

## A Questionnaire Study on Attitudes toward Birth and Child-rearing of University Students in Japan, China, and South Korea

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This study examines the attitudes of young Japanese, Chinese, and South Koreans toward birth and child-rearing. The survey targeted four-year university students ( $n = 1,668$ ) who responded to an anonymous survey using self-report questionnaires between December 2012 and April 2013. The collection rates were 72.5%, 94.7%, and 96.5% for the Japanese, Chinese, and South Korean students, respectively. Correlations among the respondents' attributes, medical and scientific literacy levels, and views of preferred qualities of children were analyzed using chi-square test, supplemented by residual analysis (significance level set at  $p < 0.05$ ). Participants were asked whether they were willing to use the following methods for obtaining preferred qualities in their children: (1) choosing a spouse (43.2%, 72.6%, and 85.1% of the Japanese, Chinese, and South Koreans, respectively, agreed); (2) using a sperm bank (cryobank) (5.8%, 60.1%, and 81.7% of the Japanese, Chinese, and South Koreans, respectively, agreed); and (3) using an egg cell bank (ova bank or cryobank) (5.3%, 47.2%, and 70.3% of the Japanese, Chinese, and South Koreans, respectively, agreed). The proportion of affirmative responses (indicating "eugenic inclination") to these statements was significantly higher among the Chinese and South Korean participants than their Japanese counterparts ( $p < 0.001$ ). Significant differences were also found in the attitudes of the 3 groups toward methods for obtaining the preferred qualities for their children: prenatal diagnosis, pre-implantation diagnosis, the environment during pregnancy, and child-rearing.

**Key words:** prenatal diagnosis, pre-implantation diagnosis, delivery and child-rearing, eugenics, healthy birth and child-rearing

**T**echnological advancements in prenatal and pre-implantation diagnosis have facilitated identification of diseases and abnormalities of an embryo or fetus prior to implantation of fertilized eggs or child-

birth. Artificial abortion or destruction of an embryo can be performed based on such a diagnosis, posing new bioethical issues around negative eugenics.

The People's Republic of China has promoted the idea of "healthy birth and better child-rearing" as a state policy [1]. The phrase "healthy birth and better child-rearing" refers to giving birth to healthier children and raising them in a better manner. It is natural

that this Chinese state policy initiative regarding eugenics has been viewed negatively and as an infringement of human rights by liberal, Western states. Meanwhile, other eugenics issues include debates around whether individual choices deemed “eugenic” can be regulated by the state. This particular issue is usually termed liberal eugenics or new eugenics.

The contemporary issues related to eugenics have been discussed in philosophical and ethical studies [2–6], and comparative law studies [7, 8]. Additionally, many positive/empirical studies [9–22] have been conducted and have contributed significantly to the discussion of these issues. The previous studies, however, have been conducted on a smaller scale, and they have been limited to domestic studies within a single country. Considering that eugenics has been traditionally discussed in relation to the state, it seems important to conduct a transnational comparative study on the attitudes toward eugenic practices of people from different countries with different institutions, including different prenatal and pre-implantation testing policies. With these issues in mind, we designed the present study on attitudes of individuals from 3 East Asian countries with different state systems and different policies for prenatal and pre-implantation diagnosis. We expect this study to contribute to further discussion of eugenics, a key issue in bioethics.

## Methods

### *Survey method and subjects, Survey items.*

Data was collected using an anonymous self-report survey. The questionnaire developed in Japanese was translated into Mandarin Chinese and Korean. The coherence between the original questionnaire and its translations were verified by 4 Chinese and four Korean bilingual scholars to ensure validity of the translated questionnaires.

Table 1 shows the collection rates in the three countries. We invited 1,950 undergraduate students from 4-year universities to participate in this study. The collection rates of the survey in Japan, China, and South Korea were 72.5% (616), 94.7% (521), 96.5% (531), respectively. To achieve adequate statistical power, at least 500 participants from each country were needed. In Japan, 18% of universities

**Table 1** The response rates from the three countries

	Distributed	Responded	Response rate
Japan	850	616	72.50%
China	550	521	94.70%
S. Korea	550	531	96.50%
Total	1,950	1,668	85.50%

are public and 82% are private. Likewise, in South Korea, 20% are public and 80% are private. The trend is reversed in China, in which 87% are public and 13% are private. The rationale for targeting university students for study participation was as follows: (1) it was necessary that the participants correctly understand the survey items, as the survey items included specialized medical terms related to prenatal and pre-implantation diagnosis and disabilities, and (2) as the study is related to childbirth and child-rearing, the targeted groups should consist mainly of young people who have not yet experienced marriage and childbirth.

The participants were asked to answer questions about the qualities they wanted their future children to have as well as about prenatal and pre-implantation diagnosis. Responses were given on a 4-point Likert scale (1 = strongly agree, 2 = agree, 3 = disagree, 4 = strongly disagree). “No response” was analyzed as a missing value.

