Chapter 2
Proximate Determinants of Fertility in Japan

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Abstract Proximate determinants link both social and biological factors to fertility. In this section, we will summarize available data related to proximate determinants of fertility in Japan while referring to some of the related literature targeting populations overseas. In addition to data from published studies, we present our original data collected in the biodemography project, an Internet-based cross-sectional survey on reproductive history conducted in 2014 targeting Japanese women between 20 and 44 years of age. Following Wood's conceptualization, the specific components of the proximate determinants of fertility referred to in this chapter are lactational infecundability, fecund waiting time to conception, and fetal loss (both spontaneous and induced). Additionally, papers on factors that are expected to significantly affect fecund waiting time to conception, i.e., frequency of sexual intercourse, length and regularity of menstrual cycle, and use of contraception and infertility treatment, will be reviewed.

Keywords Internet-based survey · Lactational amenorrhea · Menstrual cycle
Time to pregnancy (TTP) · Assisted reproductive technology (ART)
Japan

2.1 Biodemography Project

The biodemography project was an Internet-based survey that targeted women aged 20–44 years old who resided across Japan at the time of survey in 2014 [1]. This project was supported by KAKENHI 70451771 and Ritsumeikan University Institute of Human Sciences, Exploratory Research Fund. The primary purpose of the project was to estimate fecundity and its covariates, including proximate determinants, by applying the current duration approach [2, 3]. The respondents (n = 3214, a 30.7% response rate) were recruited from a group of research participants of a market research company called Intage, Inc.

Based on the rationale presented below, we deem it useful to show certain data from the biodemography project and to propose future research topics that are

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important to an understanding of the fertility trend in Japan. Internet-based recruitment of and follow-up with participants have been successfully used in recent studies on time to pregnancy (TTP) in Denmark [4] and in the USA [5]. In Japan, numerous research companies provide online research services that focus mainly on business marketing through the distribution of questionnaires to their registered research monitors. Use of the Internet is especially helpful in reaching young people, who are relatively difficult to reach with traditional recruiting methods, such as mailings or visits by researchers. Another benefit of Internet-based surveys is cost-effectiveness [4]. Because the process is much less expensive than paper- or interview-based questionnaire surveys, researchers can target a larger number of individuals compared with traditional methods with the same budget and can conduct a pilot survey before implementing a survey that targets a nationally representative sample. Although the representativeness of the sample of an Internet-based survey is not as definitive as that of a nationally representative sample, Hatch et al. [6] evaluated selection bias in an Internet-based preconception cohort (Snart Gravid $n = 4801$) with data from the Danish medical birth registry and concluded that recruiting reproductive-aged women via the Internet "may be no more prone to selection bias than traditional methods of recruitment." Based on the above-mentioned information, we conclude that an Internet-based survey is useful, especially when asking personal questions that seek information regarding factors such as contraceptive use and sexual behavior, which is hard to obtain from face-to-face or paper-based interview surveys.

We compared the participants of the biodemography project with the population of the entire country of Japan (based on the 2010 Population Census) with respect to the distribution of partnership status by women's ages (Table 2.1). In the younger age-groups, there is a higher proportion of married participants in the biodemography project compared with the national sample. In the older age-groups, the partner status distribution is more or less similar between the two populations, although the "unknown" category is included only in the national sample (in contrast to a paper-based survey, an Internet-based survey can ensure that participants select a response for every question). Basic characteristics of the respondents are summarized in Table 2.2.

2.2 Lactational Infecundability

Lactational infecundability, or postpartum amenorrhea, refers to the time period between the end of pregnancy and resumption of fecundity. In Japan [7] and many other countries [8], prolonged duration of postpartum amenorrhea is consistently found among mothers who breast-feed for longer durations compared with those who breast-feed for shorter durations. It can be hypothesized that the increasing proportion of breastfeeding mothers in Japan contributes to prolonged duration of postpartum amenorrhea, which in turn could be linked to the risk of secondary infertility. Although there is not yet enough data to test this supposition, future

Table 2.1 Age and partnership status of participants in the biodemography project and the total population of Japan [1]

	Biodemography project[a] (n = 3196) (%)				Japan[b] (%)				
	Married	Unmarried, partnered	Unmarried, no partner	Total	Married	Unmarried, partnered	Unmarried, no partner	Unknown	Total
20–24	13	35	52	100	9	34	51	5	100
25–29	49	21	30	100	36	23	36	5	100
30–34	64	14	21	100	60	10	26	5	100
35–39	71	10	19	100	69	5	23	4	100
40–44	73	7	20	100	72	26		2	100
Total	61	14	24	100	52	46		2	100

[a]No participants were in the unknown category

[b]Estimated based on the 2010 Population Census (proportions of married and unmarried) [56] and the National Survey on Fertility 2010 (proportion of women with a partner among unmarried women) [57]. Because no data are available for 40–44-year-old women in the National Survey on Fertility, the proportions of unmarried women with and without male partners could not be calculated for this age-group

Table 2.2 Basic demographic characteristics of participants in the biodemography project (n = 3196)

Characteristics	n	Proportions (%)
Age (year)		
20–24	279	9
25–29	525	16
30–34	715	22
35–39	832	26
40–44	845	26
Education[a]		
High school or less	912	29
Junior college/vocational school	1120	35
University or higher	1164	36
Annual household income (million yen)		
Less than 3	961	30
3–4.9	801	25
5–9.9	800	25
10+	634	20
Partnership status		
Married	1965	61
Unmarried, partnered	449	14
Unmarried, no partner	782	24
Number of children		
0	1753	55
1	594	19
2	669	21
3+	180	6
History of spontaneous abortion		
0	2782	87
1	299	9
2	61	2
3+	24	1
Do not know/do not want to answer	30	1
History of induced abortion		
0	2871	90
1	221	7
2	52	2
3+	22	1
Do not know/do not want to answer	30	1
Infertility consultation/treatment		
Never	2563	80
Ever (without ART[b])	365	11
Ever received ART	87	3

(continued)

Table 2.2 (continued)

Characteristics	*n*	Proportions (%)
Do not know/do not want to answer	181	6
Current contraceptive use		
None	638	20
Unreliable	1635	51
Reliable	923	29
Frequency of sexual intercourse		
1+ day per week	374	12
1–3 days per month	694	22
Less than once a month	919	29
Do not know/do not want to answer	1209	38

[a]Highest education completed by the respondent or in which the respondent is currently enrolled
[b]Assisted reproductive technology, which is defined in this book as in vitro fertilization and micro-insemination but excludes artificial insemination

research should examine the possible demographic impact of the combination of increasing age at childbearing, low frequency of sexual intercourse, and prolonged duration of breastfeeding. Considering that both primary infertility and secondary infertility are prevalent among Japanese women [9], it is important to assess the possible impact of breastfeeding behavior on fertility outcomes.

Available national data suggest that the proportion of breastfeeding mothers decreased from 1985 to 2005 and then increased in 2015. According to the national nutrition survey on preschool children in Japan, the proportion of mothers who exclusively breast-feed at 1 month after delivery slightly decreased from 49.5% in 1985 to 42.4% in 2005 and then increased to 51.3% in 2015. At 3 months after delivery, the proportions were 39.6% in 1985, 38.0% in 2005, and 54.7% in 2015 [10]. Reflecting the increase of breastfeeding mothers, the proportion of mothers who exclusively bottle feed at 1 month after delivery decreased from 9.1% in 1985 to 3.6% in 2015. The proportion of mothers who exclusively bottle feed at 3 months after delivery also decreased, going from 28.5% in 1985 to 10.2% in 2015 [10]. To the best of our knowledge, the potential demographic impact (e.g., the effect on fertility or birth intervals) of such changes in breastfeeding patterns has not yet been examined in Japan.

