The distinctive characteristics of the hourly distribution of live births on specific days in Japan

Mihoko Takahashi

Received: 12 May 2016 / Accepted: 29 August 2016 / Published online: 3 October 2016
© The Japanese Society for Hygiene 2016

Abstract

Objectives Anomalous variations in live births on February 29/March 1, April 1/April 2 and the days before the New Year holidays/New Year holidays have been reported in Japan. The distribution of live births was investigated on those days and whether or not such dates were selected due to obstetric intervention is discussed.

Methods Using a method similar to the X–R control chart, anomalous variations in the hourly number of live births were detected. The number of unusual births was estimated.

Results The number of live births at 13:00–16:59 hours was significantly higher from December 24 to 28 and significantly lower from December 29–January 3, February 29, and April 1, especially on weekdays. In hospitals, the increases from 9:00–12:59 and 13:00–16:59 hours from December 24 to 27 were approximately 10 and 25 %, respectively, of the expected births for those times in the mid-1980s; thereafter, the rates were 30 and 35 %. After 2000, the child births at 13:00–16:59 hours on February 29 and April 1 decreased by approximately 35 % in hospitals and clinics. The numbers of live births at 0:00–0:59 hours were significantly higher on March 1 and April 2 until 2001.

Conclusion Anomalous variations at 0:00–0:59 hours may be associated with fictitious reporting on birth certificates. Anomalous variations from 13:00 to 16:59 hours on weekdays suggest that many individuals may avoid obstetric intervention on February 29 and April 1 and that the number of higher-risk deliveries may significantly increase in the daytime on the days before the New Year holidays due to obstetric intervention for institutional reasons.

Keywords Hourly live births · Obstetric intervention · Birth certificate · Excess birth numbers · Descriptive epidemiology

Introduction

A previous study of Japanese birth statistics from 1981 to 2010 revealed that there were systematic variations in the numbers of live births on specific days [1]. These days included ‘leap day’, ‘the change of the school year’, ‘Golden Week’, ‘Bon’, ‘the days before the New Year holidays’ and ‘the New Year holidays’ (Table 1). The anomalous variations were especially prevalent on February 29 (leap day) and March 1, March 31 to April 1 and April 2 and the days leading up to the New Year holidays and the New Year holidays. The anomalies suggest that some of the birth dates were based on institutional reasons where the doctors wished to avoid holidays, or maternal preferences, with mothers preferring to give birth on March 1 instead of leap day, or April 2 (oso-umare) instead of April 1 (haya-umare). The definitions of oso-umare and haya-umare are described in ‘2. The change of the school year’ of Table 1. Many mothers prefer their children to be oso-umare because people believe that the relative physical and mental abilities of haya-umare children when entering elementary school are inferior to those of oso-umare children [2].

Maternal preferences regarding birth dates have also been reported elsewhere [3–5]. In a study of Chinese live birth
births, socio-cultural reasons were a common indication for cesarean deliveries, such as mothers wishing to give birth on an auspicious date [5]. The WHO states that cesarean section deliveries should only be performed when there is a medical indication because they are associated with an increased risk of maternal morbidity (e.g., blood transfusion and admission to hospital) and mortality [6].

In the Japanese birth statistics, an anomalous variation in the numbers of live births was noted around the ‘Hinoe-Uma (Fire Horse)’ year [7]. This anomaly was partly caused by conception control and fictitious reporting on birth certificates. ‘Hinoe-Uma’ is one of the sexagenary cycles in which two astrological cycles converge. It occurs every 60 years; the last occurred in 1966. In Japan, the ‘Hinoe-Uma’ year was considered to be unlucky, which led to a decrease in the desire to give birth in that year. However, the reasons underlying the anomalous variations on those specific days in Japan has not been clarified. Obstetric interventions, such as cesarean section and induced labor, have become widespread in Japan [8, 9] and may be responsible for the variations on the above-mentioned days.

Birth date modification by obstetric intervention is also a concern from the perspective of public health, in terms of the health of mothers and newborns because it involves prolonging or shortening the gestational age. The prolonging or shortening of the gestational age may increase the risk of maternal and neonatal morbidity, such as meconium staining of the amniotic fluid, which is related to fetal distress, and transient tachypnea in the newborn, which is related to childhood asthma [10–13].

The purpose of the present study was to investigate the distribution of live births on the aforementioned days in Japan, and to discuss whether obstetric intervention was responsible for the numbers of births on these dates.

### Methods

#### Sample

The data on live births between 1981 and 2013, which included the time (in 1-h intervals), date and birthplace (hospitals, clinics), were obtained from the National Vital Statistics of Japan [14]. The data from 1981 to 1994, which were not published, were kept in the Statistics and Information Department of the Ministry of Health and were photocopied with permission. The data from 1995 to 2013 were obtained from e-Stat (http://www.e-stat.go.jp/), the portal site for the official statistics of Japan.

The National Vital Statistics is a survey that is based entirely on the information obtained from birth records. It is published as an annual report, which describes the collective data (not the individual data). Thus, it is considered that the use of these data did not require any particular ethical considerations.

| Specific days | Explanation of related culture |
|---------------|--------------------------------|
| Leap day [February 29/March 1] | Different laws can be found to define the handling of the birthday of a child born on a leap day, moving it either to February 28 or March 1 of non-leap years. Systematic variations on those days suggest the preference of the parents for their children’s birthdays to be on March 1. |
| The change of the school year [March 31, April 1/April 2] | Under the Japanese school system, April is the first month of the new school year. A person born between January 1 and April 1 is called haya-umare. A person born between April 2 and December 31 is called oso-umare. (Children born from April 2 through April 1 of the next year also join the same school year.) |
| Golden Week [May 1, 2 and 7] | Golden Week is a cluster of holidays at the end of April and the beginning of May in Japan. National holidays, April 29 (Showa Day), May 3 (Constitution Day), 4 (Greenery Day), and 5 (Children’s Day) in combination with weekends create a long vacation known as Golden Week. |
| Bon [August 13 to 16] | Bon (August 13 to 16) is a Japanese Buddhist festival where people pay their respects to their ancestors. The Bon holidays are not national holidays, but many people take a long holiday during the period. |
| The days before the New Year holidays [December 24 to 27] | There are no related cultural beliefs. It is thought that systematic variations were visible just because of its proximity to the New Year holidays. |
| The New Year holidays [December 29 to January 3] | In Japan, the last 3 days of the year and the first three days of the New Year are observed as holidays. This is in preparation for the celebration of New Year’s Eve and New Year’s Day even though the only national holiday during the period is on January 1 (New Year’s Day). The government and municipal offices define these days as holidays in an ordinance, because the New Year holidays are by far the biggest holiday in Japanese society. |

The contents of this table were created from the article listed as Reference [1]
Statistical analysis

Using a method that was similar to the X–R control chart, the anomalous variations in the hourly number of live births on specific days were detected. The numbers of live births attributable to certain social factors, such as leap day, the last few days of the school year, and the New Year holidays, were also estimated. First, the days of the week, and seasonal and yearly variations in live births were considered as potential confounding variables [1, 15, 16]. To remove the confounding effects, the distributions of the ratios of the hourly number of births for each day of the week in the respective years were estimated using data from non-specific days (several days before and after the specific days were excluded to ensure that the impact of social factors was avoided) to estimate the reference range. The method is described in detail in ‘4’. Next, the statistical significance and the magnitude of the variation in hourly live births on the specific days were evaluated by comparing the observed and expected values of those distributions. Finally, the number of excess births was estimated. The procedure was as follows:

1. The days excluded and included in the estimation of the reference range of hourly births
The following days were excluded from the estimation: December 18 to 31, January 1 to 7, March 25 to April 1, April 2 to 8, February 23 to March 7, April 24 to May 14 and August 8 to 21. These days, which fell around the specific days, were excluded to avoid the influence of social factors related to the specific days. This is because a previous study revealed anomalous variations in the numbers of daily live births on specific days. However, the distribution of the hourly live births was not apparent prior to the present study. Therefore, more days were excluded from the reference range estimation process, due to the possible influence of anomalous variations. All of the other days were considered to be non-specific days and were used to estimate the reference range.

2. The data on live births
   Hourly number of births: \( H_{tdmy} \)

   Number of daily births: \( D_{dmy} = \sum_{t=0}^{23} H_{tdmy} \)

   where \( t \) is the time of day (0–23, in 1-h intervals), \( d \) the day of the month, \( m \) the month, and \( y \) the year (1981–2013).

3. The ratio of the hourly number of births, \( x_{tdmy} \)
   The \( x_{tdmy} \) value was determined for all of the data. This was done to remove the effects of potentially confounding differences in the yearly and seasonal variations in live births. The seasonal effects were measured using the seasonal index, SI\(_{my} \), which was calculated as the ratio of the mean number of daily births on non-specific days in a month to the mean number of daily births on non-specific days in a year.

\[
x_{tdmy} = \frac{H_{tdmy}}{SI_{my} \times \bar{Y}} = \frac{H_{tdmy}}{\frac{D_{dmy}}{\bar{Y}} \times \bar{Y}} = \frac{H_{tdmy}}{D_{dmy}}
\]

where SI\(_{my} \) is the seasonal index by month. In \( \bar{D}_{dmy}/\bar{Y}, \) \( \bar{Y} \) is the mean number of daily births on non-specific days in a year and \( \bar{D}_{dmy} \) the mean number of daily births on non-specific days in a month.

