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Authors
Qi, Yaqiang
Mason, William M.

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California Center for Population Research
University of California - Los Angeles

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Yaqiang Qi
William M. Mason

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Prenatal Sex-Selective Abortion and High Sex Ratio at Birth in Rural China: A Case Study in Henan Province*

Yaqiang Qi
and
William M. Mason

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Department of Sociology

University of California, Los Angeles

***All direct correspondences please send to Department of Sociology, UCLA, 264 Haines Hall, 375 Portola Plaza, Los Angeles, CA 90095-1551, USA, email: yaqiang@soc.ucla.edu, masonwm@ucla.edu.

Prenatal Sex-Selective Abortion and High Sex Ratio at Birth in Rural China: A Case Study in Henan Province

Abstract

The high sex ratio at birth in China has attracted considerable attentions from demographers. Previous studies assert that female infanticide, underreporting of female births, and prenatal sex-selective abortion were the immediate causes of the initial increase of the sex ratio at birth. Recent studies suggest that prenatal sex selection became the leading immediate cause of more recent increase in the sex ratio at birth. A snowball sampling survey conducted in rural Henan in 2001 collected information on women's abortion histories. Using these data, we analyze the practice and mechanisms regarding to prenatal sex selection, as well as its impact on SRB. Results show that prenatal sex selection is widely known and commonly practiced in the studied area. The SRB is the highest among births that have only sister(s), and close to normal for other births. Using a population-average model, we found that female fetuses that have only sister(s) are most likely to be aborted. Finally, our imputation suggests that sex-selective abortion has been the predominant, if not the sole, immediate cause of the high SRB.

1 Introduction

China experienced a remarkable fertility change during the late 20th century. The total fertility rate (TFR) in China decreased from 5.18 in the 1960s to 4.01 in the 1970s, and it further went down to 2.46 in the 1980s (Mu 1995). Since the early 1990s, the TFR in China has been well below the replacement level (2.10), and recent studies show that it was around 1.70-1.80 in 2000 (Yu 2002; Wang 2003).

While fertility declined, the sex ratio at birth (SRB) in China increased, beginning in 1980, and has been elevated ever since. The SRB was 108.5 in 1981 (Zeng et al. 1993), which was still close to the biologically normal level. It increased to 111.3 in 1989 (State Statistics Bureau 1993), and by 1999 it was 119.9 (Population Census Office under the State Council 2002). Over the last two decades, the SRB in China has increased by more than 11 percent and the overall SRB in China is now possibly the highest in the world. In addition, rural China has a much higher SRB than urban China. According to China's 2000 census, the SRB in cities was 114.2, while it was 119.9 in towns and 121.7 in the countryside (Population Census Office under the State Council 2002).

There have been many studies addressing causes of the high SRB in China. Female infanticide, sex-differentials in birth underreporting, and sex-selective abortion are regarded as three potential causes of the high reported SRB (Hull 1990; Johansson and Nygren 1991; Zeng et al. 1993; Coale and Banister 1994). Nevertheless, regardless of which of them is the leading immediate cause, the stringent birth control policy adopted in China since 1979 has been regarded as the drive of the rising SRB (Hull 1990; Coale and Banister 1994).

Moreover, most of the latest studies suggest that sex-selective abortion has been the dominant immediate cause of the continued increase of the SRB in China since the mid-1990s

(Yan and Lu 1995; Xie 1998; Chu 2001a, 2001b; Qiao 2004). Due to difficulties in collecting reliable data on prenatal sex selection, most of these studies (with the exception of Chu 2001a, 2001b) draw their conclusions based on inference rather than direct evidence of prenatal sex selection. Furthermore, the underlying mechanisms concerning sex-selective abortion have been little examined in previous studies. As a result, our knowledge about prenatal sex-selective abortion in China is still limited.

A snowball sample survey conducted in Henan collected complete pregnancy histories of rural women. Employing these data, this paper aims to describe the practice of prenatal sex selection in China, analyze the underlying mechanisms of sex-selective abortion, and estimate how much the SRB has been affected by prenatal sex selection. The paper is organized as follows: First we review previous studies on SRB and prenatal sex selection in China. Next we elaborate the survey design and describe the data. Subsequently, we provide detailed evidence of the existence and describe patterns of sex-selective abortion. In the following, we model the observed patterns of prenatal sex selection and SRB, and we show that ex ante fetal sex and family sibset composition are the dominant factors that determines the whole process. Lastly, we summarize and evaluate our results.

2 Background

Recent SRB levels in China are well documented. Hull (1990) shows that the SRB in rural China is higher than that in urban areas, and that the SRB has a parity-based pattern: Normal for the first birth, and abnormally high for the following births. Johnson and Nygren (1991) demonstrate dramatic differences between the sex ratios of children born within and outside the local birth plan. Compared with the largely normal sex ratios for live births within the birth plan, sex ratios for children born outside the plan are much higher. However, instead of addressing the issue of prenatal sex selection, these earlier studies rule out the possibility of prevalent prenatal sex selection in China based on their doubts about the availability of modern technologies for prenatal sex determination, especially in rural areas.

