How long Japanese mothers quit smoking when they start raising children? New evidences from a very large national data

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Abstracts

Background: The exposure of children to secondhand smoke at home and elsewhere has been largely an overlooked problem in Japan, regardless of widely well spread knowledge about health risk of secondhand smoke exposure to children. Furthermore, evidence and study are limited and little is known about relationship between smoking behavior and socio-economic factors in Japan.

Objectives: Our broad perspective is to identify the important risk factors of women's smoking. We first focus on mother who has greater impact on child health. Thus, our main interest here is to demonstrate mothers' behavior during the course of one year after child birth. We also address association between women's smoking behavior from several different point of views including their characteristic, family or social environments.

Methods: The four different years (2001, 2004, 2007, 2010) of Comprehensive Survey of Living Conditions, a nationally representative data, are used. Multivariate logistic regression is conducted as setting one for smoking and zero for non-smoking. Followed by this, marginal effects of each variable are estimated.

Results: Mothers cessation of smoking after delivery is unstable in Japan, depending on the age and the parity of a child. For a first child, more than two-thirds of women who used to smoke, abstain from smoking at least for one year. For a second child, compared with a first child, only a half of the mothers quits temporarily in its first year. In both cases, cessation efforts decline rapidly over time. By the time a mother has a third child, she barely quits smoking. Although an increasing proportion of mothers are quitting in the first year, the difference narrows considerably in subsequent years. We also found that, among Japanese women, such factors as marital status, husband's smoking status, other smokers in household are strongly related to smoking, while job-types, living with head of household's parents, and housing have differential impacts on it.

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Introduction

The exposure of children to secondhand smoke at home and elsewhere has been largely an overlooked problem in Japan. Unlike many other externality problems, the problem must be solved at home, because the most serious risk usually comes first from their mothers, second from fathers, and then from the rest of the family members. The purpose of this paper is to focus on the changes in the smoking behavior of a mother as her child grows older, at the same time identifying relevant individual and socio-economic factors that affect the smoking prevalence of women in the child-bearing age (between age 20 and age 45) .

For children, the health risk of mother's smoking is the greatest during her pregnancy. It has been known for some time that smoking during pregnancy increases such risks as perinatal death, premature birth, spontaneous abortion, congenital anomaly and lower birth weight, etc. (e.g. ASH, 2011; U.S. Department of Health and Human Services, 2006). In spite of these established findings, in Japan, even the physician's response was very late in coming. After declaring its intention in 2007 to join the tobacco free movement, in 2011, Japanese Association of Obstetricians and Gynecologists finally revised its Practice Guideline. The guideline now mandates its member physicians to ask questions on the smoking status of a pregnant woman, to give a clear answer, if asked, on the harmful effects to the pre-born baby of her own and other's smoking, to give her directions to stop her own and her partner's smoking, and to avoid secondhand smoke (Minakami et al., 2011).

It is fair to say that, prior to 2000, Japanese government, most notably the powerful Ministry of Finance, in cooperation with Japan Tobacco Company, a giant partially government-owned monopoly, dragged its feet in warning the general public on the risks of tobacco smoking. Even collecting information on tobacco exposure had been a virtual taboo in national surveys, leaving pre-born children or new born children unprotected for decades. In spite of this, it turned out that, since 1990, in a little known national survey called National Growth Survey of Infants and Children, conducted only once in ten years, the Ministry of Health and Welfare (MHLW) has quietly started to ask a set of questions on the smoking of mothers and fathers/co-residents during pregnancy. According to this survey, the proportions of smoking mothers during pregnancy almost doubled from 5.5% in 1990 to 10.0% in 2000, but fell suddenly to 5.0% in 2010. In the meantime, the proportion of unknowns, which had been 0.1% in 1990 and 0.2% in 2000, suddenly increased to 2.8% in 2010. On average, as the survey is taken one year after the birth, and by the public health officials, however, there is some question as to the reliability of the data (Ohida et al., 2007)[1].

[1] Recent studies seem to point to much higher rates than National Growth Survey's 5.0%. For example, a recent large-sample (N>5,000) study by Sasaki et al. (2011) shows that 14% of pregnant mothers were smokers in the third trimester of gestation, although their data is limited to Hokkaido, a prefecture with one of the highest women's smoking rates. A small-sample study (N=125) by Yamashita (2012), using data from Nara prefecture, shows that 19% of women in early stages of pregnancy (10.6 ± 1.9weeks) were smokers. According to a report by Ohashi (2009) using data from

A prime example of the government's belittling of tobacco problems, we believe, is its smoking statistics. Using their average smoking rate of women, for example, would be very misleading in estimating the risk of secondhand smoke to children in Japan. There are a small number of solid evidences that point to a considerable downward bias in women's smoking rates in government statistics. This bias was first exposed by a survey conducted by Meiji Yasuda Life Insurance (Akiyama et al., 2000). The MYLI survey covered more than four million adults who purchased their life insurance policies between 1993 and 1998, getting responses from more than 96% from them. The survey is considered to be free of unacceptability bias which we will discuss shortly, because the questions were cleverly added at the bottom of the insurance notification page, giving them an appearance of a part of the insurance notification. The differences in smoking rates were substantial; for example, in 1997 MYLI's data, smoking rate of the women in their 20's was 27.0%, instead of 21.3% of MHLW, and that of women in their 30's was 26.1%, instead of 15.6% of MHLW[2]. In our view, two problems, one technical and the other substantive, account for this downward bias in MHLW statistics.

The technical issue is simply a shortcoming in their sampling process. The official smoking rates statistics are computed from the samples of National Health and Nutrition Survey (Nutrition Survey). Each year, MHLW selects only 300 survey districts in stratified random sampling for this survey. They correspond to only 0.015% of the survey districts of the National Census, and only 0.007% of Japanese households[3]. Municipal public-health officials of these districts distribute questionnaires to every household in the district, but manage to get responses from less than 70% of the households. Moreover, the response rates have huge variations across districts. If the response rates are higher in low smoking-rate districts/households, and lower in high smoking-rate districts/households, they are bound to get a sample mean much lower than the true population mean. This bias is not corrected. Judging from the discrepancy between the results of high quality surveys like MYLI or two of Ohida's which we will discuss shortly, this must be what has been happening.

The second problem is the unacceptability bias, a tendency to under-report socially undesirable activities in social surveys. A number of recent studies have successfully shown that smoking is significantly under-reported among pregnant women in the U.S., in Europe, and in Japan (e.g. England et al., 2007; Ford et al., 1997; George et al., 2006; Jung-Choi et al., 2012; Kang et al., 2013; Ohashi, 2009; Shipton et al., 2009;

Hyogo prefecture, smoking rate was 22.6% in the early stage of pregnancy, and 15.5% in the late stage (N=460).

[2] Unfortunately, two surveys used two different definitions of smokers, making a simple comparison difficult. The MYLI's definition of smokers included those who had quitted smoking within the last 12 months, while MHLW classifies them as non-smoking, ex-smokers.

[3] The number of survey districts of 2000 National Census was 939,537. Each survey district of National Census is divided into two survey districts in Survey of Living Conditions and Nutrition Survey

Yamashita)[45]. In Japan, however, the unacceptability bias in smoking is neither a new problem, nor limited to pregnant women. It is an old problem for the general population of women as smoking had been considered a socially unacceptable behavior for them[6]. Although the bias has been disappearing rapidly during the last decade, the older data must contain substantial underreporting.

