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**Article**

# Exploring the Link Between Parental Sociodemographic Characteristics and Multiple Births: Insights from National Birth Data in Japan, 1995–2020

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**Abstract**

This present study investigated the parental characteristics of multiple births using national birth data in Japan. This study included birth data from Vital Statistics: Occupational and Industrial Aspects every five fiscal years from 1995 to 2020. The multiple birth rates were defined as the number of live-birth deliveries with multiple fetuses (e.g., twins, triplets) per total live-birth deliveries. Parental ages, nationalities, occupations and household occupation (occupation of the top earner of the household) were considered as parental characteristics. The multiple birth rates were calculated based on parental characteristics for each year, and a log-binomial regression model was used to assess the association between parental characteristics and multiple births. The multiple birth rate for Japanese mothers consistently exceeded that for non-Japanese mothers over the years, and the rate increased progressively from manual workers to lower non-manual workers and then to upper non-manual workers for both maternal and paternal occupations. The regression results indicated that the risk ratio (RR) for multiple births among non-Japanese mothers was significantly lower than that among Japanese mothers. Moreover, concerning household occupation, the RRs of self-employed individuals, full-time employees at smaller companies, others, and the unemployed were significantly lower than those of full-time employees at larger companies. Furthermore, the RRs of lower non-manual and manual workers were significantly lower than those of upper non-manual workers in maternal and paternal occupations. The results suggested an association between multiple births and parental socioeconomic status in Japan.

**Keywords:** Japan; Multiple birth; Vital statistics; Occupation

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Multiple births refer to deliveries with multiple fetuses. The rate of twins or multiple births has increased in Japan and globally over recent decades (Imaizumi, 1994; Monden et al., 2021; Pison et al., 2015; Smits & Monden, 2011), although Japan's twin rate remains relatively lower than those of other developed countries in Europe (Pison et al., 2015). In Japan, the twinning rate per 1000 births increased from 6.4 in 1951 to 7.5 in 1992. One contributing factor to this increase in the number of multiple births during the late 20th century was the heightened use of ovulation drugs (Imaizumi, 1994). Multiples (e.g., twins, triplets) face a higher risk of adverse birth outcomes, including preterm birth and low birth weight (Blondel et al., 2002; Ooki, 2010), and are at a higher risk of infant mortality compared with singleton infants (Misra & Ananth, 2002). Furthermore, multiples are more prone to birth defects, such as anencephaly, congenital heart defects, and congenital esophageal atresia (Zhang et al., 2011). Additionally, parents raising twins often experience increased psychological stress than parents with singletons (Ellison et al., 2005; van den Akker et al., 2016; Wenze et al., 2015). Moreover, the rate of child maltreatment for twins was higher than that of singletons (Yokoyama et al., 2015), and the risk of fatal child maltreatment for multiples was 2.7 times as high as that of singletons in Japan (Ooki et al., 2013).

It is known that higher maternal age and infertility treatment are known predictors of multiple births in Japan (Imaizumi, 1994; Ministry of Health, Labour and Welfare, 2024a), while research on sociodemographic factors associated with multiple births remains limited. Some studies conducted in other countries have found some sociodemographic predictors of multiple births. For instance, in the United States, the multiple birth rate was found to be higher in black populations than in white populations (Russell et al., 2003), while the multiple birth rate increased more rapidly in white populations than in black populations from 1980 to 1999, possibly because of increased use of infertility treatment in white populations (Russell et al., 2003). In Greece, the multiple birth rate varied depending on maternal nationality (Malamitsi-Puchner et al., 2019). Twin pregnancies were positively associated with the wealthiest neighborhood-income quintile in Canada (Urquia et al., 2007), and in Brazil, the twin rate was shown to increase with the socioeconomic level of hospitals (Colletto et al., 2003). Conversely, investigations into these sociodemographic factors associated with multiple births have not been conducted in Japan. In Japan, the utilization of assisted reproductive technology varied based on regional social capital (Jwa et al., 2021), suggesting that socioeconomic status affects the multiple birth rate. Identifying sociodemographic characteristics associated with a higher

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likelihood of experiencing multiple births may help raise awareness among parents who do not desire multiple births.

This study investigated parental sociodemographic characteristics associated with multiple births using national birth data in Japan.

