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【Abstract】
This paper reports findings about the relationship between children's academic ability and family background using the "Japan Child Panel Survey 2011 (JCPS2011)" to serve as a follow-up of Akabayashi et al. (2011) that described the results of the JCPS2010. For this analysis, we pay particular attention to how the child's gender, birth month, presence of siblings, parents' educational attainment, and level of household income impact scores in mathematics, Japanese, and reasoning tests. The results of this study are the followings: (1) Father's educational attainment of a college degree or higher positively influences the scores in mathematics and Japanese; (2) Mother's educational attainment of a college degree or higher positively influences the scores in mathematics, Japanese, and reasoning; (3) Child's birth month between January 1 and April 1 negatively influences the scores in mathematics; (4) Household annual income positively influences the scores in mathematics, Japanese, and reasoning

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Summary

This paper reports findings about the relationship between children's academic ability and family background using the "Japan Child Panel Survey 2011 (JCPS2011)" to serve as a follow-up of Akabayashi et al. (2011) that described the results of the JCPS2010. For this analysis, we pay particular attention to how the child's gender, birth month, presence of siblings, parents' educational attainment, and level of household income impact scores in mathematics, Japanese, and reasoning tests. The results of this study are the followings: (1) Father's educational attainment of a college degree or higher positively influences the scores in mathematics and Japanese; (2) Mother's educational attainment of a college degree or higher positively influences the scores in mathematics, Japanese, and reasoning; (3) Child's birth month between January 1 and April 1 negatively influences the scores in mathematics; (4) Household annual income positively influences the scores in mathematics, Japanese, and reasoning.

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Section 1 Introduction[2]

Triggered by a national discussion over a decline in academic ability and the resulting social problems, Japanese society has entered "the period of the academic ability survey" in order to collect information on the situation (Kariya, 2009). As a result, based on the historical comparison of international academic ability surveys such as the Program for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS), researchers discovered that the academic ability of children and students has declined rapidly (Sato, 2009). In addition, a comparison of the basic academic abilities of mathematics and Japanese, using the same questions and the same school groups as those used 20 years ago (Kariya and Shimizu, 2004), showed a decline in the correct response rate regarding content that was not mentioned or explanations that were omitted from the "Yutori Education (pressure-free education)" of the 1990s. These results revealed that children's basic academic abilities have actually decreased.

In 2002, the Ministry of Education, Culture, Sports, Science and Technology (hereafter MEXT) promoted the "Encouragement for Learning" program to address the decline in academic ability by changing the previous policy of Yutori Eduation. One of the program's new slogans was "Solid Scholastic Ability." In this policy, it is worth noting that the acquisition of basic knowledge and the establishment of study habits in the home were included as education goals. If only taking note of the fact that the acquisition of basic knowledge is specified in this policy, it would seem that the "pendulum of education" (Shimizu, 2005) has swung back from pressure-free education to the postwar education model that strongly emphasized knowledge. However, considering that students' daily study habits and acquisition of learning skill for lifelong learning are also emphasized, the nature of academic ability targeted by the governmental guidelines for teaching seems to be greatly different from that of the 1960s

[2] This paper was written in response to the report by Akabayashi et al. (2011) describing the results of the children's survey that was performed together with the Japan Household Panel Survey (JHPS) in 2010, which means that we conducted a similar analysis and similar study as that of Akabayashi et al. In this analysis, we used the individual data obtained from the Keio Household Panel Survey (KHPS) in the Keio/Kyoto Joint Global Center of Excellence Program and the individual data obtained from the Japan Child Panel Survey (JCPS) in the Joint Research Center for Panel Studies at Keio University. The analysis of this paper was supported by the Grant-in-Aid for Scientific Research (A) 20243020. This paper was based on the report in the Keio University Joint Research Center for Pane Studies workshop held at Keio University in November 2011. We acknowledge with gratitude the valuable and constructive comments for the report in the workshop from Mr. Yoshio Higuchi, Mr. C.R. McKenzie, and all the participants and the analysis support of Ms. Hiroko Araki, Mr. Takashi Hansaki, and Ms. Sachi Aizawa (all from the Graduate School of Economics, Keio University).

and 1970s. In other words, while acquisition of basic knowledge is targeted, the new program's basic concept focuses on acquiring knowledge supported by daily study habits and learning skills designed to promote lifelong learning, not a system that focuses on cramming education such that teachers force children to acquire knowledge.

Based on these new education policies, various actions (e.g., actively imposing homework and establishing a time for reading in the morning) have been developed on the educational front in order to improve basic academic ability (Kageyama, 2010). The association between teachers offering these learning tools and children's academic ability has also been demonstrated (Tanaka, Kihara, and Ono, 2009). In the field of educational psychology, not only methods of effective teaching and evaluation (Takagaki, Tazume, Nakatani, Ito, Kobayashi, and Mishima, 2011; Murayama, 2006; Suzuki, 2011) but also the effect of instruction in specific learning skills (Shinogaya, 2011; Uesaka, 2010) have been discovered to be important for the acquisition of knowledge and improved motivation.

However, in addition to the decline in academic ability itself, there is another problem related to children's and students' academic ability in Japan, which is the widening "academic ability gap" (Sato, 2009). Household sociocultural factors have been pointed to as a possible explanation of this widening gap in academic ability. In previous academic ability surveys, it was shown that a child's academic ability was affected by his or her parents' educational attainment and income (Kariya and Shimizu, 2004). It was also revealed that the correct response rate decreased remarkably for the "No study kids" who did not study in any place other than a school, which indicated that the impact of school teaching on a child's academic ability has decreased, whereas the impact of home environment has increased (Kariya, 2008). Thus, considering that the home environment has an influence on children's academic ability, recent social changes such as growing socio-economic inequality and increasing poverty may have resulted in the accelerated decline in academic ability and the widening academic ability gap across household sociocultural factors (Uchida, 2007). Therefore, in order to address the two main issues of academic ability—decline in academic ability and academic ability gap—it may be important to clarify the impact of household sociocultural factors such as parents' educational attainment and income on children's academic abilities as well as the process of this impact.

In this context, this paper examines the correlation between a child's attributes and home environment and the child's academic abilities; the paper examines this correlation in light of the report by Akabayashi et al. (2011) that discussed the association between academic ability and household budget,

using JCPS2010 and JHPS2010. Specifically, by taking up household sociocultural factors such as the parents' educational attainment and income, a distribution regarding the association between the values and the test scores is identified, and statistical tests are performed. Then, the academic ability score is defined as a dependent variable. Estimations are made using the ordinary least squares regression (OLS) with children's attributes and home environment as explanatory variables.

The next sections are organized in the following way: Section 2 describes the method for construction of the academic ability scores in the subjects of the Japan Child Panel Survey 2011 that we used in this study, and also outlines the distribution of academic ability and family background variables. Section 3 shows the association between a child's attributes and family background variables and the child's academic abilities using charts. Section 4 illustrates the association between the household cultural environment variables and academic ability by using charts and summarizes the results of the statistical test. For the test, nonparametric analysis (Kruskal Wallis test and Wilcoxon-Mann-Whitney test) is conducted. Section 5 shows the results estimated by the OLS of the impact of family background on academic abilities. Section 6 provides future prospects.

Section 2 Data and indicators of academic ability

1. Data

In 2008, Keio University established a joint center, called the "Joint Research Center for Panel Studies at Keio University," in order to institute a panel study and accelerate research activities using the panel data. In this study, we used the data from the "Japan Child Panel Survey" as a part of the activities of this center.

In 2011, the Japan Child Panel Survey was conducted with children who belonged to the households that were participating in the Keio Household Panel Survey (KHPS).[3] This survey, JCPS2011, included 1,126 subjects who were between the first grade in an elementary school and the third grade at a junior high school as of March 2011. Before this survey, we requested additional cooperation for the Japan Child Panel Survey from the subjects in the KHPS survey conducted in January 2011, and sent and obtained questionnaires by mail from the subjects who consented to participate in our study. As a gesture

[3] For more information of the Keio Household Panel Survey, refer to other studies (e.g., Seko et al. [2011]).

of gratitude for cooperating in the survey, a book card equivalent to 500 yen and a plastic document folder were offered to each child as a reward. For feedback purposes, the subjects were allowed to read the summary of the individual survey results using their pre-assigned ID and password.

This survey consisted of the Children's Questionnaire, designed to investigate a child's basic academic ability and study environment, and the Parent's Questionnaire completed by the child's parent as a subject of KHPS. This Children's Questionnaire included the achievement tests for mathematics, Japanese, and reasoning, as well as the questionnaire survey on the child's study situation and quality of life. Different questions according to school year were prepared and the subjects were asked to answer them by themselves within a certain time limit (20 minutes).[4] The questionnaire survey also included questions on such issues as afterschool activities, favorite and least favorite study subjects, school life, and homework situation. The Parent's Questionnaire included survey items such as the type of school that the child attended, the size of the class that the child belonged to, the experience of an entrance examination for private or national school, the time the child spent studying, the actual household expenditures on education, and the child's sociality. Parents who had two or more children in the survey were asked to respond to the questionnaire individually for each child. The above survey was designed based on the Japan Child Panel Survey 2010 (JCPS2010) for the subjects who were in the households of the JHPS subjects in 2010, and its comparability was achieved. However, it was modified appropriately according to existing findings.[5]

A total of 659 subjects responded to the achievement test in the Children's Questionnaire. This is the number of respondents who cooperated with the JCPS2011, excluding the subjects who cooperated only with the Parent's Questionnaire. Among these 659 subjects, 220 children were in the lower grades of elementary school, 232 children were in the upper grades of elementary school, and 207 respondents were junior high school students. Of these, 333 and 326 respondents were male and female, respectively. For birth month, 158 respondents were born between April and June, 171 were born between July and September, 165 were born between October and December, and 165 were born between January and March. For the number of siblings, 60 respondents belonged to the group of one sibling (an only child),

[4] A survey by Drop-Off /Pick-Up method may have some issues; for example, the third person including the parent may revise mistakes in the test after the child responded. Although all problems have not been solved, we took measures in our study; children were requested to put a sticker in the questionnaire by themselves just after it was completed.

[5] For the summary of the JCPS2010, refer to the study by Shikishima et al. (2011) and the study by Yamashita et al. (2011).

333 respondents belonged to the group of two siblings, 205 respondents belonged to the group of three siblings, 44 respondents belonged to the group of four siblings, and 17 respondents belonged to the group of five or more siblings.

2. Measures of academic ability

The measures of academic ability used to explain the relationship between a child's academic ability and family background were standardized by the following methods. The allotment of marks per question in each subject (mathematics, Japanese, and reasoning) was scored as 1, to be summarized simply, and then was standardized to a mean of 50 and a standard deviation of 10 by each school year. In Japan, the Z score computed in this manner (i.e. "hensachi") is generally used as a standardized score in the school setting. The distributions of the Z score are shown in Figure 1.