In what follows, first, we will review the findings of the previous studies on Japanese mother's smoking, including those on smoking during pregnancy. We will pay close attention to the quality of data used, and we will argue that there is no conclusive study yet on the mother's smoking behavior after delivery. Then, we will proceed to explain the methods of our analysis, followed by the results and the discussion. Finally, we will state our conclusions and their implications.

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4 As Connor Gorber et al. (2010) has noted, according to Fendrich et al. (2005), "increased public concerns about the dangers of active and passive smoking have strengthened the perception of smoking as a socially undesirable behavior, which could further undermine the validity of self-reported estimates"

5 In Yamashita (2012), 11 out of 24 smokers claimed non-smoker status, and in Ohashi (2009), 78 out of 128 smokers claimed non-smoker status in early stages of pregnancy. Yamashita's samples were from just one hospital that gives strong messages for non-smoking to pregnant women, and Ohashi's data were collected as a part of the municipal prenatal checkups. On the other hand, in Sasaki et al. (2011), only 134 out of 709 smokers claimed non-smoker status, which is in line with a majority of literature in Europe or US.

6 In other parts of Asia, a similar point has been made. (Barraclough 1999 for Indonesia, Chun et al., 2006 and Chung et al., 2010 for Korea).

Background

Motivated by a mounting concern on the increasing prevalence of smoking among pregnant women in Japan, a large number of research papers have been published in medical journals during the last few decades. The statistical bases and findings of quality papers are summarized in the well-cited two review papers, the first one by Kurumatani et al. (1998), and the second one by Kubo and Emisu (2007). Together they reviewed 39 research papers on the topic spanning four decades, from 1965 to 2007. It is not surprising to find the estimated prevalence rates in the reviewed papers vary substantially, as their sample sizes are typically small, usually covering narrow regions, and taken at non-uniform timing. Nevertheless, if we look at the ten papers published since 2000, they are distributed in a surprisingly narrow range. More specifically, without weighing by sample sizes, the pre-conception average smoking rate is 25.5%, and its standard deviation is 3.6%. The average smoking rate during pregnancy is 8.6%, with its standard deviation at 1.6%. Excluding Ohida's two papers to be discussed shortly changes the figure little; only the pre-conception standard error changes from 3.6% to 4.4%, but the other figures remain unchanged. .

Since 2000, other than the above-mentioned National Growth Survey, we have found two nation-wide surveys that can serve as our benchmarks. Both surveys were conducted by Ohida and his associates, first in 2002 and then in 2006. Each time more than one percent of pregnant Japanese women receiving prenatal care were in their samples. They found out that, in 2002, 24.6% of would-be mothers had been smoking before they knew they were pregnant. After learning about their pregnancy, only 10% of pregnant women continued to smoke. In 2006 survey, the pre-conception smoking rate was 25.7%, and smoking rate during pregnancy was 7.5%. Their findings are quite informative for a number of reasons.

- Their pre-conception smoking rates of 25% are much higher than the government smoking rates of women in these two years, but similar to those obtained by Akiyama et al. (2000) and the other 8 studies that appeared since 2000 and surveyed by Kubo and Emisu (2007). This gave us a very good reason for us to suspect a downward bias in the national smoking rate statistics of MHLW.
- Their percentages of continued smokers are slightly higher than, but within one standard error of, the average (8.6±1.6%) of the other 8 studies in the 2000-2007 period, mentioned above.
- The proportions of continued smokers are much smaller, and those of abstainers are much larger, than those reported in Europe and in the US (Cnattingius et al., 1992; Fingerhut et al., 1990; Hannover et al., 2002; Lelong et al, 2001; McLeod et al., 2003)[7]. Also Ohida found that higher education reduces the prevalence of smoking during pregnancy, as previous studies in Europe or U.S. had found.

[7] According to Colman and Joyce (2003), "Although the prevalence of smoking 3 months before pregnancy was stable at around 26%, quitting during pregnancy rose from 37% to 46% between 1993 and 1999". In France, Lelong et al found smoking rate before pregnancy was 40%, but "Among the women smoking before pregnancy, about 40% quit during pregnancy (p.335)".

- They found that two thirds of the pregnant women are exposed to secondhand smoke either at home or at work, but 80 % of the smoke is coming from their husbands.

After giving birth, however, many Japanese mothers who have quitted resume smoking (Yasukouchi et al. 2006, Yasuda et al. 2013[8]) , although not quite as quickly as in those in Western Europe or in U.S. (e.g. Colman et al.,2003; Lelong et al., 2001 ; Polanska et al., 2011; Solomon et al., 2007). Of course, infants and small children are vulnerable to secondhand smoke, too. The smoke increases such risks as the overall mortality, sudden infant death syndrome, respiratory infections, asthma, neurobehavioral disorders, obesity, hyper-tension, diabetes etc.. (e.g. Kabir et al., 2011; Linnet et al., 2005; Montgomery et al., 2002; Oken et al., 2005; Toschke et al., 2003; Williams et al., 1998; Yolton et al., 2005). According to a report of the Surgeon General (2006), in the U.S., almost 60% of children between 3 years old and 11 years old are exposed to secondhand smoke. We could find no comparable public information on the extent of such exposure of Japanese small children[9]. As a first step toward this goal, we will analyze the smoking behavior of a Japanese mother starting from the delivery of her first child, until the time her third child reaches 18 years old.

In Japan, until very recently, research on the effects of socioeconomic factors on smoking had been very difficult; in the first place, in large-scale national surveys, inclusion of questions on smoking behavior had been a virtual taboo, and in the second place, inclusion of questions on income and education, key socioeconomic indicators in health related behaviors, had been regarded as very difficult. A good example is Comprehensive Survey of Living Conditions which we are going to use for our statistical analysis. This once in every three years survey started in 1986 with a sample of almost a quarter of a million households. It was not until 2001 when questions about smoking and drinking were added. It was only in 2010 when the survey included questions on education levels.

- National Growth Survey on Infants and Small Children is conducted by MHLW in the month of October once every 10 years. The survey takes physical measurements of infants and small children to establish national growth curves, and help pediatricians to give proper guidance to parents on their children's growth. The samples are infants more than two weeks old and less than 2 years old, and children more than two years old but less than the school age. The total sample sizes were 11,787 in 1990, 10,021 in 2000, and 7,652 in 2010. Since 1990, the survey contains questions on the smoking behaviors of mothers, and

[8] Using a data from Fukuoka prefecture (N=191), Yasukouchi et al. (2006) found that the smoking rate was 23.1% when women learned about pregnancy, 7.9% during pregnancy, and 14.7% in four months after delivery. On the other hand, Yasuda et al. (2013) found much lower relapse rates among the quitters; the relapse rate is 22.5% in 3~4 months, 43.5% in 18 months, and 51.4% in 36 months.

[9] The only exception is the Kaneita et al. (2006) but their results are only for those born in 2001.

father/coresidents (since 2000). With respect to smoking, Ohida et al. (2007) pointed out, the survey answers may be subject to recall bias.

- Nakamura et al. 1994 used the forth Survey of Cardiovascular Disease conducted by MHW in 1990 (8916 samples) on general population. They analyzed regional and age groups differences in the smoking prevalence in male and female populations, separately. They have found significant age-group differences in male population, but significant urban-rural difference in female population.

- Ohida et al. (2001) utilized Active Survey of Health and Welfare, conducted by MHW in 1996 (34,464 samples). They found out that the smoking rate of men is higher in rural communities, but the smoking rate of women is higher in urban communities. Another interesting finding is that as household size increases, the smoking rate of women decreases.