## Materials and Methods

### *Data*

We used birth data from the Vital Statistics: Occupational and Industrial Aspects, covering a span of every five fiscal years from 1995 to 2020. These datasets were provided by the Ministry of Health, Labour and Welfare in accordance with Article 33 of the Statistics Act in Japan. These national data cover all birth data in Japan during those years. Specifically, we used data on parental nationalities, birth dates, status of wedlock and occupations, as well as the infants' birth dates, prefecture, municipality, number of fetuses, birth order of multiple fetuses, and gestational weeks. Moreover, we included data on household occupation, which represents the occupation (employment status) of the top earner of the household. This comprised six types of occupation: farmer, self-employed, full-time employees at smaller companies (full-time employees at companies with fewer than 100 employees), full-time employees at larger companies (full-time employees at companies with 100 or more employees, along with executives, board members, or public servants), others, and unemployed.

### *Explanatory Variables*

Parental ages were categorized into the following age groups: 19 years or younger, 20–24 years, 25–29 years, 30–34 years, 35–39 years, and 40 years or older. Parental nationalities were classified into Japanese and non-Japanese. The categories of parental occupations underwent slight modifications over the years, comprising 10 types in the 1995–2000 fiscal years, 11 types in 2005 fiscal years, and 13 types in 2010–2020 fiscal years. Previous studies in Japan have classified parental occupations into occupational classes for ease of interpretation (Tanaka et al., 2021; Tomioka et al., 2020). In this study, we classified occupations into four categories: upper non-manual workers, lower non-manual workers, manual workers, and others. The specific occupations within each occupational class are listed in Supplementary Table S1.

### *Outcome Variable*

In this study, the multiple birth rate was defined as the number of multiple deliveries divided by the total number of deliveries, and multiple deliveries refer to those involving multiple fetuses (e.g., twins, triplets). Regardless of the number of fetuses, giving birth to a singleton, twins or triplets counts as one delivery. Furthermore, if one of the fetuses died in a multiple delivery, those deliveries were still considered multiple deliveries.

Given the uncertainty regarding which infants were born in the same delivery based solely on the available data, inference was needed. Specifically, if multiples shared identical prefecture, municipality, birth date, birth dates of parents, nationalities of parents, number of fetuses, and differing birth orders, they were categorized as born in the same delivery.

Conversely, it is possible for infants in the same delivery to have varying birth dates. If the difference in birth dates is consistent with the difference in gestational weeks, and all the other characteristics except birth order are identical among multiples, those infants were also considered to be born in the same delivery. A total of 285 infants (138 deliveries) corresponded to those cases with different birth dates in the data. Furthermore, in some cases, only one character in a parent's birth date differed between multiples, while all the other characteristics, excluding birth order, remained the same. Those cases were deemed clerical errors, and the infants were judged to have been born in the same delivery.

We created a binary variable for the status of multiple births (singleton or multiple deliveries) and used it in the regression analysis.

### *Statistical Analysis*

We counted number of singleton and multiple deliveries by parental characteristics. In addition, we calculated the multiple birth rate by dividing number of multiple deliveries by total number of deliveries by parental characteristics for each of the analyzed years. Furthermore, a log-binomial regression model was used to investigate the association between parental characteristics and multiple births. The outcome variable was the binary variable of the status of multiple birth, and explanatory variables included parental age groups, parental nationalities, parental occupations, household occupation, and year. In addition to an unadjusted analysis using each explanatory variable, an adjusted analysis with all explanatory variables was performed. For each characteristic, we computed the risk ratio (RR) with the 95% confidence interval (CI) and $p$ value. A $p$ value of less than .05 was considered statistically significant. Multicollinearity was checked based on generalized variance inflation factor (GVIF), and $\mathrm{GVIF}^{(1/(2\times \text{Degree of freedom}))}$ was used as a measure in the adjusted analysis (Fox & Monette, 1992). $\mathrm{GVIF}^{(1/(2\times \text{Degree of freedom}))}$ of approximately 1.5–1.6 was used as a criterion of multicollinearity in previous studies (Hu et al., 2024; Zahan et al., 2020).

Because paternal characteristics were included in the analysis, only births within marriage were used. Furthermore, the study population was limited to unique deliveries because parental characteristics were basically consistent among multiple births. Complete case analysis was conducted to address missing data. Moreover, we used the multiple imputation method for sensitivity analysis (van Buuren & Groothuis-Oudshoorn, 2011). Predictive mean matching was used for imputing missing values, and number of imputations was 10. All statistical analyses were conducted using R (4.1.3; R Core Team, 2024), and car and mice were used as packages. The statistics presented in this study were generated by the authors using the data provided by the Ministry of Health, Labour and Welfare, and the results in this study are not statistics published by the Ministry itself.