Next, the adjustment of the Z scores between the grades is discussed. In the many analyses in this paper, all the surveyed school years are pooled (for six school years of elementary school and for three school years of junior high school). The merits and demerits of such an analysis were examined by Akabayashi et al. (2011). However, we summarized a part of the statement by Akabayashi et al. (2011) below because it is important for this paper, which also used similar data to that used in the study conducted by Akabayashi et al. First, it should be kept in mind that the scores based on different tests depending on school year are pooled in order to be analyzed. In this case, the scores are required to be adjusted by Item Response Theory (IRT), which was virtually impossible, considering the characteristics of the test, the number of the questions, and the sample size. However, when systematic estimation results would be obtained even if the simplest standardization method is used, the estimate can be considered robust. Consequently, in this paper, we conduct analyses based on these statements.

Section 3 Child's attributes and academic ability

This section examines the association between gender, birth month, number of siblings, and children's academic ability. In reference to the study conducted by Akabayashi et al. (2011), we also compare our results with those of the JCPS2010, which was performed together with the JHPS using the same achievement test.

1. Influence of gender

Figure 2 shows a comparison of the average level of academic ability in mathematics, Japanese, and reasoning for male and female children. In Figure 2, mathematics and reasoning scores seem to be higher for males than females (a difference of 1.2 points in mathematics; 0.7 points in reasoning), whereas there is no difference between males and females in Japanese. These results are nearly similar to the analysis of the JCPS2010.

2. Influence of birth month

Figure 3 shows a comparison of academic ability according to the four birth month groups (April to June; July to September; October to December; January to March). In **Figure 3**, there is no remarkable difference in academic ability among the birth month groups. However, for mathematics and reasoning, the mean values seems to be slightly lower just in the group of subjects born between January 1 and April 1. These results are nearly similar to the analysis of the JCPS2010.

3. Influence of the number of siblings

Figure 4 shows a comparison of academic ability judging by the mean score in each subject according to the number of siblings. In this figure, academic ability in every subject seems to gradually decline as the number of siblings increased. This tendency is observed more clearly in comparison to the analysis of the JCPS2010.

4. Results of statistical hypothesis test

The association between children's attributes and academic ability was tested to determine whether the association was actually statistically significant (**Table 1**). For more information on the testing method, refer to the note in **Table 1**. The test results show that the variables with significant difference at a 5% level are the number of siblings and birth order. For the number of siblings, there is a significant difference in all three subjects. For birth order, there is a significant difference in mathematics and Japanese. These results are slightly different from the analysis of the JCPS2010, which shows a significant association with birth month.

Section 4 Family background and academic ability

This section, by focusing on parents' educational attainments and income level, examines the association between academic ability and children's socio-economic home environment. As in Section 3, referring to

the study conducted by Akabayashi et al. (2011), we performed a comparison with the results of the JCPS2010, which was performed together with the JHPS using the same achievement test.

1. Influence of parent's educational attainment

Figure 5 shows the average child's academic ability in relation to their mother's highest educational attainment (junior high school, high school, junior college/technical college, or 4-year college).[6] First, for the levels of academic ability in mathematics and Japanese, there is a remarkable association with the mother's highest educational level. Generally, a child's academic ability scores tend to increase as the mother's educational attainment is higher. On the other hand, for reasoning, there is no definite association, and the average academic ability scores tend to be higher in the groups of mothers whose highest educational attainment is junior high school or college. However, it should be noted that the sample size is relatively small for the group of mothers whose highest educational attainment is junior high school, which results in a large standard error.

Figure 6 shows the association between father's educational attainment and academic ability scores. In this figure, for mathematics and Japanese, there is a strong positive correlation between the father's educational attainment and the average academic ability scores. On the other hand, the scores for reasoning are slightly associated with the father's educational attainment, in contrast with the tendency shown in the figure relating to the mother's educational attainment. However, this association for reasoning is weaker than that for mathematics and Japanese. Taking account of the standard error of the academic ability scores, this result seems not to lead to any definite conclusions. The above-mentioned tendencies are observed more clearly in this study than in the analysis of the JCPS2010.

2. Influence of household income

Figure 7-1 shows the average academic ability of children from the quartile groups based on household annual income in 2010, based on the survey items of the KHPS.

In this figure, for mathematics and Japanese, there is a clear positive correlation between household annual income and academic ability scores; above all, the difference between the mean scores of the group with the lowest household annual income (first quartile) and the three other groups is remarkably

[6] In this paper, we call 4-year college graduate simply as "college graduate." In Japanese government statistics, 4-year college is called "university" which is used in the JCPS questionares. Under our educational classification, the group belonging to "others" has not been shown on the graph. Further, there was no mother in the sample who indicated that they had completed graduate school.

wide. For reasoning, although the mean score tends to decrease in the first quartile group, there is no definite association between annual income and the mean score in the second or higher quartile group. **Figure 7-2** shows how academic ability gap by income quartile would change with the progress of school year (the nine grades in the sample are grouped into lower grades and upper grades at an elementary and junior high school). As a result, for mathematics, Japanese, and reasoning, there is a tendency to neither expand nor reduce academic ability gap definitely by a shift in school year. However, the mean score of the first quartile group is the lowest across all subjects and school years, which supports the results obtained from **Figure 7-1**.

Figure 7-3 shows the association between parents' employment status and children's academic ability according to regular and non-regular employment.[7] This figure suggests that parents' employment status has two different impacts on children's academic ability. In other words, the average child's academic ability is higher when the father has regular employment, whereas the average child's academic ability is lower when the mother has regular employment.

The analysis in this section shows a tendency similar to the analysis of the JCPS2010. However, it should be noted that there were also similar issues that were pointed out in the JCPS2010. That is to say, it is not easy to interpret this tendency as a causal relationship. There is a significant correlation between the father's educational attainment and the child's academic ability; at the same time, it is expected that the educational attainment may be associated with employment status. In addition, in families with a full-time working mother, children might complete the achievement test in the parents' absence, which might influence the results through differences in enforcement conditions of the test.

3. Results of statistical hypothesis test

We used a statistical test to assay the association between children's academic ability and parents' educational attainment and annual income, as mentioned in the previous paragraphs. The results of the test are shown in **Table 2**. For parents' educational attainment, the samples were classified according to the educational attainment, which is the same as **Figure 5** and **6**, and then were tested to see whether there was a difference in mean score between the groups. In addition, it was determined whether the child's academic ability was affected by each parent's educational attainment (college graduate or

[7] Here, "regular" employment refers to the employment status of being hired and having working arrangements corresponding to that of full-time employment. Further, in total, the unemployed sample has been included in "Non-regular employment."

non-college graduate). For household annual income, the samples were classified according to quartile of annual income, and then were tested to see whether there was a difference in mean score between the groups. For mathematics and Japanese, the tests showed there was a statistically significant difference in the scores between the groups for all the comparisons. These results are consistent with the tendency mentioned above. For the scores in reasoning, there is no difference associated with the mother's educational attainment, but for other variables showing other family backgrounds, significant association was found at the 10% or higher level.

Section 5 Estimated results of OLS

This section describes the estimated results of the OLS. For mathematics and Japanese, the Z scores standardized by each school year were used as a dependent variable. Simple tabulation was used in the number of correct responses for reasoning.[8] The independent variables used in this estimation could be mostly classified into two groups: a variable to show the child's attribute and a variable to show the family background. For a variable to show the child's attribute, gender (Female dummy), birth period (Being born between January 1 and April 1; dummy), and birth order (First-born child; dummy) were used. For a variable to show family background, parent's educational attainment (Father's college graduate or higher, dummy; Mother's college graduate or higher, dummy), parent's employment status (Father's regular employment, dummy; Mother's regular employment, dummy), and tax-included household incomes were used. **Table 3** shows descriptive statistics for these explanatory variables. In the following estimation, two kinds of identification were used: household income controlled linearly and the dummy variable based on quartiles. This is because of the possibility that the association between household income and academic ability might not always be linear, according to the discussion about **Figure 7-1**.

Table 4 shows estimated results of the OLS, and the numerical value in parentheses shows heteroskedasticity robust standard error. The following are the primary estimated results obtained consistently without depending on identification of income:

- When a child has been born between January 1 and April 1, the mathematics score decreases by approximately 2 points. On the other hand, when a child is a first-born child,the mathematics

[8] Reasoning is the total score, between 0-4, of the raw scores. To ascertain the difference in the average score by each school year, the school year dummy was used when reasoning was a dependent variable. Of course it is ideal to use the scores when the impact of school year has been removed; in this paper, simple tabulation was used to compare scores with those of the study by Akabayashi et al. (2011).

score rises by approximately 1.8 points.

- When a father is a college graduate or higher, the mathematics score rises by approximately 2.5 points and the Japanese score also rises by approximately 2 points.
- When a mother is a college graduate or higher, the mathematics score rises by approximately 2.5 points and the Japanese score rises by approximately 3.6–3.7 points. For the reasoning scores, there is a rise in the raw score of approximately 0.3 points out of a total of 4 points (after the difference of the scoring average between the school years was controlled).
- When household income increases to 1 million yen, both mathematics and Japanese scores rise by approximately 0.04 points; for the scores of reasoning, the raw score rises approximately 0.04 points. In addition, for the effect of household income according to quartile group, the nonlinearity of the effect of income is suggested, as is originally expected; for mathematics and Japanese, the effect of the quartile is the largest.
- Child's gender and mother's employment status showed no statistically-significant systematic difference.

Finally, we summarize briefly the differences between the results of our analysis and the results of the previous analysis using the JCPS2010 that was performed together with the JHPS (Akabayashi et al., 2011). For the children's attributes, similarly to the previous analysis, there is a negative impact of being born between January 1 and April 1 on mathematics, but unlike the previous analysis, a positive impact of being the first-born child on mathematics was also found. For parents' attributes, just as in the previous analysis, there is a positive impact of the father's and mother's educational attainment on mathematics and Japanese. The impact of the mother's educational attainment on mathematics is stable, in particular, in our analysis. Positive impact of household income on the test scores tends to be remarkable in our analysis.

Section 6 Conclusion

In order to analyze our data in light of the report by Akabayashi et al. (2011), which described the results of the JCPS2010 and the JHPS2010, we focused on the association of variables indicating children's gender, birth month, the presence of siblings, parents' educational attainment, and the level of household income with the scores of mathematics, Japanese, and reasoning. There were slight differences in some variables, but basically results similar to those of the study conducted by Akabayashi et al. (2011) were confirmed.