4. The geometric mean \( M_{nwy} \) and 99.7 % range (reference range) \([R_{nwy-99.7L} ; R_{nwy-99.7U}] \) of the ratio of the hourly number of births at that time on non-specific days

The statistics for each day of the week in individual years were determined using only the data for non-specific days. This was done by considering the differences in the variations in live births on each day of the week. In the present study, the term ‘reference range’ describes the range covering 99.7 % of the births on non-specific days of the year. The ranges were estimated using the three sigma limits [17, 18]. If the cause was simply by chance, the probability that a data point might fall above the upper limit or below the lower limit of the reference range would be three in one thousand. As this is a very small risk, the limits can be considered to provide practical assurance that if a point fell outside the limits of the reference range, then the variation could be attributed to a cause [17]. It is therefore customary to use the three sigma limits to establish a reference range. The present study followed this normal practice.

\[
M_{nwy} = \exp \left\{ \frac{1}{n_{w} \cdot \sum_{m=1}^{12} \sum_{d \in D_{dmy}} \log(x_{tdmy})} \right\} *,
\]

\[
R_{nwy-99.7L} = \exp \{ \log(M_{nwy}) - 3 \times SD_{nwy} \} *,
\]

\[
R_{nwy-99.7U} = \exp \{ \log(M_{nwy}) + 3 \times SD_{nwy} \} *,
\]

\[
SD_{nwy} = \left( \frac{\sum_{m=1}^{12} \sum_{d \in D_{dmy}} (\log(x_{tdmy}) - \log M_{nwy})^2}{n_{w} - 1} \right)^{1/2},
\]

\[
n_{w} = \sum_{m=1}^{12} \sum_{d \in D_{dmy}} 1,
\]

where \( w \) is the day of the week on the date, and \( D_{dmy} \) the set of non-specific days (d) which was the day of
the week \(w\) in a month \(m\) in a year \(y\).

*: If the data \(\log(x_{tdmy})\) on non-specific days of the same day of the week in a year were not normally distributed (Shapiro–Wilk’s test, \(p < 0.05\)), the values in the brackets were replaced by the 50th, 0.15th and 99.85th percentile, respectively.

5. **The ratios of the hourly number of births on specific and non-specific days**

In the following calculation, ‘\(w\)’, indicates the day of the week corresponding to the day of the month ‘\(d\)’.

5.1. **Statistical analysis**

The difference between \(x_{tdmy}\) and \(M_{wys}\), which belonged to the same day of the week \(w\) in a year was judged to be statistically significant \((p < 0.003)\) if \(x_{tdmy}\) was outside the reference range \([R_{wys, 99.7L}, R_{wys, 99.7U}]\)

5.2. **The excess number of births at a particular time on specific days, \(\Delta_{tdmy}\)**

The excess number of births \(\Delta_{tdmy}\) was estimated by calculating the difference between the observed and expected values for the hourly number of births.

\[
\Delta_{tdmy} = \exp\{\log(x_{tdmy}) - \log(M_{wys})\} \times D_{my}
\]

### Results

#### The ratios of the hourly number of births on specific and non-specific days

**February 29 (leap day) and the days around leap day**

In most leap years, the ratio of the hourly number of births showed a significant decrease on February 29. In most cases, a compensatory increase occurred only on March 1 (Fig. 1).

The ratio of the hourly number of births on February 29 showed significantly lower values in hospitals over relatively wide time intervals on the day in 1984 (13 h) and 1988 (12 h). These values were 0.5–0.8 times lower than the values that were expected for these dates and times. More regular time intervals could be calculated for the significantly lower values in clinics for the years until 1992, which were as follows: 1984 (24 h), 1988 (19 h), and 1992 (15 h). These values were 0.2–0.7 times lower than the expected values. Subsequently, the ratio of the hourly number of births on all of the subsequent leap years (except 2004) was significantly lower during the daytime, especially from 13:00 to 16:59 hours, in both hospitals and

---

**Fig. 1** The representative distribution of the observed values, expected values and 99.7 % ranges (reference range) of the ratio of the hourly number of births from February 28 to March 2 in 1984, 1992 and 2012 in hospitals (a) and clinics (b)
The observed values were approximately 0.65 times lower than the expected values. These characteristics were always observed only on weekdays in hospitals and on days other than Sundays and holidays in clinics.

In contrast, the ratios of the hourly number of births on March 1, 1984 were significantly high from 0:00 to 0:59 hours in comparison to the upper limit of the reference range in hospitals. In clinics, a similar phenomenon was observed each leap year until 1996, regardless of the day of the week. These observed values in hospitals were 1.7 times higher than the expected values, while those in clinics were 1.7–1.9 times higher than the expected values.

The change of school year

In most years, the ratio of the hourly number of births decreased on March 31 and April 1. Compensatory increases were only observed on April 2 (Fig. 2).

The ratios in the hourly number of births on March 31 and April 1 were generally significantly lower during the daytime, especially from 13:00 to 16:59 hours. These characteristics were only observed on weekdays in hospitals and on days other than Sunday and holidays in clinics. The values in hospitals were 0.5–0.8 times lower than the expected values, while those in clinics were 0.4–0.9 times lower than the expected values. The ratios of the hourly number of births from 23:00 to 23:59 hours on April 1 were significantly lower than the lower limit of the reference range in clinics until 1999, regardless of the day of the week. These values were 0.3–0.6 times lower than the expected values.

In contrast, the ratios of the hourly number of births on April 2 were significantly high from 0:00 to 0:59 hours in comparison to the upper limit of the reference range. This characteristic was observed in hospitals between 1981 and 1986 and in clinics between 1981 and 2001, regardless of

![Fig. 2](image_url)
the day of the week. The values in hospitals were 1.5–1.6 times higher than the expected values, while those in clinics were 1.5–2.5 times higher than the expected values.

In clinics in the 1980s, the ratios of the hourly number of births on April 1 were much lower than the expected; the minimum values of the day were 0.4–0.5 times lower than the expected values. In contrast, on April 2 they were notably higher at relatively wide time intervals (7–21 h) throughout the day. The maximum values of the day were 1.8–2.5 times higher than the expected values. These characteristics were continuously observed, irrespective of the day of the week.

**Golden Week**

If there were working days between the holidays, there was a significant increase in the ratio of the hourly number of births in the daytime on those days. The effect was most noticeable from 13:00 to 16:59 hours on May 1 and 2 in hospitals and on May 1 in clinics (Fig. 3). Furthermore, this occurred on weekdays and Saturdays in both hospitals and clinics. These characteristics were frequently seen in hospitals from 2003. The values in hospitals were 1.2–1.6 times higher than the expected values, while those in clinics were 1.2–1.6 times higher than the expected values.

In hospitals, significant increases in the ratio of the hourly number of births at 13:00–16:59 hours on weekdays were also observed on April 27 and May 7. However, those increases were only seen in 8 years out of the 33-year period from 1981 to 2013 and for 6 years during the same period, respectively. The values were 1.3–1.4 times higher and 1.3–1.6 times higher than the expected values.

**Bon**

In hospitals, the impact was only visible when August 15 fell on a weekday. The ratios of the hourly number of births decreased significantly from 13:00 to 16:59 hours for the 12 years prior to 2006 (Fig. 4). In clinics, similar distributions and decreases in live births were seen from August 13 to 16 (including Saturdays). The decreases in live births in clinics were observed in most of the years that were investigated. The decreases on August 13 were apparent after 1998. Prior to 1998, almost all the effects were observed on August 14, 15, and 16. The values in hospitals were 0.61–0.76 times lower than the expected values, while those in clinics were 0.45–0.78 times lower than the expected values.

**The days before the New Year holidays and the New Year holidays**

For many years, the ratio of the hourly number of births showed a significant increase in the daytime (especially from 13:00 to 16:59 hours) from December 24 to 28 (Fig. 5). In most years, the peak occurred between December 24 and 27 in hospitals and between December 24 and 26 in clinics. The peak values were 1.3–1.7 times higher than the expected values in both hospitals and clinics. After 2005, significant increases (in comparison to the upper limit of the reference range) were observed in hospitals at 9:00–12:59 hours for the days between December 25 and 28.

Each year, the distribution pattern changed completely from December 29 to January 3 in hospitals and from December 30 to January 4 in clinics. The ratio of the hourly number of births was significantly lower in the daytime, especially from 9:00 to 18:59 hours in hospitals and from 12:00 to 18:59 hours in clinics. These values in hospitals were 0.2–0.8 times lower than the expected values, while those in clinics were 0.3–0.8 times lower than the expected values.

The above-mentioned increases and decreases during the daytime were always observed on weekdays in hospitals and on days other than Sundays and holidays in clinics.

**The estimates of the excess number of births**

**February 29 and March 1**

In 1984, the numbers of births in hospitals and clinics on February 29 decreased by approximately 35 and 60 %, respectively (Table 2). From 1999 to 2012, there was an approximately 20 % decrease in the number of hospital births; a similar decrease was observed in clinics from 2007 to 2012. In 1984, the numbers of births from 13:00 to 16:59 hours on weekdays decreased by approximately 45 % in hospitals and by approximately 60 % in clinics. A dip of approximately 35 % remained after 1995 in hospitals and after 1999 in clinics.

Regarding the increased number of births from 0:00 to 0:59 hours on March 1 in each leap year, the number of hospital births was increased by approximately 70 % in 1984, while the number of births in clinics was increased by approximately 80 % until the mid-1990s.

When February 29 fell on a weekday, the decreases from 9:00 to 16:59 hours accounted for 75–90 % of the total decreases in hospitals and 65–70 % of the total decreases in clinics from 2007.

**The end of the school year and the beginning of the school year**

In hospitals, the number of births when April 1 fell on a weekday was approximately 20 % lower than the expected value (Table 3). In clinics, there was a decrease of approximately 20–40 % until 2000, regardless of the day of
the week. Thereafter the decrease on weekdays remained at around 20%. After 1995 in hospitals and after 2001 in clinics, the number of births from 13:00 to 16:59 hours when April 1 fell on a weekday was approximately 35% lower than the expected value. After the mid-2000s, the numbers of births in hospitals decreased by approximately
20% on March 31 and by approximately 30% on April 1. These decreases were more frequently observed from 9:00 to 12:59 hours, and were only observed on weekdays.