- Ohida and his research associates conducted their national surveys twice, first in 2002, and then in 2006, on pregnant women receiving prenatal checkups. Sample sizes were 16,528 in 2002 and 19,650 in 2006, estimated to be equal to 1.4% of all pregnant women in 2002 and to 1.8% in 2006. In their 2002 survey, 500 medical institutions were randomly chosen from the list of 989 regular survey point institutions designated by the Association of Obstetricians & Gynecologists (AOG). In the 2006 survey, they asked all 940 survey point institutions to participate. The questionnaires were filled by the patients at their first prenatal checkup visits in the waiting rooms of the participating medical institutions (260 in 2002, 344 in 2006). There were no responses from one thirds of contacted institutions in both surveys. The proportion of cooperating institutions went down from 56% in 2002 to 37% in 2006, probably as a result of a prominent criminal case against an obstetrician.

- Fukuda et al. (2005b) used 2001 Comprehensive Survey to analyze the influence of individual socioeconomic factors on smoking. As they utilized income information, their sample size was limited to about 40,000 individuals. For women, they found a strong relationship between smoking and lower income, and strong effects of living with smokers and in urban areas. For younger women, having a job and being married have significantly positive effects. A second study (Fukuda et al. 2005a) examined the relationship between six “risk behaviors”, including smoking and excessive drinking, and individual characteristics (age, marital status, work and household income). They found that for both men and women, divorce, employment, sales and service jobs, and lower household income are associated with a higher likelihood of risk behaviors, including smoking. They also found higher per capita income in women was significantly associated with smoking and other risk behaviors. Another interesting finding was that marked regional differences in smoking rates were observed in women, but not in men.

- Kaneita et al. (2006), using the very first survey of Longitudinal Survey of Newborns in the 21st Century[10], examined the effects of socio-economic factors on mother/father's smoking behavior at 6 months after delivery. Based on 44,562 samples, they found the prevalence of smoking among the mothers and the fathers were 17.1% and 63.5%, respectively, and the percentage of mothers and fathers who smoked indoors were 12.1% and 36.2%. They pointed out that such factors as young age, smoking spouse, infants having many siblings, the mother not breast-feeding, lower income are significantly related to parent's indoor smoking. They concluded that passive smoking is common among Japanese infants and further public health measures should be taken.

[10] The subjects of the first survey were 53,575 babies born in 2001 and the questionnaires were mailed when babies reached 6 months old. The questionnaire covered babies' weight and height, parity, number of people who live together, parent's job, working hours and income, breastfeeding and so on. A total of 44,562 questionnaires (83.2%) were used in Kaneita et al., (2006).

Methods

Data sources

Our data comes from four different survey years (2001, 2004, 2007, 2010) of Large Scale Comprehensive Survey of Living Conditions. This survey has been conducted by Ministry of Health, Labour and Welfare since 1986. The Large Scale Survey is conducted once every three years, and it consists of four different questionnaires: 1) household questionnaire, 2) health questionnaire, 3) long-term care questionnaire, and 4) income questionnaire. The questions on smoking status were added to the health questionnaire for the first time in 2001. Each time, MHLW randomly select more than 5 thousand survey districts out of more than 930,000 survey districts of National Census. None are repeated in consecutive surveys. Thus each large scale Comprehensive Survey provides a random cross-sectional data of about 0.6% of Japanese population, translating to 280-290 thousand households, and 750 thousand individuals, respectively. Actually, the average response rate of the Survey of these four years is 81.7%, giving us a total of 2,556,159 samples. Males account for 1,228,865, and females account for 1,327,474. The exact numbers and response rates are shown in Table1 and Table2

Public health officials of the selected districts then distribute 1) household questionnaire and 2) health questionnaire to every household in their districts. On the other hand, the sample-sizes of 3) long-term care questionnaire and 4) income questionnaire are much smaller, because their survey districts are randomly selected from those for 1) and 2). In fact, income questionnaire covers only 1,000 districts and hence using the income or asset variables would have resulted in losing 13 out of every 15 possible samples in our samples. We decided not to pay this price for income information, and to keep much larger sample size for our empirical analysis.

Smoking behavior

There are four categories for smoking status in the survey: 1) I do not smoke, 2) I smoke every day, 3) I smoke occasionally, and 4) I quitted smoking more than one month ago. In this paper, 1) and 4) are defined as non-smoker and 2) and 3) are defined as smoker.

Socio-economic Variable

Age, region, marital status, type of job, husband’s smoking status, smokers in the same household other than husband, living together with own or spouse’s parents, health checkups, cancer checkups, age and parity of children, house-type, size of house, and household expenditure are included. We excluded self-reported health status and mental status, subjective symptoms for possible endogeniety problem, but we included health checkups as measures for risk aversion. We excluded education level, because the question appeared for the first time in 2010 and we would have had only have one-year samples.

Statistical Analysis

As we have explained above, the survey data we have used are random samples collected in the same way, once in every three years, from the same population. In order to get the most precise estimators possible and test statistics with most power, we pooled all of them as an independently pooled cross section data to maximize our sample size. Compared with other studies on smoking prevalence among Japanese women, the sample size of our data is several times larger. We believe this is the strength of our study.

The purpose of our analysis is to isolate the important risk factors of women's smoking that are attributable to their own characteristics, family or social environments. In order to simplify this task, we have selected only women who are either heads of households or spouses of the head of households. If one regards a single women as a single household, in a sense, the unit of our analysis is not an individual but rather a household.

Assuming that the maximum childbearing age is 45 years old, we have selected our sample to women born between 1938-1989. Furthermore, although the Basic Survey asks questions on smoking status to anyone above 12 years old, we have chosen only those at age 20 or above. This is to minimize the possibility of misclassification of smoking status in self-reports, since the legal minimum age of smoking is age 20.

We estimated a saturated logistic regression on the data. Our dependent variable is the binary smoking status set equal to 0 for a nonsmoker and equal to 1 for a smoker. All our explanatory variables are indicator variables representing the individual or household characteristics, or their categories. We control women's ages by five-year age class dummy variables, and women's birth cohorts by five-year period starting from 1936-1940 dummy variable. Besides age and birth year, the only continuous variables in our list of control variables are monthly household expenditure (in equivalent scale) and the floor size of the dwelling. Both of them are converted first to quintile categorical variables, and then to dummy variables of each category. In order to control the birth cohort effects and year effects, birth-year cohort dummy variables and survey year dummy variables are added. To analyze the time-effects, many variables were interacted with survey years.

The software we have used for estimating the logistic regression equations is stata13 MP(4). Following the estimation, we have computed the average marginal effects (AMEs) of the variables of our model using its ***margins*** command. For variables interacted with survey year dummys, we computed their marginal effects of representative values (MERs).

Although marginal effects at means (MEMs) have been widely used, recently, the average marginal effects (AMEs) are becoming very popular, too. The MEMs measure the effects of the change in a given indicator variable, setting the other variables at their mean values. On the other hand, AMEs are obtained as the average of the marginal effects at each observation (by controlling the rest of the variables at their actual values). When substantial variability is suspected across different groups, computing marginal effects at representative values（MER）is recommended (Williams, 2012). We have

followed this recommendation for variables crossed with survey years. We note here that in Stata 13, the MER option gives us confidence intervals as well.

Results and Discussion

The descriptive statistics are shown in Table 3. Limiting the samples to households with a woman who is either a head of household, or a spouse of household head, reduced the samples to 789,092 from 926,716. Excluding samples with missing values of explanatory variables, and outside the age and birth cohort restrictions, our sample size was reduced to 443,391[11].