## Results

Figure 1 illustrates a flowchart depicting the selection process for the study population. Nonmarital births were excluded from all live births, as were birth data with duplicate deliveries. As a result, a total of 6,160,882 deliveries' data were used in the analysis.

Table 1 shows the number (%) of singleton and multiple deliveries based on birth characteristics. The number of multiple deliveries was roughly one hundredth of that of singleton deliveries. Notably, the highest number of deliveries belonged to the full-time employees at larger companies among household occupations. Among maternal occupational classes, the 'others' category was the highest number of deliveries. Conversely, the category for lower non-manual workers consistently recorded the highest number of deliveries among the paternal occupational classes.

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**Table 1.** Number (%) of singleton and multiple deliveries by birth characteristics

| Characteristics | Singleton deliveries | Multiple deliveries |
|---|---|---|
| Total | 6,098,888 (100.0) | 61,994 (100.0) |
| Maternal age group | | |
| 19 years or less | 65,998 (1.1) | 343 (0.6) |
| 20–24 years | 703,038 (11.5) | 4,581 (7.4) |
| 25–29 years | 2,014,862 (33.0) | 17,722 (28.6) |
| 30–34 years | 2,152,382 (35.3) | 23,971 (38.7) |
| 35–39 years | 984,877 (16.1) | 12,965 (20.9) |
| 40 years or more | 177,728 (2.9) | 2,412 (3.9) |
| Missing | 3 (0.0) | 0 (0.0) |
| Paternal age group | | |
| 19 years or less | 29,181 (0.5) | 161 (0.3) |
| 20–24 years | 460,981 (7.6) | 2,961 (4.8) |
| 25–29 years | 1,531,934 (25.1) | 12,929 (20.9) |
| 30–34 years | 2,109,174 (34.6) | 21,895 (35.3) |
| 35–39 years | 1,324,393 (21.7) | 15,967 (25.8) |
| 40 years or more | 643,212 (10.5) | 8,081 (13.0) |
| Missing | 13 (0.0) | 0 (0.0) |
| Maternal nationality | | |
| Japanese | 6,002,855 (98.4) | 61,199 (98.7) |
| Non-Japanese | 96,033 (1.6) | 795 (1.3) |
| Paternal nationality | | |
| Japanese | 6,017,910 (98.7) | 61,197 (98.7) |
| Non-Japanese | 80,978 (1.3) | 797 (1.3) |
| Household occupation | | |
| Farmer | 151,027 (2.5) | 1,585 (2.6) |
| Self-employed | 484,258 (7.9) | 4,822 (7.8) |
| Full-time employees at smaller companies | 2,060,380 (33.8) | 19,513 (31.5) |
| Full-time employees at larger companies | 2,630,679 (43.1) | 28,919 (46.6) |
| Others | 595,884 (9.8) | 5,596 (9.0) |
| Unemployed | 66,952 (1.1) | 581 (0.9) |
| Missing | 109,708 (1.8) | 978 (1.6) |
| Maternal occupation | | |
| Upper non-manual workers | 704,761 (11.6) | 7,781 (12.6) |
| Lower non-manual workers | 1,009,646 (16.6) | 10,001 (16.1) |
| Manual workers | 119,278 (2.0) | 1,054 (1.7) |
| Others | 4,083,567 (67.0) | 41,335 (66.7) |
| Missing | 181,636 (3.0) | 1,823 (2.9) |
| Paternal occupation | | |
| Upper non-manual workers | 1,691,062 (27.7) | 18,663 (30.1) |
| Lower non-manual workers | 2,147,026 (35.2) | 21,732 (35.1) |
| Manual workers | 1,564,509 (25.7) | 14,552 (23.5) |
| Others | 465,461 (7.6) | 4,772 (7.7) |
| Missing | 230,830 (3.8) | 2,275 (3.7) |
| Fiscal year | | |
| 1995 | 1,145,321 (18.8) | 10,293 (16.6) |
| 2000 | 1,136,339 (18.6) | 11,484 (18.5) |
| 2005 | 1,018,015 (16.7) | 12,019 (19.4) |
| 2010 | 1,023,849 (16.8) | 9,988 (16.1) |
| 2015 | 973,081 (16.0) | 9,860 (15.9) |
| 2020 | 802,283 (13.2) | 8,350 (13.5) |