Consistent with numerous previous studies conducted overseas [8], the limited data in Japan show that mothers with longer durations of breastfeeding have longer postpartum amenorrhea compared to mothers who breast-feed for shorter durations. In the 1981 Field Survey of Fertility, which targeted women in three communities (Suginami Ward in Tokyo, Fukuoka City, and Hirosaki City) in Japan, more than 50% of mothers with 6-month-old babies who exclusively breast-fed were still experiencing lactational amenorrhea, whereas the proportion was as low as 10% for mothers who exclusively formula fed [7, 11]. Although it is expected that the recent increase in the proportion of breastfeeding mothers in Japan has resulted in the prolonged duration of postpartum amenorrhea, we know of no recently published

data on postpartum amenorrhea among Japanese women, with the exception of the indirect data from our own survey. Data from the biodemography project in 2014 indirectly reveal a prolonged duration of lactational amenorrhea among breastfeeding mothers. Among breastfeeding mothers (either exclusively or combined with formula milk), as many as 58% (with 0-year-old babies), 35% (with 1-year-old babies), and 14% (with 2-year-old babies) were experiencing postpartum amenorrhea at the time of survey, as indicated by an absence of menstrual bleeding in the past 6 months, whereas among nonbreastfeeding mothers, the corresponding proportions were only 10% (with 0-year-old babies), 11% (with 1-year-old babies), and 2% (with 2-year-old babies). Considering that the age at first marriage continues to increase in Japan [12] and that reproductive years during marriage are decreasing, the relative impact of postpartum amenorrhea on fertility may have increased. This hypothesis should be tested in future research.

These limited Japanese data on breastfeeding and postpartum amenorrhea show a clear contrast with reports from Western populations regarding duration [13]. According to a recent report published in the Lancet [14], the estimated proportion of mothers in Japan who breast-feed (either exclusively or not) their 12-month-old babies was 60%, compared with only 9% in Canada, 3% in Denmark, 9% in France, 23% in Germany, 19% in Italy, 23% in Spain, 0.5% in the UK, and 27% in the USA. These data suggest the possibility that the duration of postpartum amenorrhea might be longer for Japanese mothers compared to mothers in Western countries in general, indicating that the demographic impact of nursing on fertility may be more evident in Japanese populations than in Western settings.

2.3 Fecund Waiting Time to Conception

In this section, we will focus on TTP as measured by number of months or menstrual cycles between starting unprotected intercourse and conception. Strictly speaking, fecund waiting time to conception differs from TTP measured in general epidemiological surveys because a certain proportion of fetal loss is not observed due to limitations in detection. In addition, certain previous studies did not include couples who had not yet conceived, i.e., right-censored TTP, whereas other studies did. Even with these limitations, we believe it is useful to summarize available data on TTP and the cumulative probability of pregnancy among Japanese couples with references to certain previous studies conducted overseas. Because TTP in a population commonly shows skewed distribution with some very long TTP and certain studies include right-censored TTP, the cumulative probability of conception is easy to understand and commonly used in many previous studies. Additionally, using data from the biodemography project, we present descriptive statistics of right-censored TTP, i.e., the duration of unprotected intercourse that has not resulted in pregnancy. Right-censored TTP is not comparable to TTP but provides an idea of the number of nulliparous couples who are waiting more than 12 months to conceive, which is a commonly used cutoff for infertility.

Table 2.3 Probability of conception by duration of marriage among Japanese women [15]

Duration of marriage (years)	Probability of conception in each year (%)	Proportion of women not yet pregnant at the end of each year (%)	Probability of conception in later years among those who did not conceive by the end of each year (%)
1	67.9	32.1	68.8
2	40.5	19.1	47.5
3	18.7	15.5	35.4
4	12.9	13.5	25.8
5	8.8	12.4	18.7
7	3.5	11.4	12.1
10	0.7	10.9	7.7
15	0.4	10.3	1.8

Information regarding the basic characteristics of participants, survey year, and location is unknown.

In 1939, Shinoda [15] targeted 7500 married women (Table 2.3) and reported that 67.9% of the women became pregnant within 1 year after marriage. Among the women who did not conceive within 1 year after marriage, 68.8% became pregnant thereafter and the other 31.2% did not conceive by the time of the survey. More recently, Arakawa and colleagues [16, 17] conducted a series of studies in three areas in Japan to examine the possible effects of environmental exposure on TTP, targeting mothers who had never received infertility treatment. At a hospital in Tokyo, they distributed questionnaires to n = 132 pregnant women [with a mean age of 30.1 (4.6) years]. The range of TTP was 0–54 months, and the mean (SD) was 5.9 (9.2) months. In a study that examined the association between hair mercury concentration and TTP, the authors targeted 298 mothers aged 31.4 (4.2) years who delivered at two hospitals in a coastal area of the Tohoku district. The questionnaire was distributed to mothers at 3 days postpartum and collected the following day. A total of 180 women (60%) reported TTP ranging between 0 and 80 months with a mean of 5.1 (7.3) months. Another study of theirs examined the association between dioxin concentrations in breast milk and TTP, targeting 153 pregnant women [with a mean age of 28.6 (4.5) years] at two clinics in the Miyazaki prefecture. A total of 99 women (65%) reported TTP ranging from 0 to 53 months with a mean of 4.5 (7.5) months. All three of these studies included both nulliparous and parous women, and the mode of TTP was 1 month. In the series of studies by Arakawa and colleagues, the cumulative probability of pregnancy after 6 months of trying was approximately 80%, which is similar to data from previous studies overseas. A study targeting pregnant women in Denmark that examined the association between moderate alcohol consumption and TTP targeted n = 39,612 pregnant women, among whom n = 29,844 (75%) reported their pregnancy to be planned and provided TTP values [18]. Among these women, 48% reported TTP of 0–2 months, 21% reported TTP of 3–5 months, 16% reported 6–12 months, and 15% reported TTP longer than 12 months. Another study compared TTP between

couples in European countries and Thai couples and reported that among primigravida women with planned pregnancies, 73.7% of the European women reported TTP equal to or shorter than 6 months and 74.8% of the Thai women reported the same TTP [19]. Among multigravida women, the corresponding proportions were 74.9% for European women and 66.8% for Thai women.

Although the proportion of women with TTP longer than 6 months did not substantially differ between Japanese and Western data when noncensored TTP was considered, much less is known about right-censored TTP, i.e., the duration of trying to conceive without success. According to Shinoda [15], less than 70% of newly married couples conceived within 12 months after marriage. Comparative data from more recent populations in Japan [20] show that this proportion varies greatly depending on the couples' ages and tends to be lower than that found in previous studies in Western settings. The proportion of women who conceived within 12 months after discontinuing contraception was 80% for those aged 24–26 years, 66% for those aged 30–32 years, and 48% for those aged 36–38 years [20].

To examine the distribution of right-censored TTP and its associated factors, we limit the biodemography project sample to nulliparous women who were not currently pregnant and were not using any contraceptives ($n = 235$).[1] We defined right-censored TTP[2] as the duration of unprotected intercourse without pregnancy that leads to a live birth. Right-censored TTP could not be obtained from 118 women (50%).[3] Among those who reported valid right-censored TTP values ($n = 117$), 15% ($n = 18$) reported 0–11 months and 28% ($n = 33$) reported 10 years or longer (Fig. 2.1). As many as 85% of the couples reported right-censored TTP equal to or longer than 12 months. These data suggest that the nulliparous group comprised both women who had recently discontinued contraception and women who had been waiting to conceive for years. The median (interquartile range) of right-censored TTP for the 118 women was 63 (25, 130) months.