Zeng et al. (1993) argue that Chinese women practiced prenatal sex selection as early as the 1980s, based on high sex ratios for live births delivered in hospitals during 1988-1991. Because such data preclude the possibility of birth underreporting and female infanticide, Zeng et al. (1993) conclude that sex-selective abortion existed in China in the 1980s. Nevertheless, this research provides limited evidence of the prevalence of sex-selective abortion, due to the selectivity of births delivered in hospitals in China (Coale and Banister 1994).

Recent studies of the sex ratio of aborted fetuses in China further demonstrate the existence of prenatal sex selection. For instance, drawing on unsourced data, Wu (1996) reports that over 85 percent of aborted fetuses were female in a county in Zhejiang province during 1986-1990. A survey conducted by the Chinese Population Information and Research Center (CPIRC) in Southeast China in 1993 found that the sex ratio of aborted fetuses was 86.7 (Wu 1996). Unfortunately, these studies provide no further direct evidence of prenatal sex selection and their conclusions may be based on underestimates of sex-selective abortions, since some abortions occur in private clinics and may not be reported. Peng and Huang (1999) show that the traditional Chinese medicine such as pulse diagnosis has been used for prenatal sex identification, and the result is remarkably accurate when the diagnosis is made by a skilled practitioner.

Using a snowball sample from central rural China, Chu (2001a) provides the first direct evidence of prenatal sex selection practices in the studied area. In Chu's data, 84 percent of respondents know about ultrasound technology, over three quarters of them believe that prenatal sex identification through ultrasound scanning is common in their communities, and about 11 percent of respondents have had at least one sex-selective abortion. Moreover, there is a clear pattern of prenatal sex selection by order of pregnancy. Women rarely have a sex-selective abortion in their first pregnancy; however, during second and last pregnancies, a number of women use ultrasound scanning, are informed of the fetal sex, and/or terminate pregnancies with abortions. In another paper, Chu (2001b) also reports that pregnancy order, fetal sex, and the sex composition of prior children, are the main risk factors for sex-selective abortion. Specifically, fetuses of higher-order pregnancies, female fetuses, and especially fetuses having an elder sister are more likely to end up with abortions.

Although Chu (2001a, 2001b) provides valuable direct evidence of sex-selective abortion in rural China, her analyses have several limitations. She used only first, second, and last pregnancies. Thus, her results are based on incomplete data. She employed only bivariate logistic regressions and thus did not control the effects of other covariates. Most importantly, like other researchers, Chu described the pattern of sex-selective abortion and SRB by pregnancy order. However, in our paper we will show that the pattern of pregnancy order is somewhat misleading. The key variable to understand prenatal sex selection is the family sibset composition.

3 Data

In this study, we use data collected from the 2001 survey of "Women's Fertility Preferences and Behaviors in Rural China". The survey site is a rural county in Henan province. The fieldwork was conducted by researchers (including one of the authors, Qi) from the Institute of Population Research at Beijing University.

Located at the basin of the Yellow River, Henan is one of the major origins of Chinese civilization. Traditional culture of son preference is still prevalent in Henan, especially in rural communities. As the most populous province in China, Henan has a rural population of more than 70 million, which accounts for over 10 percent of the rural population of China (Henan Statistical Bureau 2001). Henan also has an extremely high SRB. The SRB in Henan province in the 2000 census was 130.3, one of the highest in China. Furthermore, the SRB was 116.7 in cities, 133.7 in towns, and 132.3 in the countryside (Population Census Office under the State Council 2002). Because there are substantial regional differentials in culture and socioeconomic level in China, a study of rural Henan cannot represent the overall situation in rural China. However, since the sex ratio at birth is elevated all over China, this study can nonetheless provide insights into the mechanisms that sustain the imbalance.

The survey started from a village in central Henan. Nineteen local women with at least high school education were trained as interviewers (the three researchers also did some interviews with the help of local women). The interviewers were asked to interview those of their female relatives, friends, and neighbors who were currently married, had an agricultural *hukou*, and were of reproductive ages (i.e., below 45).

In total, 1,056 rural women were interviewed. Detailed information was collected on the respondents' basic sociodemographic characteristics, as well as their knowledge, attitudes and practices in relation to prenatal sex identification and sex-selective abortion. In addition, respondents' completed pregnancy and fertility histories were also obtained with the beginning and ending times for each pregnancy. Furthermore we asked whether, for each pregnancy, ultrasound scanning was used, and if so, the time, place, purpose, and outcome. If a fetus was aborted, we also asked the primary reason for an abortion.