The main challenges for the future are similar to those found by Akabayashi et al. (2011). The first challenge is to analyze the mechanisms through which income difference impacts academic ability. It can be thought that income differences may produce academic ability difference through an investment in the education of a child (private school, cram school), and the parents' education level and genetic factors may additionally affect academic ability. Therefore, such a mechanism should be clarified comprehensively. The second challenge is to determine the association between population demographics (the group that a child belongs to) and academic ability; specifically, it is necessary to clarify the relationship between region, school, and academic ability. The main purpose of the JCPS2011 is to clarify the impact of personal factors such as home environment on a child's academic ability. By linking the KHPS data to local information or school information, an analysis that considers population factors may reveal how region and school impact a child's academic ability. The third challenge is to determine the association between academic ability and behaviors besides academic ability. By simultaneously analyzing the determinants of both academic ability and behaviors besides academic ability, we may discuss the multifaceted roles that home and school play in this process, which so far have not been identified systematically.

Appendix: Characteristics of the sample

The subjects of the JCPS2011 used in the proof of this paper were respondents who participated in the KHPS2011, conducted in January 2011, who had a child (or children) between first grade at an elementary school and third grade at a junior high school. In the beginning of the study, we confirm the representativeness of the JCPS2011 sample in reference to the study conducted by Yamashita et al. (2011). Specifically, we examine the cooperation rate by each school year and the problem of whether participation in this survey was prescribed by the respondent's attributes.

The value of the cooperation rate for the KHPS2011 is defined as the number of cooperators (the number of respondents in the JCPS) divided by the number of potential respondents (the number of subjects who might cooperate with the JCPS), just as it was in the study conducted by Yamashita et al. (2011). As a result, as shown in Table A-1, the cooperation rate of the lower grades at elementary school (first to third graders at elementary school), the upper grades at elementary school (fourth to sixth graders at elementary school), and junior high school students were 68.5%, 59.3%, and 50.0%, respectively; this indicates that the cooperation rate might tend to decrease as the level of education increases. As shown

in Table A-2, which focuses on each school year, the cooperation rates for first graders, second graders, third graders, fourth graders, fifth graders, and sixth graders at elementary school, and first graders, second graders, and third graders at junior high school were 63.0%, 72.7%, 69.2%, 61.0%, 56.9%, 60.1%, 52.8%, 56.4%, and 40.6%, respectively. The highest cooperation rate was observed in the second graders at elementary school, and the lowest cooperation rate was observed in the third graders at junior high school; the difference was 32.1%.

Then, using a binomial probit model, we examine whether the presence of responses might be prescribed by the attribute of the household budget. We looked at the following variables: (1) child's school year; (2) child's gender; (3) child's birth period; (4) child's birth order; (5) household annual income; (6) parents' educational attainment (whether parents are college graduates or not); and (7) parents' employment status (regular employment or not). Table A-3 shows the estimated results, and we confirmed the following points. In the case where the sample included all school years, father's and mother's educational attainment are significantly positive. There was no significant variable in the first to third graders at elementary school. In the fourth to sixth graders at elementary school, father's educational attainment was significantly positive. In first to third graders at a junior high school, father's and mother's educational attainment and mother's employment status were significantly positive individually. These results revealed the following points: (1) There is a tendency that the cooperation rate might vary depending on children's (student's) school year and parents' educational attainment; (2) A similar tendency was found in the JCPS2010, but the association was weaker than in this study (JCPS2011); (3) On the whole, except for the mother's employment status, there is no association between other individual and household attributes.

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Figures and Tables

Table 1 Association between children's attributes and academic ability: Results of tests of the statistical hypothesis

Subject	Birth month (quarter)	Birth period (April to June vs. January to March)	Gender	Number of siblings	Birth order
Mathematics	—	*	*	* * *	* *
Japanese	—	—	—	* * *	* *
Reasoning	—	—	—	* * *	—

Note: Null hypothesis indicates that "there is no difference in deviate between the groups." For birth month (quarter), the differences between four groups (April to June; July to September; October to December; January to March) are compared. For birth month (April to June and January to March), the difference between only the two groups in parentheses are compared. The number of siblings is classified into five groups (1-5 persons) and the birth order is classified into five groups (first to fifth). For two groups, the Wilcoxon-Mann-Whitney test is used. For three or more groups, the Kruskal Wallis test is used. ***, **, and * indicate that estimated coefficient is statistically significant at 1%, 5%, and 10% levels, respectively.

Table 2 Association between family background and children's academic ability: Results of tests of the statistical hypothesis

Subject	Mother's educational attainment	College graduate, Mother (Figure omitted)	Father's educational attainment	College graduate, Father (Figure omitted)	Household annual income (Quartile)
Mathematics	＊＊＊	＊＊＊	＊＊＊	＊＊＊	＊＊＊
Japanese	＊＊＊	＊＊＊	＊＊＊	＊＊＊	＊＊＊
Reasoning	—	＊	＊	＊＊＊	＊＊＊

Note: Null hypothesis indicates that “there is no difference in deviate between the groups.” Mother’s educational attainment is classified into five groups (junior high school graduate; high school graduate; junior college/technical college; 4-year college graduate or higher). Father’s educational attainment is classified into six groups (junior high school graduate; high school graduate; junior college/technical college; 4-year college graduate; graduate school). Household income is classified into four groups (quartile). For two groups, the Wilcoxon-Mann-Whitney test is used. For three or more groups, the Kruskal Wallis test is used. ***, **, and * indicate that estimated coefficient is statistically significant at 1%, 5%, and 10% levels, respectively.

Table 3 Descriptive statistics of the variables related to family background used in OLS

Variable	Mean	Standard deviation	Minimum	Maximum
Child's gender (Female = 1)	0.49	0.50	0	1
Child's birth period (Birthday between January 1 and April 1 = 1)	0.25	0.43	0	1
Child's birth order (First-born child = 1)	0.45	0.50	0	1
Father's educational attainment (College graduate or higher = 1)	0.41	0.49	0	1
Mother's educational attainment (College graduate or higher = 1)	0.17	0.37	0	1
Father's employment status (Regular employment = 1)	0.74	0.44	0	1
Mother's employment status (Regular employment = 1)	0.12	0.32	0	1
Household annual income (in millions of yen)	7.18	3.46	1.0	25.0

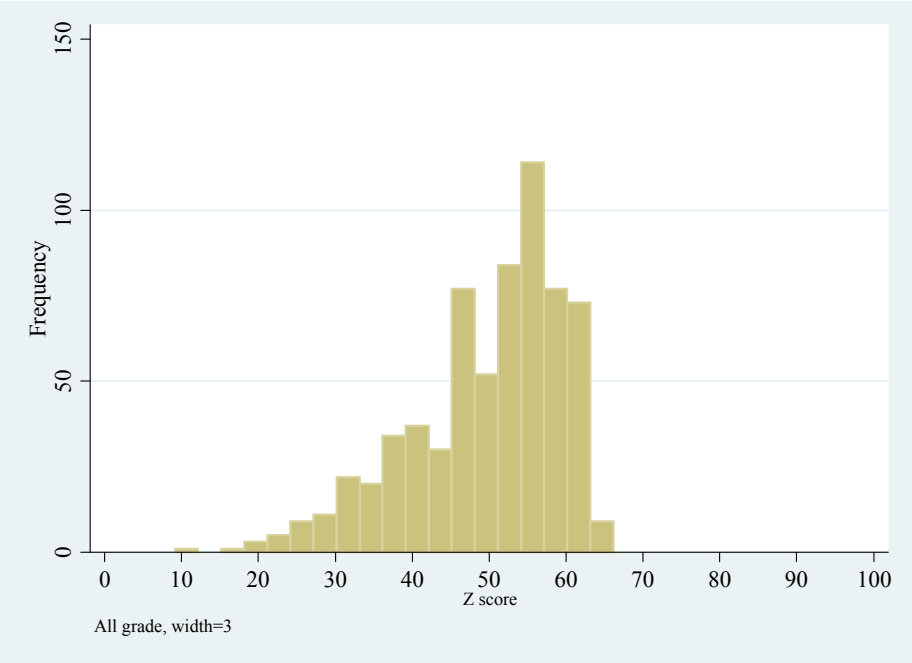
Table 4 Relationship between children's attributes and family background and academic ability: Estimated results of OLS

	Mathematics		Japanese		Reasoning	
	Coefficient (S.E.)	Coefficient (S.E.)	Coefficient (S.E.)	Coefficient (S.E.)	Coefficient (S.E.)	Coefficient (S.E.)
Child's gender (Female = 1)	-1.0630	-1.0663	0.2478	0.2467	-0.0636	-0.0661
	(0.7564)	(0.7592)	(0.7663)	(0.7649)	(0.1032)	(0.1026)
Child's birth period (Birthday between January 1 and April 1 = 1)	-2.0022**	-1.9999**	-0.9182	-0.9603	-0.1613	-0.1553
	(0.8725)	(0.8780)	(0.9146)	(0.9054)	(0.1216)	(0.1222)
Child's birth order (First-born child = 1)	1.8709**	1.8295**	1.3607*	1.2712	0.1733*	0.1667
	(0.7809)	(0.7707)	(0.7812)	(0.7788)	(0.1021)	(0.1023)
Father's employment status (Regular employment = 1)	2.4802***	2.6175***	1.8065**	2.0215**	0.1000	0.1366
	(0.8680)	(0.8596)	(0.8773)	(0.9090)	(0.1166)	(0.1194)
Mother's employment status (Regular employment = 1)	2.5176***	2.6144***	3.6605***	3.7427***	0.2818**	0.3013**
	(0.9122)	(0.9426)	(0.8441)	(0.8470)	(0.1321)	(0.1339)
Father's employment status (Regular employment = 1)	-0.9809	-1.4577	-1.3671	-2.0930**	-0.1291	-0.2181*
	(0.8994)	(0.9657)	(0.8988)	(0.9669)	(0.1228)	(0.1298)
Mother's employment status (Regular employment = 1)	-1.5262	-1.1051	-1.6840	-1.1782	-0.2085	-0.1248
	(1.1736)	(1.2079)	(1.2262)	(1.2259)	(0.1595)	(0.1599)
Household annual income	0.5129***	———	0.4885***	———	0.0412**	———
	(0.1385)		(0.1167)		(0.0163)	
Income category: Second quartile	———	2.4059**	———	3.9040***	———	0.2623*
		(1.1611)		(1.1575)		(0.1487)
Income category: Third quartile	———	3.6413***	———	4.3775***	———	0.5280***
		(1.1942)		(1.2284)		(0.1548)
Income category: Fourth quartile	———	4.6771***	———	4.9892***	———	0.3513**
		(1.2231)		(1.3579)		(0.1718)
Grade; dummy	No	No	No	No	Yes	Yes
N	646	646	646	646	646	646
R^2	0.0824	0.0777	0.0664	0.0716	0.0406	0.0459