In Table 4, the results of logistic regression analysis for females are shown. In Table 5, the marginal effects of the variables are shown.

To the best of our knowledge, in Japan, so far no studies have tried to analyze systematically the effect of children's age on parent's smoking.

Unfortunately, since the Survey of Living Conditions do not ask any question about pregnancy, we have nothing to contribute on women's smoking during pregnancy. Some physicians argued that pregnancy provides a natural opportunity for smoking women to quit, particularly in the early stage of pregnancy when many suffer from nausea and vomiting (Yasukouchi and Sata 2006, 2008). Partly due to this, and partly due to medical consultations, family persuasions and social pressures, there is a consensus that at least a half, and possible more than two thirds, of smoking women quit during pregnancy (Yasuda et al 2013, Ohida et al. 2007, Kaneita et al. 2007, Kurumatani et al. 1998, Kubo and Emistu, 2007). The cessation, however, may not always last throughout the pregnancy as recent studies on unacceptability bias among the Japanese pregnant women suggest (Yamashita 2012, Sasaki 2011).

Once a baby is born, however, the Survey provides information on baby's age (by year as well as by month) and its order of birth in the family. We can evaluate the effects of the age and the parity of the baby on mother's smoking behavior, at the same time controlling for the other socio-economic variables of the family. In order to detect the possible effects of time during the first 12 months after birth, at first we examined the effect of baby's age in months. In spite of the fact that we have more than 16,000 zero year old babies in our sample, after controlling for the survey years and birth-cohorts, the resulting fluctuations in coefficients were still difficult to interpret. Hence we took a quarter of a year (three months) as our unit of measurement for baby's age in its first year. Our findings are summarized in Table 6 and Table 7. First, there are several things to note in Table 6;

- There is a clear evidence of a relapse in mother's smoking cessation in the third and fourth quarters of her first baby. For example, in 2010, a first baby in its first or second quarters after birth would have reduced its mother's smoking rate by 16.5% point and 14.9%, respectively. The effect would have fallen to 12.7% point in the third quarter, and to 10.1% in the fourth quarter, respectively. In other word, one out of three mothers who had quitted before pregnancy restart in six months after giving birth to first babies. Our result seems to agree with the

[11] One observation was dropped in the logit regression because of predicted failure.

existing Japanese literature, although it is limited to the first baby.

- Quitting rates for the first baby, particularly in the first two quarters, seem to be increasing in the last decade, subject to fluctuations. For instance, in 2001, a first baby in its first quarter would have reduced the mother's smoking rate by 9.2%, but, a similar baby in 2010 would have reduced it by 16.5%. This is probably a result of increasing public awareness on the harmful effects of second hand smoking on infants.

- On one hand, for the second baby, mother's cessation rate is smaller from the very beginning, but on the other hand, it does not seem to decline much in the course of the first year. For a second baby born in 2010, the corresponding negative effects are 6.7% points, 5.2% points, 7.1% points, and 6.0% points, respectively for 1^{st}, 2^{nd}, 3^{rd} and 4^{th} quarter after its birth. Thus mother's quitting rate does not seem to have a clear downward trend for a second baby.

- For a third baby or a baby of higher order, it seems that a smoking mother barely makes an attempt to quit. Her smoking rates in the first four quarters are almost indistinguishable from the general female smoking rate. A natural interpretation of this result is self-selection; namely, those who can quit have already quitted during the two previous pregnancies and thereafter, and only the most addicted mothers are still smoking. Alternatively, by the time of a third baby, her addiction has become so entrenched that it can no longer be removed even for a limited time.

The smoking rates of mothers in the first year at various age (by month) and parity of a child are shown in Table 7. Very good news is that most recent survey (2010) suggests that a significant reduction has taken place in mother's smoking rate for a first child and a second. In fact, for a first child, less than 5% of mothers were smoking in the first two quarters, compared with almost 14% of mothers during the same periods in 2001. The reduction in the smoking rates in its fourth quarter is equally impressive; in 2010, it was 7.2% compared with 18.6% in 2001. For a second child, the proportions of smoking mothers were higher than for a first child by 2% points or so, but they were still less than 10%. In contrast, for a third child, even in 2010, more than 15% of mothers were smoking in the first three quarters.

After the first year, our results are summarized in Table 8 and Table 9. For the first child aged zero, one, two, three, four and five years old, according to the latest (2010) survey, mother's probability to smoke decreases by 12.9%, 6.4%, 4.3%, 2.4%, 2.2% and 2.1%, respectively (Table 8). Moreover, when compared with women with no children, the prevalence of smoking among women who have a first baby less than one year old is lower by almost 14% point, implying that more than two thirds of women who used to smoke abstain from smoking at least for a year. In the second year, around one half of the women who had quitted (12.9% minus 6.4%, or 6.5%) resume smoking, and in the third year, about one third of the remaining women who had quitted (6.4% minus 4.3%, or 2.1%) resume smoking, and so on. In six years after the birth, the cessation-effects have virtually disappeared.

The marginal effects of a first child are considerably different from those of a second child, or a third/higher order child. According to the latest survey (2010), the marginal effects of a second baby are -6.2%, -2.7%, -2.3%, -1.2%, -2.2% and +0.7%, at its zero, one, two, three, four and five year old period, respectively. Thus compared with the first child, only half of the smoking mothers quit temporarily for the second baby in the first year. Then, in its second year, almost 60% of these quitters restart. In six years, the cessation effect disappears. Our results also indicate that by the time a mother has a third baby, she barely quit smoking.

The proportions of mothers smoking at various ages (between zero and five years old) of a child are shown in Table 9. The figures in the table also show increasing trend for quitting immediately after delivery. For example, for a first child less than a year old, only 5.5% of mothers smoked in 2010, compared with 10.5% in 2001. The difference narrows substantially for a one year old baby as 10.1% mothers were smoking in 2010, compared with 15.0% mothers in 2001. For a second child, the difference starts at around 5% in 2010, with 8.3% mothers smoking, compared with 13.0% mothers in 2001. For a third child, the difference is less than 1%, with 15.6% mothers smoking, compared with 16.3% in 2001. Thus, although in the beginning the differences are wider, the difference either narrows considerably even for a first child, or vanishes for a second and a third child.

Just as we have just shown, a number of studies in the US and in Europe have already found that a mother is more likely to quit for her first baby (Cnattingius et al., 1992; Kvalvik et al., 2008; Paterson et al., 2003). However, in Japan, this result has not been established yet (Imamura et al., 2001; Kaneko et al., 2008; Kubo et al., 2011; Suzuki et al., 2010). There are a few studies that showed the propensity, but their data were not national and their sample sizes were relatively small (Akaike et al. 1986, Suzuki et al. 2005). Only Kaneita et al.(2006) showed, using the first wave of Survey of Babies in the 21st Century (a national panel data of 53,575 samples), that a second or third baby gives higher adjusted odds ratios of mother's smoking compared with a first one. But their samples were taken when the babies were 6 month-old, and they did not provide differential marginal effects of the parities of babies. Thus, our study is the first to show complete relationship between smoking behavior of women and her children's age and parity in Japan.

Moreover, our findings contradict what Fukuda et al. (2005b) had conjectured: according to them, "For women aged 25 to 39 years, marital status did not show a significant association with smoking. For men in the same age group, being married was significantly and positively associated with smoking. Although the events of pregnancy and child rearing are related to the chance of smoking cessation (22-24), this study suggests the possibility that these events do not promote smoking cessation in the Japanese population." We have shown that pregnancy and childbearing affect mother's smoking, but behavior depends on the parity of the baby and time after the birth.