In addition, we explored several factors that potentially affect right-censored TTP in this limited sample of the biodemography project. We found that couples who received ART reported longer right-censored TTP compared to other women. For those who had never undergone infertility treatment, the right-censored TTP was 54 (19, 119) months, whereas for those who had undergone general infertility treatment, it was 56 (21, 124) months, and for those who had ever received ART, it was 84 (54, 124) months. Women with lower coital frequency reported longer

[1]Total number of participants in the biodemography project was $n = 3196$, among whom $n = 1965$ (61%) were married. Among the married women, $n = 562$ were nulliparous and currently not pregnant; among this smaller group, $n = 235$ were not using any contraception.

[2]For $n = 89$ women who reported that they had never used contraceptives, the right-censored TTP was defined as the duration between marriage and the time of the survey. For $n = 146$ women who reported that they had stopped using contraceptives, the right-censored TTP was defined as the duration between the cessation of contraceptive use and the time of survey.

[3]$n = 23$ did not report the month and year of marriage, and $n = 95$ did not report the month and year they discontinued contraception.

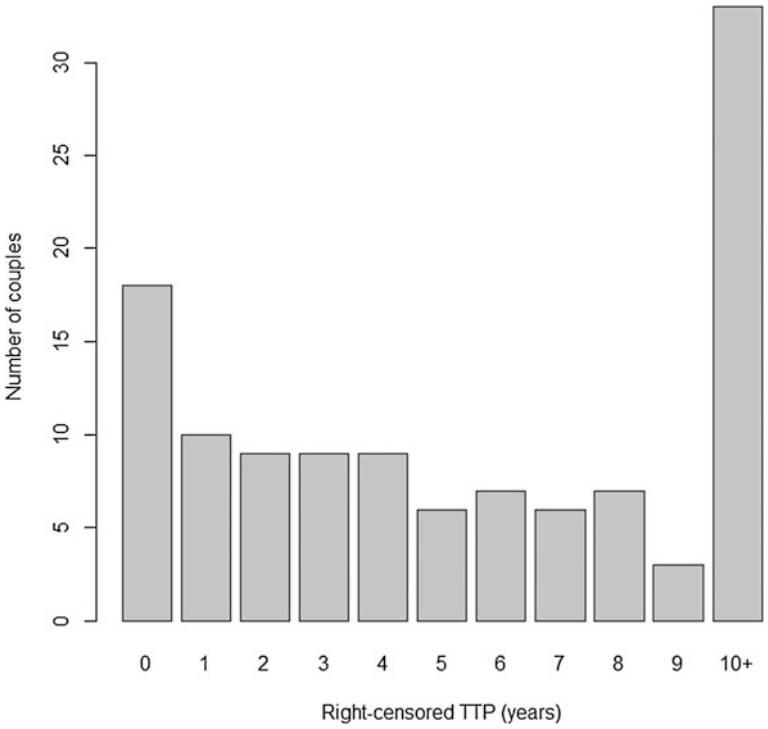

Fig. 2.1 Distribution of right-censored TTP for 118 married nulliparous women who were not pregnant at the time of the survey and were not using contraception. Data obtained from the 2014 biodemography project [1]

right-censored TTP. The median (interquartile range) was 25 (10, 41) months for women with 1 day or more of intercourse per week, 33 (7, 52) months for women with 1–3 days of intercourse per week, 98 (61, 152) months for those having intercourse less than once a month, and 84 (43, 160) months for those who did not report coital frequency. These data suggest that low coital frequency is common among couples who had not been using contraceptives for years but had not yet conceived.

2.4 Frequency of Sexual Intercourse

Frequency of sexual intercourse is one of the most influential components of fecund waiting time to conception. Recent research suggests that frequency of sexual intercourse tends to be lower among Japanese couples compared to couples overseas (e.g., [1,21]).

Table 2.4 Frequency of sexual intercourse during the past 6 months among married women in Japan by age at the time of the survey (unweighted %, n = 1965)

Frequency	Wife's age at the time of the survey (years)					
	20–24	25–29	30–34	35–39	40–44	Total
1+ day per week	11 (31%)	56 (22%)	72 (16%)	55 (9%)	57 (9%)	251 (13%)
1–3 days per month	14 (39%)	100 (39%)	149 (32%)	167 (28%)	111 (18%)	541 (28%)
Less than once a month	8 (22%)	70 (27%)	169 (37%)	271 (46%)	314 (51%)	832 (42%)
Do not know/do not want to answer	3 (8%)	32 (12%)	71 (15%)	101 (17%)	134 (22%)	341 (17%)
Total	36 (100%)	258 (100%)	461 (100%)	594 (100%)	616 (100%)	1965 (100%)

Number and proportions in each age category. Data obtained from the 2014 biodemography project [1]

The biodemography project revealed an overall low frequency of intercourse (Table 2.4). Additionally, when the participants were further categorized by their pregnancy intention, only 24% of married women who wanted to become pregnant and were not pregnant at the time of the survey were having intercourse 1+ day per week [1]. The proportion of women having intercourse 1+ day per week was even smaller for those who wanted to become pregnant in the future (14%) or who did not want to become pregnant (12%) [1]. The National Survey of Work and Family in Japan conducted in 2007 [21] also reported low coital frequency (Table 2.5); only 23% of women desiring a child had sexual intercourse at least once a week. The same survey showed that 21% of women aged between 20 and 29 years and 37% of women aged between 30 and 39 years were in sexless marriages, which refers to married or cohabitating couples who have not had any sexual intercourse for more than 1 month (Table 2.5, sum of "once in 2 months", "once in 6 months", and "not at all") [21]. In a series of studies conducted by Arakawa and colleagues [16] to examine a possible association between chemical exposure and TTP, more than 70% of the respondents answered that the frequency of intercourse before their latest pregnancy was equal to or less than once a week (Table 2.6). These data suggest that the frequency of intercourse tends to be low among couples in Japan today, even when the sample is limited to couples who eventually achieved pregnancy or were actively trying to conceive.

Although they are not directly comparable, previous studies conducted in Western settings seem to report higher frequencies of intercourse compared to previous studies conducted in Japan. A study based on the 2002 National Study of Family Growth of the USA revealed that the mean coital frequency for married women aged 25–45 years was 6.59 (95% CI: 6.27–6.91) times per month [22]. A study targeting pregnant women in the UK reported that the mean coital frequency before pregnancy was 1.9 (95% CI: 1.8, 1.9) times per week for fecund

Table 2.5 Frequency of marital intercourse during the past year (weighted %) by wife's age

Frequency of sexual intercourse	Age of women (years)				Total (n = 2464) (%)
	20–29 (n = 143) (%)	30–39 (n = 683) (%)	40–49 (n = 756) (%)	50–59 (n = 844) (%)	
1+ per week	29	19	12	8	14
Once every 2 weeks	25	14	12	10	13
Once a month	15	17	13	11	13
Once every 2 months	4	6	8	5	6
Once every 6 months	10	16	15	15	15
Never	7	15	24	37	24
Other	2	2	1	0	1
No answer	8	11	15	14	13
Total	100	100	100	100	100

Data obtained from the National Survey of Work and Family in Japan, 2007 [21]

Table 2.6 Mean (SD) age of mothers at the time of the survey and distribution (n and % in each study area) of the frequency of sexual intercourse before the current pregnancy

	Tokyo (n = 68)	Tohoku (coast) (n = 149)	Tohoku (city) (n = 297)	Miyazaki (n = 153)
Age (years)	30.1 (4.6)	29.2 (5.1)	31.4 (4.2)	28.6 (4.5)
Frequency of sexual intercourse (n)				
2+ times a week	16 (24%)	42 (28%)	51 (17%)	32 (21%)
Once a week	15 (22%)	59 (40%)	99 (33%)	76 (50%)
Less than once a week	36 (53%)	48 (32%)	120 (40%)	44 (29%)
Unknown	1 (1%)	0 (0%)	27 (9%)	1 (1%)

Questions were posed to pregnant women (mothers) in four places in Japan between 2000 and 2005 [16]

women (TTP $\leq$ 12 months) and 1.9 (95% CI: 1.8, 2.0) for subfecund women (TTP > 12 months) [23]. In a prospective cohort study on TTP targeting 2820 Danish women trying to conceive, the proportion of participants reporting 4 or more times of intercourse per week was 30.7% for women aged <25 years, 20.7% for women aged 25–29 years, 14.8% for women aged 30–34 years, and 15.4% for women aged 35–40 years at the baseline [24].