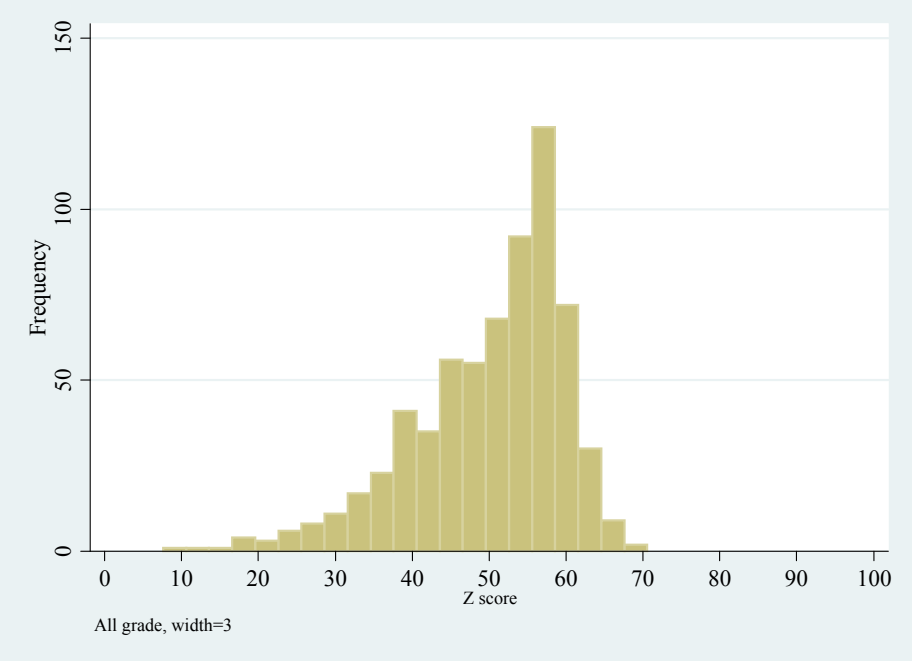
Note: ***, **, and * indicate that the estimated coefficient is statistically significant at 1%, 5%, and 10% levels, respectively. Simple tabulation is used for the reasoning scores. Robust standard error is in parentheses.

Figure 1 Distribution of standard score (histogram)

(1) Mathematics

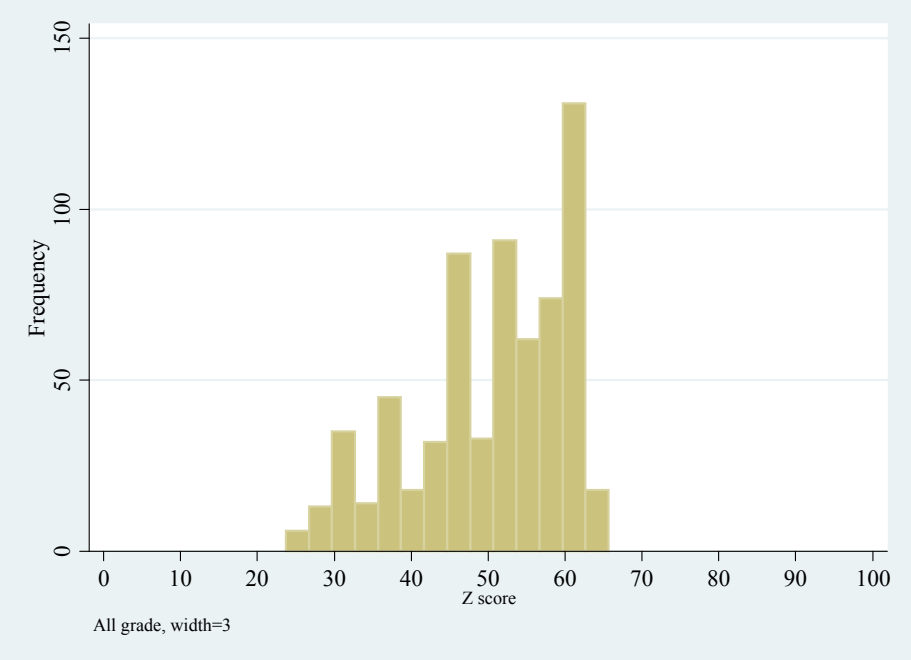


(2) Japanese



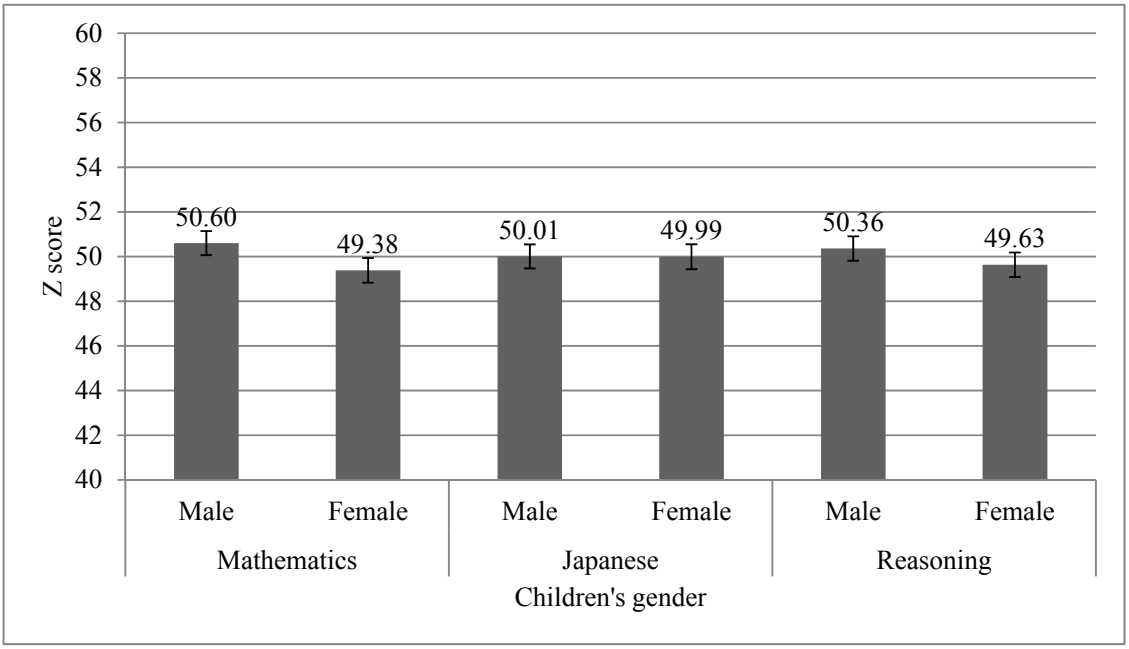
(*Continued*)

(3) Reasoning



Note: Vertical axis, frequency; Horizontal axis, Z score; the sample of all school years are pooled.

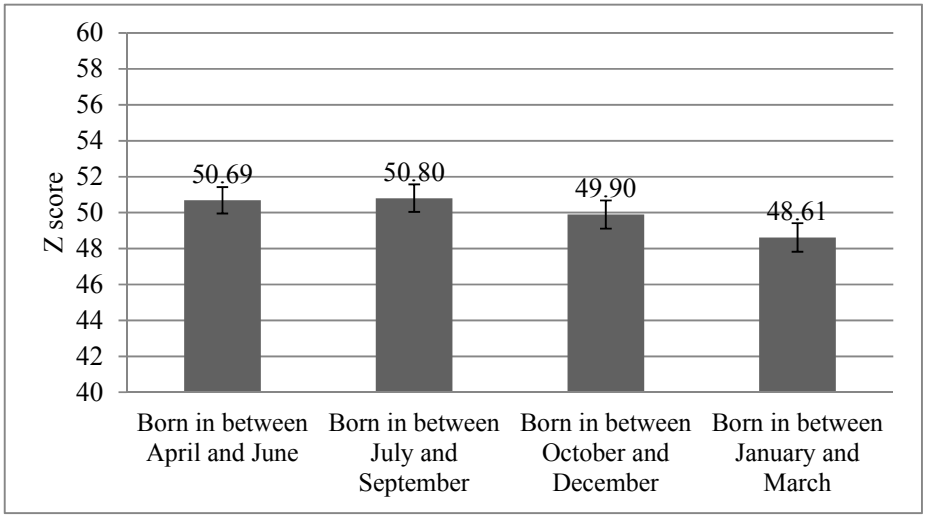
Figure 2 Children’s gender and level of academic ability



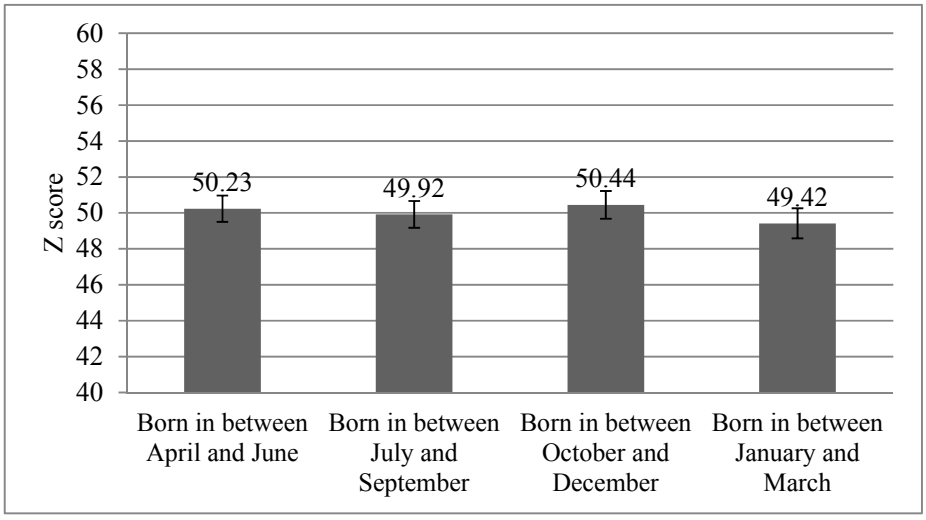
Note: The count of the average score is based on all grade-pooled samples of the deviation. The error bars show standard error for every group.