Compared with the previous survey conducted by Chu (2001a, 2001b), this data set is unique in several aspects: First, completed pregnancy and fertility histories were collected instead of partial and selective histories[1], which allows us to thoroughly examine the pattern of prenatal sex selection and SRB. Second, more detailed information on each pregnancy was available. For instance, we asked respondents about the ex ante fetal sex, i.e., their knowledge of the fetal sex before birth. And finally, information on women's sociodemographic characteristics and family statuses is also included.

Because this survey is based on snowball sampling, it is not necessarily representative of rural women of even the county in which the survey was conducted. The justification of the use of snowball sampling is that we obtained sensitive information that would have been difficult or impossible to obtain by other means.

Tables 1 and 2 compare the age and education distributions of respondents in our survey with those from a one-per-thousand sample of the 2000 census. To improve comparability, we restricted the census sample to currently married women who live in rural Henan and have an agricultural *hukou*. The comparison demonstrates that the two age distributions are similar. The education level in our sample is a little higher than the corresponding census distribution. All our interviewers had at least a high school education, and their friends, relatives, and neighbors (the potential respondents) might for this reason have been better educated. Nevertheless, these comparisons suggest that our snowball sample is not seriously biased, at least with respect to age and education. Moreover, in our sample, about a half (46 percent) of the respondents had the experience of going out for work. Among those who ever went out, 38 percent have been to another province. This shows that our snowball sample is anything but a "closed" population.

Tables 1 and 2 here

[1] We obtained detailed information for the first five and the last pregnancies for each respondent, if applicable. Only two respondents had more than six pregnancies (see Table 3).

Table 3 shows the reported number of pregnancies and abortions for respondents. No respondent had more than seven pregnancies, and the majority (over 99 percent) had five or fewer pregnancies. About two-thirds of respondents had no experience of induced abortion. In other words, more than 30 percent of respondents had at least one abortion.

Table 3 here

In total, there are 2,362 completed pregnancies in the data. About 18 percent of pregnancies were terminated with abortion. Among these abortions, about 35 percent were aborted because of undesired fetal sex. Other reported reasons include not permitted by local birth control policy (19 percent), undesired pregnancy (15 percent), and undesired timing (11 percent).

The SRB is 116.9 for the live births counted in this survey, which is substantially higher than the normal level (103-107); however, the sex ratio at birth would have been very close to the normal level (about 100.7) if all of the sex-selectively aborted fetuses had been born alive[2]. It is clear that sex-selective abortion accounts for the high sex ratio at birth in our data. This also suggests that underreporting of sex-selective abortions is negligible in these data.

4 The Awareness and Practice of Prenatal Sex Selection in Rural Henan

For the purpose of investigating pregnancies that are not allowed by birth control program, ultrasound machines have been available for almost all China since the 1980s. As an unexpected result, ultrasound scan, as the modern technique of prenatal sex identification, becomes a practical choice for people who have strong sex preference. Realizing the severely demographic outcome of prenatal sex selection, as early as 1986 the Chinese government announced that

[2] The sex ratio at birth is still lower than 132.3, reported in the 2000 census for rural Henan. However, the period covered in our data is 1975 to 2001. It is almost impossible to calculate a reliable sex ratio at birth for each year given the small sample size. Nevertheless, the sex ratio at birth during 1980-1989 was 104, and increased to 125 during 1990-2001.

prenatal sex identification and sex-selective abortion other than health consideration is prohibited (Chu 2001a).

Our survey asked respondents' knowledge of ultrasound scan. It is widely known (about 86 percent) for respondents that ultrasound scan can be used for prenatal sex selection. For those who acquire this knowledge, the majority of respondents (74 percent) learn about it from their social network (relatives, friends, and neighbors), and other sources of information include doctors, family planning staff, and mass media. A little more than two-thirds of respondents think that fetal sex identification through ultrasound scan is very reliable or reliable most of the time.

Compared to the modern technology, pulse diagnosis, as a traditional method of Chinese medicine, is also fairly known. About a half (48 percent) of respondents know that pulse diagnosis can be used for sex identification. However, they do not trust pulse diagnosis as much as ultrasound scan. Among those who have the knowledge, less than 20 percent of them think that the result of pulse diagnosis is very reliable or mostly reliable.

Taken together, 90 percent of the sample is aware of at least one method of fetal sex identification, which means for people who know about pulse diagnosis, most of them also know ultrasound scan. Hence, we can safely conclude that ultrasound scan is the main technique used for prenatal sex identification in the studied sample.

Do respondents know that prenatal sex identification is illegal? How do they think about prenatal sex selection? The data show that only 42 percent of respondents know that prenatal sex identification is illegal. However, more than a half (58 percent) is aware that prenatal sex selection will make it harder for their sons to marry in the future. With regard to the ethical consideration, only 61 percent of them disagree that using sex-selective abortion to assure a son is right, whereas 19 and 20 percent of them, respectively, think that it is right or unclear.