Although recent studies report relatively low frequency of sexual intercourse among Japanese couples compared to those in Western countries, studies conducted in the past report a higher frequency of intercourse among Japanese couples. For example, in 1955, Tsukamoto [25] reported that more than 80% of married women had sexual intercourse once a week or more (Table 2.7). Infrequent sexual

Table 2.7 Frequency of sexual intercourse among married women in agricultural villages in Yamanashi and Saitama prefectures in Japan (n = 97) [25]

Frequency of sexual intercourse	Right after marriage (n = 97)	At the time of the survey by women's age (years) and total				
		20–29 (n = 23)	30–39 (n = 34)	40–49 (n = 23)	50–59 (n = 7)	Total (n = 88)
8+ times a week	5 (5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
4–7 times a week	57 (59%)	4 (17%)	3 (9%)	1 (4%)	0 (0%)	8 (9%)
1–3 times a week	35 (36%)	19 (83%)	29 (82%)	14 (61%)	2 (29%)	65 (74%)
Less than once a week	0 (0%)	0 (0%)	2 (6%)	4 (17%)	4 (57%)	10 (11%)
Almost never	0 (0%)	0 (0%)	0 (0%)	4 (17%)	1 (14%)	5 (6%)
Total						

Frequency of intercourse is shown separately for immediately after marriage and at the time of survey (by women's age and total). The survey was conducted between 1953 and 1954

intercourse among Japanese couples in recent years may be the result of socio-cultural factors, including prevalent premarital sex [26], higher unemployment rates, and long working hours among those who are employed [27]. It is also possible that a lower frequency of marital sexual intercourse is often accompanied by active sexual activity outside the marital relationship, although we do not have sufficient data to support or reject this supposition.

2.5 Menstrual Cycle

Menstrual cycle abnormalities, such as irregularity and short or long cycle lengths, have been linked to infertility, particularly through ovulation disorders and longer TTP [28–31]. The Japan Society of Obstetrics and Gynecology defines a normal menstrual cycle length as between 25 and 38 days and defines a regular cycle as that with a length that changes by less than 7 days [32]. A seminal study by Matsumoto [33] on 701 housewives of coal miners found that their average cycle length was 30.37 days (SD = 6.54 days) and that the average shift[4] in menstrual cycle length was 8.15 days (SD = 5.98 days).

Using data from the biodemography project, we present our analysis on cycle length and regularity of menstruation.[5] Short and long menstrual cycles are often related to anovulation, which prolongs TTP [28, 31]. According to

[4]Cycle length variation was calculated by taking the difference between the maximum and minimum lengths among 10 consecutive ovulatory cycles randomly selected from 65 subjects.

[5]Appendix shows the original survey questionnaire items used to measure cycle length and regularity.

Table 2.8 Cross-tab between cycle lengths and cycle irregularity[a] (n = 2454)

		Regular Cycle	Irregular Cycle	Total
Short cycle (<25 days)	*N*	51	32	83
	%	61	39	100
Normal cycle (25–37 days)	*N*	1170	747	1917
	%	61	39	100
Long cycle (>37 days)	*N*	7	43	50
	%	14	86	100
No particular cycle length	*N*	59	345	404
	%	15	85	100
Total	*n*	1287	1167	2454
	%	52	48	100

Data obtained from the 2014 biodemography project [1]
[a]Cycle irregularity is defined as changes in cycle length of 7+ days during the past 6 months

Matsumoto [33], anovulation, as measured by basal body temperature, was much more prevalent (approximately 17%) among short (<25 days) and long (>38 days) cycles than among normal cycles, where only 3.2% were anovulatory. Cycle length variability commonly occurs a few years after menarche and before menopause and has been found to be related to lower fecundability [34, 35] and a history of fetal loss and infertility[6] [36]. In analyzing our data, we selected women who were not pregnant or breastfeeding and who had experienced menstruation at least once in the past 6 months. We excluded women who took steroids or other hormonal medicine in the 3 months prior to the survey. The sample size for the current selection is 2454.

Our data show that among respondents who reported their cycle lengths (n = 2050), the average menstrual cycle length was 28.9 days with a standard deviation of 3.7 days. Approximately 94% of the reported cycle lengths fell within the normal length of 25–38 days. Regarding cycle irregularity, 37% of respondents have experienced an irregular menstrual cycle with more than 6 days of shift. Additionally, approximately 10% of respondents reported that their cycle is too irregular to know whether they have experienced a cycle length shift. Table 2.8 shows the cross-tabulation between cycle lengths and cycle irregularity. Approximately 86% of women with long cycle lengths reported that they have experienced cycle irregularity of more than 6 days, whereas approximately 60% of those with short or normal cycle lengths indicated that they have never experienced cycle irregularity. Among those who indicated that they do not have a fixed cycle length, approximately 15% of them stated that they have a regular cycle, i.e., they have not experienced a change in cycle length greater than 6 days even though they do not have a fixed schedule.

[6]Infertility is defined as more than one year of having unprotected intercourse without pregnancy.

To better understand how social and behavioral factors affect the length and irregularity of menstrual cycles, we conducted multivariate analyses. For the analysis of menstrual cycle length, we used the following three categories for the dependent variable: short (<25 days) cycle, long (>38 days) cycle, and normal (25–38 days) cycle. Approximately 3% of the sample reported having short cycles (n = 83), and approximately 2% reported having long cycles (n = 50). We used a multinomial logistic regression with normal cycle length as a reference group. For the analysis of irregularity, we defined irregularity as a change in cycle length by more than 6 days in the past 6 months; we also included those whose cycles are too irregular to report. Overall, those who reported irregularity constitute 48% (n = 1167) of the total sample. Our independent variables are age, parity, educational background, BMI, smoking, and work hours per week.

