. H. 1990. Avian siblicide. *American Scientist*, 78(5), 438-449.

Muhuri, P. K., & Preston, S. H. 1991. Effects of family composition on mortality differentials by sex among children in Matlab, Bangladesh. *Population and Development Review*, 17(3), 415-434.

Murphy, M., & Knudsen, L. B. 2002. The intergenerational transmission of fertility in contemporary Denmark: The effects of number of siblings (full and half), birth order, and whether male or female. *Population Studies*, *56*(3), 235-248.

Park, C. B., & Cho, N. H. 1995. Consequences of son preference in a low-fertility society: imbalance of the sex ratio at birth in Korea. *Population and Development Review*, *21*(2) 59-84.

Sear, R., & Mace, R. 2008. Who keeps children alive? A review of the effects of kin on child survival. *Evolution and Human Behavior*, *29*(1), 1-18.

Sear, R., & Coall, D. 2011. How much does family matter? Cooperative breeding and the demographic transition. *Population and Development Review*, *37*(s1), 81-112.

Sulloway, F. J. 2007. Birth Order and Sibling Competition. In Robin Dunbar and Louise Barrett (Eds.) *The Oxford Handbook of Evolutionary Psychology*, 297-311. Oxford: Oxford University Press, 2007

Trivers, R. 1985. *Social Evolution*. Menlo Park: Benjamin/Cummings Publishing Company.

Voland, E. 1998. Evolutionary ecology of human reproduction. *Annual Review of Anthropology*, *27*, 347-374.

Zajonc, R. B., & Markus, G. B. (1975). Birth order and intellectual development. *Psychological Review, 82*(1), 74.

Zeng, Y., Tu, P., Gu, B., Xu, Y., Li, B., & Li, Y. 1993. Causes and implications of the recent increase in the reported sex ratio at birth in China. *Population and Development Review, 19*(2), 283-302.