On April 2, increases of approximately 35–60% were observed from 0:00 to 0:59 hours until 1995 in hospitals, while increases of approximately 45–150% were observed in clinics until 2001 (with the exception of 1997). When March 31 and April 1 fell on weekdays, the decreases in hospitals from 9:00 to 16:59 hours accounted for 80–90% of the total decreases after 2005. In the 2000s, the proportion in clinics was approximately 50–75%.

Golden Week

In hospitals, the number of births on weekdays and Saturdays between May 1 and 2 was increased by approximately 10% in comparison to the expected values until 2003 (Table 4). Thereafter, the increases seemed to rise slightly. The total increases in the last 5 years of the study period were approximately 17%. The number of births from 13:00 to 16:59 hours increased by approximately 20% until 2003. Thereafter, they became close to 30%. In clinics, the fluctuations were steadier throughout the study period. The total number of births was significantly increased by 11.9–19.6%. While the number of births from 13:00 to 16:59 hours increased by 19.5–38.3%.

In the last 5 years of the study period, the increases from 9:00 to 16:59 hours on weekdays and Saturdays between May 1 and 2 accounted for 56–100% of the total increases in hospitals and 52–73% of the total increases in clinics.

Bon

In hospitals, there was a slight decline in the decreases during the Bon period. Between 2000 and 2004, the number of births from 13:00 to 15:59 hours on August 15 (on weekdays) was approximately 15% lower than the expected value; thereafter, the decrease was close to 10% (Table 5). In clinics, decreases of approximately 25% were observed from 13:00 to 16:59 hours on weekdays and...
Saturdays during the Bon period; this trend continued until the mid-1980s. Thereafter, the decrease was approximately 30%.

In the last 5 years of the study period, the decreases from 9:00 to 16:59 hours on weekdays on August 15 in hospitals and between August 13 and 15 in clinics...
Table 2: The estimated values of excess live births on February 29 (leap day) and March 1 in all leap years in hospitals (A) and clinics (B)

| Year | Day of the week | February 29 (leap day) | March 1 |
|------|----------------|------------------------|--------|
|      |                | Total 9:00–12:59 hours | 13:00–16:59 hours | 23:00–23:59 hours | Total 0:00–0:59 hours | 9:00–12:59 hours | 13:00–16:59 hours |
|      |                |                        |                    |                    |                        |                    |                    |
| A    |                |                         |                    |                    |                        |                    |                    |
| 1984 | Wed            | −850 (−36.1) *          | −162 (−34.3) *      | −309 (−47.0) *     | −37 (−53.4) *          | Thu                | 553 (24.4) *        | 46 (69.0) *        | 119 (26.0) *       | 177 (28.2) *       |
| 1988 | Mon            | −658 (−31.3) *          | −120 (−30.7) *      | −246 (−41.8) *     | −21 (−33.8) *          | Tue                | 231 (10.4)          | 32 (49.7)          | 39 (8.6)           | 71 (11.0)          |
| 1992 | Sat            | −266 (−17.4) *          | −56 (−17.1)         | −77 (−23.4) *      | −6 (−11.5)             | Sun                | 149 (11.4)          | 7 (14.2)           | 21 (8.1)           | 28 (12.1)          |
| 1996 | Thu            | −463 (−24.3) *          | −91 (−24.9)         | −200 (−35.9) *     | −6 (−10.6)             | Fri                | 223 (12.5)          | 17 (32.3)          | 59 (17.3)          | 109 (21.1)         |
| 2000 | Tue            | −394 (−19.4) *          | −48 (−12.5)         | −207 (−34.3) *     | −8 (−14.1)             | Wed                | 69 (3.6)            | −3 (−5.5)          | 34 (9.1)           | 51 (9.1)           |
| 2004 | Sun            | −19 (−1.6)              | 17 (7.9)            | −16 (−8.0)         | −3 (−7.5)              | Mon                | −4 (−0.2)           | −2 (−4.1)          | 5 (1.5)            | 0 (0.0)            |
| 2008 | Fri            | −282 (−17.1) *          | −75 (−20.9)         | −174 (−33.9) *     | 0 (0.2)                | Sat                | 40 (3.6)            | 5 (11.2)           | 35 (16.2)          | −1 (−0.3)          |
| 2012 | Wed            | −368 (−21.8) *          | −105 (−27.0)        | −172 (−32.9) *     | −18 (−43.9) *          | Thu                | 73 (4.5)            | 26 (66.3) *         | 19 (4.9)           | 12 (2.5)           |
| B    |                |                         |                    |                    |                        |                    |                    |                    |
| 1984 | Wed            | −1,104 (−59.5) *        | −248 (−61.4) *      | −280 (−60.0) *     | −33 (−64.5) *          | Thu                | 628 (36.5)          | 47 (92.4)          | 110 (28.7)         | 219 (52.5)         |
| 1988 | Mon            | −705 (−44.6) *          | −138 (−43.8) *      | −203 (−49.4) *     | −33 (−70.5) *          | Tue                | 297 (18.3)          | 35 (71.5)          | 43 (12.4)          | 78 (18.3)          |
| 1992 | Sat            | −468 (−35.1) *          | −99 (−34.0)         | −106 (−32.1) *     | −24 (−61.1) *          | Sun                | 284 (27.0)          | 32 (86.9)          | 71 (31.6)          | 46 (24.7)          |
| 1996 | Thu            | −391 (−27.3) *          | −54 (−18.7)         | −154 (−43.0) *     | −9 (−20.7)             | Fri                | 317 (21.7)          | 35 (79.9)          | 40 (14.2)          | 90 (23.8)          |
| 2000 | Tue            | −399 (−24.3) *          | −62 (−20.1)         | −159 (−36.8) *     | −16 (−34.1) *          | Wed                | 105 (7.0)           | 4 (9.4)            | −1 (−0.5)          | 37 (9.3)           |
| 2004 | Sun            | −113 (−9.9)             | −24 (−10.7)         | −33 (−16.4)        | −9 (−23.1)             | Mon                | 79 (5.4)            | −2 (−3.9)          | 15 (5.5)           | 25 (6.8)           |
| 2008 | Fri            | −315 (−20.7) *          | −57 (−19.8)         | −145 (−33.9) *     | −4 (−8.8)              | Sat                | 164 (12.7)          | 13 (30.5)          | 44 (17.9)          | 46 (14.5)          |
| 2012 | Wed            | −240 (−16.5) *          | −45 (−15.7)         | −123 (−29.3) *     | 6 (14.0)               | Thu                | 125 (9.6)           | 6 (15.6)           | 24 (9.3)           | 35 (9.7)           |

*p < 0.003; the observed value was greater or less than the reference range

a The values in parentheses indicate the proportion of excess live births according to the number of live births that were expected on the indicated dates and times
Table 3  The estimated values of excess live births on March 31, April 1, and April 2 in all of the years in hospitals (A) and clinics (B)

| Year | The end of the school year | Day of the week | March 31 | April 1 | Day of the week | April 1 |
|------|-----------------------------|-----------------|---------|---------|-----------------|--------|
|      |                             | Total 9:00–12:59 hours |         |         | Total 9:00–12:59 hours |         |
|      |                             | 13:00–16:59 hours |         |         | 13:00–16:59 hours |         |
|      |                             | 23:00–23:59 hours |         |         | 23:00–23:59 hours |         |

A

| Year | Tue | Wed | Thu | Fri | Sat | Mon | Wed | Fri | Sat |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1981 | -285 | -26 | -143 | -213 | -500 | -94 | -209 | -335 | -15 |
| 1982 | -192 | -30 | -58 | -94 | -467 | -104 | -202 | -337 | -19 |
| 1983 | -210 | -22 | -101 | -159 | -421 | -182 | -207 | -265 | -8 |
| 1984 | -94  | -32 | -27 | -63 | -160 | -9.7 | -37 | -12.5 | -11 |
| 1985 | -119 | -9.5 | 5 | (1.8) | -575 | -25.2 | -198 | -31.3 | -34 |
| 1986 | -265 | -113 | -133 | -21.9 | -601 | -25.9 | -232 | -34.7 | -15 |
| 1987 | -276 | -10.4 | -138 | -20.0 | -637 | -29.1 | -327 | -45.3 | -10 |
| 1988 | -297 | -10.9 | -122 | -20.9 | -473 | -23.3 | -207 | -35.8 | -14 |
| 1989 | -210 | -11.6 | -109 | -18.9 | -232 | -14.5 | -36 | -26.7 | -10 |
| 1990 | -62  | -5.4 | -7 | -1.9 | -146 | -10.6 | -56 | -22.5 | -21 |
| 1991 | -34  | -1.4 | -10 | -4.0 | -489 | -22.5 | -212 | -36.8 | -16 |
| 1992 | -87  | -5.4 | -82 | -13.8 | -515 | -26.3 | -242 | -42.5 | -23 |
| 1993 | -270 | -15.6 | -103 | -17.3 | -368 | -19.5 | -215 | -38.2 | -5 |
| 1994 | -222 | -12.2 | -109 | -18.9 | -353 | -18.7 | -181 | -32.3 | -5 |
| 1995 | -216 | -7.4 | -74 | -13.7 | -101 | -7.0 | 10 | -13.1 | -10 |
| 1996 | 19   | 17   | -11 | -4.7 | -335 | -18.0 | -124 | -42.5 | -13 |
| 1997 | -155 | -9.1 | -60 | -12.1 | -443 | -22.3 | -212 | -36.8 | -16 |
| 1998 | -203 | -15.6 | -103 | -17.3 | -407 | -20.8 | -242 | -41.0 | -11 |
| 1999 | -209 | -9.9 | -92 | -16.7 | -438 | -22.6 | -224 | -39.6 | -18 |
| 2000 | -204 | -13.3 | -127 | -23.3 | -46 | -3.3 | -8 | -6.8 | 7 |
| 2001 | -64  | -6.1 | -6 | -2.4 | -34 | -2.7 | -10 | -4.3 | -31 |
| 2002 | 36   | -15 | -6 | 20 (9.3) | -334 | -19.1 | -60 | -18.8 | -159 |
| 2003 | -133 | -8.1 | -15 | -5.0 | -377 | -20.3 | -216 | -38.0 | -7 |
| 2004 | -328 | -21.1 | -137 | -25.4 | -387 | -21.9 | -178 | -33.3 | -10 |
| 2005 | -206 | -10.2 | -110 | -21.6 | -357 | -22.0 | -131 | -26.4 | -10 |
| 2006 | -196 | -21.5 | -81 | -16.2 | -76 | -6.6 | -5 | -2.3 | -17 |
| 2007 | -64  | -5.6 | 0 | -4.0 | -67 | -6.3 | -24 | -11.6 | 4 |
| 2008 | -184 | -24.5 | -79 | -17.2 | -337 | -19.1 | -190 | -34.5 | -1 |
| 2009 | -288 | -20.8 | -129 | -23.5 | -412 | -23.8 | -209 | -38.7 | -19 |
| 2010 | -271 | -14.7 | -137 | -26.3 | -333 | -19.6 | -186 | -35.9 | 2 |
| 2011 | -291 | -20.5 | -147 | -28.6 | -330 | -20.0 | -186 | -37.1 | 5 |
| 2012 | -12  | -5.1 | -6 | -3.4 | -50 | -5.1 | -17 | -9.6 | 6 |
| 2013 | -46  | -3.3 | -18 | -10.4 | -335 | -21.0 | -173 | -36.1 | -14 |
### Table 3 continued
Excess live births (%)<sup>a</sup>