Table 2.9 indicates that compared to 30–34-year-old women, women who are younger than 30 years are more likely to have irregular menstrual cycles, whereas

Table 2.9 Effect of lifestyle factors on menstrual cycle irregularity. Odds ratios and 95% confidence intervals from binomial logistic regressions (n = 2454)

Explanatory variables	Irregular menstrual cycle
Age (years)	
20–24	2.18 (1.57, 3.03)
25–29	1.31 (0.99, 1.74)
30–34	Reference
35–39	0.73 (0.57, 0.92)
40–44	0.81 (0.64, 1.02)
Parity	
Nulliparous	Reference
Parous	0.91 (0.61, 1.36)
Education	
HS or less	Reference
Vocational school	0.91 (0.75, 1.12)
College+	0.86 (0.70, 1.06)
BMI	
Underweight (<18.5)	1.31 (1.06, 1.62)
Normal (18.5–25)	Reference
Overweight (25+)	1.47 (1.13, 1.91)
Smoking	
No (never or former)	Reference
Current	1.17 (0.91, 1.49)
Work hours per week	
0 h	Reference
1–34 h	0.97 (0.79, 1.19)
35–49 h	1.03 (0.84, 1.26)
50+ h	1.49 (1.03, 2.14)

Data obtained from the 2014 biodemography project [1]

Table 2.10 Effect of lifestyle factors on menstrual cycle length

Explanatory variables	Short cycle (<25 days)	Long cycle (>38 days)
Age (years)		
20–24	3.05 (1.19, 7.81)	0.95 (0.36, 2.52)
25–29	1.63 (0.61, 4.30)	0.95 (0.42, 2.17)
30–34	Reference	Reference
35–39	2.08 (0.91, 4.73)	0.57 (0.26, 1.24)
40–44	2.50 (1.13, 5.53)	0.29 (0.12, 0.72)
Parity		
Nulliparous	Reference	Reference
Parous	3.84 (0.52, 28.17)	1.20 (0.28, 5.14)
Education		
HS or less	Reference	Reference
Vocational school	0.79 (0.45, 1.37)	0.95 (0.45, 2.01)
College+	0.89 (0.51, 1.35)	1.25 (0.61, 2.55)
BMI		
Underweight (<18.5)	1.09 (0.61, 1.95)	1.21 (0.60, 2.45)
Normal (18.5–25)	Reference	Reference
Overweight (25+)	1.05 (0.51, 2.16)	1.94 (0.87, 4.33)
Smoking		
No (never or former)	Reference	Reference
Current	1.89 (1.06, 3.35)	1.80 (0.84, 3.86)
Work hours per week		
0 h	Reference	Reference
1–34 h	2.45 (1.36, 4.41)	1.05 (0.52, 2.12)
35–49 h	1.26 (0.66, 2.40)	0.69 (0.33, 1.44)
50+ h	1.65 (0.59, 4.62)	0.83 (0.23, 2.96)

Odds ratios and 95% confidence intervals from multinomial logistic regressions (Ref = 25–37 days, n = 2050). Data obtained from the 2014 biodemography project [1]

those older than 35 years are less likely to report cycle irregularity. Underweight and overweight women are more likely to have irregular menstrual cycles. Data also show that women who work 50+ hours per week are approximately 50% more likely to experience irregular menstrual cycles compared with women who do not work at all. With respect to short (<25 days) menstrual cycles (Table 2.10), as compared to the normal cycle length of 25–38 days, 25–34-year-old women are less likely to have short cycles than women in all other age-groups. Smoking appears to increase the risk of short menstrual cycles by 89%. In addition, women who work part-time (1–34 h per week) are at a greater risk of having a short menstrual cycle than women who do not work at all. Regarding long (>38 days) cycles, we did not find any strong associations except that 40–44-year-old women are much less likely to report long cycles compared to 30–34-year-old respondents. The effect of age on cycle lengths is

somewhat in line with previous studies, which report shorter cycle lengths after age 35 years and several years prior to menopause [37, 38].

Our analyses suggest that social and behavioral factors have different effects on menstrual cycle irregularity and length. For example, BMI has a consistent effect on irregular menstruation, whereas smoking increases the risk of a short menstrual cycle. Work hours are also important, given that an increasing number of women continue to work after marriage [39]. Our data also suggest that overwork (i.e., 50+ hours per week) may increase irregular menstrual cycles, whereas part-time work (i.e., 1–34 h per week) may be linked to short menstrual cycles. Future studies may investigate the effect of women's work and family environments on menstrual cycle characteristics.

2.6 Use of Contraception

Contraception affects fecund waiting time to conception either by decreasing the frequency of insemination (e.g., barrier methods) or by decreasing the proportion of ovulatory cycles (e.g., oral contraceptives). As reported in many previous studies (e.g., [1, 16, 18]), the use of oral contraceptive pills is not yet very common in Japan, where the male condom remains the most frequently used contraceptive method. According to the Japan National Fertility Survey (JNFS) conducted in 2005, the proportion of never-married sexually active women aged 18–34 years who used contraceptive pills at their most recent sexual intercourse was only 1.6%, whereas 73.9% used condoms and 9.4% used withdrawal [26]. Another survey, which targeted a nationally representative sample of women aged between 16 and 49 years and was conducted in 2002, revealed that only 3.5% of respondents currently used oral contraceptives [40]. More recently, using biodemography study data, Konishi and Tamaki [1] reported that 2% of married women and 10% of unmarried (and partnered) women always used contraceptive pills, whereas the proportions using condoms were 30% for married women and 48% for unmarried (and partnered) women (Tables 2.11 and 2.12).

Cultural, historical, and/or sociological backgrounds of the current contraceptive behavior of Japanese couples is beyond the focus of this book, but the low prevalence of contraceptive pill use among Japanese women may be a reflection of the recent approval of low-dose contraceptive pills (in 1999), low coital frequency, and/or a high artificial abortion rate. Unreliable contraceptive use and the associated risks of unintended pregnancy among nonmarried couples are expected to play an important role in fertility trends in this country. One fact that supports this notion is that an increasing proportion of couples marry following premarital pregnancy [41]. Therefore, fertility intention, together with detailed data on contraceptive behavior and the probability of conception, should be thoroughly investigated in future research to understand the mechanism of fertility trends in this setting.

Table 2.11 Current contraceptive use by married women in Japan (n = 1361)[a]

Type of contraceptive	Always use	Sometimes use	Stopped using	Never used	Do not know/ do not want to answer
Condom	409 (30%)	277 (20%)	500 (37%)	175 (13%)	0 (0%)
Oral contraceptive	24 (2%)	5 (0%)	117 (9%)	1215 (89%)	0 (0%)
Emergency pill	0 (0%)	0 (0%)	22 (2%)	1333 (98%)	6 (0%)
Withdrawal	140 (10%)	195 (14%)	204 (15%)	682 (50%)	140 (10%)
Calendar	131 (10%)	149 (11%)	215 (16%)	826 (61%)	40 (3%)
Basal body temperature	119 (9%)	76 (6%)	460 (34%)	689 (51%)	17 (1%)
Other	25 (2%)	24 (2%)	31 (2%)	919 (68%)	362 (27%)

Data obtained from the 2014 biodemography project [1]

[a]Sample is limited to women who were not pregnant at the time of the survey, had menstruated in the past 6 months, answered the question regarding the frequency of condom and oral contraceptive use, and neither were sterilized nor had a partner who was sterilized. See [1] for the definition of the analytic sample

Table 2.12 Current contraceptive use of unmarried women with a partner (n = 385)[a] in Japan

	Always use	Sometimes use	Stopped using	Never used	Do not know/do not want to answer	Total
Condom	184 (48%)	84 (22%)	79 (21%)	38 (10%)	0 (0%)	385 (100%)
Oral contraceptive	38 (10%)	4 (1%)	40 (10%)	303 (79%)	0 (0%)	385 (100%)
Emergency pill (morning pill)	0 (0%)	2 (1%)	20 (5%)	358 (93%)	5 (1%)	385 (100%)
Withdrawal	47 (12%)	69 (18%)	41 (11%)	204 (53%)	24 (6%)	385 (100%)
Calendar	52 (14%)	48 (12%)	19 (5%)	260 (68%)	6 (2%)	385 (100%)
Basal body temperature	30 (8%)	23 (6%)	64 (17%)	263 (68%)	5 (1%)	385 (100%)
Other	3 (1%)	2 (1%)	5 (1%)	263 (68%)	112 (29%)	385 (100%)