Other Control Variables

After controlling for cohort effects, age-effects, job-types, family effects, the coefficients of the year dummies show that there are only small negative effects still unaccounted for in the four waves of Survey of Living Conditions (2001~2010).

Coefficients of birth-year dummies indicate that the peak of the female smoking prevalence had been achieved by women born between 1975 and 1980, followed by a sudden decline in subsequent cohorts. In fact, in all the cohorts born before 1975, the smoking rates had been increasing by 2% point by each five-year cohort. In cohorts born after 1985, however, the smoking rate dropped by almost 6 % point for each five-year cohort. In Japan, Marugame et al. (2006) examined the smoking trends by birth cohorts from 1900 and 1977, but they had not found the peak for women then. Thus, our study is the first one to show that the increasing prevalence of smoking among Japanese women finally ended in the cohort born between 1975 and 1980.

After controlling for the other factors, once we control the cohort effects, the effect of age seems to be very small in female smoking behavior. In fact, our results show that the proportions of female smokers remain almost constant in their 30's and the 40's, but start to decline a little in the 50's (-1.3% point) and modestly in the 60's (-2.7%). It is not until they reach age 70 when a substantial number of women start quitting.

With respect to marital status, the unmarried have a small, but statistically insignificant, higher risk of smoking compared with the married, but the divorced have the highest risk of smoking, exceeding the married almost by 9 percent point. From the point of view of children, having mothers who experienced a divorce increases their risk of secondhand smoke exposure very substantially. The widowed, on the other hand, do not seem to be statistically different from the married in terms of smoking risk. Thus, if women who are divorced have children, their children have to face much greater risk of secondhand smoke. In protecting children from secondhand smoke, it is important to pay special attention to such groups as children in single mother households.

We have found almost no study that examined the effects of marital status on smoking by women in Japan, except Fukuda's article (who used the same dataset as ours). In contrast, Nystedt (2006) revealed the strong connection between marital life course and smoking behavior. He stated that the divorced are more likely to smoke and getting a divorce is related to initiation of smoking particularly for women. Moreover, the lowest cessation rates are observed for newly divorced women. Also Lee et al. (2005) pointed out that compared with women who remained married, women who are divorced/widowed have more than twofold greater a risk of relapsing/starting smoking. In Korea, never-married, widowed and divorced women aged 25-54 showed increased risk of smoking compared to married women (Cho et al., 2008)

As to jobs, those who work in agricultural and forestry have the lowest risk of smoking among the working female groups, followed by clerical staff, and by specialists. These three job-holders have lower risks than non-workers. In contrast, those who jobs are characterized as "service jobs" have the

highest risk of smoking, more than 5% point higher than non-workers, followed by "management" (+4.1% point), "sales" (+3.7% point), and production-line, communication and transportation workers (+1.9% point). Not surprisingly, the characteristics of these risky jobs/industries coincide with the findings of Fukuda et al. (2005a) who used a part of the same data. In contrast, in Korea, according to the results of Cho et al. 2013, among the three categories of jobs (non-manual, manual and service), service workers show a higher risk of smoking than manual workers, and manual workers show a higher risk than non-manual workers.

There is a considerable amount of evidence that women's smoking behavior is strongly influenced by that of her partner's (Daly et al., 1993; Dollar et al,. 2009; Homish et al., 2005; Kahn et al., 2002; Sutton 1993,)[12]. Our results too show that smoking behaviors of husbands and wives are closely correlated. Compared with a woman without husband, the risk of a married woman increases substantially if her husband is a regular smoker (+4.2% point), but the risk decreases substantially if he is a non-smoker (-9.3 % point), or an ex-smoker (-9.0% point). The risk also decreases significantly if he is an occasional smoker (-5.5% point). These results do not necessarily prove causal relationships, as non-smoking men are highly likely to marry no-smoking women, leaving smoking women often marry smoking men.

We also looked into the effect of smokers other than the husband, if any, in the same household. We found that an increase in number of smoker in the household elevates the risk significantly. One smoker in the household increases the risk by 4.5% point, two smokers by 7.6% point, three smokers by 9.1% point, and four smokers by 14.0% point[13].

One of the interesting and subtle points is the asymmetric effects of three-generation households on women's smoking: living with the parents of the heads of household reduces the smoking risk, but living with the parents of the spouses does not have a statistically significant effect. Since an overwhelming majority of the women in our sample are not heads of household but spouses, these results imply that living with parents-in-law discourages her smoking, but living with own parents does not have a similar negative effect[14]. One of the most important factors for pregnant Japanese

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12 Although there is a considerable amount of literature on the smoking behaviors in married couples focusing on pregnant or postpartum women (e.g. Mcbride et al., 1998; Mullen et al., 1997; Nafstad et al., 1996; Severson et al., 1995). Similar study also exist in Japan (e.g. Kaneko et al. 2008, Kouketsu et al. 2010, Suzuki et al. 2010, Bando et al. 2013, Imamura et al. 2011)

13 Fukuda et al. (2005b) examined the effect of other smokers in household on smoking status by different age groups and showed significant association between other smokers and smoking status.

14 However, Ohida and et al.(2000) observed that more non-smoking wives tend to form three-generation households, as percentage of former smoker in three-generation households are similar to the other households.

women to quit smoking, according to Ohida et al. (2001), is the advices given by other family members. Our results suggests that, holding the number of smokers in the family constant, while spouses cannot completely ignore the advices coming from their parents-in-law, they can ignore those coming from their own parents.

We looked at the effects of different types of residence on smoking. Compared with the owner-occupied housing, most types of rented housing increase the risk of smoking. Another interesting finding of ours is that the company-provided housing decreases the risk of smoking compared with owner-occupied housing. It seems likely that wives living in company-provided housing are very conscious of their neighbor's eyes and try to avoid a socially unacceptable behavior as smoking.

With respect to health check-ups, those who have had health check-ups or cancer check-ups (except lung-cancer check-up) have lower prevalence of smoking. Although the sizes of these effects are moderate, around 2% (except 0.4% for stomach cancer) point each, they are statistically quite significant. These results are consistent with what the theory of health capital predicts; a risk-averse individual tends to invest in health-checkups and cancer-checkups and avoid risk behaviors. We note in passing that lung-cancer chekup would have worked in the opposite direction: in fact, the women who had the check-up have a higher risk of smoking (around 2% point). The strong causal relationship between smoking and lung cancer has been so well-known that smokers are conscious of their own higher risk and have lung cancer checkup as a secondary preventive measure. For this reason, we have removed this variable from the list of our regressors.

As we have explained at the outset, using income information would have reduced the size of our sample to 1/7.5 of what we are using. We traded away the luxury of income information for the sample size, believing that the household expenditure in the previous month would be sufficient for our purpose. In so doing, just as the equivalent scale in income, we have adjusted our household expenditure by the square root of the household size[15]. Based on the equivalent scale expenditure, we have computed their quintile index and used the dummies to control for the income. With a reference to the lowest expenditure group, all the other groups except for the highest one were less likely to smoke. According to Fukuda et al. (2005b), income was the strong predictor of smoking and odds ratios would become smaller as income increase on the basis of lowest income group. Since our equivalent scale expenditure produces similar effects as their equivalent scale income, we can safely say that household expenditure could be used instead of household income.