To examine the sociodemographic patterns of respondents' knowledge and attitudes in regard to prenatal sex selection, we model these items as functions of respondents' age, education, son preference, and family income. Considering our sample is from a snowball sample, respondents who were interviewed by the same interviewer may not be independent. Hence we estimate population-average logistic models for these items, which control for the possible cluster effect. The general form of the model is as follows:

$$\text{logit}(Y_{ij}) = \alpha + \sum_{k} \beta_k X_{kij} \quad (1)$$

where Y_{ij} is the outcome dummy variable that denotes whether the $i\ th$ respondent interviewed by the $j\ th$ interviewer has a positive value for the given item, and the X_{kij} are corresponding explanatory variables. Moreover, we bootstrap each model 2,000 times to get robust results.

Table 4 shows the definitions and descriptive statistics for these items and the explanatory variables. The regression results are presented in Table 5.

For the knowledge of ultrasound scan, the model shows clearly sociodemographic differentials. There is a substantial cohort gradient regarding to the knowledge acquirement. Specifically, the older the respondent is, the less likely that she is aware of ultrasound scan. This is consistent with the recency of the availability of modern technology. At the same time, highly educated respondents are more likely to know ultrasound scan; respondents with a higher family income are also more likely to acquire the information. This suggests that people at a better socioeconomic position have some advantages in acquiring new knowledge. Respondents with strong son preference are also more likely to acquire the ultrasound knowledge. It can be explained that these people have a larger and eager demand on technology of prenatal sex selection.

With respect to pulse diagnosis, the traditional method of Chinese medicine, there is no obvious sociodemographic differential among respondents. Only respondents with Junior Middle Schooling slightly have more knowledge on pulse diagnosis than those less educated. Similar to the model on ultrasound scan, women who have a better socioeconomic position are substantially more likely to be aware that prenatal sex selection is illegal. Regarding to the awareness of the difficulty in finding a mate for boys, we also do not find clear patterns. The only significant coefficient is for those women age 25-29. They show less awareness than the youngest age cohort, but the significance is at best marginal. Finally, for the ethical consideration of prenatal sex selection, women with strong son preference show substantively more agreement on the behavior to assure a son through prenatal sex selection.

Table 4 and 5 here

With the complete pregnancy histories, we can examine the practice of prenatal sex selection in great detail. The purpose of prenatal sex selection is to obtain the desired sex structure of offspring within a limited family size. Hence, the practice of prenatal sex selection greatly depends on the existing sibset composition. For those respondents who have no child, they generally have no motive to do prenatal sex selection. According to the one and a half child policy in rural Henan, parents will get another draw if their first child is a daughter. For people who already have one or more son, they are least likely to selectively abort a girl. In contrast, for parents with only daughters, they are most likely to practice sex selection, given the prevalent tradition of son preference in the studied area. Lastly, for people who already get at least one of each, they also do not have a strong motive to practice sex selection.

Table 6 describes the patterns of prenatal sex selection and sex ratios at birth by family sibset composition before each pregnancy. We aggregate the sibset composition into four categories: No siblings; brother(s) only; sister(s) only; and both brother(s) and sister(s). As expected, the category of having sister(s) only stands out for experiencing prenatal sex selection. Specifically, fetuses that have sister(s) only are most likely to be scanned. About a half (47 percent) of them experienced ultrasound scan. The corresponding percentages for other categories are substantially lower: 23 percent for fetuses without siblings, 12 percent for those having only brother(s), and only five percent for those having both brother(s) and sister(s).

Table 6 here

However, ultrasound scan can be used for many purposes other than fetal sex identification, such as maternal and fetal health check. Therefore, we asked the primary purpose of ultrasound scan if it is practiced, almost all (91 percent) the scans for fetuses of sister(s) only category are aimed at sex identification. The category of brother(s) only also has a higher proportion (51 percent) for purpose of sex identification. We suspect that the parents may seek for a daughter to make their family more perfect. The category of having both brother(s) and sister(s) also shows a very high percentage for fetal sex identification, but the number of cases is too small to support the observed pattern.

Since prenatal sex identification has been prohibited by Chinese government since 1986, it is hard to get such service from the public hospitals. Hence, many people resort to private clinics to get the information of fetal sex. As Table 6 shows, when parents who have only daughter(s) want to get ultrasound scan service, a great portion of them go to private clinics. For fetuses having only sister(s), 59 percent of the scans are done at private clinics. The corresponding percentages for the other three categories are much smaller.

Are parents successful for getting the information of fetal sex? Our data show that about a half (44 percent) of fetuses that have only sister(s) had a known sex before birth. For other categories, the percentages are 15 percent for no siblings, 10 percent for brother(s) only, and only six percent for having both brother(s) and sister(s).