**Analysis methods.** Analyses were conducted using IBM SPSS Statistics (ver. 19.0). Correlations between the attributes of the respondents, their medical and scientific literacy, and their views of preferred qualities of children and others were explored. The chi-square tests were conducted at a significance threshold of  $p < 0.05$ , supplemented by residual analysis. Responses were given on a 4-point Likert scale, but were converted into dichotomous data (agree or disagree) for analysis.

**Survey period.** The survey data were collected between December 2012 and April 2013. Specifically, data in Japan, China, and South Korea were collected from December 2012–April 2013, December 2012–March 2013, and December 2012–March 2013, respectively.

**Ethical considerations.** The present study was approved by the ethics committee of the Graduate School of Medicine, Dentistry and Pharmaceutical Sciences of Okayama University (acceptance number:

1539). The purpose and objectives of the survey were explained to the participants in writing. Subjects were also informed about the following in writing: (1) personal information and collected data will not be used for purposes other than the present study; (2) the anonymity of the subjects is assured; (3) participation in the survey is completely voluntary; and (4) the results will be published in academic research papers.

### Results

**Respondents' preferences for children.** In terms of the attributes of respondents, the mean ages of the participants in Japan, China, and South Korea were 20.4 years (SD = ± 3.16), 20.9 years (SD = ± 1.59), and 21.4 years (SD = ± 2.43), respectively. Table 2 shows the sex and grade of the respondents.

Table 3 shows the number of children that respondents from each country want to have in the future. When Japanese respondents were asked how many children they would like to have in future, 7.6% (46) answered "no children," 5.3% (32) responded "1 child," 62.8% (382) responded "2 children," and 24.3% (148) responded "3 or more children." Among Chinese

respondents, the results were 19.9% (103) for "no children," 35.5% (183) for "1 child," 37.4% (193) for "2 children," and 7.2% (37) for "3 or more children." South Korean results were 6.4% (34) for "no children," 10.8% (57) for "1 child," 59.8% (317) for "2 children," and 23.0% (122) for "3 children," Japanese subjects answered that they wanted to have "2 children" or "3 or more children" significantly more often than "0" or "1 child." Alternately, a significantly higher proportion of Chinese respondents answered "0 child," "1 child," or "2 children," than "3 or more children" ( $p < 0.001$ ).

Table 4 represents the responses to the questions about methods for obtaining the preferred qualities in their children. The proportion of respondents who agreed with the statement, "I want to have a child with preferred qualities by choosing a spouse," was 43.2% (240), 72.6% (281), and 85.1% (421) in Japan, China, and South Korea, respectively. The proportion of positive responses was significantly higher among the South Korean and the Chinese respondents compared to their Japanese counterparts ( $p < 0.001$ ). We did not find any significant difference in the proportion of positive responses between male and female respon-

Table 2 Attributes of respondents

		Japan (n = 616)	China (n = 521)	S. Korea (n = 531)
	Age (±SD)	20.4 (±3.16)	20.9 (±1.59)	21.4 (±2.43)
Sex	Male	223 (36.8%)	168 (32.2%)	154 (29.3%)
	Female	383 (63.2%)	353 (67.8%)	372 (70.7%)
grade	1st year students	227 (37.8%)	47 (15.2%)	204 (39.2%)
	2nd year students	138 (23.0%)	67 (21.7%)	162 (31.2%)
	3rd year students	118 (19.6%)	39 (12.6%)	86 (16.5%)
	4th year students	118 (19.6%)	156 (50.5%)	68 (13.1%)

Table 3 The number of children they want in the future

	Japan (n = 608)	China (n = 516)	S. Korea (n = 530)	Adjusted residual		
				J	C	S
0 (no child)	46 (7.6)	103 (19.9)	34 (6.4)	-3.5	7.8	-4.1
1 child	32 (5.3)	183 (35.5)	57 (10.8)	-9.4	14.1	-4.3
2 children	382 (62.8)	193 (37.4)	317 (59.8)	5.5	-9.1	3.3
3 or more children	148 (24.3)	37 (7.2)	122 (23.0)	4.6	-8	3.2

J, Japan; C, China; S, S. Korea.

**Table 4** The methods for obtaining the preferred qualities for their children

	Japan n (%)	China n (%)	S. Korea n (%)	Adjusted residual			Significance threshold ( $\chi^2$ test)
				J	C	S	
( i ) I want to have a child with preferred qualities by choosing a spouse	240 (43.2)	281 (72.6)	421 (85.1)	-14.1	3.4	11.3	$p < 0.001$
( ii ) I want to have a child with preferred qualities even by means of a sperm bank (cryobank)	32 (5.8)	218 (60.1)	402 (81.7)	-24.5	6.1	19.5	$p < 0.001$
( iii ) I want to have a child with preferred qualities even by means of an egg cell bank (ova bank or cryobank).	29 (5.3)	169 (47.2)	344 (70.3)	-20.7	3.7	17.7	$p < 0.001$

J, Japan; C, China; S, S. Korea.

dents in any country.