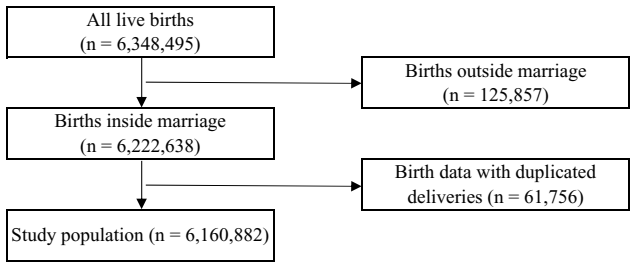


**Figure 1.** The flowchart depicting the selection process for the study population.

Table 2 presents the multiple birth rates by parental characteristics and year. Notably, the highest multiple birth rates were observed in 2005 for most of the characteristics, and the multiple birth rate decreased between 2005 and 2010. Additionally, there was a tendency for the rate to increase with maternal and paternal age. Throughout the years, the multiple birth rate among Japanese mothers exceeded that among non-Japanese mothers, while the relationship between rate and parental nationality varied depending on the years. Among household occupations, unemployed households tended to have the lowest rate, whereas the full-time employees at larger companies consistently exhibited the highest rate. Furthermore, the rate increased progressively from manual workers to lower non-manual workers and then to upper non-manual workers for both maternal and paternal occupations.

The multiple birth rates by maternal age group and year are also shown in Figure 2.

Table 3 shows the results of the regression analysis investigating the association between parental characteristics and multiple births. The adjusted RR tended to increase with maternal and paternal age, with the '40 years or more' age group having the highest: RR: 1.19 (95% CI [1.13, 1.24]) and 1.08 (95% CI [1.05, 1.11]) respectively. Additionally, the adjusted RR of non-Japanese mothers was significantly lower than that of Japanese mothers: RR: 0.79 (95% CI [0.73, 0.85]). Furthermore, the adjusted RRs of self-employed individuals, the full-time employees at smaller companies, others, and unemployed households were significantly lower than that of the full-time employees at larger companies: RR: 0.91 (95% CI [0.89, 0.94]), 0.91 (95% CI [0.90, 0.93]), 0.91 (95% CI [0.88, 0.93]), and 0.86 (95% CI [0.79, 0.94]) respectively. Moreover, the adjusted RRs of lower non-manual and manual workers were significantly lower than that of upper non-manual workers in both maternal and paternal occupations. Specifically, adjusted RRs of

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**Table 2.** Multiple birth rate (per 1,000 deliveries) by parental characteristics and year