Finally, the pattern of sex ratios at birth further confirms the practice of sex-selective abortions. The SRB is substantively high for fetuses having only sister(s) in our sample. It is about 218, more than twice of the normal SRB. However, for the category of no siblings or brother(s) only, the SRBs are slightly lower than the normal level. We cannot confidently conclude that this is due to selectively aborting male fetuses, because of both the small difference and the comparatively small number of cases. However, this pattern is consistent with other national data. Using the 1988 two-per-thousand Chinese National Sample Survey of Fertility and Contraception, Peng and Huang (1999) find that among births born between 1980-1988 in China, the SRB is much higher for births that have only sister(s); however, for births that have two or more brothers, the SRB is slightly lower than the normal level.

5 Population-Average Models of Induced Abortion

5.1 Model Specification

As mentioned above, there are two main reasons for respondents to abort a fetus. One is the undesired fetal sex; the other is to limit the family size, voluntarily or required by family planning staff. For the first reason, prenatal sex selection, we expect that the ex ante fetal sex and family sibset composition are the most powerfully explanatory variables. For the second reason, family limitation, again, family sibset composition also plays an important role because both the one and a half child policy in the survey site and parents' fertility desire are closely connected to family sibset composition.

The first row in each panel of Table 7 shows the observed pattern of abortions, by ex ante fetal sex and family sibset composition. The percentages of fetus aborted vary substantively across the four categories of sibset composition. At the same time, unlike the other three categories, there are substantial differentials in the probability of being aborted for fetuses in the category of sister(s) only, according to the ex ante fetal sex. Hence, we model these patterns using the reduced interactions between ex ante fetal sex and family sibset composition. Specifically, we aggregate the cells in Table 7 into six categories: Has no siblings; has brother(s) only; has sister(s) only and ex ante fetal sex is male; has sister(s) only and ex ante fetal sex is female; has sister(s) only and ex ante fetal sex is unknown; and has both brother(s) and sister(s).

Table 7 here

With respect to the choice of the form of the model, we choose population-average model that controls for the possible cluster effect across interviewers. We prefer the population-average model over random effect model or fixed effect model for three reasons: First, the population-average model estimated by GEE is a marginal model, which allows us to fit the predicted probabilities straightforward after the model estimation. Second, we plan to bootstrap the model to get robust results; however bootstrapping random effect model will substantially increase the computing time due to the complicated error structure for RE model. Third, because respondents interviewed by two interviewers have no experience of abortion, these cases will be dropped when other forms of model are chosen. However, in population-average model, these cases are included in the model estimation. Nevertheless, no matter which form of model we select, the main results are similar.

The base line model is as follows:

$$\text{logit}(abortion_{ij}) = \alpha + \beta_2 Bro_{ij} + \beta_3 SisMale_{ij} + \beta_4 SisFem_{ij} + \beta_5 SisDK_{ij} + \beta_6 BroSis_{ij} \qquad (2)$$

where $abortion_{ij}$ is whether the i th pregnancy that belongs to a woman interviewed by the j th interviewer is terminated by abortion. The explanatory variables are the reduced interaction terms between ex ante fetal sex and family sibset composition. The category of no siblings is treated as omitted category.

Besides the base line model, we also estimate a model that controls for both respondents' sociodemographic characteristics and variables specific to fetus to examine whether the estimated pattern in the base line model can be explained away by other variables. Table 8 shows descriptive statistics for variables included in the model.

Table 8 here

5.2 Results

The results for the population-average models on induced abortion are shown in Table 9. We present bootstrapping coefficients and standard errors.

Table 9 here

Model 1 is corresponding to the base line model. The coefficient shows that fetuses that has only sister(s) and are known to be female before birth are most likely to be aborted. However, with the same sibset composition, if the ex ante fetal sex is male, it is least likely to be aborted. The coefficient is not significantly different from those fetuses without siblings. This is strong evidence of prenatal sex selection in the studied population. Meanwhile, fetuses that have brother(s) only or have both brother(s) and sister(s) are also more likely to be aborted than those having no siblings. We believe this is largely due to the family limitation behavior, either voluntary or required by local birth control policy. The same is also applicable to fetuses that have sister(s) only but the ex ante sex is unknown.

In Model 2, we add more controlling variables to see if the pattern can be explained by other fetal characteristics such as the length of pregnancy interval and the ending year of pregnancy, as well as maternal age and education. For the ending year of pregnancy, we include it as a spline function[3]. Because the prohibition of prenatal sex selection was announced in 1986, we select year 1986 as the first knot for the spline, and use five-year period thereafter (for the last period, 1996-2001, it is actually five and a half years). To our surprise, when these controlling variables are included, the estimated pattern does not change at all, and the coefficients even become stronger than those in Model 1.

Moreover, some of the coefficients for the controlling variables are of special interest. There is very strong cohort difference in terminating a pregnancy by abortion. The younger the mother is, the more likely a fetus ends up with abortion. We consider two alternative explanations: First, as mentioned above, young women are more aware of knowledge on prenatal sex selection than their older counterparts; hence they may practice sex-selective abortions more prevalently. Second, the ideal family size for younger cohort may be smaller than that for older respondents; therefore they are more likely to resort to induced abortions to control the family size. We believe that either of them plays some role here. At the same time, fetuses from highly educated mothers also are more likely to be terminated by abortions. Again, both of the above mechanisms can result in the observed phenomenon.