| Year | Day of the week | The beginning of the next school year |
|------|----------------|--------------------------------------|
|      | April 2        | 0:00–0:59 hours | 9:00–12:59 hours | 13:00–16:59 hours |
| A    |                |              |                  |                  |
| 1981 | Thu            | 376 (16.6)*  | 38 (55.0)*       | 71 (15.8)        |
|      | Fri            | 313 (14.2)*  | 34 (51.4)*       | 80 (18.4)*       |
|      | Sat            | 428 (21.5)*  | 41 (60.6)*       | 68 (15.6)        |
|      | Mon            | 167 (7.4)    | 25 (39.0)        | 18 (4.3)         |
|      | Tue            | 377 (15.7)*  | 40 (55.3)*       | 63 (12.9)*       |
|      | Wed            | 293 (13.5)   | 35 (55.2)*       | 14 (3.3)         |
|      | Thu            | 121 (5.6)    | 25 (40.8)        | −26 (−5.9)       |
|      | Fri            | 290 (17.0)*  | 27 (40.2)        | 71 (18.8)*       |
|      | Sat            | 307 (15.5)*  | 31 (58.7)        | 27 (6.8)         |
|      | Mon            | 204 (14.6)*  | 25 (47.8)        | 18 (6.4)         |
|      | Tue            | 168 (8.5)    | 19 (36.4)        | 35 (9.6)         |
|      | Wed            | 194 (9.2)    | 24 (40.9)        | 5 (1.1)          |
|      | Thu            | 307 (15.5)*  | 31 (58.7)        | 27 (6.8)         |
|      | Fri            | 263 (14.1)*  | 30 (55.9)*       | 36 (10.2)        |
|      | Sat            | 274 (18.3)*  | 18 (33.6)        | 62 (20.6)*       |
|      | Mon            | 101 (7.7)    | 28 (55.7)        | 26 (10.5)        |
|      | Tue            | 132 (6.5)    | 13 (21.2)        | −3 (−0.8)        |
|      | Wed            | 184 (9.7)    | 6 (11.1)         | 11 (2.9)         |
|      | Thu            | 146 (7.6)    | 9 (16.7)         | 10 (2.8)         |
|      | Fri            | 225 (11.8)*  | 11 (19.6)        | 24 (6.7)         |
|      | Sun            | 104 (8.1)    | −2 (−4.9)        | 58 (24.3)*       |
|      | Mon            | 45 (2.6)     | 13 (27.1)        | 9 (2.8)          |
|      | Tue            | 59 (3.1)     | 22 (40.4)        | 7 (1.8)          |
|      | Wed            | 16 (0.9)     | −17 (−33.6)      | 12 (3.5)         |
|      | Thu            | 209 (11.9)   | 7 (12.9)         | 24 (6.8)         |
|      | Fri            | 81 (6.8)     | 2 (5.0)          | 10 (4.5)         |
|      | Sat            | 113 (10.6)   | 17 (40.1)        | 22 (10.7)        |
|      | Mon            | 154 (9.8)    | 9 (22.3)         | 12 (3.7)         |
|      | Tue            | 133 (7.7)    | −1 (−1.8)        | 36 (9.6)         |
|      | Wed            | 125 (7.2)    | 16 (38.8)        | 81 (20.5)        |
|      | Thu            | 164 (9.8)    | 2 (5.1)          | 65 (17.0)        |
|      | Fri            | 48 (4.2)     | 5 (10.7)         | 23 (10.2)        |
|      | Sat            | 121 (7.9)    | 3 (8.7)          | 34 (9.9)         |
|      | Mon            | 124 (7.1)    | −3 (−7.6)        | 23 (5.6)         |

<sup>a</sup> Excess live births (%) relative to the beginning of the next school year.
### Table 3 continued

| Year | The end of the school year | March 31 | April 1 |
|------|----------------------------|----------|---------|
|      | Day of the week | 9:00–12:59 hours | 13:00–16:59 hours | Total | 9:00–12:59 hours | 13:00–16:59 hours | 23:00–23:59 hours |
|      | Day of the week | Total | 9:00–12:59 hours | 13:00–16:59 hours | Total | 9:00–12:59 hours | 13:00–16:59 hours | 23:00–23:59 hours |
| 1981 | Tue | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1982 | Wed | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1983 | Thu | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1984 | Fri | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1985 | Sat | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1986 | Mon | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1987 | Tue | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1988 | Wed | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1989 | Thu | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1990 | Fri | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1991 | Sat | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1992 | Sun | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1993 | Tue | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1994 | Wed | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1995 | Thu | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1996 | Fri | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1997 | Sat | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1998 | Sun | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 1999 | Tue | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 2000 | Wed | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 2001 | Thu | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 2002 | Fri | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 2003 | Sat | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 2004 | Sun | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 2005 | Tue | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 2006 | Wed | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 2007 | Thu | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 2008 | Fri | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 2009 | Sat | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |
| 2010 | Sun | 536 (45.1)* | 263 (45.1)* | 273 (45.1)* | 377 (45.1)* | 223 (45.1)* | 94 (45.1)* | 10 (45.1)* |

*Excess live births (%)*
| Year | Day of the week | April | The beginning of the next school year |
|------|----------------|-------|-------------------------------------|
|      |                | Total | 0:00–0:59 hours | 9:00–12:59 hours | 13:00–16:59 hours |
| 1981 | Thu            | 924   | (50.2)* | 70 | (121.5)* | 171 | (41.9)* | 203 | (45.5)* |
| 1982 | Fri            | 726   | (40.9)* | 66 | (128.3)* | 165 | (43.0)* | 139 | (30.0)* |
| 1983 | Sat            | 724   | (42.5)* | 81 | (145.8)* | 115 | (29.5)* | 179 | (45.3)* |
| 1984 | Mon            | 518   | (28.4)* | 32 | (65.0)* | 117 | (31.9)* | 83  | (17.8) |
| 1985 | Tue            | 603   | (33.2)* | 53 | (97.4)* | 67  | (16.8)* | 199 | (42.8)* |
| 1986 | Wed            | 644   | (38.6)* | 68 | (148.8)* | 131 | (36.4)* | 136 | (31.5)* |
| 1987 | Thu            | 542   | (34.9)* | 63 | (144.6)* | 77  | (22.3)* | 115 | (29.2)* |
| 1988 | Fri            | 499   | (35.4)* | 54 | (126.6)* | 55  | (16.8)  | 121 | (35.9)* |
| 1989 | Sat            | 300   | (27.2)* | 30 | (73.3)  | 63  | (27.1)* | 46  | (23.5) |
| 1990 | Mon            | 233   | (15.2)* | 38 | (95.2)* | 34  | (10.8)* | 38  | (9.5)  |
| 1991 | Tue            | 334   | (21.3)* | 40 | (89.8)* | 41  | (12.5)  | 95  | (22.4)* |
| 1992 | Thu            | 382   | (27.0)* | 41 | (100.8)*| 73  | (24.5)  | 85  | (23.1)* |
| 1993 | Fri            | 333   | (22.6)* | 32 | (80.8)* | 67  | (23.1)* | 84  | (21.1)* |
| 1994 | Sat            | 299   | (21.8)* | 24 | (55.6)  | 46  | (15.9)  | 116 | (34.6)* |
| 1995 | Sun            | 187   | (16.9)* | 35 | (87.9)* | 39  | (17.3)  | 19  | (9.8)  |
| 1996 | Tue            | 231   | (14.4)* | 31 | (66.6)* | 82  | (26.4)* | 18  | (4.3)  |
| 1997 | Wed            | 216   | (14.8)* | 12 | (25.4)  | 60  | (21.2)  | 50  | (12.9) |
| 1998 | Thu            | 184   | (12.4)  | 24 | (53.3)* | 11  | (3.9)   | 74  | (19.3) |
| 1999 | Fri            | 215   | (14.3)* | 35 | (78.0)* | 45  | (16.0)  | 62  | (15.6) |
| 2000 | Sun            | 171   | (15.0)* | 20 | (45.8)  | 37  | (16.2)  | 62  | (31.2) |
| 2001 | Mon            | 122   | (8.4)   | 31 | (71.4)* | 28  | (10.5)  | 15  | (4.2)  |
| 2002 | Tue            | 194   | (12.2)* | 8  | (16.2)  | 36  | (12.1)  | 53  | (12.7) |
| 2003 | Wed            | 178   | (11.9)  | 18 | (40.3)  | 37  | (13.1)  | 49  | (12.3) |
| 2004 | Fri            | 121   | (8.1)   | 4  | (9.6)   | 52  | (18.8)* | 38  | (9.3)  |
| 2005 | Sat            | 114   | (9.0)   | 9  | (22.1)  | 46  | (18.9)* | 35  | (11.1) |
| 2006 | Sun            | 117   | (10.6)  | 11 | (28.3)  | 20  | (9.2)   | 35  | (17.9) |
| 2007 | Mon            | 138   | (9.7)   | 18 | (42.7)  | 47  | (18.7)  | 3   | (0.8)  |
| 2008 | Wed            | 168   | (11.3)  | 18 | (41.0)  | 72  | (20.6)* | 53  | (13.5) |
| 2009 | Thu            | 160   | (11.3)  | 8  | (19.2)  | 56  | (20.6)* | 53  | (13.5) |
| 2010 | Fri            | 108   | (7.5)   | 2  | (−4.6)  | 15  | (5.6)   | 46  | (11.1) |
| 2011 | Sat            | 99    | (8.1)   | 24 | (64.5)* | −14 | (−6.0)  | 38  | (12.6) |
| 2012 | Mon            | 105   | (8.1)   | 5  | (14.5)  | 25  | (10.4)  | 38  | (10.5) |
| 2013 | Tue            | 31    | (2.3)   | 14 | (37.7)  | −1  | (0.3)   | 10  | (2.6)  |