| | Fiscal year | | | | | |
|---|---|---|---|---|---|---|
| Characteristics | 1995 | 2000 | 2005 | 2010 | 2015 | 2020 |
| Total | 8.9 | 10.1 | 11.6 | 9.7 | 10.1 | 10.3 |
| Maternal age group | | | | | | |
| 19 years or less | 5.3 | 5.5 | 5.8 | 4.5 | 4.8 | 4.3 |
| 20–24 years | 6.2 | 6.6 | 6.7 | 6.6 | 6.4 | 6.9 |
| 25–29 years | 8.5 | 8.9 | 9.4 | 8.2 | 8.5 | 9.1 |
| 30–34 years | 10.4 | 11.7 | 13.0 | 10.1 | 10.2 | 10.6 |
| 35–39 years | 11.1 | 14.1 | 16.8 | 12.3 | 12.5 | 12.0 |
| 40 years or more | 9.0 | 12.4 | 17.6 | 14.1 | 13.8 | 12.4 |
| Paternal age group | | | | | | |
| 19 years or less | 5.8 | 5.5 | 5.7 | 5.4 | 5.1 | 5.2 |
| 20–24 years | 6.0 | 6.4 | 6.8 | 6.6 | 6.1 | 6.6 |
| 25–29 years | 8.1 | 8.5 | 9.0 | 7.8 | 8.4 | 9.0 |
| 30–34 years | 9.5 | 10.4 | 11.7 | 9.9 | 9.8 | 10.6 |
| 35–39 years | 10.4 | 12.7 | 15.0 | 11.1 | 11.7 | 11.1 |
| 40 years or more | 10.0 | 13.3 | 16.0 | 12.1 | 12.1 | 11.6 |
| Maternal nationality | | | | | | |
| Japanese | 9.0 | 10.1 | 11.7 | 9.7 | 10.1 | 10.3 |
| Non-Japanese | 6.0 | 7.0 | 7.0 | 8.1 | 9.3 | 9.8 |
| Paternal nationality | | | | | | |
| Japanese | 8.9 | 10.1 | 11.6 | 9.7 | 10.1 | 10.4 |
| Non-Japanese | 8.1 | 9.2 | 12.4 | 11.3 | 9.9 | 9.0 |
| Household occupation | | | | | | |
| Farmer | 9.8 | 10.7 | 11.4 | 9.9 | 10.0 | 12.8 |
| Self-employed | 8.7 | 10.4 | 11.1 | 9.5 | 10.2 | 9.7 |
| Full-time employees at smaller companies | 8.3 | 9.2 | 10.8 | 9.0 | 9.5 | 9.5 |
| Full-time employees at larger companies | 9.5 | 10.9 | 13.0 | 10.4 | 10.8 | 10.9 |
| Others | 8.2 | 9.4 | 10.3 | 9.2 | 9.1 | 10.2 |
| Unemployed | 7.7 | 9.5 | 7.7 | 9.1 | 8.0 | 9.4 |
| Maternal occupation | | | | | | |
| Upper non-manual workers | 9.2 | 11.2 | 12.9 | 10.5 | 10.7 | 11.1 |
| Lower non-manual workers | 8.4 | 10.0 | 11.6 | 9.3 | 10.1 | 9.8 |
| Manual workers | 7.9 | 8.7 | 10.4 | 8.5 | 8.9 | 8.7 |
| Others | 9.0 | 10.0 | 11.5 | 9.7 | 10.0 | 10.4 |
| Paternal occupation | | | | | | |
| Upper non-manual workers | 9.8 | 10.6 | 12.7 | 10.6 | 10.6 | 11.2 |
| Lower non-manual workers | 8.9 | 10.0 | 11.6 | 9.9 | 10.1 | 10.1 |
| Manual workers | 8.4 | 9.4 | 10.5 | 8.8 | 9.4 | 9.3 |
| Others | 8.7 | 9.9 | 11.2 | 9.3 | 10.3 | 11.0 |

lower non-manual and manual worker were 0.93 (95% CI [0.90, 0.96]) and 0.88 (95% CI [0.83, 0.94]), respectively for maternal occupation and 0.96 (95% CI [0.94, 0.98]) and 0.95 (95% CI [0.93, 0.97]), respectively for paternal occupation. The results of unadjusted and adjusted analysis were relatively similar, while a statistically significant difference was not observed in the '19 years or less' of the paternal age group and 'others' for parental occupational classes in the adjusted analysis. The highest value of the generalized variance inflation factor$^{(1/(2 \times \text{Degree of freedom}))}$ was 1.14 in the adjusted analysis, indicating that multicollinearity among variables was not strong.

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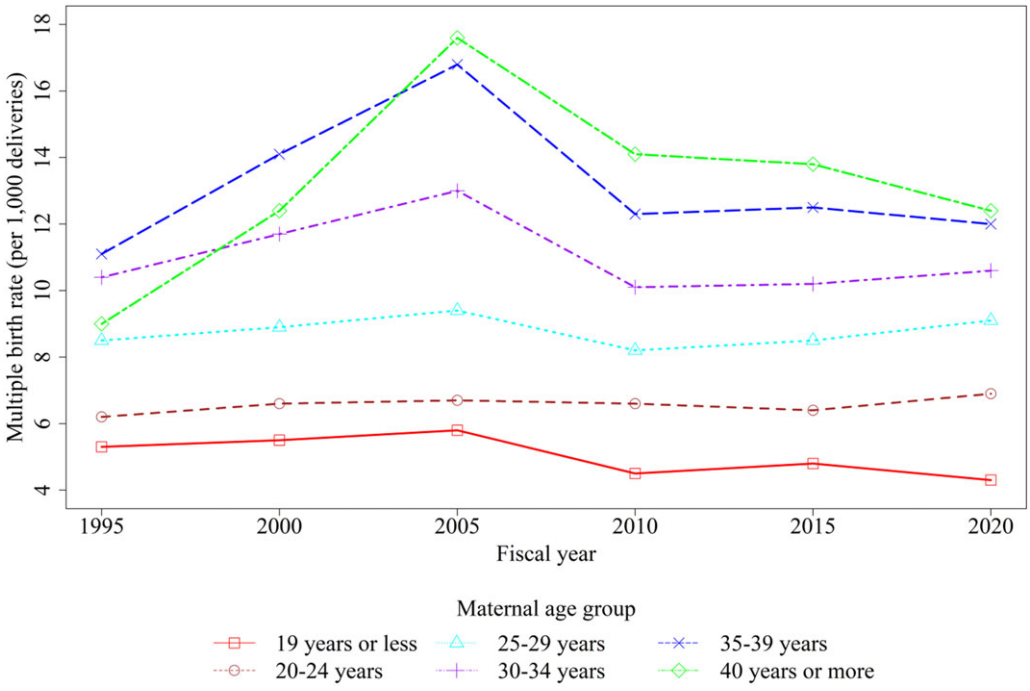