For the statement "I want to have a child with preferred qualities even by means of a sperm bank (cryobank)," 5.8% (32) of Japanese, 60.1% (218) of Chinese, and 81.7% (402) of South Korean respondents replied in the affirmative. Both the South Korean and the Chinese respondents gave a significantly higher proportion of positive responses than their Japanese counterparts ( $p < 0.001$ ). Among the Japanese and the South Koreans, male respondents gave significantly higher proportion of positive responses than females. However, we saw the opposite trend among Chinese respondents. In addition, 5.3% (29) of Japanese, 47.2% (169) of Chinese, and 70.3% (344) of South Korean respondents concurred with the statement "I want to have a child with preferred qualities even by means of an egg cell bank (ova bank or cryobank)." Significant differences existed between the three countries. Respondents from South Korea and China had significantly higher proportions of positive responses to this question than their Japanese counterparts ( $p < 0.001$ ). Among the Japanese and South Korean respondents, we found a significantly higher proportion of positive responses from male respondents than females; however, there was no gender-specific significant difference in responses among the respondents from China.

**Prenatal diagnosis.** Table 5 displays the responses to the questions about whether respondents wanted to undergo prenatal testing in the future and whether they would want (their spouse) to carry to full term a fetus for whom testing found abnormalities.

The proportion of respondents who agreed with the statement, "If I, my spouse, or family/relative have a genetic disease, I want (my spouse) to take a prenatal test," was 72.1% (405) among Japanese, 81.5%

(330) among Chinese, and 92.4% (459) among South Korean participants. The proportion of positive responses was significantly higher for South Korean than Japanese respondents ( $p < 0.001$ ). Among the Japanese respondents, there was no significant gender-based difference in the responses. However, for the Chinese and South Korean respondents, we received a significantly higher proportion of positive responses from female respondents than males.

The proportion who agreed with the statement "If I (or my spouse) have an advanced maternal age at pregnancy, I want (my spouse) to take a prenatal test," was 75.0% (421) among Japanese, 76.3% (309) among Chinese, and 91.5% (454) among South Korean participants. The South Korean respondents gave a significantly higher proportion of positive responses than their Japanese and Chinese counterparts ( $p < 0.001$ ). There was no significant gender-based difference in responses among the Japanese and the South Korean respondents. Among the Chinese respondents, female respondents gave a significantly higher proportion of positive responses than males.

Regarding the statement "If I (or my spouse) am working in a work environment that would have adverse effects on the fetus in the future, I want (my spouse) to take a prenatal test," 77.6% (433) of Japanese, 93.2% (370) of Chinese, and 92.7% (460) of South Korean respondents agreed. The proportion of positive responses was significantly higher among the South Korean respondents than their Japanese counterparts ( $p < 0.001$ ). Among the Japanese and the Chinese, male respondents gave significantly higher proportions of positive responses than females. On the other hand, the South Korean respondents showed the opposite tendency.

For the item "Because a prenatal test can lead to

Table 5 The responses to the questions related to prenatal testing

	Japan n (%)	China n (%)	S. Korea n (%)	Adjusted residual			Significance threshold ( $\chi^2$ test)
				J	C	S	
( i ) If I, my spouse, or family/relative have a genetic disease, I want (my spouse) to take a prenatal test.	405 (72.1)	330 (81.5)	459 (92.4)	-7.4	0	7.6	$p < 0.001$
( ii ) If I (or my spouse) have an advanced maternal age at pregnancy, I want (my spouse) to take a prenatal test.	421 (75.0)	309 (76.3)	454 (91.5)	-4.6	-2.8	7.4	$p < 0.001$
( iii ) If I (or my spouse) am working in a work environment that would have adverse effects on the fetus in the future, I want (my spouse) to take a prenatal test.	433 (77.6)	370 (93.2)	460 (92.7)	-8.5	4.3	4.7	$p < 0.001$
( iv ) Because a prenatal test can lead to the screening of life (i.e., to give life to the superior and to eliminate inferior life).	142 (25.5)	76 (19.5)	95 (19.3)	2.7	-1.3	-1.6	$p = 0.023$
( v ) Even if the fetus is checked to be healthy in a regular prenatal checkup, I want (my spouse/family/relative) to take the prenatal test for confirmation.	219 (39.4)	298 (73.8)	322 (64.8)	-11	7.7	4	$p < 0.001$
( vi ) I want to take a prenatal diagnosis regardless of the cost of testing.	179 (32.1)	249 (61.8)	211 (42.5)	-7.1	8.5	-0.7	$p < 0.001$
( vii ) I want (my spouse) to take the prenatal test regardless of the cost of testing.	198 (35.5)	239 (59.6)	316 (63.8)	-9.8	3.7	6.6	$p < 0.001$
( viii ) I want (my spouse) to take the prenatal test, regardless of the reliability of the test results.	152 (28.8)	217 (55.1)	155 (31.8)	-5	8.7	-3.1	$p < 0.001$
( ix ) Even if the fetus is diagnosed with hemophilia (a blood disease where a sufferer can live a normal life very close to that of a healthy individual by taking medication) during the prenatal test, I want (my spouse) to continue the pregnancy and have the child.	439 (79.2)	157 (39.1)	312 (62.9)	10.3	-11.4	0.2	$p < 0.001$
( x ) Even if the fetus is diagnosed with Down syndrome (characterized by intellectual and frequent cardiovascular and other disabilities due to chromosomal abnormality severe enough to require long hours of care), I want (my spouse) to continue the pregnancy and have the child.	284 (52.1)	153 (37.9)	136 (27.5)	7.5	-0.9	-6.8	$p < 0.001$
( xi ) Even if the fetus is diagnosed with anencephaly (a critical congenital disease with a defective cerebrum and cranium and normally leads to death within a week after birth) during the prenatal test, I want (my spouse) to continue the pregnancy and have the child.	200 (36.6)	110 (27.3)	107 (21.6)	5.1	-0.8	-4.4	$p < 0.001$