*p < 0.003; the observed value was greater or less than the reference range

a The values in parentheses indicate the proportion of excess live births according to the number of live births that were expected on the indicated dates and times.
accounted for 55–90 % and 64–100 % of each of the total decreases.

The days before the New Year holidays and the New Year holidays

In hospitals in the 1980s, the number of births on weekdays between December 24 and 27 increased by approximately 10 % in comparison to the expected values (Table 6).

| Year | No. of days | From May 1 to 2 | Total | 13:00–16:59 hours |
|------|-------------|-----------------|-------|-------------------|
| A    |             |                 |       |                   |
| 1981 | 2           | 706 (16.5)*     | 304   | (28.8)*           |
| 1982 | 1           | 196 (9.9)       | 61    | (14.3)            |
| 1983 | 1           | 79 (3.3)        | 80    | (12.4)            |
| 1984 | 2           | 373 (7.8)       | 153   | (11.5)            |
| 1985 | 2           | 520 (11.3)      | 262   | (20.3)            |
| 1986 | 2           | 559 (12.8)      | 233   | (18.7)            |
| 1987 | 2           | 534 (13.3)      | 208   | (20.3)            |
| 1988 | 1           | 265 (12.3)*     | 116   | (19.3)*           |
| 1989 | 2           | 398 (9.1)       | 216   | (16.9)            |
| 1990 | 2           | 220 (5.1)       | 152   | (11.9)            |
| 1991 | 2           | 482 (11.8)      | 299   | (24.9)*           |
| 1992 | 2           | 424 (12.1)      | 197   | (21.7)            |
| 1993 | 1           | 241 (16.0)*     | 91    | (28.6)*           |
| 1994 | 1           | 232 (11.6)*     | 190   | (34.0)*           |
| 1995 | 2           | 200 (4.9)       | 196   | (16.7)            |
| 1996 | 2           | 392 (9.8)       | 189   | (16.5)            |
| 1997 | 2           | 356 (9.0)       | 160   | (13.9)            |
| 1998 | 2           | 463 (13.9)      | 209   | (25.0)            |
| 1999 | 1           | 130 (9.1)       | 35    | (12.2)            |
| 2000 | 2           | 373 (9.6)       | 251   | (22.1)            |
| 2001 | 2           | 265 (6.8)       | 178   | (15.4)            |
| 2002 | 2           | 447 (12.1)      | 215   | (19.7)            |
| 2003 | 2           | 301 (8.6)       | 163   | (15.3)            |
| 2004 | 1           | 179 (14.7)      | 77    | (31.8)*           |
| 2005 | 1           | 229 (14.8)*     | 158   | (34.5)*           |
| 2006 | 2           | 612 (17.8)*     | 257   | (24.3)            |
| 2007 | 2           | 327 (9.5)       | 209   | (19.5)*           |
| 2008 | 2           | 646 (19.3)*     | 307   | (30.0)*           |
| 2009 | 2           | 525 (19.3)      | 299   | (41.5)*           |
| 2010 | 1           | 176 (15.7)*     | 82    | (36.6)*           |
| 2011 | 1           | 356 (23.3)*     | 176   | (38.7)*           |
| 2012 | 2           | 390 (11.2)      | 298   | (27.6)*           |
| 2013 | 2           | 526 (15.5)      | 222   | (21.2)            |

Table 4 continued

Excess live births (%)a

| Year | No. of days | May 1 | Total | 13:00–16:59 hours |
|------|-------------|-------|-------|-------------------|
| B    |             |       |       |                   |
| 1981 | 1           | 307   | (16.0)* | 104   | (21.0)            |
| 1982 | 1           | 259   | (15.5)* | 114   | (29.1)*           |
| 1983 | 0           | –     | –     | –     | –                |
| 1984 | 1           | –79   | (4.1) | –17   | (3.5)            |
| 1985 | 1           | 284   | (16.3)* | 111   | (24.8)*           |
| 1986 | 1           | 190   | (11.9) | 78    | (19.5)*           |
| 1987 | 1           | 317   | (19.1)* | 158   | (36.1)*           |
| 1988 | 0           | –     | –     | –     | –                |
| 1989 | 1           | 75    | (4.6) | 32    | (7.5)            |
| 1990 | 1           | –46   | (2.8) | 14    | (3.3)            |
| 1991 | 1           | 306   | (19.6)* | 159   | (38.3)*           |
| 1992 | 1           | 212   | (14.0)* | 68    | (16.4)           |
| 1993 | 1           | 211   | (15.3)* | 114   | (33.7)*           |
| 1994 | 0           | –     | –     | –     | –                |
| 1995 | 1           | 30    | (1.9) | 41    | (10.0)           |
| 1996 | 1           | 220   | (13.9) | 86    | (21.6)           |
| 1997 | 1           | 126   | (8.4) | 75    | (19.7)           |
| 1998 | 1           | 181   | (11.6) | 117   | (28.6)*           |
| 1999 | 1           | 246   | (18.0)* | 93    | (28.6)*           |
| 2000 | 1           | 164   | (10.8) | 76    | (20.3)*           |
| 2001 | 1           | 40    | (2.5) | 48    | (11.2)           |
| 2002 | 1           | 170   | (10.8) | 117   | (28.1)*           |
| 2003 | 1           | 56    | (3.8) | 20    | (5.3)            |
| 2004 | 1           | 237   | (17.8)* | 80    | (24.0)*           |
| 2005 | 0           | –     | –     | –     | –                |
| 2006 | 1           | 175   | (11.9)* | 56    | (14.6)           |
| 2007 | 1           | 59    | (3.8) | 53    | (12.6)           |
| 2008 | 1           | 213   | (14.6)* | 87    | (21.9)*           |
| 2009 | 1           | 248   | (17.7)* | 126   | (31.7)*           |
| 2010 | 1           | 131   | (10.6) | 78    | (25.7)*           |
| 2011 | 0           | –     | –     | –     | –                |
| 2012 | 1           | 57    | (4.0) | 47    | (11.6)           |
| 2013 | 1           | 214   | (16.1)* | 121   | (31.7)*           |

*p < 0.003; the observed values on all weekdays and Saturdays of the given period were greater or less than the reference range

a The values in parentheses indicate the proportion of excess live births according to the number of live births that were expected on the indicated dates and times

b No. of days include weekdays and Saturdays

Thereafter, the increases steadily rose. From 2003 to 2013, the total increase was approximately 20 %. An increase of approximately 10 % was observed from 9:00 to 12:59 hours in the first half of the 1980s; it reached approximately 30 % after 2007. Furthermore, an increase
of approximately 25% was observed from 13:00 to 16:59 hours in the first half of the 1980s. Thereafter, the increase became close to 35%.

On weekdays between December 29 and January 3, a greater decrease was observed. The number of births from 9:00 to 12:59 hours decreased by almost 15%, while the number of births from 13:00 to 16:59 hours decreased by approximately 35% in the first half of 1980s. After 2007, the number of births from 9:00 to 12:59 hours decreased by approximately 40%, while the number of births from 13:00 to 16:59 hours decreased by approximately 60%.