In the second and third rows of each panel in Table 7, we show the predicted percentages of fetus aborted, based on Model 1 and Model 2, respectively. Compared to the observed patterns in the first row, our models perform perfectly to predict the percentages. The number shows that

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[3] We also tried using dummies for the ending year of pregnancy as the alternative to the spline function. However, the likelihood ratio test cannot reject the spline specification. Nevertheless, the change does not affect our main results.

for fetuses that have only sister(s), over 80 percent of them will be aborted if the ex ante sex is female; however, almost none of them (only two percent) will be aborted if the ex ante sex is male.

Finally, we also tried controlling for more variables such as respondents' son preference, family income, and family status (results not shown here). These new variables contribute nothing to modeling induced abortion in our data. Furthermore, in the data set, we also asked respondents if they had a birth permit during each pregnancy. No doubt whether having a birth permit or not is itself a very important variable in predicting abortions. We did not include this variable into our final model because of the possible endogeneity problem between birth permit and abortion. However, whether or not including this variable into the model does not affect our main conclusion.

5.3 The Sex Ratio at Birth

In this section, we try to explore how much the high SRB observed in our sample is resulted from sex-selective abortion. We calculate the hypothesized SRB based on the information on ex ante fetal sex. When the ex ante fetal sex is unknown, we assigned three alternative values of SRB to these fetuses: they are 106, 105, and 100. Table 10 shows our imputations. No matter which value of assumed SRB we choose, all the computed SRBs are very close to the normal level. For instance, based on the ex ante fetal sex, the SRB of fetuses for category of sister(s) only is around 107-108, which is far lower than the observed 218 and close to the normal level. Therefore, we can safely conclude that the high observed SRB in our sample is almost completely due to sex-selective abortion. In other words, prenatal sex selection is the predominant, if not the sole, cause of the abnormally high SRB.

Table 10 here

6 Conclusions

Although prenatal sex identification and sex-selective abortion have been prohibited by the Chinese government since the mid-1980s, several studies have argued that sex-selective abortion is one of the leading immediate causes of the elevated sex ratio at birth in China. However, systematic studies of sex-selective abortion are scarce. Although this situation is unsurprising when the sensitivity of the topic is taken into consideration, such research is badly needed in order to understand the whole picture of the ongoing fertility transition in China.

In this paper, we employed data from a snowball sampling survey to investigate prenatal sex selection and its impact on SRB. Consistent with Chu's (2001a) findings, we found that most women in the sample have sufficient knowledge of modern techniques of prenatal sex identification, especially ultrasound scanning. A moderate proportion of the sampled rural women believe that prenatal sex selection is an acceptable way to assure a son. Using logistic regressions, we found that there are important sociodemographic differentials in the knowledge of ultrasound scan among respondents. Young women, or women at a better socioeconomic position, are more likely to acquire such knowledge. From examination of the pregnancy and fertility histories, it is clear that prenatal sex identification and sex-selective abortion is commonly practiced in the studied population, especially for couples who have only daughters.

Moreover, we used population-average models to estimate the pattern of induced abortion. We found that the ex ante fetal sex and family sibset composition are the most important predicting variables for abortions. Specifically, if a fetus has sister(s) only and it is known to be female, it will almost absolutely end up with abortion. This result is robust and not affected by other variables or selected form of model. Younger and more highly educated mothers are also more likely to practice abortions than their counterparts. In addition, a simple imputation suggests that sex-selective abortion is the predominant cause of the imbalanced sex ratio at birth in our sample. Had the sex-selectively aborted fetuses been born alive, the sex ratio at birth would have been very close to the normal level under the condition of no sex preference.

Finally, it is important to restate that the data used in our analysis are from a snowball sample. The results presented here may, or may not, be representative of all of rural China. Larger, more representative, samples are needed in order to tell whether our results generalize beyond a single county in a single province.

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Table 1. Comparison of Age Distribution between our Sample and One-Per-Thousand Sample of 2000 Census

	Data Source	
Age	2001 Rural Henan Survey	2000 Population Census
18-24	10.4%	8.2%
25-29	22.1	22.9
30-34	31.5	29.0
35-39	25.8	23.3
40-44	10.1	16.5
Total	100.0%	99.9%
N	1,056	11,144

Note: The 2000 Census samples are restricted to currently married women who live in the countryside of Henan, are in the 18-44 age range, and have an agricultural hukou.

Table 2. Comparison of Educational Attainment between our Sample and One-Per-Thousand Sample of 2000 Census

Education	Data Source	
	2001 Rural Henan	2000 Population Census
Primary school or less	28.4%	37.0%
Junior Middle School	62.1	58.5
High School or above	9.5	4.6
Total	100.0%	99.9%
N	1,056	11,144

Note: The 2000 census samples are restricted to currently married women who live in the countryside of Henan, are in the 18-44 age range, and have an agricultural hukou.