Figure 3 Birth month and level of academic ability

(1) Mathematics

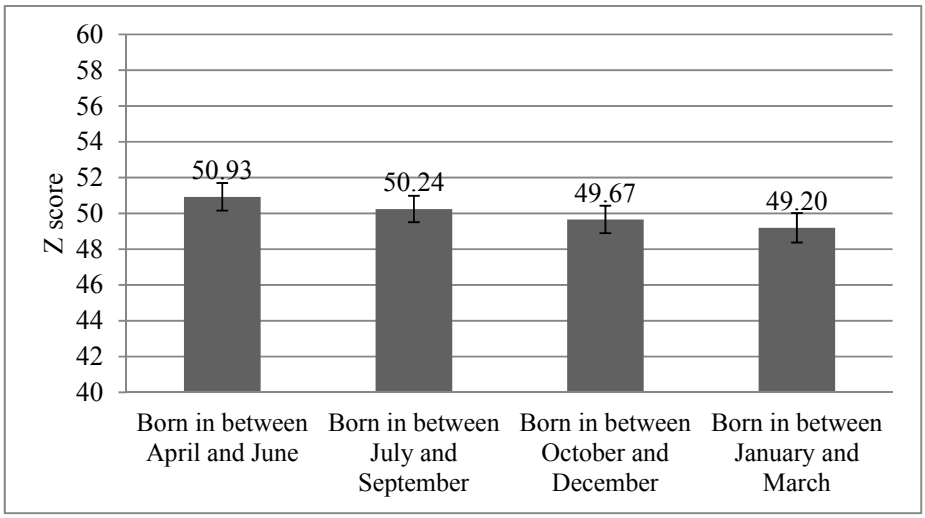


(2) Japanese



(*Continued*)

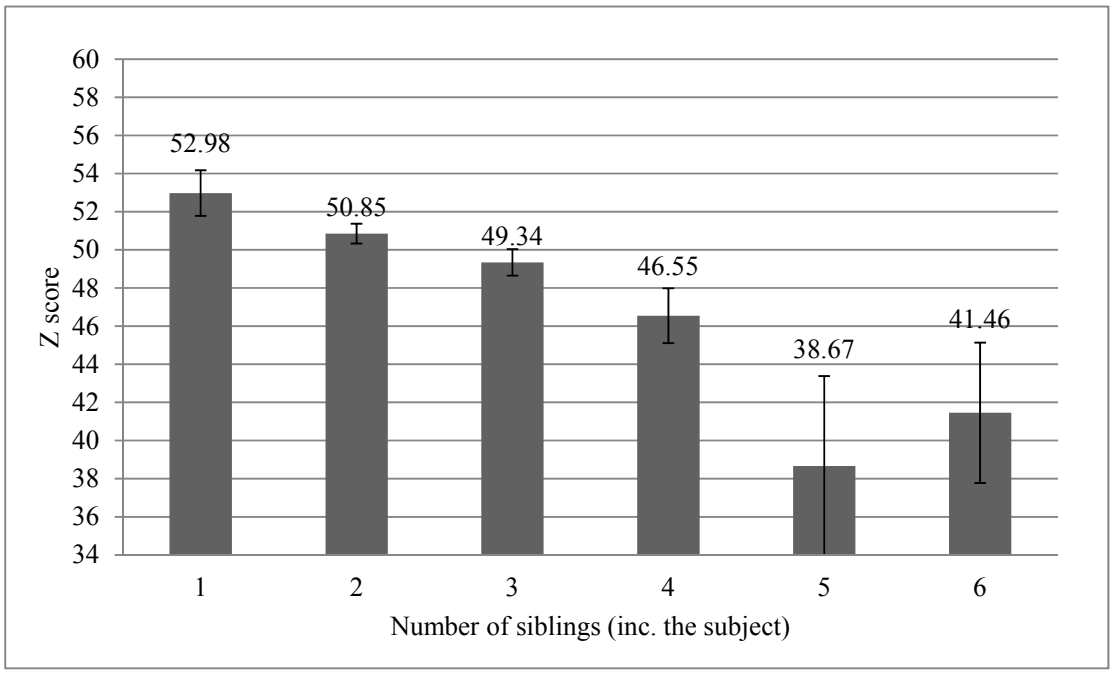
(3) Reasoning



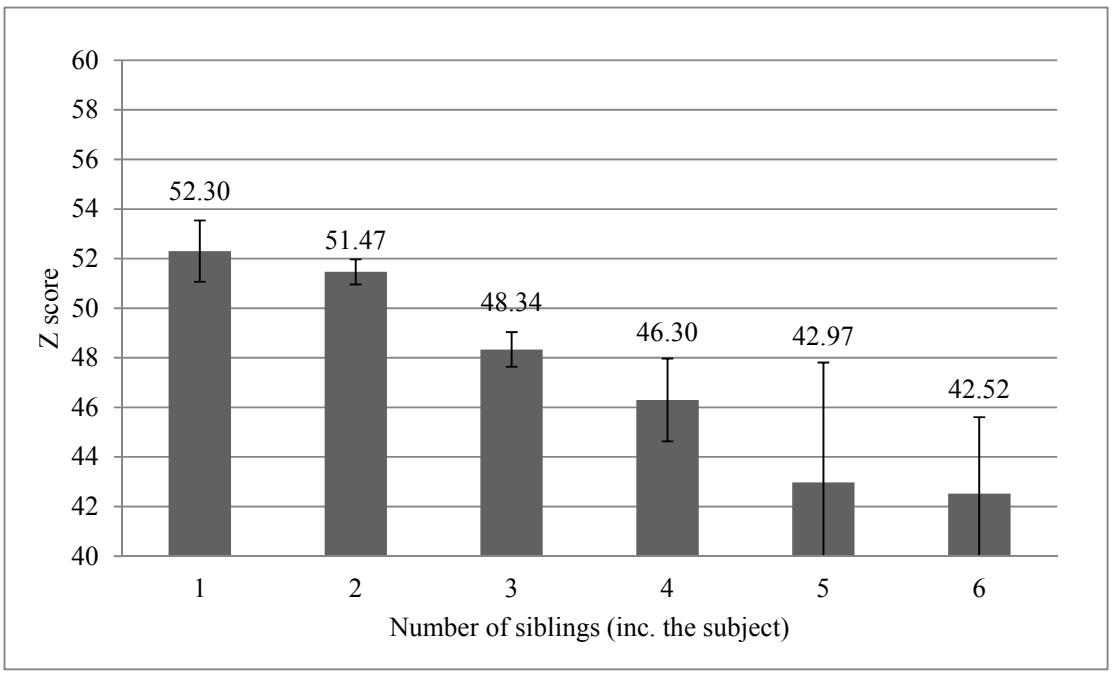
Note: The count of average score is based on all grade-pooled samples of the deviation. The error bars show standard error for every group.

Figure 4 Number of siblings and level of academic ability

(1) Mathematics



(2) Japanese



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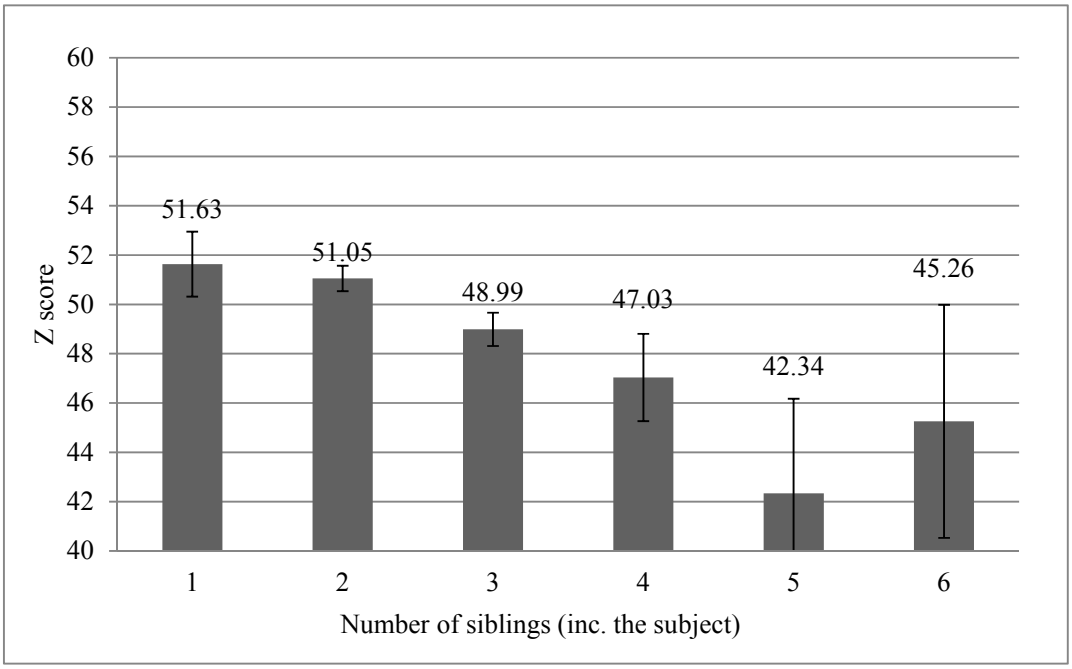
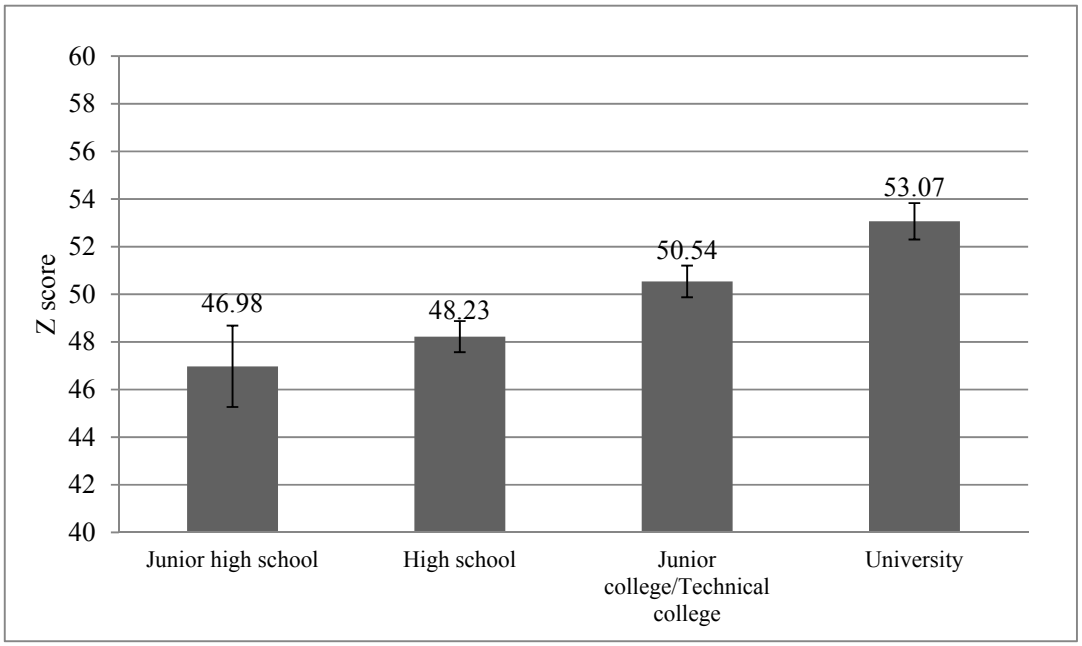
(3) Reasoning