Data obtained from the 2014 biodemography project [1]

[a]Sample is limited to women who were not pregnant at the time of the survey, had menstruated in the past 6 months, answered the question regarding the frequency of condom and oral contraceptive use, and neither were sterilized nor had a partner who was sterilized. See [1] for the definition of the analytic sample

2.7 Infertility Treatment

Infertility treatment may affect fecund waiting time to conception in various ways. Assisted reproductive technology (ART) can possibly shorten time to conception for couples who have obvious reproductive issues and could never conceive naturally. However, the extent to which TTP may be shortened for couples without any obvious reasons for infertility is unknown. For example, a 2016 Cochrane review article reported that for couples with unexplained infertility, there is no firm evidence of an increased cumulative live birth rate among couples undergoing artificial insemination versus those trying to conceive with timed intercourse [42]. According to a 2015 Cochrane review article, in vitro fertilization may yield a higher cumulative live birthrate compared with expectant management or artificial insemination, but there is insufficient evidence to draw a firm conclusion [43]. Considering that Japan had the world's highest number of infertility treatment cycles in 2010 [44], interrelationships between ART and TTP and between ART and the cumulative pregnancy rate should be thoroughly studied in future research.

According to the world report of the International Committee for Monitoring Assisted Reproductive Technologies, Japan recorded 153,729 aspirations for fresh in vitro fertilization and micro-insemination and 242,833 frozen embryo transfer cycles in 2010 [44]. These numbers were much higher than those in the USA (81,075 aspirations and 176,214 frozen embryo transfer cycles), which ranked second in terms of the number of aspirations in the same year. In Japan, pregnancy rate per aspiration was 9.3% and delivery rate per aspiration was 6.2% in 2010 (considering only fresh cycles), which are lower than the means, i.e., 27.0 and 20.1%, respectively, for all countries (approximately $n = 60$) listed in the report. When both fresh and frozen embryo transfer cycles were considered, the estimated cumulative delivery rate per aspiration was 18.1% for Japan, which again is lower than the figure (27.1%) for all listed countries. The relatively low rate of success may partly be related to the fact that compared with many other countries, Japan is characterized by a smaller number of embryos transferred to the mother's uterus at one time. In fact, 70.0% of the 65,024 fresh nondonor IVF and ICSI cycles constituted single embryo transfers, whereas only 28.5% involved transfers of 2 embryos and 1.6% involved transfers of 3+ embryos, which is probably linked to low multiple birthrates (5.3% twin births and 0.1% triplet+ births) in 2010. Among all countries listed in the paper, the corresponding proportions were 20.4% for twin births and 1.1% for triplet+ births [44].

The high number of ART cycles conducted in Japan may reflect three possible factors, none of which are necessarily exclusive: (1) Compared to other populations, more Japanese couples may be experiencing infertility, i.e., longer TTP; (2) Japanese couples are more likely to consult a doctor about infertility issues; and (3) once couples in Japan begin infertility treatment, they are more likely to undergo ART. With the currently available data, we cannot determine which factors are more or less important and thus it is worth examining what factors contribute to the very frequent use of ART in Japan.

Using data obtained from the biodemography project, we report preliminary results regarding who is more likely to have undergone infertility treatment (ART or any other kind) (Tables 2.13 and 2.14). Here, a woman is considered to have undergone ART if she has ever undergone either in vitro fertilization and/or micro-insemination. If a woman ever visited a doctor for treatment of and/or consultation for infertility, she was deemed to have received infertility treatment. The "any other infertility treatment" category in Table 2.13 includes those who have ever undergone a medical examination for infertility and/or utilized the timing method, ovulation induction, and/or artificial insemination but excludes women who have ever undergone ART. In this study population, we find that ART is common across all socioeconomic status subgroups (Table 2.13), but our multivariate analysis revealed that women with household incomes less than 3 million yen were less likely to have received infertility treatment (Table 2.14). In Table 2.14, the "any infertility treatment" category includes those who received ART. Compared to nulliparous women, parous and especially multiparous women are significantly less likely to have experienced either type (ART or other) of infertility treatment. This result may reflect the fact that many women who have undergone infertility treatments have not yet succeeded in having children. Infrequent sexual intercourse was significantly associated with higher odds of having undergone infertility treatment. Due to the cross-sectional study design, we cannot tell whether couples had infrequent sex as a result of infertility treatments or if couples who had infrequent sexual intercourse were more likely to undergo such treatments. Although we should await further research to test whether the causal link exists, it can be noted that infertility treatment seems to be closely linked to frequency of sexual intercourse, which is one of the most influential proximate determinants of fertility.

Here, we summarize findings related to infertility treatment based on previous studies that targeted nationally representative populations. Using data from the 13th National Fertility Survey in 2005, Iwasawa and Mita [9] estimate that proportion of married women at reproductive ages who ever had infertility treatment was 13% and that the proportion who were currently receiving infertility treatment was 1.2%. They also argue that the number of couples receiving infertility treatment not only reflects the number of infertile couples but also behavioral differences, i.e., the tendency to consult with medical doctors. The 14th National Fertility Survey in 2010 showed that 31.1% of married couples (with wives ranging in age from 20 to 29 years) reported that they "had ever worried about infertility" [45]. The proportion of married couples (with wives ranging in age between 20 and 49 years) who had ever had clinical tests or treatments for fertility was 16.4%. The proportions were even higher when the sample was limited to nulliparous couples; 28.6% actually had infertility tests or treatment [45]. These data suggest that an increasing proportion of couples are unable to have children and that more couples are worried about their own fecundity today than in the past in part because of increased awareness of fertility issues.

The prevalence of ART among couples in Japan is evidenced by the fact that 3.7% of all live births resulted from conceptions achieved through ART [46].

Table 2.13 Basic characteristics of married women by experience with infertility treatment (n = 1852)

Explanatory variables	ART[a] (n = 85)	Any other infertility treatment[b] (n = 329)	No infertility treatment (n = 1438)	Total (n = 1852)
Parity				
Nulliparous	43 (51%)	120 (36%)	406 (28%)	569 (31%)
Primiparous	24 (28%)	98 (30%)	393 (27%)	515 (28%)
Multiparous	18 (21%)	111 (34%)	639 (44%)	768 (41%)
Wife's age at the time of the survey (years)				
20–24	0 (0%)	2 (1%)	34 (2%)	36 (2%)
25–29	3 (4%)	24 (7%)	219 (15%)	246 (13%)
30–34	17 (20%)	100 (30%)	316 (22%)	433 (23%)
35–39	34 (40%)	115 (35%)	412 (29%)	561 (30%)
40–44	31 (36%)	88 (27%)	457 (32%)	576 (31%)
Wife's age at the time of marriage (years)				
<20	2 (2%)	4 (1%)	23 (2%)	29 (2%)
20–24	4 (5%)	66 (20%)	351 (24%)	421 (23%)
25–29	42 (49%)	162 (49%)	615 (43%)	819 (44%)
30–34	23 (27%)	75 (23%)	289 (20%)	387 (21%)
35–39	8 (9%)	17 (5%)	82 (6%)	107 (6%)
40+	2 (2%)	1 (0%)	13 (1%)	16 (1%)
Duration of marriage (years)				
0–4	22 (26%)	95 (29%)	486 (34%)	603 (33%)
5–9	29 (34%)	124 (38%)	366 (25%)	519 (28%)
10–14	24 (28%)	73 (22%)	319 (22%)	416 (22%)
15+	6 (7%)	33 (10%)	198 (14%)	237 (13%)

(continued)

Table 2.13 (continued)