Table 3. Number of Pregnancies, Abortions, and Sex-Selective Abortions (N = 1,056)

	Pregnancies		Abortions	
Number	Frequency	Cum. %	Frequency	Cum. %
0	18	1.7	725	68.7
1	260	26.3	258	93.1
2	391	63.4	54	98.2
3	242	86.3	17	99.8
4	106	96.3	1	99.9
5	31	99.2	1	100.0
6	6	99.8	-	-
7	2	100.0	-	-

Table 4. Measurements and Descriptive Statistics for Variables Used in the Logistic Regressions

Variables	Measurement	Mean	N
Dependent Variables			
Ultrasound scan	Do you know ultrasound scan for diagnosing fetal sex (1 = yes; 0 = no)	0.8589	1,056
Pulse diagnosis	Do you know pulse diagnosis for diagnosing fetal sex (1 = yes; 0 = no)	0.4848	1,056
Illegal	Do you know sex-selective abortion is illegal (1 = yes; 0 = no)	0.4205	1,056
Find mate	It is difficult for boys to find mate later (1 = yes; 0 = no or unclear)	0.5758	1,056
Right	It is right to assure a son by sex-selective abortion (1 = yes; 0 = no or unclear)	0.1932	1,056
Covariates			
Age			
18-24*		0.1042	1,056
25-29		0.2216	1,056
30-34		0.3153	1,056
35-39		0.2576	1,056
40-44		0.1013	1,056
Education			
Primary school or lower*		0.2841	1,056
Junior middle school		0.6212	1,056
High school or higher		0.0947	1,056
Son preference	prefer a son if only one child is permitted (1 = yes; 0 = a daughter or no preference)	0.5814	1,056
Gross family income in year 2000			
3,000 *yuan* or less*		0.3042	1,052
3,001 – 5,000 *yuan*		0.3156	1,052
5,001 – 7,000 *yuan*		0.1673	1,052
More than 7,000 *yuan*		0.2129	1,052
Family income quartile	The gross family income is grouped by quartiles	2.2890 (S.D.=1.1139)	1,052

Note: * Omitted category.

Table 5. Logistic Regression of Items for Prenatal Sex Selection (N=1,052)

Independent Variables	Coefficients				
	Ultrasound Scan	Pulse Diagnosis	Illegal	Find mate	Right
Age (below 25 omitted)					
25-29	-0.8874	0.1198	0.2636	-0.4794*	0.1198
	(1.3190)	(0.2446)	(0.3000)	(0.2163)	(0.3091)
30-34	-2.3285*	0.3111	0.0263	-0.2791	0.1094
	(1.1703)	(0.3091)	(0.2742)	(0.2178)	(0.3260)
35-39	-2.8624**	0.2784	-0.0796	-0.2619	-0.0469
	(1.0902)	(0.3336)	(0.3000)	(0.2187)	(0.2938)
40+	-3.1632**	0.4880	-0.5029	-0.0623	-0.0413
	(1.1285)	(0.3511)	(0.4197)	(0.2501)	(0.3910)
Education (primary schooling or less omitted)					
Junior middle school	0.9044***	0.2709*	0.3768**	0.1670	-0.1628
	(0.1977)	(0.1247)	(0.1365)	(0.1399)	(0.2126)
High school or above	1.0696***	0.4408	0.9769***	0.3576	-0.1233
	(0.3115)	(0.2306)	(0.2959)	(0.2283)	(0.2451)
Son preference	0.5798*	-0.0923	-0.2563	-0.1426	1.0771***
	(0.2949)	(0.1097)	(0.2279)	(0.1902)	(0.2405)
Family income quartile	0.2888**	0.0330	0.2734***	0.0496	-0.0382
	(0.1057)	(0.0668)	(0.0685)	(0.0723)	(0.0861)
Intercept	2.4937*	-0.6137	-1.1247**	0.2901	-2.0601***
	(1.1164)	(0.3592)	(0.3616)	(0.3537)	(0.3934)
Wald X^2 (8)	67.24***	14.91	58.35***	10.65	35.01***

Note: * p<0.05, ** p<0.01, *** p<0.001. Numbers in parenthesis are bootstrapping standard errors after 2,000 repeated sampling. All the regressions are grouped by interviewers. The models are estimated by "XTGEE" in STATA 9.0.

Table 6. Prenatal Sex Selection and SRBs by Family Sibset Composition

	Family Sibset Composition			
	No Sibs	Brother(s) Only	Sister(s) Only	≥ 1 Each
Percent of pregnancies scanned before birth	23% (1,105)	12% (451)	47% (701)	5% (105)
Percent of scans for prenatal sex-identification	24% (255)	51% (55)	91% (328)	80% (5)
Percent of scans in private clinics	20% (255)	33% (55)	59% (328)	40% (5)
Percent of known-sex fetuses before birth	15% (1,105)	10% (451)	44% (701)	6% (105)
Sex ratio at birth	97.1 (1,031)	96.6 (287)	218.2 (420)	113.6 (47)

Note: Numbers in parentheses are base Ns.