[15] Fukuda used "OECD equivalence scale" but we used the latest "Square root scale")

Conclusion

This chapter employed a nationally representative survey data and examined the smoking behavior of Japanese mothers, paying close attention to their children's age and their birth orders. Thanks to the survey's large sample size, and high quality, we were able to obtain much more precise estimators with more statistical power compared to any other previous studies.

We have found that mothers quitting status after delivery is quite unstable in Japan, depending on the age and the parity of a child. Based on the comparison with women with no children, we estimated that for a first child, more than two-thirds of women who used to smoke, abstain from smoking at least for one year. In the second year, around one half of the abstainers resume smoking, and in the third year, about one third of the abstainers resume smoking, and in six years after the birth, the first-child effect virtually disappears. For a second child, compared with a first child, only a half of the mothers quits temporarily in its first year. Then, in its second year, almost 60% of these quitters restart, and in six years, the second-child effect disappears. By the time a mother has a third baby, she barely quit smoking.

We have noticed, in the first decade of this century when the Japanese government started its public campaign against public smoking for the first time, an increasing trend for quitting among Japanese mothers immediately after delivery. The phenomenon was particularly pronounced for a child, less so for a second child, and almost none for a third. Although in the beginning the changes are large, they seem to narrow rapidly as time goes on even for a first child, or vanishes for a second in five years. In fact, our estimation suggests that in 6 years after delivery, mothers return to the smoking habits of their cohort's.

We also found that, among Japanese women, such factors as marital status, husband's smoking status, other smokers in household are strongly related to smoking, while job-types, living with head of household's parents, and housing have differential impacts on their smoking.

There are several limitations in our analysis. First of all, as the survey data we used is not a longitudinal survey, it is inherently difficult to evaluate changes over time. We hope to have overcome much of this difficulty by controlling sample years, birth cohorts, regions, and parities, using the rich socio-economic information and the large sample-sizes of our data. But they are not perfect substitutes for a longitudinal survey.

Another limitation is that our analysis focuses only on women or mothers. From the point of view of secondhand smoke exposure of children, husbands' smoking also affects their health significantly. A research focusing on both husbands and wives is clearly needed and we intend to carry out such one shortly.

The most substantial limitation is that our statistical analyses are based on the self-reported smoking status of the survey. As we have explained at the outset, there are good reasons to suspect that a substantial proportion of Japanese women hide their true

smoking status. We had no alternative but to take the self-reports at their face values. Nevertheless, our statistical work is a considerable improvement over the official statistics as is clear in Figure 1. In the figure, we have compared the smoking rates of Japanese women using all the samples (with population weights) in the Survey of Living Conditions, with those of Nutrition Survey (official government statistics), and JT Survey. The 95% confidence intervals are shown for our data in the figure, and the two representative smoking statistics are outside the ranges.

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Table 1 Sample size of survey

(number of household)

Survey year	Number of survey objectives	Number of objects reponded	Response rate	Number of objects tabulated*
2001	282999	247278	87.4%	247,195
2004	276682	220948	79.9%	220,836
2007	287807	230596	80.1%	229,821
2,010	289363	229785	79.4%	228,864
Total	1136851	928607	81.7%	926716

* excluding house which were unable to tabulate

Table 2 Number of male and femal by survey year

Survey year	Male	Female	Total
2001	338,997	364,402	703,399
2004	297,661	321,912	619,573
2007	299,936	324,232	624,168
2010	292,091	316,928	609,019
Total	1,228,685	1,327,474	2,556,159

Table 3 Descriptive statistic (categorical variables)

	2001		2004		2007		2010		Total	
	N	%	N	%	N	%	N	%	N	%
Birth-cohort by 5-year										
1935-1939	5,905	4.99	4,640	5.14	4,710	4.01	4,069	3.47	19,324	4.36
1940-1944	17,734	14.97	13,820	15.31	15,041	12.79	13,101	11.19	59,696	13.46
1945-1949	19,558	16.51	14,739	16.33	17,735	15.09	15,989	13.65	68,021	15.34
1950-1954	18,440	15.57	13,250	14.68	16,854	14.34	15,896	13.57	64,440	14.53
1955-1959	14,787	12.48	10,654	11.8	13,868	11.8	13,681	11.68	52,990	11.95
1960-1964	13,546	11.44	9,753	10.81	12,747	10.84	12,769	10.9	48,815	11.01
1965-1969	12,532	10.58	9,015	9.99	12,346	10.5	12,554	10.72	46,447	10.48
1970-1974	10,323	8.72	8,525	9.45	12,157	10.34	12,818	10.94	43,823	9.88
1975-1979	4,747	4.01	4,290	4.75	7,930	6.75	9,092	7.76	26,059	5.88
1980-1984	874	0.74	1,573	1.74	3,326	2.83	5,023	4.29	10,796	2.43
1985-1989	0	0	0	0	842	0.72	2,138	1.83	2,980	0.67
Age group										
20-29	12,594	10.63	6,695	7.42	7,562	6.43	6,617	5.65	33,468	7.55
30-39	25,417	21.46	17,835	19.76	23,244	19.77	21,330	18.21	87,826	19.81
40-49	31,315	26.44	20,574	22.79	25,374	21.58	25,189	21.51	102,452	23.11
50-59	38,080	32.15	28,078	31.11	34,702	29.52	29,307	25.02	130,167	29.36
60-69	11,040	9.32	17,077	18.92	26,674	22.69	29,525	25.21	84,316	19.02
70-79	0	0	0	0	0	0	5,162	4.41	5,162	1.16
Job category										
no work	49,104	41.46	38,440	42.59	48,620	41.36	50,234	42.89	186,398	42.04
Specialist	12,722	10.74	10,140	11.23	15,567	13.24	15,426	13.17	53,855	12.15
Management	1,676	1.41	1,107	1.23	1,224	1.04	1,323	1.13	5,330	1.2
Clerical	14,301	12.07	10,611	11.76	15,248	12.97	14,676	12.53	54,836	12.37
Sales	10,002	8.44	7,615	8.44	6,891	5.86	6,280	5.36	30,788	6.94
Services	13,080	11.04	9,947	11.02	15,607	13.28	15,180	12.96	53,814	12.14
Seculity	484	0.41	227	0.25	112	0.1	89	0.08	912	0.21
Agricultural and forestry	3,021	2.55	2,565	2.84	2,883	2.45	2,777	2.37	11,246	2.54
Production	12,136	10.25	8,118	8.99	8,685	7.39	8,073	6.89	37,012	8.35
Others	1,920	1.62	1,489	1.65	2,719	2.31	3,072	2.62	9,200	2.07
Marital status										
Married	100,709	85.03	77,162	85.49	98,927	84.15	97,387	83.14	374,185	84.39
Unmarried	7,712	6.51	4,674	5.18	6,588	5.6	6,449	5.51	25,423	5.73
Bereaved (widow)	4,002	3.38	3,773	4.18	5,352	4.55	6,219	5.31	19,346	4.36
Divorced	6,023	5.09	4,650	5.15	6,689	5.69	7,075	6.04	24,437	5.51
Living with househead's parents										
0	102,188	86.27	78,803	87.31	104,250	88.68	105,266	89.87	390,507	88.07
1	13,008	10.98	9,326	10.33	10,958	9.32	9,869	8.43	43,161	9.73
2	3,250	2.74	2,130	2.36	2,348	2	1,995	1.7	9,723	2.19
Living with spouse's parents										
0	115,714	97.69	88,083	97.59	114,898	97.74	114,698	97.92	433,393	97.75
1	2,328	1.97	1,884	2.09	2,309	1.96	2,140	1.83	8,661	1.95
2	404	0.34	292	0.32	349	0.3	292	0.25	1,337	0.3
Number of smokers in household excluding husband										
0	99,301	83.84	76,463	84.72	101,952	86.73	104,337	89.08	382,053	86.17
1	15,944	13	11,537	13	13,382	11.38	11,110	9.49	51,973	11.72
2	2,901	2	2,053	2	2,023	1.72	1,555	1.33	8,532	1.92
3	277	0	191	0	182	0.15	113	0.1	763	0.17
4	23	0.02	14	0.02	17	0.01	15	0.01	69	0.02
5	0	0	1	0	0	0	0	0	1	0
Husband's smoking status										
Without husband	19,800	16.72	14,833	16.43	22,017	18.73	24,138	20.61	80,788	18.22
Not smoke	43,129	36.41	36,224	40	50,143	42.65	51,926	44	181,422	40.92
Smoke everyday	51,825	43.75	34,764	39	39,008	33.18	33,386	29	158,983	35.86
Smoke sometimes	1,803	1.52	1,456	2	1,862	1.58	1,708	1	6,829	1.54
Ex-smoker	1,889	1.59	2,982	3.3	4,526	3.85	5,972	5.1	15,369	3.47