Explanatory variables	ART[a] (n = 85)	Any other infertility treatment[b] (n = 329)	No infertility treatment (n = 1438)	Total (n = 1852)
Highest educational level[c]				
Less than college	20 (24%)	80 (24%)	448 (31%)	548 (30%)
College	33 (39%)	133 (40%)	536 (37%)	702 (38%)
University	32 (38%)	116 (35%)	454 (32%)	602 (33%)
Annual household income (million yen)				
<3	12 (14%)	53 (16%)	332 (23%)	397 (21%)
3–4	24 (28%)	121 (37%)	457 (32%)	602 (33%)
5–9	30 (35%)	125 (38%)	445 (31%)	600 (32%)
10+	19 (22%)	30 (9%)	204 (14%)	253 (14%)
Intention of becoming pregnant				
Currently want (within 1 year from now)	51 (60%)	153 (47%)	309 (21%)	513 (28%)
Want in the future (more than 1 year from now)	2 (2%)	26 (8%)	172 (12%)	200 (11%)
No	32 (38%)	150 (46%)	957 (67%)	1139 (62%)
Smoking				
No (never or former)	79 (93%)	303 (92%)	1272 (88%)	1654 (89%)
Current	6 (7%)	26 (8%)	166 (12%)	198 (11%)
Menstrual cycle characteristics[d]				
Regular	36 (42%)	114 (35%)	576 (40%)	726 (39%)
Short	12 (14%)	38 (12%)	178 (12%)	228 (12%)
Long	24 (28%)	101 (31%)	453 (32%)	578 (31%)
Irregular	13 (15%)	76 (23%)	228 (16%)	317 (17%)
Never	0 (0%)	0 (0%)	3 (0%)	3 (0%)

(continued)

Table 2.13 (continued)

Explanatory variables	ART[a] (n = 85)	Any other infertility treatment[b] (n = 329)	No infertility treatment (n = 1438)	Total (n = 1852)
Frequency of sexual intercourse[e]				
1+ day per week	7 (8%)	45 (14%)	197 (14%)	249 (13%)
1–3 days per month	19 (22%)	100 (30%)	418 (29%)	537 (29%)
<1 day per month	42 (49%)	155 (47%)	619 (43%)	816 (44%)
Unknown	17 (20%)	29 (9%)	204 (14%)	250 (13%)

A total of 113 married women who did not answer the question regarding infertility treatment were excluded. Numbers and proportions in each category (i.e., ART, any other infertility treatment, no infertility treatment, and total) are shown. Data obtained from the 2014 biodemography project [1]

[a]Ever used assisted reproductive technology, i.e., in vitro fertilization or micro-insemination

[b]Ever visited a doctor for treatment of and/or consultation for infertility. This category includes those who have ever undergone a medical examination for infertility and/or employed the timing method, ovulation induction, and/or artificial insemination but excludes women who have ever used ART

[c]Highest education level completed or in which respondent is currently enrolled

[d]Participating women were asked either to state their ordinal menstrual cycle length or to choose one of the following answers: "cycle length is irregular (and there is no ordinal cycle length)" or "have never experienced menstrual bleeding." If stated cycle length was shorter than 27 days, the respondent was categorized as having a short cycle, and if stated cycle length was equal to or longer than 30 days, the respondent was categorized as having a long cycle. Respondents were categorized as having regular cycles if the reported cycle length was between 27 and 29 days

[e]In the past 6 months

Although it is true that couples who are unable to have a child without ART are now able to do so with the help of medical technology, the success rate of ART steadily declines as women age and thus ART can overcome age-related decline in fecundity only to a certain extent. Data on the success rates of ART accumulated by the Japan Society of Obstetrics and Gynecology clearly show that age-related decline of fecundability is evident among pregnancies resulting from ART. In 2012, live birthrates per ART cycle were 21.8% for 30-year-old women, 17.3% for 35-year-old women, 8.1% for 40-year-old women, and 0.7% for 45-year-old women [47]. These data clearly indicate that decreased fecundability due to aging cannot be fully overcome by ART. Related to this notion, Leridon uses a simulation model and suggests that ART in its present form is unable to address the loss of births due to age-related decreases in fecundability [48]. Although studies from overseas that included both censored and noncensored TTP report that age-related decline in fecundability starts at around age 30 years or in the mid-30s [24, 49, 50], Konishi et al. [20] report, based on TTP for the first child, that fecundability was highest among couples who discontinued contraception when the wife was aged 24–26 years and was significantly lower for older ages. Future research targeting

Table 2.14 Odds ratios (95% confidence interval) of having experienced ART or any infertility treatment by participant characteristics (n = 1852 married women)

Explanatory variable	ART[a]	Any infertility treatment[b]
Parity		
Nulliparous	1.00	1.00
Primiparous	0.70 (0.40, 1.22)	0.74 (0.54, 1.00)
Multiparous	0.52 (0.26, 1.03)	0.70 (0.50, 0.97)
Wife's age at marriage (years)		
25–29	1.00	1.00
<20	1.97 (0.39, 10.12)	1.08 (0.40, 2.90)
20–24	0.21 (0.07, 0.62)	0.70 (0.50, 0.99)
30–34	1.22 (0.69, 2.18)	0.96 (0.70, 1.31)
35–39	2.50 (1.01, 6.17)	1.25 (0.73, 2.13)
40+	9.17 (1.68, 50.16)	1.65 (0.41, 6.58)
Duration of marriage (years)		
0–4	1.00	1.00
5–9	2.98 (1.57, 5.68)	3.32 (2.37, 4.65)
10–14	6.22 (2.82, 13.72)	3.75 (2.47, 5.69)
15+	4.73 (1.49, 15.02)	3.06 (1.79, 5.24)
Highest educational level[c]		
Less than college	1.00	1.00
College	0.83 (0.44, 1.57)	1.19 (0.87, 1.63)
University	0.91 (0.47, 1.75)	1.20 (0.86, 1.68)
Annual household income (million yen)		
3–4	1.00	1.00
<3	0.74 (0.34, 1.60)	0.60 (0.42, 0.86)
5–9	1.25 (0.69, 2.27)	1.05 (0.79, 1.41)
10+	1.58 (0.78, 3.19)	0.71 (0.47, 1.06)
Intention of becoming pregnant		
Currently want (within 1 year from now)	1.00	1.00
Want in the future (more than 1 year from now)	0.11 (0.03, 0.48)	0.26 (0.16, 0.41)
No	0.15 (0.08, 0.27)	0.17 (0.12, 0.23)
Smoking		
No (never or former)	1.00	1.00
Current	0.53 (0.20, 1.41)	0.73 (0.47, 1.13)

(continued)

Table 2.14 (continued)

Explanatory variable	ART[a]	Any infertility treatment[b]
Menstrual cycle characteristics[d]		
Regular	1.00	1.00
Short	1.05 (0.50, 2.21)	1.22 (0.82, 1.82)
Long	1.02 (0.57, 1.81)	1.18 (0.88, 1.58)
Irregular	1.14 (0.56, 2.33)	2.16 (1.54, 3.03)
Never	1.00	1.00
Frequency of sexual intercourse[e]		
1+ day per week	1.00	1.00
1–3 days per month	1.34 (0.53, 3.38)	1.16 (0.77, 1.73)
<1 day per month	2.28 (0.95, 5.47)	1.51 (1.02, 2.24)
Unknown	2.96 (1.11, 7.90)	1.09 (0.66, 1.80)

A total of 113 married women who did not answer the question regarding infertility treatment were excluded from the analysis. A logistic regression analysis was used, and all variables in the table were included as explanatory variables. Separate models were used for the ART experience (vs. no ART or no infertility treatment) and for any infertility treatment (vs. no infertility treatment). Data obtained from the 2014 biodemography project [1]

[a]Ever undergone in vitro fertilization or micro-insemination

[b]Ever visited a doctor for treatment of and/or consultation for infertility. This category includes women who have ever undergone a medical examination for infertility and/or utilized the timing method, ovulation induction, artificial insemination, and/or ART.