J, Japan; C, China; S, S. Korea.

'the selection of life' (i.e., to give life to superior and to eliminate inferior life), I do not want to take the test(s) in any case," 25.5% (142), 19.5% (76), and 19.3% (95) of respondents from Japan, China, and South Korea, respectively, agreed. We found a significantly higher proportion of positive responses from the South Koreans compared to the Japanese respondents ( $p = 0.023$ ). There was no significant difference in the proportion of positive responses between male and female respondents in any country.

The next question, "Even if the fetus is checked to be healthy in a regular prenatal checkup, I want (my spouse) to take the prenatal test for confirmation," yielded agreement from 39.4% (219) of Japanese,

73.8% (298) of Chinese, and 64.8% (322) of South Korean respondents. The South Korean and Chinese respondents gave a significantly higher proportion of positive responses than the Japanese respondents ( $p < 0.001$ ). We found a significantly higher proportion of positive responses among Japanese males than females; however, no significant gender-based differences were found in the Chinese and the South Korean respondents.

The proportion of respondents who agreed with the statement, "I want (my spouse) to take a prenatal diagnosis regardless of the possibility of harm to the mother and the fetus," was 32.1% (179) in Japan, 61.8% (249) in China, and 42.5% (211) in South

Korea. The proportion of positive responses was significantly higher among the Chinese respondents compared to their Japanese counterparts ( $p < 0.001$ ). There was no significant difference in the proportion of positive responses between male and female respondents in any of the countries surveyed.

For the item "I want (my spouse) to take the prenatal test regardless of the cost of testing," 35.5% (198) of Japanese, 59.6% (239) of Chinese, and 63.8% (316) of South Korean respondents agreed. A significantly higher proportion of positive responses was found among respondents from South Korea and China compared to the respondents from Japan ( $p < 0.001$ ). There was a significantly higher proportion of positive responses among Japanese males than females, while no significant gender-based differences were found among the Chinese and the South Korean respondents.

For the statement, "I want (my spouse) to take the prenatal test, regardless of the reliability of the test results," 28.8% (152) of Japanese, 55.1% (217) of Chinese, and 31.8% (155) of South Korean respondents concurred. The Chinese respondents gave a significantly higher proportion of positive responses than the Japanese and the South Korean respondents ( $p < 0.001$ ). We found a significantly higher proportion of positive responses among Japanese males compared to females, with no significant gender-based differences in the Chinese and the South Korean respondents.

Respondents endorsed "Even if the fetus is diagnosed with hemophilia (a blood disease where a sufferer can live a normal life very close to that of a healthy individual by taking medication) during the prenatal test, I want (my spouse) to continue the pregnancy and have the child" at a level of 79.2% (439) for the Japanese, 39.1% (157) for the Chinese, and 62.9% (312) for the South Koreans. The proportion of positive responses was significantly higher among Japanese respondents compared to the Chinese ( $p < 0.001$ ). The Japanese and South Korean females gave significantly higher proportions of positive responses than their male counterparts. We found no significant gender-based difference among the Chinese respondents.

The proportion of respondents who agreed with the statement "Even if the fetus is diagnosed with Down syndrome (characterized by intellectual and frequent

cardiovascular and other disabilities due to chromosomal abnormality), which is severe enough to require long hours of care, I want (my spouse) to continue the pregnancy and have the child," was 52.1% (284) in Japan, 37.9% (153) in China, and 27.5% (136) in South Korea. We found a significantly higher proportion of positive responses from the Japanese respondents compared to their South Korean counterparts ( $p < 0.001$ ). Although there was no significant gender-based differences in responses from Japan and China, South Korean females showed a significantly higher proportion of positive responses than males.

Lastly, the proportion of respondents who supported the statement "Even if the fetus is diagnosed with anencephaly (a critical congenital disease with a defective cerebrum and cranium, which normally leads to death within a week after birth) during the prenatal test, I want (my spouse) to continue the pregnancy and have the child," was 36.6% (200), 27.3% (110), and 21.6% (107) in Japan, China, and South Korean samples, respectively. The proportion of positive responses was significantly higher among the Japanese respondents than the South Koreans ( $p < 0.001$ ). As for the Japanese respondents, we received a significantly higher proportion of positive responses from female respondents than males, while there was no significant gender-based difference in the responses from China and South Korea.