In clinics, the total increases on weekdays between December 24th and 26th remained at around 15% from
### Table 6

The estimated values of excess live births on all weekdays from December 24 to December 27 and from December 29 to January 3 in all years in hospitals (A) and from December 24 to December 26 and from December 29 to January 3 in all years in clinics (B).

| Year       | From December 24 to December 27 | From December 29 to January 3 |
|------------|----------------------------------|-------------------------------|
|            | Number of weekdays (days) | Total | 9:00–12:59 hours | 13:00–16:59 hours | Number of weekdays (days) | Total | 9:00–12:59 hours | 13:00–16:59 hours |
| A          |                                |       |                 |                  |                                |       |                 |                  |
| 1981–1982  | 2                               | 497   | (11.0)          | 109 (12.3)       | 258 (21.0)                    | 3     | –1,346          | –(19.2)*         |
| 1982–1983  | 2                               | 552   | (11.7)          | 72 (8.1)         | 334 (26.2)*                   | 4     | –1,951          | –(20.8)*         |
| 1983–1984  | 2                               | 318   | (6.4)           | 66 (6.9)         | 275 (20.3)                    | 3     | –1,588          | –(22.0)*         |
| 1984–1985  | 4                               | 998   | (10.5)          | 145 (7.7)        | 644 (24.5)*                   | 3     | –2,047          | –(29.6)*         |
| 1985–1986  | 4                               | 882   | (9.6)           | 209 (11.2)       | 648 (25.0)*                   | 4     | –2,510          | –(27.4)*         |
| 1986–1987  | 3                               | 785   | (11.7)          | 117 (8.6)        | 550 (28.6)*                   | 4     | –2,066          | –(22.9)*         |
| 1987–1988  | 2                               | 663   | (15.6)*         | 119 (13.8)       | 458 (37.9)*                   | 3     | –1,569          | –(23.8)*         |
| 1988–1989  | 2                               | 567   | (13.1)          | 138 (16.3)       | 397 (32.1)*                   | 3     | –1,599          | –(25.3)*         |
| 1989–1990  | 3                               | 708   | (11.1)          | 140 (11.1)       | 488 (26.4)                    | 3     | –1,813          | –(29.2)*         |
| 1990–1991  | 3                               | 921   | (15.2)          | 94 (7.7)         | 571 (31.7)*                   | 3     | –1,764          | –(29.9)*         |
| 1991–1992  | 4                               | 1,368 | (16.9)          | 160 (9.9)        | 879 (36.4)*                   | 4     | –2,340          | –(29.2)*         |
| 1992–1993  | 2                               | 626   | (16.1)          | 103 (13.4)       | 424 (37.0)*                   | 3     | –1,373          | –(23.0)*         |
| 1993–1994  | 2                               | 608   | (16.0)*         | 66 (9.4)         | 436 (39.9)*                   | 4     | –1,766          | –(23.0)*         |
| 1994–1995  | 2                               | 737   | (17.9)*         | 157 (20.4)       | 407 (34.2)*                   | 3     | –1,579          | –(26.0)*         |
| 1995–1996  | 3                               | 704   | (12.4)          | 116 (10.8)       | 445 (27.1)*                   | 3     | –1,562          | –(27.7)*         |
| 1996–1997  | 4                               | 1,152 | (15.2)          | 205 (14.1)       | 724 (32.9)*                   | 4     | –2,139          | –(28.2)*         |
| 1997–1998  | 3                               | 1,057 | (18.6)*         | 225 (20.7)       | 669 (40.8)*                   | 4     | –1,711          | –(22.5)*         |
| 1998–1999  | 2                               | 701   | (18.5)*         | 186 (25.8)       | 375 (34.0)*                   | 3     | –1,315          | –(22.4)*         |
| 1999–2000  | 2                               | 433   | (11.9)          | 58 (8.6)         | 351 (33.5)*                   | 4     | –1,678          | –(22.7)*         |
| 2000–2001  | 3                               | 526   | (9.3)           | 80 (7.5)         | 434 (26.3)                    | 3     | –1,693          | –(29.6)*         |
| 2001–2002  | 3                               | 798   | (14.7)          | 163 (15.6)       | 478 (29.4)*                   | 3     | –1,690          | –(31.6)*         |
| 2002–2003  | 4                               | 1,057 | (14.9)          | 197 (14.3)       | 697 (33.0)                    | 4     | –2,095          | –(29.5)*         |
| 2003–2004  | 3                               | 1,090 | (20.8)*         | 196 (19.0)       | 628 (39.7)*                   | 4     | –1,924          | –(27.6)*         |
| 2004–2005  | 2                               | 619   | (18.7)*         | 128 (20.4)       | 380 (38.1)*                   | 4     | –1,934          | –(28.8)*         |
| 2005–2006  | 2                               | 567   | (17.6)*         | 131 (20.9)       | 326 (33.2)*                   | 3     | –1,383          | –(28.1)*         |
| 2006–2007  | 3                               | 623   | (12.3)*         | 214 (21.3)*      | 387 (24.8)*                   | 3     | –1,655          | –(32.8)*         |
| 2007–2008  | 3                               | 836   | (16.4)*         | 234 (21.6)       | 471 (30.2)*                   | 3     | –1,881          | –(37.7)*         |
| 2008–2009  | 3                               | 1,212 | (23.4)*         | 357 (31.6)       | 645 (40.5)*                   | 4     | –2,140          | –(31.5)*         |
| 2009–2010  | 2                               | 675   | (19.8)          | 232 (30.2)       | 341 (32.3)*                   | 3     | –1,589          | –(30.4)*         |
| 2010–2011  | 2                               | 583   | (17.7)          | 211 (29.1)       | 377 (37.8)*                   | 4     | –2,037          | –(30.8)*         |
| 2011–2012  | 2                               | 705   | (22.1)*         | 265 (37.9)*      | 373 (38.3)*                   | 3     | –1,544          | –(31.3)*         |
| 2012–2013  | 3                               | 841   | (16.5)          | 308 (26.0)*      | 484 (30.7)*                   | 3     | –2,085          | –(42.2)*         |
| 2013–2014  | 4                               | 1,238 | (18.3)*         | 401 (25.2)*      | 624 (29.8)                    |       |                 |                  |

Excess live births (%)^a

^a^ Data includes only clinics (B) from December 29 to January 3 in all years.
### Table 6 continued

| Year          | From December 24 to December 26 | From December 29 to January 3 |
|---------------|----------------------------------|-------------------------------|
|               | Number of weekdays (days) | Total | 9:00–12:59 hours | 13:00–16:59 hours | Total | 9:00–12:59 hours | 13:00–16:59 hours |
| B             |                                  |       |                 |                  |       |                 |                  |
| 1981–1982     | 2                                | 322   | (8.8)           | 131 (16.5)       | 200   | (21.8)          | 3                |
| 1982–1983     | 1                                | 296   | (15.9)          | 46 (11.4)        | 104   | (21.5)          | 4                |
| 1983–1984     | 1                                | 19    | (1.0)           | –34 (–9.0)       | 54    | (11.2)          | 3                |
| 1984–1985     | 3                                | 607   | (11.0)          | 77 (6.6)         | 412   | (29.6)          | 3                |
| 1985–1986     | 3                                | 477   | (9.3)           | 36 (3.1)         | 369   | (28.4)          | 4                |
| 1986–1987     | 3                                | 343   | (6.8)           | 69 (6.3)         | 309   | (23.8)          | 4                |
| 1987–1988     | 2                                | 366   | (11.5)          | 87 (12.4)        | 200   | (24.3)          | 3                |
| 1988–1989     | 1                                | 65    | (4.0)           | –55 (–17.0)*     | 99    | (23.5)*         | 3                |
| 1989–1990     | 2                                | 395   | (12.1)          | 88 (12.9)        | 204   | (23.7)          | 3                |
| 1990–1991     | 2                                | 465   | (15.3)          | 33 (5.1)         | 268   | (33.4)*         | 3                |
| 1991–1992     | 3                                | 547   | (11.8)          | 56 (5.7)         | 344   | (27.9)          | 4                |
| 1992–1993     | 2                                | 446   | (15.0)          | 42 (6.8)         | 237   | (30.0)*         | 3                |
| 1993–1994     | 1                                | 242   | (16.2)*         | 34 (11.5)        | 133   | (32.8)*         | 4                |
| 1994–1995     | 1                                | 73    | (4.6)           | –23 (–7.5)       | 90    | (21.8)*         | 3                |
| 1995–1996     | 2                                | 281   | (9.2)           | 70 (11.8)        | 178   | (22.3)          | 3                |
| 1996–1997     | 3                                | 573   | (12.7)          | 87 (9.7)         | 270   | (23.6)          | 4                |
| 1997–1998     | 3                                | 260   | (5.7)           | 14 (1.6)         | 193   | (16.3)          | 4                |
| 1998–1999     | 2                                | 456   | (15.3)          | 48 (8.5)         | 179   | (23.3)          | 3                |
| 1999–2000     | 1                                | 93    | (6.1)           | –30 (–10.4)      | 100   | (25.0)*         | 4                |
| 2000–2001     | 2                                | 213   | (6.8)           | 36 (6.3)         | 154   | (19.3)          | 3                |
| 2001–2002     | 2                                | 296   | (9.6)           | 6 (1.0)          | 171   | (20.9)          | 3                |
| 2002–2003     | 3                                | 542   | (12.0)          | 41 (4.8)         | 326   | (27.5)*         | 4                |
| 2003–2004     | 3                                | 509   | (11.2)          | 66 (7.7)         | 290   | (24.1)          | 4                |
| 2004–2005     | 1                                | 190   | (12.7)*         | 51 (18.5)*       | 97    | (23.8)*         | 4                |
| 2005–2006     | 1                                | 164   | (11.7)*         | –3 (–1.2)        | 136   | (37.1)*         | 3                |
| 2006–2007     | 2                                | 394   | (13.0)          | 17 (3.1)         | 211   | (25.9)*         | 3                |
| 2007–2008     | 2                                | 396   | (13.0)*         | 56 (9.7)         | 213   | (25.3)*         | 3                |
| 2008–2009     | 3                                | 335   | (7.4)           | 27 (3.1)         | 273   | (21.6)          | 4                |
| 2009–2010     | 2                                | 404   | (13.8)          | 26 (4.6)         | 210   | (25.3)          | 3                |
| 2010–2011     | 1                                | 148   | (10.1)          | –16 (–5.9)       | 115   | (27.2)*         | 4                |
| 2011–2012     | 1                                | 177   | (13.1)*         | 35 (14.2)        | 75    | (20.2)*         | 3                |
| 2012–2013     | 2                                | 443   | (15.9)*         | 60 (11.2)        | 219   | (27.4)*         | 3                |
| 2013–2014     | 3                                | 530   | (12.8)          | 92 (11.5)        | 269   | (22.8)          | –                |

* *p < 0.003; the observed values on all weekdays of the given period were greater or less than the reference range

* The values in parentheses indicate the proportion of excess live births according to the number of live births that were expected on the indicated dates and times.
1981 to 2013, while the increase from 13:00 to 16:59 hours remained at approximately 25%. In contrast, the decreases on weekdays between December 29 and January 3 appeared to lessen. In the first half of the 1980s, the number of births from 9:00 to 12:59 hours was decreased by approximately 25%; in the mid-1990s, the decrease in the number of births had fallen to approximately 15%. However, the decreases from 13:00 to 16:59 hours remained at approximately 35%.