[c]Highest education level completed or in which respondent is currently enrolled

[d]Participants were asked either to report their ordinal menstrual cycle length or to select one of the following answers: "cycle length is irregular (there is no ordinal cycle length)" or "have never experienced menstrual bleeding." If the stated cycle length was shorter than 27 days, the respondent was categorized as having a short cycle, and if the stated cycle length was equal to or longer than 30 days, the respondent was categorized as having a long cycle. Respondents were categorized as having regular cycles if the reported cycle length was between 27 and 29 days

[e]In the past 6 months

the Japanese population is needed to assess the extent to which this age-related decline in fecundability can be compensated by efficient utilization of ART. The limited evidence available thus far clearly indicates that the use of ART is very common among couples, but the impact of infertility treatment on the fertility of a population has not yet been fully evaluated in this setting.

2.8 Fetal Loss

Fetal loss includes both spontaneous pregnancy loss (natural abortion) and induced (artificial) abortion. In this book, we define abortion as any pregnancy loss that occurs at any gestational age. The term "stillbirth" is not used in this book because there are several definitions of stillbirth and thus the terminology may be confusing.

For example, the World Health Organization defines stillbirths as "a baby born with no signs of life at or after 28 weeks' gestation" [51] whereas the Centers for Disease Control and Prevention of the USA maintains that "a stillbirth is the death of a baby before or during delivery" [52]. There is no universally accepted definition of when a fetal death is called a stillbirth, and the meaning of this term varies internationally.

2.8.1 Spontaneous Pregnancy Loss

When pregnancy tests with greater sensitivity are used, it is more likely that pregnancies that end during early gestational period will be detected. With less sensitive pregnancy tests, one is more likely to be unaware of those pregnancies and thus detect fewer pregnancy losses. Even with this limitation in detection, the age pattern of spontaneous pregnancy loss is clearly evident, as will be described below.

The probability of spontaneous pregnancy loss increases as a woman and man age. Figure 2.2 shows the ratios of the number of natural pregnancy losses to the number of live births in Japan and Denmark, both of which are based on national data ([53], see the footnote of Fig. 2.2 for data source). Although the ratios of the two countries differ with respect to certain age-groups, the age pattern of spontaneous pregnancy loss is similar between the two countries, with an evident increase

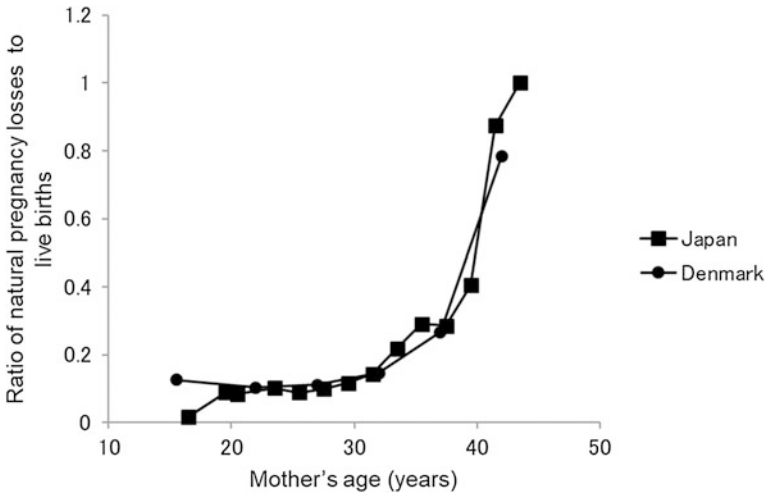

Fig. 2.2 Ratios of the number of natural pregnancy losses to the number of live births by mother's age at the time of pregnancy. Data obtained from [53]. The original data for Japan came from the 13th National Fertility Survey on married couples [58]. The sum of the numbers of first to fifth pregnancies was used to calculate the ratio of natural pregnancy losses to live births. The original data for Denmark came from [59]

Table 2.15 Proportions of married and single women in each age-group who had experienced spontaneous or induced abortion

Age (years)	Married			Single		
	n	Spontaneous	Induced	*n*	Spontaneous	Induced
20–24	36	19% (3%)	14% (0%)	243	0% (0%)	1% (0%)
25–29	258	11% (2%)	12% (2%)	263	1% (0%)	5% (1%)
30–34	461	16% (3%)	11% (3%)	246	2% (0%)	9% (3%)
35–39	594	18% (4%)	9% (2%)	222	6% (1%)	10% (4%)
40–44	616	21% (6%)	12% (3%)	211	6% (0%)	9% (2%)
Total	1965	18% (4%)	11% (2%)	1185	3% (0%)	7% (2%)

Percentages in parentheses indicate the proportions of women who had experienced two or more abortions in each category. Data obtained from the 2014 biodemography project [1]

when women reach their late 30s. These data indicate that as a woman ages, she faces a higher risk of pregnancy loss.

The biodemography project shows that more than 20% of married women aged 40–44 years had ever experienced spontaneous abortion (Table 2.15). This proportion is slightly higher than that in the National Fertility Survey of 2015 [54], in which the proportions of married couples who had ever experienced spontaneous abortions were 18.1% for couples married for 15–19 years and 17.6% for those married for more than 20 years.

2.8.2 Artificial Abortion

Although we have little evidence to believe that age patterns of spontaneous pregnancy loss vary significantly across populations, the rates of artificial abortion reflect sociocultural settings and vary across both populations and calendar years. In Japan, the induced abortion rate per 1000 women aged 15–49 years decreased from 14.9 in 1989 to 6.9 in 2014, which is lower than the induced abortion rate of developed countries (excluding eastern Europe), which was 17 in 2008 [55]. The low induced abortion rate in Japan seems to reflect a low number of total pregnancies rather than a lower proportion of pregnancies that end in induced abortions. According to Senda [53], in Japan in 2009, there were 1,070,029 live births and 223,388 induced abortions, yielding a ratio of induced abortions to live births of approximately 21% (223,388/1,070,029). In 1955, there were 1,730,689 live births and 1,169,079 induced abortions (1,169,079/1,730,689 = 68%). The corresponding proportions were 38% in 1970 and 37% in 1990. Reflecting the high proportion of pregnancies that end in induced abortion, it is estimated that among cohorts born in 1970, more than 20% of Japanese women experienced induced abortion by the age of 32.5 years [26].

According to the biodemography project, 9–14% of married women in each age-group experienced induced abortion (Table 2.15). Among single women aged

35–39 years, as many as 10% had experienced induced abortion. These data suggest that both married and single women conceive and experience fetal loss. Therefore, to understand the mechanisms of fertility trends, it is necessary to study the reproductive behavior of both married couples and single women and men.

Appendix: Survey Questionnaire Items in the Biodemography Project

1. How long is your menstrual cycle (not the length of menstrual bleeding but rather the length between the first day of one menstrual period and the first day of the next period)?

   1.1. About ( ) days
   1.2. No particular cycle length
   1.3. I have never experienced menstruation.

2. In the past 6 months, have you experienced any changes in the onset of a menstrual cycle by more than 6 days?

   2.1. Yes, I have experienced such a change at least once
   2.2. No, I have not experienced any change (almost always on schedule)
   2.3. My menstrual period is too irregular to know my usual schedule
   2.4. I have not menstruated in the past 6 months.

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