**Questions regarding pre-implantation diagnosis.** Table 6 presents the results of responses to questions about the willingness to undergo pre-implantation testing in the future.

The respondents who agreed with the statement "Although extracorporeal (external) fertilization is usually conducted as infertility treatment and in my case such treatment is unnecessary, I want to go through the trouble of taking a pre-implantation test in order to check for abnormalities in fertilized eggs" constituted 10.5% (55) of Japanese, 72.0% (286) of Chinese, and 30.4% (150) of South Korean participants. We found no significant gender-based differences in the Japanese responses. However, we found a significantly higher proportion of positive responses among Chinese males than females and the opposite gender-based trend among South Korean respondents. Overall, the Chinese respondents gave a significantly higher proportion of positive responses compared to their Japanese and South Korean counterparts ( $p <$

Table 6 The responses to the questions related to pre-implantation testing

	Japan n (%)	China n (%)	S. Korea n (%)	Adjusted residual			Significance threshold ( $\chi^2$ test)
				J	C	S	
( i ) Although extracorporeal (external) fertilization is usually conducted as infertility treatment, I want to go to the trouble of taking a pre-implantation test in order to check for abnormalities in fertilized eggs.	55 (10.5)	286 (72.0)	150 (30.4)	-14.7	18.5	-2.5	$p < 0.001$
( ii ) Although commonly, in case of extracorporeal (external) fertilization, eggs without abnormalities are selected for implantation from fertilized eggs by means of pre-implantation diagnosis, I consider such selection to lead to 'the selection of life' and, therefore, want to have randomly-selected eggs implanted.	145 (27.8)	88 (22.3)	102 (20.9)	2.7	-0.9	-1.9	$p = 0.024$
( iii ) Even if the fertilized eggs are diagnosed with hemophilia (a blood disease in which a person can live a normal life very close to that of a healthy individual by taking medication) during the pre-implantation test, I want to use the fertilized eggs to have children.	249 (47.8)	115 (29.3)	171 (35.0)	5.7	-4.2	-1.8	$p < 0.001$
( iv ) Even if the fertilized eggs are diagnosed with Down syndrome (characterized by intellectual and frequent cardiovascular and other disabilities due to chromosomal abnormality) severe enough to require long hours of care, I want to use the fertilized eggs to have children.	166 (31.9)	88 (22.4)	68 (13.8)	6.2	-0.3	-6	$p < 0.001$
( v ) Even if the fertilized eggs are determined to have a predisposing factor for severe muscular dystrophy (where a person progressively loses his or her muscular strength and progresses gradually to death) during the pre-implantation test, I want to use the fertilized eggs to have children.	126 (24.4)	62 (15.8)	53 (10.8)	5.4	-0.9	-4.7	$p < 0.001$

J, Japan; C, China; S, S. Korea.

0.001).

The proportion of respondents who supported the statement, "Although commonly, in case of extracorporeal (external) fertilization, eggs without abnormalities are selected for implantation from fertilized eggs by means of pre-implantation diagnosis, I consider such selection to lead to 'the selection of life' and, therefore, want to have randomly-selected eggs implanted," was 27.8% (145) among Japanese, 22.3% (88) among Chinese, and 20.9% (102) among South Korean respondents. We found a significantly higher proportion of positive responses from the Japanese respondents than their South Korean ( $p = 0.024$ ) counterparts. There was no significant gender-based differences in responses from Japan and South Korea, but the Chinese male respondents showed a significantly higher proportion of positive responses than females.

For the item "Even if the fertilized eggs are diagnosed with hemophilia (a blood disease in which a person can live a normal life very close to that of a healthy individual by taking medication) during the pre-implantation test, I want to use the fertilized eggs to

have children," the proportion of positive responses was 47.8% (249) in Japan, 29.3% (115) in China, and 35.0% (171) in South Korea. A significantly higher proportion of Japanese students gave positive responses than their Chinese counterparts ( $p < 0.001$ ). Although there was no significant gender-based difference on this item in Japan, the Chinese and South Korean males showed a significantly higher proportion of positive responses than their female counterparts.

For the statement "Even if the fertilized eggs are diagnosed with Down syndrome, which is severe enough to require long hours of care, I want to use the fertilized eggs to have children," the proportion of respondents who concurred was 31.9% (166), 22.4% (88), and 13.8% (68) among the Japanese, Chinese, and South Korean respondents, respectively. The proportion of positive responses was significantly higher among the Japanese than South Korean respondents ( $p < 0.001$ ). However, we found no significant differences in the proportion of positive responses between the 3 countries as well as between male and female respondents in any of the countries.

Lastly, for the statement, "Even if the fertilized

eggs are determined to have a predisposing factor for severe muscular dystrophy (where a person progressively loses his or her muscular strength and progresses gradually to death) during the pre-implantation test, I want to use the fertilized eggs to have children," the proportion of positive respondents was 24.4% (126) in Japan, 15.8% (62) in China, and 10.8% (53) in South Korea. The Japanese respondents gave a significantly higher proportion of positive responses than the South Korean respondents ( $p < 0.001$ ). No significant difference was found in the proportion of positive responses among the three countries or between male and female respondents in any of those countries.