Table 3 Descriptive statistic (categorical variables), continued

Health check-up										
0	68,036	57.44	53,758	59.56	70,860	60.28	75,126	64.14	267,780	60.39
1	50,410	42.56	36,501	40.44	46,696	39.72	42,004	35.86	175,611	39.61
Cancer check-ups										
Stomack cancer										
0	93,970	79.34	71,296	78.99	88,632	75.4	86,056	73.47	339,954	76.67
1	24,476	20.66	18,963	21.01	28,924	24.6	31,074	26.53	103,437	23.33
Lung cancer										
0	102,692	86.7	78,106	86.54	91,979	78.24	90,722	77.45	363,499	81.98
1	15,754	13.3	12,153	13.46	25,577	21.76	26,408	22.55	79,892	18
Uterus cancer										
0	83,768	70.72	62,666	69.43	82,181	69.91	78,513	67.03	307,128	69.27
1	34,678	29.28	27,593	30.57	35,375	30.09	38,617	32.97	136,263	30.73
Breast cancer										
0	93,168	78.66	68,521	75.92	89,239	75.91	83,315	71.13	334,243	75.38
1	25,278	21	21,738	24	28,317	24	33,815	28.87	109,148	24.62
Colon cancer										
0	100,105	84.52	74,916	83	92,724	78.88	91,233	77.89	358,978	80.96
1	18,341	15	15,343	17	24,832	21	25,897	22	84,413	19.04
House-type										
Owner-occupied housing	81,292	68.63	65,261	72.3	85,388	72.64	85,411	72.92	317,352	71.57
Rented housing (private)	22,731	19	15,149	17	20,209	17	19,679	16.8	77,768	17.54
Company-provided housing	4,861	4	3,175	4	3,636	3	3,229	2.76	14,901	3.36
Rented housing (public)	7,791	6.58	5,225	5.79	5,397	4.59	5,268	4.5	23,681	5.34
Others	1,771	2	1,449	2	2,926	2	3,543	3.02	9,689	2.19
Area of floor -quintile										
1	27,693	23.38	18,687	20.7	25,697	21.86	24,092	20.57	96,169	21.69
2	26,088	22	18,570	21	25,628	22	24,729	21.11	95,015	21.43
3	22,718	19	17,615	20	22,152	19	22,716	19.39	85,201	19.22
4	22,045	18.61	18,287	20.26	22,540	19.17	22,770	19.44	85,642	19.32
5	19,902	17	17,100	19	21,539	18	22,823	19.49	81,364	18.35
Household expenditure-quintile										
1	13,986	11.81	14,078	15.6	20,815	17.71	22,556	19.26	71,435	16.11
2	21,910	18.5	17,656	19.56	23,034	19.59	23,561	20.12	86,161	19.43
3	23,704	20.01	17,946	19.88	23,452	19.95	23,128	19.75	88,230	19.9
4	28,109	23.73	19,253	21.33	25,695	21.86	24,013	20.5	97,070	21.89
5	30,737	25.95	21,326	23.63	24,560	20.89	23,872	20.38	100,495	22.67
Total	118,446		90,259		117,556		117,130		443,391	

Table 3 Descriptive statistic (continued)

Child age and Parity		2001	2004	2007	2010	Total
Zero	1st	1,810	1,221	1,476	1,388	5,895
	2nd	1,547	1,041	1,254	1,137	4,979
	3rd	602	390	513	500	2,005
One	1st	2,011	1,341	1,511	1,416	6,279
	2nd	1,605	1,131	1,265	1,199	5,200
	3rd	652	395	473	557	2,077
Two	1st	2,064	1,435	1,657	1,501	6,657
	2nd	1,569	1,158	1,458	1,303	5,488
	3rd	589	443	496	552	2,080
Three	1st	2,010	1,487	1,729	1,521	6,747
	2nd	1,601	1,098	1,447	1,347	5,493
	3rd	716	437	543	520	2,216
Four	1st	2,077	1,500	1,850	1,598	7,025
	2nd	1,638	1,161	1,363	1,274	5,436
	3rd	659	442	500	468	2,069
Five	1st	2,019	1,447	1,863	1,615	6,944
	2nd	1,654	1,164	1,465	1,427	5,710
	3rd	703	448	528	499	2,178
6-12 year		32,934	22,234	28,576	28,200	111,944
13-18 year		32,091	20,671	24,471	23,558	100,791
Total		90,551	60,644	74,438	71,580	297,213

Table 4 Logistic regression result

	CE	SE	Z	P>|z|	95% CI	
Birth-cohort by 5-year (reference=1975-1979)						
1935-1939	-0.974	0.068	-14.34	0	-1.107	-0.840
1940-1944	-0.883	0.056	-15.87	0	-0.992	-0.774
1945-1949	-0.690	0.050	-13.87	0	-0.788	-0.593
1950-1954	-0.553	0.044	-12.43	0	-0.640	-0.466
1955-1959	-0.344	0.040	-8.52	0	-0.423	-0.265
1960-1964	-0.177	0.035	-5.13	0	-0.245	-0.109
1965-1969	-0.179	0.029	-6.17	0	-0.236	-0.122
1970-1974	-0.075	0.023	-3.24	0.001	-0.120	-0.029
1980-1984	-0.148	0.032	-4.58	0	-0.211	-0.085
1985-1989	-0.542	0.055	-9.83	0	-0.651	-0.434
Survey year (reference=2001)						
2004	-0.069	0.026	-2.66	0.008	-0.120	-0.018
2007	-0.084	0.025	-3.3	0.001	-0.134	-0.034
2010	-0.158	0.028	-5.59	0	-0.213	-0.102
Age group (reference=20-29)						
30-39	-0.048	0.026	-1.85	0.064	-0.098	0.003
40-49	-0.025	0.038	-0.67	0.505	-0.099	0.049
50-59	-0.122	0.047	-2.57	0.01	-0.215	-0.029
60-69	-0.265	0.059	-4.53	0	-0.380	-0.150
>70	-0.723	0.106	-6.85	0	-0.930	-0.516
Job category (reference=no work)						
Specialist	-0.067	0.031	-2.21	0.027	-0.127	-0.007
Management	0.431	0.070	6.13	0	0.293	0.569
Clerical	-0.136	0.029	-4.64	0	-0.193	-0.078
Sales	0.389	0.030	12.97	0	0.331	0.448
Services	0.464	0.027	17.34	0	0.412	0.517
Seculity	0.238	0.122	1.95	0.051	-0.001	0.478
Agricultural and forestry	-0.150	0.069	-2.17	0.03	-0.285	-0.015
Production	0.103	0.030	3.39	0.001	0.044	0.163
Others	0.056	0.067	0.83	0.406	-0.076	0.187
Marital status (reference=married)						
Unmarried	0.050	0.034	1.48	0.139	-0.016	0.116
Bereaved (widow)	0.146	0.036	4.07	0	0.076	0.217
Divorced	0.808	0.031	25.84	0	0.746	0.869
Living with parents (reference =0)						
Head of household's	-0.220	0.014	-16.21	0	-0.246	-0.193
Spouse's	-0.032	0.028	-1.14	0.256	-0.087	0.023
Number of smokers in household excluding husband (reference =0)						
1	0.399	0.015	26.87	0	0.370	0.428
2	0.628	0.030	20.91	0	0.569	0.687
3	0.733	0.093	7.88	0	0.551	0.915
4	1.051	0.293	3.59	0	0.477	1.626
5	0.000 (empty)					
Husband's smoking status (reference= no husband)						
Not smoke	-1.043	0.029	-35.36	0	-1.101	-0.985
Smoke everyday	0.315	0.028	11.12	0	0.259	0.370
Smoke sometimes	-0.521	0.050	-10.44	0	-0.619	-0.423
Ex-smoker	-1.002	0.045	-22.25	0	-1.091	-0.914