On weekdays between December 24 and 27, the increases from 9:00 to 16:59 hours accounted for approximately 80–100% of the total increases in hospitals after 2003 and approximately 60–90% of the total increases in clinics after 1999.

Discussion

The most important characteristic of the distribution of live births was that the anomalous increases between the Golden Week holidays and the days before the New Year holidays and the anomalous decreases on the New Year holidays, the Bon holidays, February 29, and April 1 always occurred during the daytime. Moreover, these variations always occurred on weekdays in both hospitals and clinics and on Saturdays in clinics. These anomalies occurred nationwide and are unlikely to be random events. With obstetric intervention, the date of birth can be artificially determined within the appropriate childbirth period. It is thought that obstetric interventions spread rapidly throughout Japan between the 1960s and the mid-1980s [19, 20]. Obstetric interventions are usually performed during the daytime on weekdays when there is adequate access to medical facilities and services [21]. In Japan, live births on weekdays have a single-peak or double-peak distribution pattern, with the maximum values occurring during daytime, especially from 13:00 to 15:59 hours, in both hospitals and clinics [22, 23]. In contrast, the live births on Sundays were found to have a slight bimodal distribution in both hospitals and clinics, with maximum values before noon and minimum values in the evening. On the other hand, the distribution of the average number of live births in maternity homes is slightly higher in the early morning and slightly lower in the evening, where only the midwives help with any spontaneous deliveries [14, 24, 25]. In the USA, the percentage of non-induced vaginal deliveries is similar to that observed in maternity homes in Japan [26]. The distribution of live births (by time of day) in maternity homes in Japan is the same for every day of the week. Thus, the increase in the number of births on Sunday afternoon at hospitals and clinics in Japan is thought to be a result of obstetric intervention. However, this intervention is much less than that performed on weekdays. Matsushima examined the distribution of live births (by time and type of facility) in Japan from 1981 to 1998 and hypothesized that obstetric intervention affected the time distribution of live births, with more than 10% of the births that would have occurred during the night and early morning being shifted to normal working hours (9:00 to 17:00 hours) [24]. Consequently, if the dates are set using obstetric interventions, a larger increase or decrease in the number of live births should be observed during the daytime on specific days.

In this study, anomalous increases were observed from 13:00 to 16:59 hours on weekdays between the Golden Week holidays and immediately before the New Year holidays. There were no significant decreases in the number of births on the actual Golden Week holidays in comparison to other holidays. There were no increases before the Bon holidays because many hospitals do not close during the Bon period. However, in clinics, which are often closed for the Bon holidays, decreases were observed in the number of births during Bon (in comparison to other weekdays), even though there were no increases beforehand. While there is no official national data on the medical facilities that are open or closed during Bon, the Web sites for various cities reveals a strong trend for clinics to be closed and hospitals to be open during this period [27–30]. While most of the New Year holidays are not national holidays, they are treated as national holidays by Japanese society. That means that both hospitals and clinics close during that time, resulting in both the aforementioned increases immediately before the New Year holidays and decreases during the New Year holidays. The medical facilities and services that patients have access to in this period are inadequate. The results suggest that some of the births that were expected in the New Year holidays might have been moved forward to the days before the New Year holidays using obstetric interventions for institutional reasons. After the mid-2000s, the anomalous variations in these dates appeared to increase in hospitals. However, the increases in births in the days before the New Year holidays remained stable in clinics throughout the study period. From 2006 to 2009, some pregnant women had a difficult time finding a hospital that would admit them in emergency cases. This dysfunction of the maternal emergency medical system in Japan received considerable attention as a social issue and led to the revision of the fire service law in 2009 [31]. Under the emergency medical system in Japan, fire stations must transport an emergency case to a medical institution by ambulance. In this revision, each prefecture was required to determine the standard of conduct regarding ambulance transportation by fire stations and admission of emergency cases to medical institutions. In the last week of 2008, there was a sudden 30% increase in the number of live births from 9:00 to 12:59 hours in
hospitals. This was probably because doctors encouraged pregnant women with some risk factors, such as cesarean sections, to give birth before the holiday period when access to regional medical services (including blood supplies for transfusions, the maternal emergency medical system, and other services) would decrease.

December 23 became a Japanese national holiday in 1989. May 4 became a holiday in 2007. However, those changes seem to have had no impact on the number of births either on or around that day. The only factor seems to be the day of the week. The reason why a 30% increase was observed in the number of live births at 13:00–16:59 hours on weekdays during the Golden Week holidays after the mid-2000s in hospitals might have been partially the same as that for the increase observed in the anomalous variations of the daytime on weekdays before the New Year holidays after the mid-2000s in hospitals.

The other important characteristic was that anomalous increases occurred from 0:00 to 0:59 hours on March 1 in leap years and on April 2, even if it was a Sunday. A similar phenomenon occurred around 1966, the ‘Hinoe-Uma’ year. The number of births decreased significantly on the last few days of 1966, whereas the number of births increased significantly on January 1 and 2 in 1967. This was interpreted as being the result of fictitious reporting on birth certificates [7]. The above-mentioned anomalous increases from 0:00 to 0:59 hours may be associated with fictitious reporting on the birth certificates, which was performed to please the parents.

If achieved by fictitious reporting on birth certificates, birth date modification can disturb the provision of appropriate health services to children. Health services for newborns, such as the scheduling of health checks, the diagnosis of the state of the growth and nutrition of the baby and the provision of health guidance would be affected by these results, since they are based on the number of days after birth. In the present study, the significant increase in hospital births from 0:00 to 0:59 hours disappeared after the mid-1990s and in clinics after 2001. The significant decrease that was observed in clinics during a wider time interval on February 29 and April 1 also disappeared after the 1980s. These results suggest that until the mid-1990s, the birth dates were altered in relatively large numbers in hospitals, and more frequently in clinics, by fictitious reporting on birth certificates.

The reason why the increases were largely stopped by the 1990s was that Japan adopted the 10th revision of the international classification of diseases and related health problems (ICD-10) in 1995, which revised the birth certificate form and clarified its significance [32]. This likely led to a decreased rate of fictitious reporting.

Under the Medical Care Law, a hospital must have at least three physicians, while a clinic must have at least one. One reason why the ratio of the hourly number of births for 0:00 to 0:59 hours showed a greater increase over a longer period in clinics (in comparison to hospitals) may be because a majority of the clinics were private. The doctors in the private clinics might have felt more at ease making fictitious reports on birth certificates than doctors in hospitals.

The anomalous decrease from 13:00 to 16:59 hours on February 29 and April 1, when they fell on weekdays, continued to occur in both hospitals and clinics. In conclusion, approximately 35% of the births that were originally expected on those dates and times decreased after 2000. The more recent variations on February 29 and April 1 suggest that many individuals may have avoided obstetric intervention on those days. Almost no compensatory increases were seen during the daytime on February 28, March 1, or April 2. The deliveries on those days might have instead been conducted by moving up the birth schedule by one or more days.

The results in the present study do not directly show that the obstetric practices regarding cesarean sections or induced labor increased on the days before the New Year holidays or decreased on leap days and April 1 in Japan. Thus, additional studies will be necessary to confirm any suspected association between the distribution of live births and the practices on those specific days. However, the following three findings appear to support the above-mentioned interpretation of the variations during the Golden Week holidays, during the Bon holidays, and on the days before the New Year holidays, leap day/March 1, and April 1/April 2. First, the distribution of live births that were attended by midwives could only be observed until the mid-1980s, because the numbers after those years were too low to analyze. Through the mid-1980s, the systematic variations in the hourly live births were not observed on the days before the New Year holidays and the New Year holidays, during the Bon holidays, and during the Golden Week. The anomalous variations in live births on February 29/March 1, April 1/April 2 could be observed at wider time intervals on each day. The above characteristics in maternity homes, where deliveries occur spontaneously, appeared to differ from those in hospitals and clinics, where there was a significant variation during the daytime. Second, the results regarding the excess live births suggested that the reason for the total increases between the Golden Week holidays and on the days before the New Year holidays, and also the total decreases seen on February 29, March 31–April 1 and August 13–16 on weekdays were predominantly due to the variations in the live births from 9:00 to 16:59, particularly in the 2000s. Third, the cesarean delivery rate in Japan increased linearly from 8.2 to 24.8% in hospitals and from 6.1 to 13.6% in
clinics from 1984 to 2014 [33]. Although the precise rate of induced labor in Japan remains unknown, reports from hospitals and clinics and the results of surveys inquiring about the type of delivery for women who had just given birth indicate that the rates after the mid-1990s were approximately 10–25% [34–39]. Consequently, the proportion of obstetric interventions after 2000 might be approximately 35% of the total live births.

The data on the type of delivery (such as spontaneous vaginal delivery, cesarean section and induced labor) in live births are not included in the National Vital Statistics in Japan. Furthermore, there are no data on fictitious reports. For these reasons, the present study focused on the distribution of live births by time of day. The times that showed systematic variations could be detected with a study method that was similar to the concept of the X–R control chart. However, some of the excess numbers of births might be inadequate because approximately 10% of the ratios of the hourly number of births (by the days of the week) on non-specific days of each year (which were used for the calculation) were not normally distributed.