**The environment during the periods of pregnancy and child upbringing.** Table 7 presents the responses to the questions about the future environment during the periods of pregnancy and child-rearing.

The proportion of those participants who agreed with the statement, "I want to avoid anything that poses a risk (such as smoking) to the fetus or the infant," was 97.0% (520) in Japan, 98.0% (395) in China, and 99.0% (488) in South Korea. No significant differences in positive responses to this question were observed among the 3 countries ( $p = 0.081$ ), and there were no significant differences in responses between male and female students.

For the statement "I want the fetus to listen to music that is considered beneficial to them (such as classical music)," the proportion of positive responses was 81.6% (438), 97.8% (391), and 98.4% (485)

among the Japanese, Chinese, and South Korean respondents, respectively. A significantly higher proportion of the South Korean and the Chinese students gave positive responses compared to the Japanese students ( $p < 0.001$ ). Although the Japanese female respondents gave a significantly higher proportion of positive responses than males, we found the opposite gender-based trend among Chinese respondents. There was no significant difference in the proportion of positive responses between male and female respondents from South Korea.

For the item "I want to engage in activities such as looking at paintings in order to nurture the sensibility of the fetus," 67.9% (364) of Japanese, 95.9% (378) of Chinese, and 98.2% (484) of South Korean respondents agreed. The proportion of positive responses was significantly higher among the South Korean and the Chinese respondents than the Japanese students ( $p < 0.001$ ). We found a significantly higher proportion of positive responses from the Japanese female respondents than males with no significant gender-based differences in the proportion of positive responses in the Chinese and the South Korean respondents.

The proportion of those participants who agreed with the statement, "I want to begin advanced education for the child at age 0," was 20.0% (107) in Japan, 69.9% (279) in China, and 41.2% (203) in South Korea. The Chinese respondents gave a significantly higher proportion of positive responses than the Japanese ( $p < 0.001$ ). There was no significant gender-based difference in the responses from Japan and

**Table 7** The responses to the questions concerning the environment during pregnancy and child upbringing

	Japan n (%)	China n (%)	S. Korea n (%)	Adjusted residual			Significance threshold ( $\chi^2$ test)
				J	C	S	
( i ) I want to avoid anything that poses a risk (such as smoking) to the fetus or the infant.	520 (97.0)	395 (98.0)	488 (99.0)	-2	0.1	2	$p = 0.081$
( ii ) I want the fetus to listen to music that is considered beneficial to them (such as classical music).	438 (81.6)	391 (97.8)	485 (98.4)	-11.1	5.1	6.5	$p < 0.001$
( iii ) I want to engage in activities such as looking at paintings in order to nurture the sensibility of the fetus.	364 (67.9)	378 (95.9)	484 (98.2)	-15.5	6.6	9.6	$p < 0.001$
( iv ) I want to begin advanced education for the child at age 0.	107 (20.0)	279 (69.9)	203 (41.2)	-12.7	13.7	0	$p < 0.001$
( v ) I want to start when the child is newborn to provide education that nurtures the child into a specialist, such as a professional athlete and artist.	76 (14.2)	288 (72.5)	232 (47.1)	-16.4	14.6	2.9	$p < 0.001$

J, Japan; C, China; S, S. Korea.

China, while the South Korean male respondents showed a significantly higher proportion of positive responses than their female counterparts.

Among the respondents, 14.2% (76) in Japan, 72.5% (288) in China, and 47.1% (232) in South Korea supported the statement "I want to start to provide education that nurtures the child into a specialist, such as a professional athlete and artist, when the child is newborn." A significantly higher proportion of the Chinese and the South Korean respondents gave positive responses than their Japanese counterparts. There were no significant gender-based differences in the Japanese and Chinese respondents to this question. However, among the South Korean respondents, a significantly higher proportion of males responded positively than females.

***The correlation between the number of children the respondents wanted to have in the future and the tendency of responses in the 3 countries.*** As for Japanese and South Korean respondents, we found no correlation between the number of children the respondents wanted to have in the future and the tendency of their responses. Among the Chinese respondents, a significantly higher proportion of participants who wanted "one child" gave positive responses to the statement that "Even if the fetus is checked to be healthy in a regular prenatal checkup, I want (my spouse) to take the prenatal test for confirmation," than those who answered they wanted to have "2 children" or "3 or more children" ( $p < 0.001$ ).