**Figure 2.** Multiple birth rate by maternal age group and year.

Supplementary Table S2 presents the results of the regression analysis using multiple imputation. The findings were largely consistent with those obtained from the complete case analysis.

## Discussion

This study investigated the association between parental characteristics and multiple births in Japan using national birth data. As a result, multiple birth rates varied depending on parental age groups, nationalities and occupations, and the potential interpretations and implications of these results are discussed in this section. Assisted reproductive technology is often cited as a significant factor contributing to variations in multiple birth rates across sociodemographic factors (Malamitsi-Puchner et al., 2019; Russell et al., 2003; Urquia et al., 2007), and we primarily interpret the results in the context of infertility treatment use.

Although there were some variations in the relationship between parental characteristics and the multiple birth rates depending on the year, the rates were relatively stable over time across many of the characteristics. Additionally, for numerous characteristics, the multiple birth rates peaked in 2005. The Japan Society of Obstetrics and Gynecology officially recommended in 2008 that only a single embryo should be transferred during assisted reproductive technology procedures with a few exceptions to prevent multiple births (Japan Society of Obstetrics and Gynecology, 2024), and this change may have contributed to the decrease in multiple birth rates from 2005 to 2010.

Regarding parental characteristics, higher parental ages were positively associated with multiple births. A higher parental age has been associated with a higher rate of twin births in other countries (Abel & Kruger, 2012; Dawson et al., 2015; Kleinhaus et al., 2008; McLennan et al., 2017). While maternal ages are known to be associated with multiple births in Japan, this study revealed that paternal ages were also associated with multiple births. Fertility typically declines as both men and women age (Baird et al., 2005; Kaltsas et al., 2023; Kovac et al., 2013), and it is considered that couples of advanced age are more likely to undergo infertility treatment than younger couples.

Regarding occupation, households with certain types of workers were negatively associated with multiple births compared with households with the full-time employees at larger companies. Additionally, occupational class was associated with multiple births in both men and women, with lower non-manual and manual workers showing a negative association with multiple births compared to upper non-manual workers. The socioeconomic status of households with the full-time employees at larger companies and upper non-manual workers is considered to be higher than that of the other types of households and occupational classes. The results suggest that couples with higher socioeconomic status tend to experience multiple births. In other countries, some studies have demonstrated an association between socioeconomic status and the use of assisted reproductive technology (Brautsch et al., 2023; Harris et al., 2016; Seifer et al., 2020; Smith et al., 2011). In Japan, household income is positively associated with seeking medical help for fertility problems among individuals experiencing fertility issues (Iba et al., 2021). Certain infertility treatments, such as artificial insemination and in vitro fertilization, were only covered by insurance starting from 2022 in Japan (Ministry of Health, Labour and Welfare, 2024b). Therefore, it is considered that socioeconomic status strongly influenced the decision to undergo infertility treatment until then. Additionally, there is a possibility that socioeconomic status also affects the outcomes of fertility treatment (Imrie et al., 2023). In the regression analysis, there was a statistically significant difference in 'Others' for parental occupational classes in the unadjusted analysis, but not in the adjusted analysis. This is thought to be because household occupations, including farmers and the unemployed, were adjusted. 'Others' of parental occupational classes include unemployed people and farmers, and the impact on multiple births was mitigated by including household occupation in the analysis.