Map 1. Location of our study populations

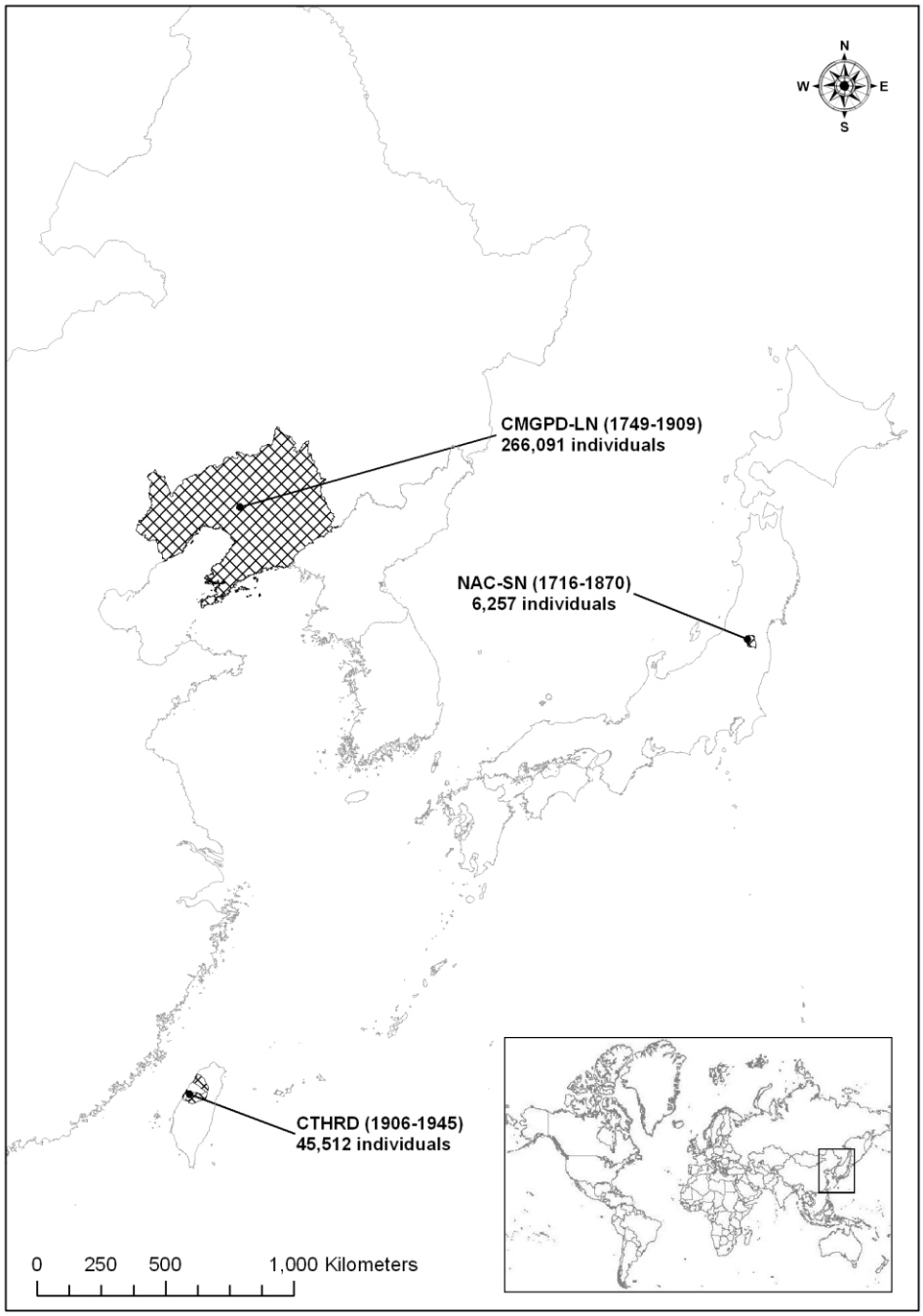

Table 1. Descriptive statistics of analytical samples of three studied populations, boys aged 0.5-8.5 in northeast China, north Taiwan and northeast Japan.

	CMGPD-LN				CTHRD				NAC-SN			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Dependent variable												
Death in next 1 or 3 years	0.044	0.206	0	1	0.014	0.119	0	1	0.031	0.172	0	1
Presence of kin in household												
Parents (Ref.: None)	0.015	0.123	0	1	0.173	0.378	0	1	0.054	0.226	0	1
Only father	0.042	0.200	0	1	0.071	0.257	0	1	0.054	0.225	0	1
Only mother	0.081	0.272	0	1	0.069	0.253	0	1	0.092	0.289	0	1
Both parents	0.862	0.344	0	1	0.688	0.463	0	1	0.801	0.399	0	1
Grandmother	0.492	0.500	0	1	0.288	0.453	0	1	0.434	0.496	0	1
Grandfather	0.341	0.474	0	1	0.228	0.419	0	1	0.391	0.488	0	1
No. of aunts (father's sisters)	0.037	0.244	0	5	0.027	0.165	0	2	0.037	0.202	0	3
No. of aunts (uncle's wifes)	1.418	1.227	0	13	0.472	0.868	0	6	0.023	0.154	0	2
No. of uncle	1.188	1.364	0	11	0.728	1.207	0	7	0.088	0.317	0	3
Individual characteristics												
Mother's age < 20 at birth	0.083	0.276	0	1	0.093	0.290	0	1	0.198	0.398	0	1
Mother's age > 36 at birth	0.227	0.419	0	1	0.333	0.471	0	1	0.087	0.282	0	1
P.B. I <= 2 years	0.099	0.299	0	1	0.307	0.461	0	1	0.093	0.290	0	1
Birth order (same sex siblings)	1.893	1.255	1	8	2.645	1.907	1	8	1.700	0.931	1	8
No. of brothers aged 0 - 9	0.325	0.574	0	5	0.627	0.789	0	4	0.263	0.480	0	3
Other controls												
Household size	15.530	13.130	1	127	10.435	7.956	1	67	5.845	2.632	1	33
Age (in sui)	6.219	2.443	2	10	5.909	2.598	2	10	5.771	2.615	2	10
Year	1858.478	33.416	1789	1906	1920.998	9.566	1906	1944	1790.926	45.456	1716	1870
Deaths	3838				648				286			
Individuals	56063				7226				1445			
Observations	86925				45130				9318			

Detailed results of analysis are available upon requrest