***Correlation between backgrounds of respondents and tendency of responses.*** No significant differences were found across any of the groups for religious beliefs or affiliations. Due to insufficient descriptions of the responses, no statistically significant results existed for the correlation between the responses and other background information, including academic major (specialty) and household income. (Data not shown)

Among Japanese students, we found no significant correlation between the educational backgrounds of parents of the respondents and the responses either to questions (i) through (iii) regarding the methods used to obtain the desired qualities in their children (Table 4) or to the responses to questions (ix) through (xi) regarding prenatal diagnosis (Table 5). In China, a significantly higher proportion of students with moth-

ers having lower educational backgrounds answered that they wanted to use a sperm bank in question (ii) (Table 4) ( $p = 0.044$ ). To question (x) (Table 6), Chinese respondents with mothers having higher educational backgrounds showed a significantly higher proportion of respondents who answered positively to giving birth even in the case of a Down syndrome diagnosis ( $p = 0.014$ ). In South Korea, participants with parents having higher educational backgrounds showed a significantly lower proportion of respondents with a positive view of an ova bank in question (ii) ( $p < 0.001$ ) and question (iii) (Table 4) ( $p = 0.005$ ). We found a significantly higher proportion of positive responses to question (ix) (giving birth to children diagnosed with hemophilia) among respondents with fathers having higher educational backgrounds ( $p = 0.001$ ) (Data not shown).

***Overlapping of positive responses to prenatal diagnosis and to pre-implantation diagnosis.*** Among the respondents who responded positively to question (iv) regarding prenatal diagnosis (*i.e.*, those who were unwilling to receive prenatal diagnosis), 38.8% (Japan), 30.0% (China), and 30.4% (South Korea) agreed with the statement in question (ii) regarding pre-implantation diagnosis (answered in favor of random use of fertilized eggs without selection of eggs), with similarly low overlapping ratios. However, 75.6%, 79.8%, and 81.2% of Japanese, Chinese, and South Korean respondents, respectively, who showed willingness to receive prenatal diagnosis answered in favor of selection of fertilized eggs, with much higher overlapping ratios (approximately 80%).

Among the Japanese, Chinese, and South Korean respondents who answered positively to question (ix) regarding prenatal diagnosis (*i.e.*, willing to give birth in the case of a hemophilia diagnosis), the proportion who answered positively to question (iii) regarding pre-implantation diagnosis (*i.e.*, wanting to have an embryo implanted even in the case of a predisposition for hemophilia) were 57.0%, 43.0%, and 51.1%. Among those who answered negatively to question (ix) regarding prenatal diagnosis (*i.e.*, unwilling to give birth to children diagnosed with hemophilia), a higher proportion, namely 86.2%, 79.7%, 91.9% of the Japanese, Chinese, and South Korean respondents, respectively, responded negatively to question (iii) regarding pre-implantation (*i.e.*, unwilling to have an

embryo with a predisposition for hemophilia implanted).

We found similar tendencies in responses to the questions regarding Down syndrome (Data not shown).

***Relationship between responses to questions regarding methods used to obtain desired qualities in children and responses to questions regarding willingness to give birth to children diagnosed with diseases by prenatal diagnosis.***

Among the participants who answered that they wanted to have a child with preferred qualities, even by means of a sperm bank (cryobank), the proportion of the respondents who answered that they were unwilling to give birth to children with diseases in questions (ix) through (xi) (Table 5) were 64.0% (hemophilia), 68.2% (Down syndrome), and 75.7% (anencephaly) in China, 40.3% (hemophilia), 74.6% (Down syndrome), and 78.6% (anencephaly) in South Korea, and 35.5% (hemophilia), 38.7% (Down syndrome), and 51.6% (anencephaly) in Japan. The proportion of those willing to give birth to diseased children were higher than those unwilling in the case of hemophilia among South Korean respondents and in the cases of hemophilia and Down syndrome among their Japanese counterparts. We confirmed similar tendencies in responses to the questions regarding an ova bank and choice of spouses. In Japan, however, 55.7% answered that they were unwilling and 44.3% were willing to give birth to children diagnosed with Down syndrome, which is a rather small difference in percentages (Data not shown).

## Discussion

Significant differences existed between respondents from the 3 countries included in the study (Japan, China, and South Korea) for responses related to "eugenic inclinations," defined in this paper as willingness to select qualities of children. Using this definition, several findings emerged.

***The methods for obtaining the desired qualities in their children and eugenic inclination.***

To questions (i) through (iii) (Table 4), South Koreans showed the highest proportion of positive responses, followed by the Chinese. Japanese subjects showed the lowest proportion of positive responses. The results from (ii) and (iii) are especially noteworthy. In these questions, we confined the purpose of using a cryobank (a sperm bank or an egg cell bank) to have a child with

preferred qualities. Thus, positive responses to these questions indicate not only the readiness to accept interventions in procreation by medical technology or a third party, but also the willingness to pay the cost and "go through the trouble" in order to have children with the qualities they preferred, *i.e.*, a eugenic inclination.

As shown in Table 4, a significantly higher proportion of South Korean and Chinese participants responded positively to (ii) and (iii), indicating a higher eugenic inclination than Japanese respondents ( $p < 0.001$ ).