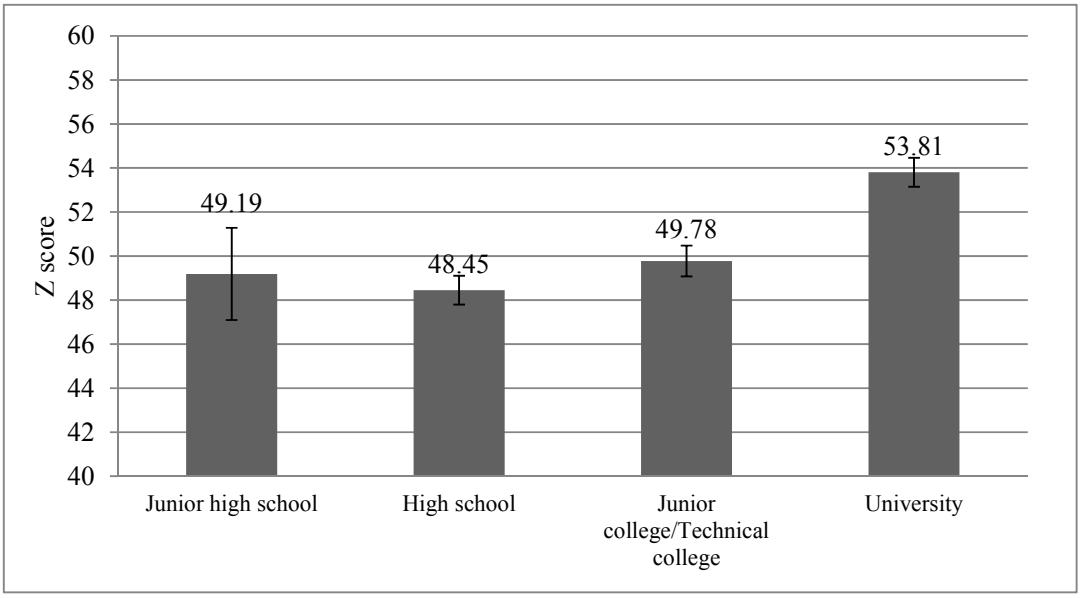
Note: The count of average score is based on all grade-pooled samples of the deviation. The error bars show standard error for every group.

Figure 5 Mother's educational attainment and level of academic ability

(1) Mathematics

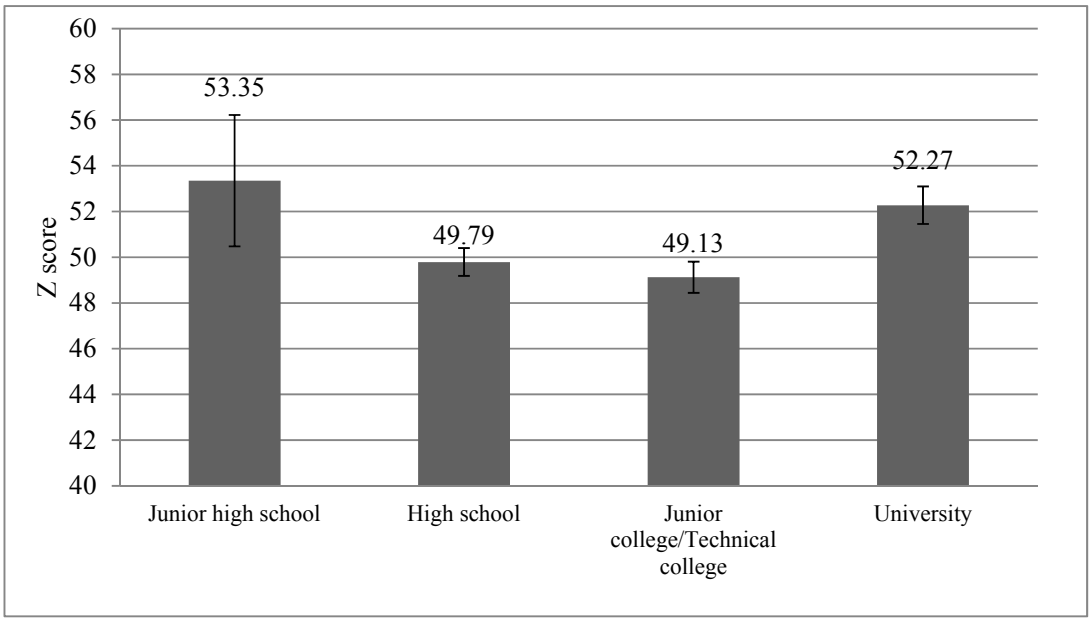


(2) Japanese



(*Continued*)

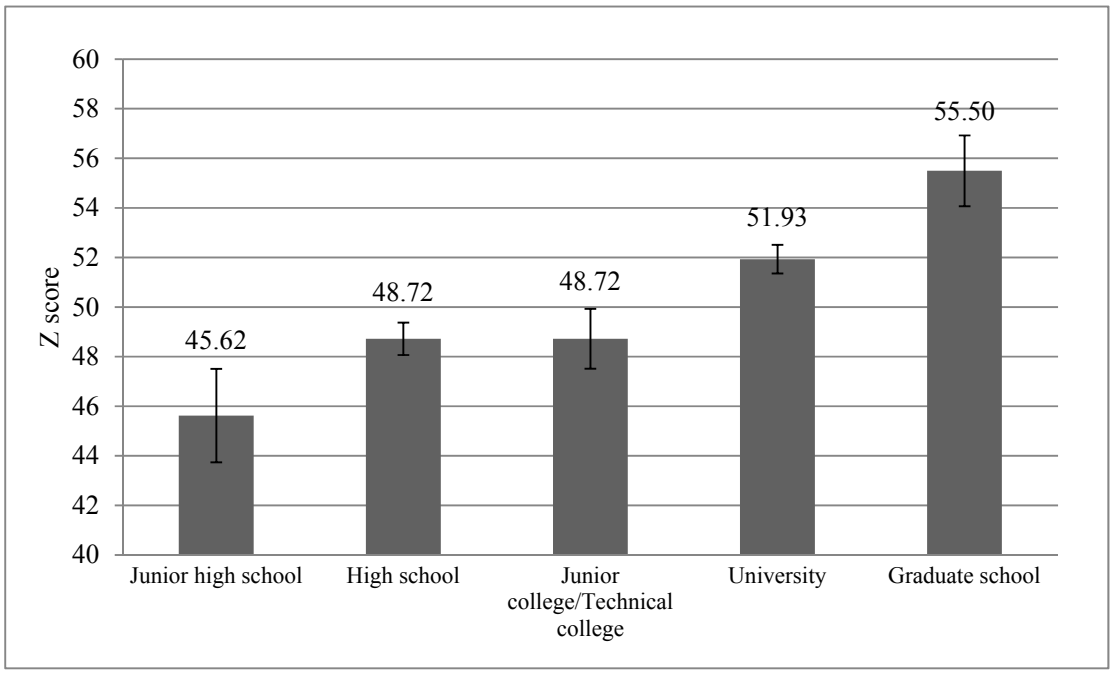
(3) Reasoning



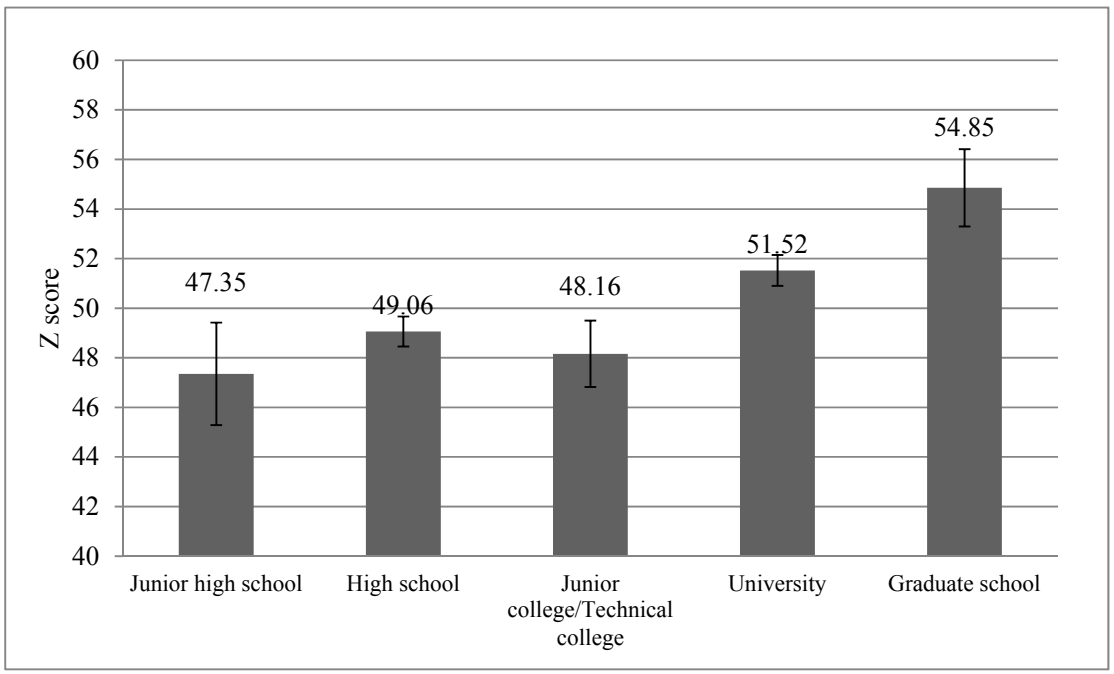
Note: The count of average score is based on all grade-pooled samples of the deviation. The error bars show standard error for every group. Unlike the data for fathers (Figure 6), there is no mother in the sample who selected graduate school.