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**Table 3.** The result of regression analysis investigating an association between parental characteristics and multiple birth

| | Unadjusted analysis | | Adjusted analysis | |
|---|---|---|---|---|
| Characteristics | RR (95% CI) | *p* value | Adjusted RR (95% CI)* | *p* value |
| Maternal age group | | | | |
| 19 years or less | 0.47 (0.42, 0.53) | <.001 | 0.56 (0.50, 0.64) | <.001 |
| 20–24 years | 0.59 (0.57, 0.61) | <.001 | 0.68 (0.65, 0.71) | <.001 |
| 25–29 years | 0.79 (0.78, 0.81) | <.001 | 0.84 (0.82, 0.86) | <.001 |
| 30–34 years | Reference | | Reference | |
| 35–39 years | 1.18 (1.16, 1.21) | <.001 | 1.15 (1.12, 1.18) | <.001 |
| 40 years or more | 1.22 (1.17, 1.27) | <.001 | 1.19 (1.13, 1.24) | <.001 |
| Paternal age group | | | | |
| 19 years or less | 0.53 (0.46, 0.63) | <.001 | 0.86 (0.72, 1.02) | .087 |
| 20–24 years | 0.62 (0.60, 0.65) | <.001 | 0.84 (0.81, 0.89) | <.001 |
| 25–29 years | 0.82 (0.80, 0.83) | <.001 | 0.93 (0.90, 0.95) | <.001 |
| 30–34 years | Reference | | Reference | |
| 35–39 years | 1.16 (1.13, 1.18) | <.001 | 1.07 (1.05, 1.09) | <.001 |
| 40 years or more | 1.20 (1.17, 1.24) | <.001 | 1.08 (1.05, 1.11) | <.001 |
| Maternal nationality | | | | |
| Japanese | Reference | | Reference | |
| Non-Japanese | 0.81 (0.75, 0.87) | <.001 | 0.79 (0.73, 0.85) | <.001 |
| Paternal nationality | | | | |
| Japanese | Reference | | Reference | |
| Non-Japanese | 0.97 (0.90, 1.05) | .447 | 1.04 (0.96, 1.12) | .304 |
| Household occupation | | | | |
| Farmer | 0.96 (0.91, 1.01) | .122 | 1.01 (0.96, 1.07) | .621 |
| Self-employed | 0.91 (0.88, 0.94) | <.001 | 0.91 (0.89, 0.94) | <.001 |
| Full-time employees at smaller companies | 0.86 (0.85, 0.88) | <.001 | 0.91 (0.90, 0.93) | <.001 |
| Full-time employees at larger companies | Reference | | Reference | |
| Others | 0.86 (0.83, 0.88) | <.001 | 0.91 (0.88, 0.93) | <.001 |
| Unemployed | 0.79 (0.73, 0.86) | <.001 | 0.86 (0.79, 0.94) | <.001 |
| Maternal occupation | | | | |
| Upper non-manual workers | Reference | | Reference | |
| Lower non-manual workers | 0.90 (0.87, 0.93) | <.001 | 0.93 (0.90, 0.96) | <.001 |
| Manual workers | 0.80 (0.75, 0.85) | <.001 | 0.88 (0.83, 0.94) | <.001 |
| Others | 0.92 (0.90, 0.94) | <.001 | 0.99 (0.96, 1.01) | .379 |
| Paternal occupation | | | | |
| Upper non-manual workers | Reference | | Reference | |
| Lower non-manual workers | 0.92 (0.90, 0.94) | <.001 | 0.96 (0.94, 0.98) | <.001 |
| Manual workers | 0.84 (0.83, 0.86) | <.001 | 0.95 (0.93, 0.97) | <.001 |
| Others | 0.93 (0.90, 0.96) | <.001 | 0.99 (0.95, 1.02) | .405 |
| Fiscal year | | | | |
| 1995 | Reference | | Reference | |
| 2000 | 1.13 (1.10, 1.16) | <.001 | 1.10 (1.07, 1.13) | <.001 |
| 2005 | 1.30 (1.27, 1.34) | <.001 | 1.24 (1.20, 1.27) | <.001 |
| 2010 | 1.09 (1.06, 1.12) | <.001 | 1.00 (0.97, 1.03) | .907 |
| 2015 | 1.13 (1.10, 1.16) | <.001 | 1.01 (0.99, 1.04) | .334 |
| 2020 | 1.16 (1.12, 1.19) | <.001 | 1.03 (1.00, 1.07) | .032 |

Note: RR, risk ratio; CI, confidence interval.