***Prenatal testing and eugenic inclination.***

Questions concerning prenatal testing (shown in Table 5) were also examined as an indicator of eugenic inclination. In particular, questions (ix) through (xi) (Table 5) are directly related to eugenic inclination (or the respondents' views of having children with disabilities of differing severity). All of these questions were intended to investigate respondents' (un)willingness to obtain an artificial abortion, when prenatal testing revealed disabilities. Therefore, positive responses to questions (ix) through (xi) indicate a low "eugenic inclination." As shown in Table 5, Japanese students presented with a significantly lower "eugenic inclination" than their Chinese and South Korean counterparts ( $p < 0.001$ ). Preceding studies on China [23, 24] are partially related to the above part of our survey, and we found a similar trend in our findings.

Question (iv) (Table 5) presupposes a connection between prenatal diagnosis and artificial abortion. Therefore, positive responses to this question also indicate a low eugenic inclination. As reflected in Table 5, this question also revealed a significantly lower eugenic inclination in Japanese respondents ( $p = 0.024$ ).

***Pre-implantation testing and eugenic inclination.***

The questions concerning pre-implantation diagnosis (shown in Table 6) addressed the selection of embryos. Positive responses to question (ii) (Table 6) indicated a reluctance to select embryos, representing a low eugenic inclination. As displayed in Table 6, responses to these questions indicate a significantly lower eugenic inclination in Japanese respondents than in their Chinese and South Korean counterparts ( $p = 0.023$ ). In addition, positive responses to questions (iii) through (v) are regarded as indications of reluctance to engage in embryo selection because of dis-

abilities or abnormalities and reflect a low eugenic inclination. As shown in Table 6, eugenic inclination is lower among Japanese participants than in respondents from the other two countries ( $p < 0.001$ ).

Lastly, question (i) (Table 6) assessed parents' (un)willingness to learn about potential abnormalities by prenatal diagnosis even at the non-trivial cost or risk, as indicated by the wording "go through the trouble." The primary reason for taking the tests despite the cost and risk is the desire to discover any embryo abnormalities, allowing for subsequent embryo selection, if issues are revealed. Thus, positive responses to this question indicate a higher eugenic inclination. The highest proportion of positive responses was found in Chinese participants, followed by South Koreans, and finally the Japanese ( $p < 0.001$ ), indicating the rank order of eugenic inclination for the three countries surveyed.

***Environment during pregnancy, child upbringing and eugenic inclination.*** Differing from the other categories of questions, the results from the questions concerning the environment during pregnancy and child upbringing (Table 7) do not directly indicate a eugenic inclination. Nevertheless, willingness to participate in special education was expected to correlate with eugenic inclination; specifically, it was expected to correlate with willingness to participate in embryo selection and the acceptability of and demand for future "designer baby" technology. For example, the proportions of positive responses to questions (iii) through (v) (Table 7) were significantly lower in Japan than in China and South Korea ( $p < 0.001$ ). We found a similar tendency in the responses that corresponded to that found in the responses to the above questions.

The only question in which no significant differences were detected among the 3 countries was question (i) (Table 7). We consider this absence of significant difference to be explained by the fact that this question only deals with inflicting risks rather than providing benefits to children.

***Conservation or consistency of "eugenic inclination."*** The data on the overlapping of respondents with positive views of prenatal and pre-implantation diagnosis described in Results (Overlapping of positive responses to prenatal diagnosis and to pre-implantation diagnosis) differ from the common understanding of eugenic attitudes. The proportion of

overlap is almost consistent among the 3 countries. In each country, the proportion of those willing to receive prenatal diagnosis and those in favor of selecting fertilized eggs overlapped significantly, whereas that of those unwilling to receive prenatal diagnosis and those with negative views of selecting fertilized eggs did not overlap very much. This suggests that higher eugenic inclination is more conserved, while lower eugenic inclination is less conserved and less likely to be translated into consistent responses. As shown in Results (Relationship between responses to questions regarding methods used to obtain desired qualities in children and responses to questions regarding willingness to give birth to children diagnosed with diseases by prenatal diagnosis), the eugenic inclination differed among diseases, which we speculate is influenced by social backgrounds unique to each country.

***Limitations of the present study.*** Three clear limitations exist in this study. First, it is not necessarily clear how well 4-year university students represent the entire younger generation. Second, the study was conducted with little attention to the type of institutions (public or private) and the difference in major (specialty), especially science or other. Regarding the type of institution, however, since the characterization of the types of institutions varies from one country to another, we do not consider that there is a strong need for analysis here. As for the major (specialty) variable, because the respondents of the present study included participants in liberal arts courses, we consider that the specialties of the respondents were balanced above a certain level. Finally, the fact the participants belonged to institutions directly or indirectly related to the authors could have entailed some selection bias.

In conclusion, the present study revealed significant differences in the attitudes ("eugenic inclination") among respondents from three countries (Japan, China, and South Korea). These differences were present for the following: i) the methods used to obtain the preferred qualities for their children, ii) prenatal diagnosis, iii) pre-implantation diagnosis, and iv) the environment during pregnancy and child upbringing. Among the three countries compared, the Japanese respondents showed consistently lower eugenic inclination. The eugenic inclinations of Chinese and South Korean respondents were reversed

in some cases. Finally, v) higher eugenic inclination was more conserved than lower inclination, yielding more consistent responses to the survey questions.

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