In conclusion, the results of this study suggested that, in Japan, birth dates are set according to maternal preferences by avoiding obstetric interventions on specific days. In contrast, obstetric interventions are rarely performed for social reasons, such as a mother wishing to give birth on a specific date. The results also suggested that some birth dates are set using obstetric intervention for institutional reasons. The deliveries that involve some risk may significantly increase in the daytime on specific days before the holiday periods. The excess number of births can therefore provide a rough estimate of these rates. Additional studies will be necessary to confirm any association between the distribution of live births and obstetric intervention practices on those specific days. It is therefore necessary to ensure that sufficient medical support is provided to decrease the risk of either shortening or prolonging the gestational age.

Compliance with ethical standards

Conflict of interest  The author declares no conflicts of interest in association with the present study.

References

1. Takahashi M, Nishina M, Ohta A. The effect of determining birthdays by social factors such as maternal preference on the distribution in the number of daily live births. Jpn J Public Health. 2014;61:16–29 (in Japanese).
2. Imamura O, Sawaki K. Effect of the month of birth on the mental and physical characteristics of children. Bull Sch Phys Educ Tokai Univ. 1989;19:73–9 (in Japanese).
3. Lo JC. Patients’ attitudes vs. physicians’ determination: implications for cesarean sections. Soc Sci Med. 2003;57:91–6.
4. Levy BR, Chung PH, Slade MD. Influence of Valentine’s Day and Halloween on birth timing. Soc Sci Med. 2011;73:1246–8.
5. Lei H, Wen SW, Walker M. Determinants of caesarean delivery among women hospitalized for childbirth in a remote population in China. J Obstet Gynaecol Can. 2003;25:937–43.
6. Lumbiganon P, Laopaiboon M, Gülmezoglu AM, et al. Method of delivery and pregnancy outcomes in Asia: the WHO global survey on maternal and perinatal health 2007–08. Lancet. 2010;375:490–9.
7. Statistics and information department, minister’s secretariat, ministry of health and welfare. A Special Article Regarding the Decrease in the Number of Live Births in 1966. [Showa 41 nen no shussei-genshou nitsuite.] In: Vital Statistics of Japan 1966 volume 1. Tokyo, Japan: Health and Welfare Statistics Association. 1969;1:68–9 (in Japanese).
8. Statistics and information department, minister’s secretariat, ministry of health, labour and welfare. Table 29–30 and Table 46–47. In: Static/Dynamic Survey of Medical Institutions and Hospital Report. 2011. Section 2. Tokyo, Japan: Health, Labour and Welfare Statistics Association. 2013; 266–9 & 274–7.
9. JSOG and JAOG. “CQ412: How Should Labor be Induced?” In: JSOG and JAOG, ed. Guidelines for Obstetrical Practice in Japan, 2014 Edition. Tokyo, Japan: Japan Society of Obstetrics and Gynecology; 2014.
10. Caughey AB, Stotland NE, Washington AE, Escobar GJ. Maternal and obstetric complications of pregnancy are associated with increasing gestational age at term. Am J Obstet Gynecol. 2007;196:155.e1–6.
11. Caughey AB, Sundaram V, Kaimal AJ, Gienger A, Cheng YW, McDonald KM, et al. Systematic review: elective induction of labor versus expectant management of pregnancy. Ann Intern Med. 2009;151(4):252–63 (W53–63).
12. Okada M, Ogino H, Koge A, Ohashi S, Fujinaka Y, Iwamura M, et al. Mode of delivery, gestational age and clinical courses for Transient Tachypnea of the newborn in term infants. J Jpn Soc Perin Neon Med. 2009;45:1317–21.
13. Fukushima M, Maeda S, Shibata T, Yoshimura S, Miki N, Yamanaka C, et al. Investigation of risk factors of transient tachypnea of the newborn in our hospital and trial for early diagnosis. Tenri Found Tenri Inst Med Res. 2014;17:67–71.
14. Statistics and information department, minister’s secretariat, ministry of health, labour and welfare. In: Vital Statistics of Japan (non-published table), 1981–2013. Tokyo, Japan: Minister’s Secretariat, Health, Labour and Welfare Statistics and Information Department. 1981–2013. (in Japanese).
15. Matsuda S, Kabyo H. Analysis of the geographical differences in the seasonality of birth in Japan. Jpn. J. Biometeor. 1993;30:60–75 (in Japanese).
16. Nonaka K, Desjardins B, Légaré J, Charbonneau H, Miura T. Effects of maternal birth season on birth seasonality in the Canadian population during the seventeenth and eighteenth centuries. Hum Biol. 1990;62:701–17.
17. NIST/SEMATECH. 6. Process or product monitoring and control. In: e-Handbook of statistical methods, http://www.itl.nist.gov/div898/handbook/ Accessed 1 Aug 2016.
18. Tango T. Clinical Laboratory. In: Miyahara H, Tango T, ed. A handbook of medical statistics, Tokyo, Japan: Asakura Shoten. 1997;514–41 (in Japanese).
19. Shin S. Changes in obstetric management—changes in deliveries. Perinat Med. 2000;30:1612–6 (in Japanese).
20. Shin S. The changes in the percentage of cesarean sections & the changes in acceptability. Obstet Gynecol. 2002;3:269–74 (in Japanese).
21. Ando K. Analysis of births by day of the week and time of induced labor. [Bunben-jikoku, youbi oyobi yuuhatsu-bunben no shussei-genshou nitsuite.] In: Vital Statistics of Japan 1966 volume 1. Tokyo, Japan: Health and Welfare Statistics Association. 1969;1:68–9 (in Japanese).
22. Ministry of Health, Labour and Welfare. Trends in live births by day of the week and time of live birth and place of delivery. In: Live Births: Specified Report of Vital Statistics in FY 2010. Tokyo, Japan: Health, Labour and Welfare Statistics Association, 2011; pp. 272–83.

23. Morita N, Matsushima N, Ogata N, Saeki K, Ishibashi M, Komukai H, et al. Nationwide description of live Japanese births by day of the week, hour, and location. J Epidemiol. 2002;12:330–5.

24. Matsushima N, Morita N, Ogata N, Saeki K, Matsuda R, Kurumatani N. Live birth distribution by time and place from 1981 to 1998 in Japan. Jpn J Hyg. 2003;57:674–81 (in Japanese).

25. Statistics and information department, minister’s secretariat, ministry of health, labour and welfare. Table 22. Trends in live births per day by day of the week and time of live birth and place of delivery, 1975 and 2009. In: Live births (specified report of vital statistics in FY 2010). Tokyo, Japan: Health and Welfare Statistics Association; 2011. pp. 278–83.

26. Mathews TJ, Curtin S. When are babies born: morning, noon, or night? Birth Certificate Data for 2013. NCHS Data Brief. 2015;200:1–7.

27. Kikuchi Medical Association. Examination hours during Bon. http://www.kikuchi-med.or.jp/news/thumbnails/563-1.pdf. 1 Aug 2016.

28. Nagaoka Medical Association. Nagaoka festival/examination hours during Bon. http://www.nagaoka-med.or.jp. 1 Aug 2016.

29. Noshiro Yamamoto medical association. Medical facility Schedules during Bon. http://www.nyma2.jp/H24obon.pdf. 1 Aug 2016.

30. Chofu Medical Association. Inquiry of Medical Facility Summer Holidays. www. Chofu-med.or.jp. 1 Aug 2016.

31. Ambulance service planning office, fire and disaster management agency. Feature article: an outline of the partial revision of the fire service law. [Shoubouhou no ichibu wo kaiseisuru houritsu no gayou.]. Shobo-no-ugoki. 2009;458:4–7 (in Japanese).

32. Ministry of Health, Labour and Welfare. II. Manual on completion of a birth certificate, and a fetal death certificate. In: Manual on completion of a death certificate, a birth certificate, and a fetal death certificate. Tokyo, Japan: Health, Labour and Welfare Statistics Association; 1995. pp. 49–53 (in Japanese).

33. Ministry of health, labour and welfare. In: Static/dynamic survey of medical institutions and hospital report. Tokyo, Japan: Health, labour and welfare statistics association, 1984–2014.

34. Tsumura N, Tsumura N, Sagawa T. The significance of induced labor in our department. [Touka niokeru bunben-yuhatsu no igi ni tsuite.]. Chitose City Hosp J. 2009;5(1):1–3 (in Japanese).

35. Shimizu Y. The frequency of use of labor-inducing drugs and the duration of labor by fiscal year. [Nendobetsu jintsu-sokushin-zai shiyou-hindo to bunben-shoyou-jikan.]. Adv Obstet Gynecol. 1999;51:239–41 (in Japanese).

36. Kiuchi A, Tetsuka S, Matsumoto I, et al. A survey on the safety of medical care in regard to deliveries at clinics with hospital beds (second report): are childbirths managed through artificial manipulation in Japan? [Yushou-shinryosho niokeru bunben no iryou-anzen nikansuru chousa (Dai 2 hou)]. Nihon no osan ha jiniteki na sousa niyotte kanri sareteirunoka?]. Tochigi Matern Health. 2010;36:11–2 (in Japanese).

37. Watanabe H, Shimada M. A study on the ideal method of carrying out deliveries from the perspective of users. In: [Riyousha no tachiba kara mite nozomashii shussan no arikata ni kansuru kenkyu.]. Health Science Research (Child and Family Research Project) Report FY 1999 2000; 3/6: pp. 357–411 (in Japanese).

38. Kano N, Shimada C, Komatsu M, et al. Experiencing Childbirth in Ibaraki prefecture: conditions and Women’s satisfaction. ASVPI. 2004;9:1–10 (in Japanese).

39. Ohama E. The rate of induction of labor among the pregnant women, Yokohama. Yokohama Med Bull. 1997;48:259–65 (in Japanese).