*Parental age groups, parental nationalities, parental occupations, household occupation, and year were included in the regression analysis.

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Regarding nationality, Japanese mothers were positively associated with multiple births compared with non-Japanese mothers. There have been few previous studies investigating the association between multiple births and nationalities. A study in Greece demonstrated that the percentage of twin deliveries was consistently higher among Greek mothers than among migrant mothers (Malamitsi-Puchner et al., 2019). Additionally, the twin rate was higher in U.S.-born women than in non-U.S.-born women in the U.S. (Oleszczuk et al., 2001). One possible explanation for the association between nationality and multiple births in Japan is socioeconomic status. Immigrant women in Japan may face challenges during childbirth partly because of their lower socioeconomic status (Kita et al., 2015). It is plausible that maternal nationality is linked to multiple births through differences in access to fertility treatments. In Canada, factors such as lack of social support, language barriers and financial instability have been identified as potential barriers to accessing fertility treatment for immigrants (Zelkowitz et al., 2015). In contrast, the difference in multiple birth rate between Japanese mothers and non-Japanese mothers decreased over the years because the rate of non-Japanese mothers increased more rapidly over the years. Although the reason for the phenomenon is uncertain from this study, one possible factor is that the proportion of non-Japanese mothers who used infertility treatment increased in the periods. The twin birth rate increased from 1980–1985 to 2010–2015 around the world (Monden et al., 2021), and medically assisted reproduction is pointed out as a reason. There are many countries where increases in twin rate were larger than Japan (Monden et al., 2021; Pison et al., 2015). In addition, the multiple birth rate for non-Japanese mothers did not decrease from 2005 to 2010 in Japan, and there might exist some differences in the effects of the recommendation for prevention of multiple birth during assisted reproductive technology procedures from 2008 depending on nationalities.

It has been suggested from the results that the multiple birth rate in Japan is associated with parental socioeconomic status. To fully comprehend the findings of this study, future research should explore the association between the utilization of infertility treatment and parental socioeconomic status. Moreover, as infertility treatment has recently become covered by insurance in Japan, it is important to monitor whether socioeconomic disparities persist or diminish in the future.

There are some limitations to this study. First, the national birth data used in this study lacks information regarding infertility treatment or other aspects of socioeconomic status, such as income and education level. Not all of the multiple births are caused by infertility treatment, and multiple birth rates shown in this study include both multiple births caused by infertility treatment and those that occurred naturally. Because the data on infertility treatment were not available, we could not show the results by the status of infertility treatment. It will be meaningful to investigate an association between multiple birth and sociodemographic characteristics by the status of infertility treatment in future studies. Additionally, the data did not distinguish between monozygotic and dizygotic twins. Furthermore, data on which infants were born in the same delivery were unavailable, so we had to judge it based on whether information in the available data coincides among multiples. However, despite these limitations, our study used comprehensive birth data from Japan, providing insights into the overall pattern of associations between sociodemographic characteristics and multiple births.

In conclusion, this study investigated the association between parental characteristics and multiple births in Japan using national birth data. The results of the regression analysis revealed that non-Japanese mothers had a lower risk of multiple births than Japanese mothers. Furthermore, lower non-manual and manual workers had a lower risk of multiple births than upper non-manual workers in both maternal and paternal occupations. These findings implied that people with lower socioeconomic status tend not to use infertility treatment compared with those with higher socioeconomic status in Japan, and it probably contributed to the difference in multiple birth rate depending on parental socioeconomic status.

**Supplementary material.** To view supplementary material for this article, please visit https://doi.org/10.1017/thg.2024.36.

**Data availability statement.** The data that support the findings of this study are available from the Ministry of Health, Labour and Welfare in Japan but restrictions apply to the availability of these data, which were used under license for the current study. However, data are available from the Ministry of Health, Labour and Welfare if the Ministry permits use of the data.

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**Competing interests.** The authors declare that they have no competing interests.

**Ethics statement.** This study was approved by the Kyushu University Institutional Review Board for Clinical Research (No. 22221-06). In addition, informed consent was not required for this study because we used the official statistics data that were provided from the Ministry of Health, Labour and Welfare on the basis of the Statistics Act in Japan.

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