Figure 6 Father's educational attainment and level of academic ability

(1) Mathematics

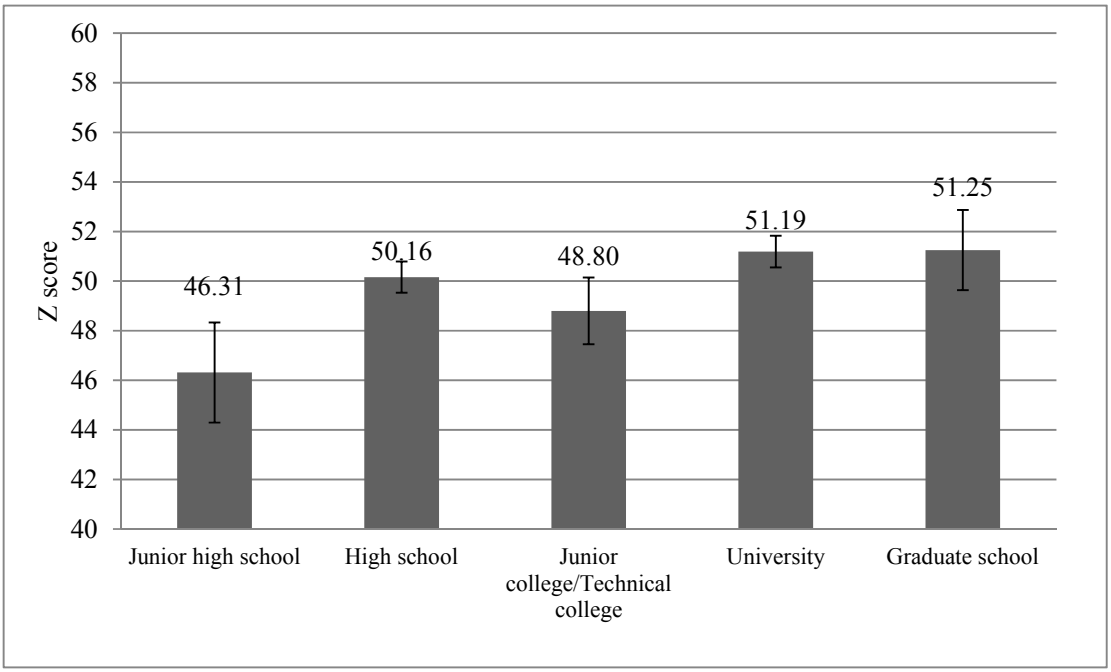


(2) Japanese



(*Continued*)

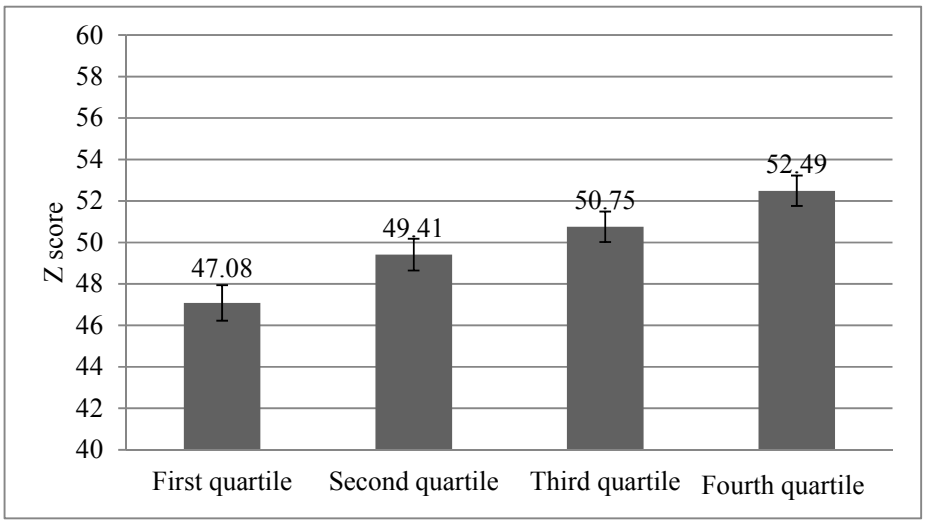
(3) Reasoning



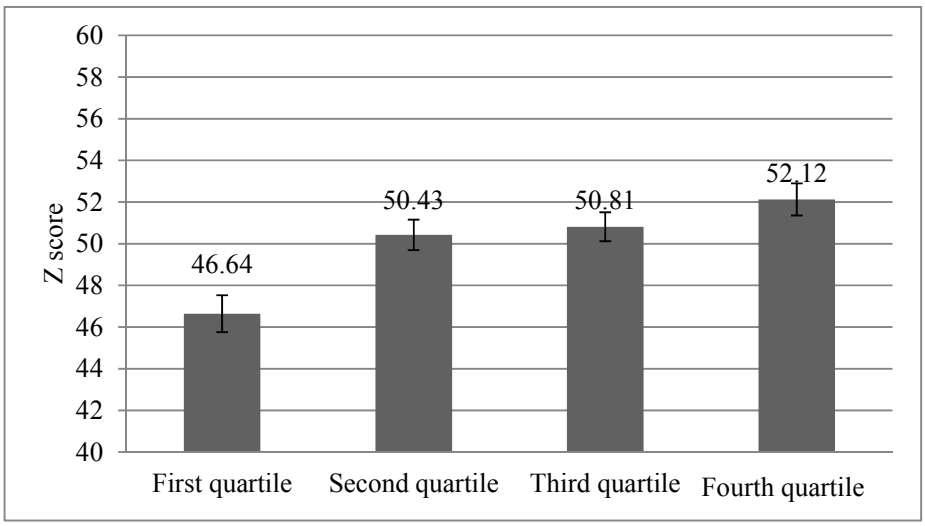
Note: The count of average score is based on all grade-pooled samples of the deviation. The error bars show standard error for every group.

Figure 7-1 Family income and academic ability

(1) Mathematics

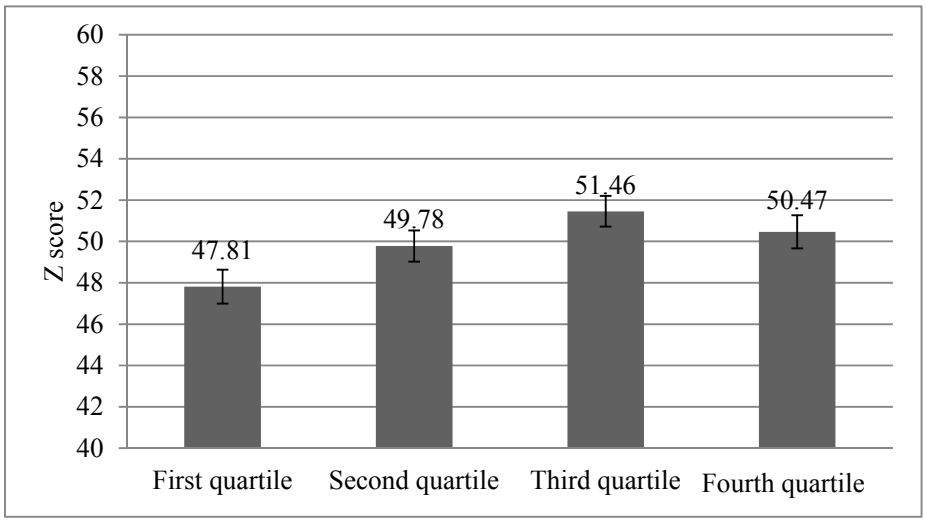


(2) Japanese



(*Continued*)

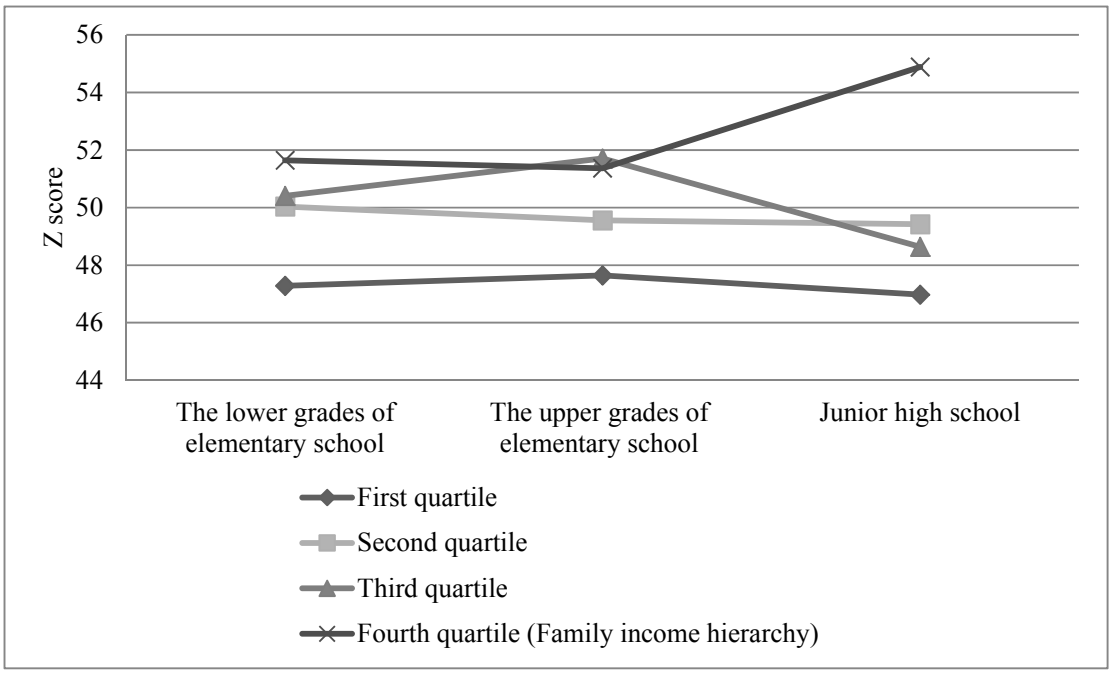
(3) Reasoning



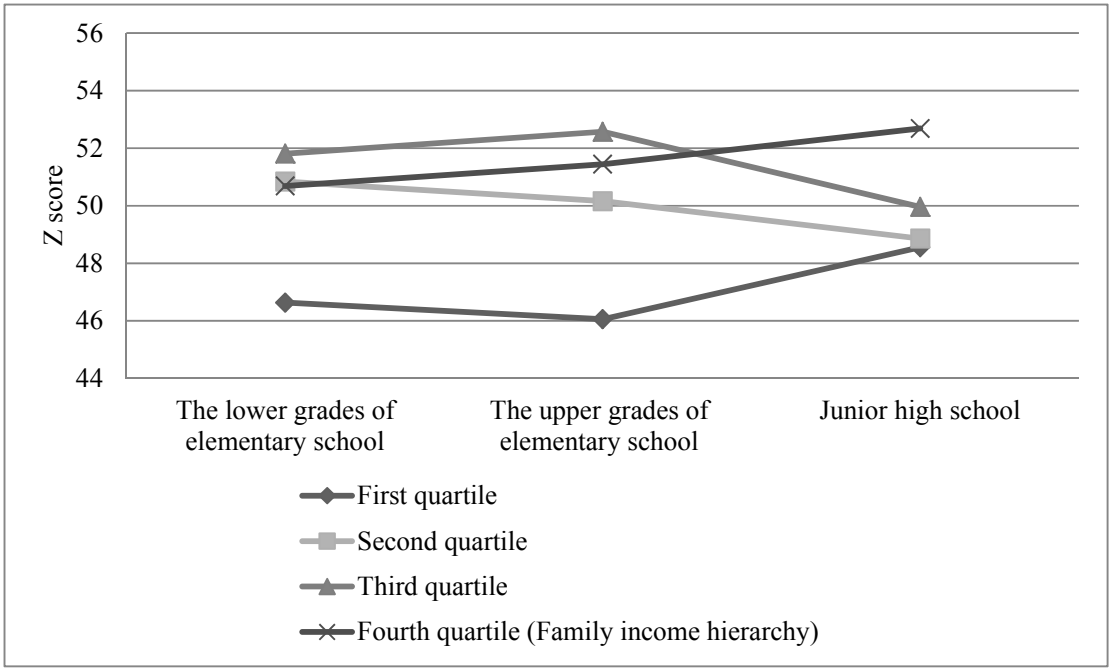
Note: The count of average score is based on all grade-pooled samples of the deviation. The error bars show standard error for every group.