Table 7. Percent of Fetuses Aborted, Conditional on Ex Ante Fetal Sex and Family Sibset Composition during Pregnancy

	Family Sibset Composition During Pregnancy			
Ex Ante Fetal Sex	No Sibs	Brother(s) Only	Sister(s) Only	≥ 1 Each
Male	0%	22%	2%	50%
	[1%]	[29%]	[2%]	[42%]
	{0%}	{35%}	{2%}	{65%}
	(77)	(27)	(146)	(4)
Female	5%	26%	83%	50%
	[1%]	[29%]	[83%]	[42%]
	{0%}	{35%}	{86%}	{65%}
	(84)	(19)	(160)	(2)
Unknown	1%	30%	24%	42%
	[1%]	[29%]	[24%]	[42%]
	{0%}	{35%}	{29%}	{65%}
	(944)	(405)	(395)	(99)

Note: Numbers in parentheses are base Ns. The total for the table is N = 2,362. Percentages in brackets are fitted using the particular interaction of sibset composition with ex ante fetal sex described in the text. Percentages in braces as fitted using the particular interaction of sibset composition with ex ante fetal sex and also regression standardized for several covariates—all described in the text.

Table 8. Measurements and Descriptive Statistics for Variables Used in Modeling Abortion (N = 2,362)

Variables	Measurement	Mean
Abortion (Dependent var.)	Whether the fetus is aborted (yes = 1; no = 0)	0.179
Sibset composition		
	0 = no prior sibling*	0.468
	1 = brother(s) only	0.191
	2 = male fetus having sisters only	0.062
	3 = female fetus having sisters only	0.068
	4 = fetus of unknown sex, having sisters only	0.167
	5 = have both brothers and sisters	0.045
Long waiting time to conception	Is the waiting time for a conception 18 months or longer (yes = 1; no = 0)	0.463
Long pregnancy interval	Is the pregnancy interval 18 months or longer (yes = 1; no = 0)	0.420
Period of the ending year of pregnancy (included as splines, proportions)		
	S1 = 1975-1985	0.112
	S2 = 1986-1990	0.291
	S3 = 1991-1995	0.291
	S4 = 1996-2001	0.306
	Total	1.000

Note: * Omitted category. Descriptive statistics for maternal age and education can be found in Table 4.

Table 9. Population-Average Models of Determinants of Induced Abortions (N = 2,632)

	Model 1		Model 2	
Independent Variables	β	**S.E.**	β	**S.E.**
Sibset composition ("no sibling" omitted)				
brother(s) only	3.3257***	0.2811	4.8676***	0.6326
male fetus having sisters only	0.3020	2.1427	1.4549	1.7362
female fetus having sisters only	5.8090***	0.2803	7.2367***	0.6626
fetus of unknown sex, having sisters only	3.0773***	0.3532	4.5716***	0.6946
have both brothers and sisters	3.9354***	0.3214	5.9874***	0.6746
Long waiting time to conception			1.2209	1.7742
Long pregnancy interval			-1.3911	1.7689
Period of the ending year of pregnancy				
1975-1985			-0.4035***	0.0740
1986-1990			-0.0468	0.0598
1991-1995			0.2425***	0.0487
1996-2001			-0.3812***	0.0943
Age ("below 25" omitted)				
25-29			-2.4353***	0.6488
30-34			-3.1541***	0.7094
35-39			-4.0264***	0.7164
40+			-4.9164***	0.6907
Education ("primary schooling or less" omitted)				
junior middle school			0.0744	0.1827
high school or above			0.7873**	0.2482
Intercept	-4.2450***	0.2650	799.0322***	146.7345
Wald X^2	463.83***(*df* = 5)		728.97***(*df* = 17)	

Note: * p<0.05, ** p<0.01, *** p<0.001. Numbers in parenthesis are bootstrapping standard errors after 2,000 repeated sampling. All the regressions are controlling for the interviewer cluster, and are estimated by "XTGEE" in STATA 9.0.

Table 10. Observed and Imputed SRBs, Using Several Different Assumptions when Ex Ante Fetal Sex is Unknown

Alternative Assumptions When Ex Ante Fetal Sex is Unknown	Family Sibset Composition			
	No Sibs	Brother(s) Only	Sister(s) Only	≥ 1 Each
Observed SRBs	97	97	218	114
Assume 106	97	103	108	114
Assume 105	97	103	108	109
Assume 100	97 or 96	102 or 101	107	109

Note: The alternatives occur under the assumed SRB of 1.00 due to the need to round fractional values (exactly 6.5 and 55.5) to integers.