Figure 7-2 Family income and academic ability (Divided based on school year)

(1) Mathematics

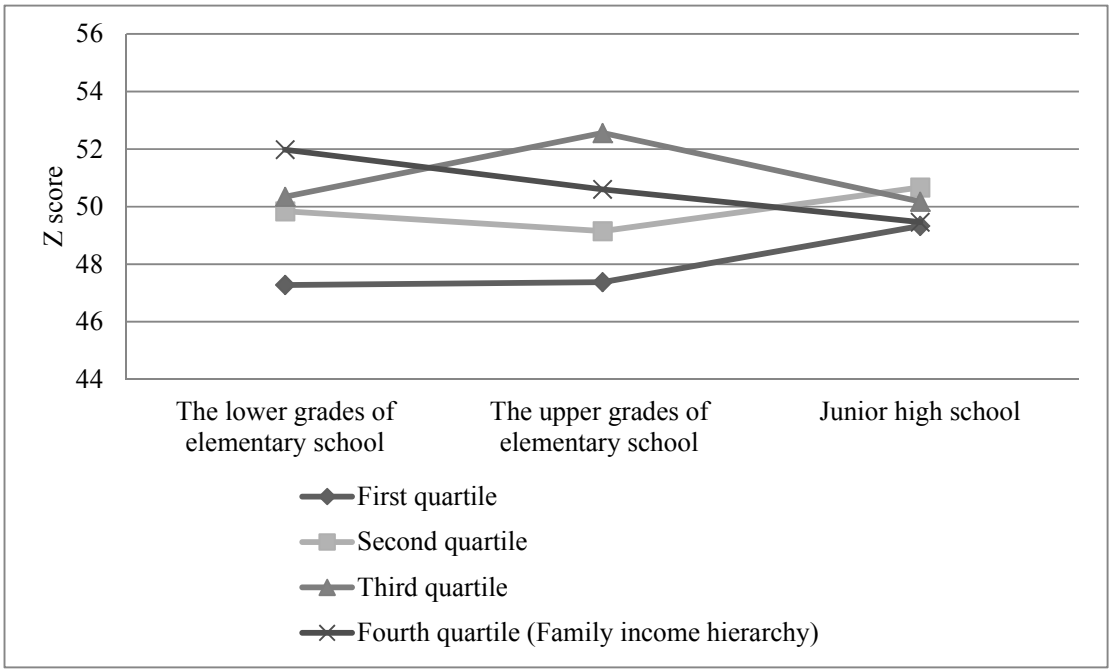


(2) Japanese



(*Continued*)

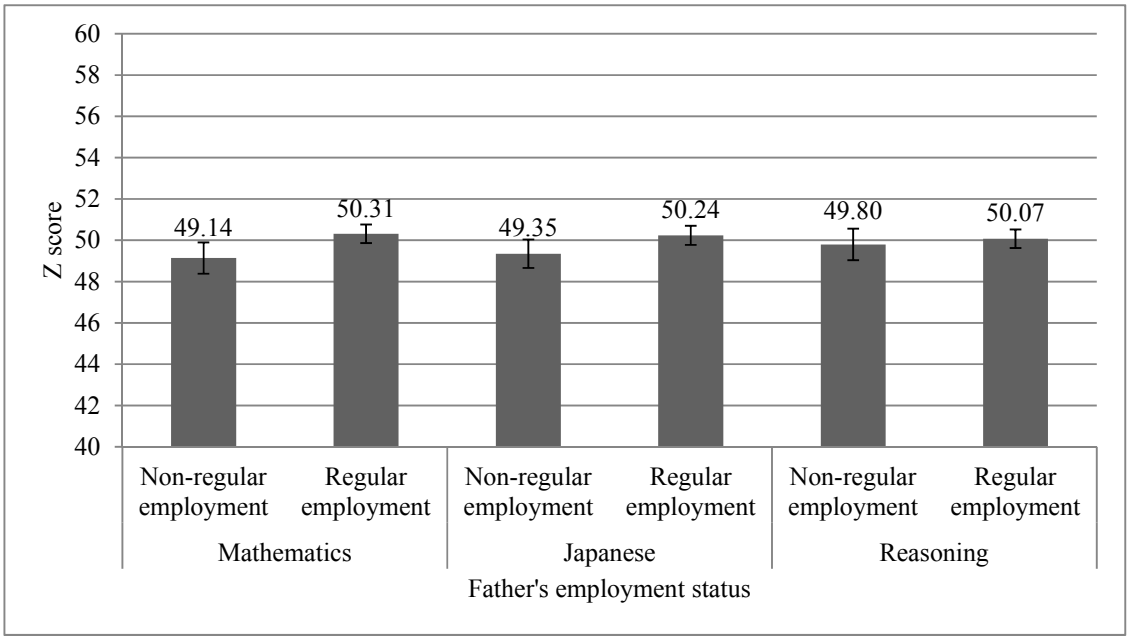
(3) Reasoning



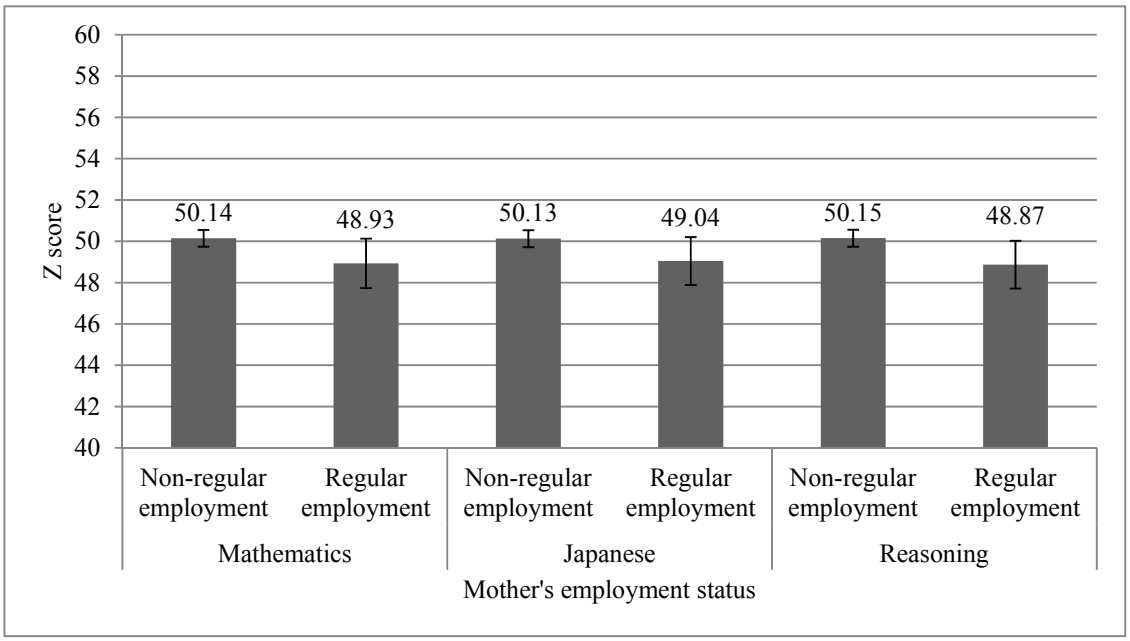
Note: The count of average score is based on all grade-pooled samples of the deviation.

Figure 7-3 Parent's employment status and academic ability

(1) Father's employment status



(2) Mother's employment status



Note: The count of average score is based on all grade-pooled samples of the deviation. The error bars show standard error for every group.

Table A-1 Cooperation rate of the Japan Child Panel Survey 2011 (Divided into 3 school groups)

	Cooperative	Uncooperative
First to third grader at elementary school	68.5%	31.5%
	(220)	(101)
Fourth to sixth grader at elementary school	59.3%	40.7%
	(232)	(159)
First to third grader at junior high school	50.0%	50.0%
	(207)	(207)
Total	58.5%	41.5%
	(659)	(467)

Note: The case of no response in the Children's Questionnaire is excluded. The number of respondents is in parentheses.

Table A-2 Cooperation of the Japan Child Panel Survey 2011 (Divided into each school year)

Grade	Cooperation rate
First grader at elementary school	63.0%
Second grader at elementary school	72.7%
Third grader at elementary school	69.2%
Fourth grader at elementary school	61.0%
Fifth grader at elementary school	56.9%
Sixth grader at elementary school	60.1%
First grader at junior high school	52.8%
Second grader at junior high school	56.4%
Third grader at junior high school	40.6%

Table A-3 Determinant of cooperative probability of the Japan Child Panel Survey 2011 to the child survey (Probit model)

Response cooperation; dummy (1 = cooperation, 0 = noncooperation)	All samples	First to third grader at elementary school	Fourth to sixth grader at elementary school	First to third grader at junior high school
	Coefficient	Coefficient	Coefficient	Coefficient
	(S. E.)	(S. E.)	(S. E.)	(S. E.)
Child's gender (Female= 1)	0.0078	0.1932	-0.2229	0.0259
	(0.0795)	(0.1565)	(0.1374)	(0.1306)
Child's birth period (Birthday between January 1 and April 1 = 1)	0.1096	-0.0010	0.1559	0.1110
	(0.0925)	(0.1875)	(0.1562)	(0.1504)
Child's birth order (First-born child = 1)	0.0397	0.0976	-0.0765	0.1010
	(0.0805)	(0.1562)	(0.1396)	(0.1303)
Father's educational attainment (College graduate or higher = 1)	0.3903***	0.2908	0.5538***	0.3436**
	(0.0943)	(0.1921)	(0.1618)	(0.1505)
Mother's educational attainment (College graduate or higher = 1)	0.3011**	0.1283	0.2857	0.5593**
	(0.1301)	(0.2344)	(0.2108)	(0.2450)
Father's employment status (Regular employment = 1)	-0.1148	-0.0557	-0.0914	-0.1254
	(0.0943)	(0.1812)	(0.1693)	(0.1499)
Mother's employment status (Regular employment = 1)	0.0686	-0.3386	-0.0011	0.3611*
	(0.1240)	(0.2627)	(0.2107)	(0.1951)
Household annual income	-0.0039	0.0189	-0.0249	-0.0046
	(0.0130)	(0.0276)	(0.0235)	(0.0199)
Grade; dummy	Yes	Yes	Yes	Yes
N	1,078	305	374	399
R^2	0.0474	0.0275	0.0426	0.0474

Note: ***, **, and * indicate that estimated coefficient is statistically significant at 1%, 5%, and 10% levels, respectively.