Note: Number of obs = 443390 Log likelihood = -154150.27 Pseudo R2 = 0.1372

Table 4 Logistic regression result (continued)

		CE	SE	Z	P>|z|	95% CI	
Health check-up		-0.228	0.011	-21.31	0	-0.249	-0.207
Cancer check-ups							
Stomack cancer		-0.035	0.017	-2.05	0.04	-0.068	-0.002
Uterus cancer		-0.182	0.014	-13.44	0	-0.208	-0.155
Breast cancer		-0.262	0.016	-16.05	0	-0.294	-0.230
Colon cancer		-0.210	0.018	-11.39	0	-0.246	-0.174
House-type (reference=owner-occupied housing)							
Rented housing (private)		0.350173	0.014894	23.51	0	0.320981	0.379364
company-provided housing		-0.22785	0.028325	-8.04	0	-0.28337	-0.17233
Rented housing (public)		0.505348	0.01925	26.25	0	0.467619	0.543078
Others		0.326551	0.02787	11.72	0	0.271927	0.381175
Area of floor -quintile (reference=lowest)							
2		-0.06447	0.013345	-4.83	0	-0.09062	-0.03831
3		-0.11434	0.016015	-7.14	0	-0.14573	-0.08296
4		-0.18413	0.017503	-10.52	0	-0.21843	-0.14983
5		-0.2944	0.019516	-15.09	0	-0.33265	-0.25615
Household expenditure-quintile (reference=lowest)							
2		-0.04791	0.014986	-3.2	0.001	-0.07728	-0.01854
3		-0.06638	0.015373	-4.32	0	-0.09651	-0.03625
4		-0.07929	0.015496	-5.12	0	-0.10966	-0.04892
5		-0.02797	0.016125	-1.73	0.083	-0.05958	0.003632
Omit region dummy							
Child age	Parity						
0-2month	1st	-0.84	0.16	-5.23	0	-1.15	-0.52
	2nd	-0.19	0.15	-1.27	0.206	-0.48	0.10
	3rd	-0.05	0.23	-0.23	0.818	-0.50	0.39
3-5month	1st	-0.82	0.14	-5.78	0	-1.10	-0.55
	2nd	-0.35	0.14	-2.42	0.015	-0.63	-0.07
	3rd	-0.19	0.22	-0.87	0.387	-0.63	0.25
6-8month	1st	-0.89	0.14	-6.61	0	-1.16	-0.63
	2nd	-0.23	0.14	-1.68	0.092	-0.50	0.04
	3rd	-0.58	0.27	-2.16	0.031	-1.11	-0.05
9-11month	1st	-0.42	0.12	-3.56	0	-0.66	-0.19
	2nd	-0.40	0.14	-2.84	0.004	-0.68	-0.13
	3rd	-0.51	0.23	-2.25	0.025	-0.96	-0.07
One	1st	-0.31	0.06	-5.12	0	-0.43	-0.19
	2nd	-0.37	0.08	-4.85	0	-0.53	-0.22
	3rd	-0.10	0.10	-0.97	0.332	-0.31	0.10
Two	1st	-0.19	0.06	-3.12	0.002	-0.31	-0.07
	2nd	-0.12	0.07	-1.62	0.105	-0.26	0.03
	3rd	-0.01	0.11	-0.12	0.902	-0.23	0.20
Three	1st	-0.24	0.07	-3.58	0	-0.37	-0.11
	2nd	-0.19	0.07	-2.64	0.008	-0.33	-0.05
	3rd	0.13	0.10	1.37	0.171	-0.06	0.33
Four	1st	-0.17	0.07	-2.5	0.012	-0.29	-0.04
	2nd	-0.02	0.07	-0.32	0.746	-0.15	0.11
	3rd	0.14	0.10	1.4	0.16	-0.06	0.34
Five	1st	-0.03	0.07	-0.38	0.701	-0.15	0.10
	2nd	-0.17	0.07	-2.5	0.012	-0.31	-0.04
	3rd	0.04	0.10	0.41	0.683	-0.16	0.24
6-12 year		-0.02	0.02	-1.49	0.136	-0.05	0.01
13-18 year		-0.03	0.02	-2.11	0.035	-0.06	0.00

Note: Number of obs = 443390 Log likelihood = -154150.27 Pseudo R2 = 0.1372

Table 5 Average marginal effects

	Delta-method dy/dx	SE	Z	P>|z|	95% CI	
Birth-cohort by 5-year (reference=1975-1979)						
1935-1939	-0.099	0.007	-14.93	0	-0.112	-0.086
1940-1944	-0.092	0.006	-15.3	0	-0.104	-0.080
1945-1949	-0.076	0.006	-13.1	0	-0.087	-0.065
1950-1954	-0.063	0.005	-11.63	0	-0.074	-0.052
1955-1959	-0.042	0.005	-8.11	0	-0.052	-0.032
1960-1964	-0.022	0.004	-4.97	0	-0.031	-0.014
1965-1969	-0.023	0.004	-5.94	0	-0.030	-0.015
1970-1974	-0.010	0.003	-3.19	0.001	-0.016	-0.004
1980-1984	-0.019	0.004	-4.74	0	-0.027	-0.011
1985-1989	-0.062	0.005	-11.37	0	-0.073	-0.051
Survey year (reference=2001)						
2004	-0.007	0.002	-4.63	0	-0.010	-0.004
2007	-0.010	0.002	-6.21	0	-0.013	-0.007
2010	-0.018	0.002	-9.37	0	-0.022	-0.014
Age group (reference=20-29)						
30-39	-0.005	0.003	-1.82	0.068	-0.011	0.000
40-49	-0.003	0.004	-0.66	0.507	-0.011	0.005
50-59	-0.013	0.005	-2.53	0.011	-0.023	-0.003
60-69	-0.027	0.006	-4.49	0	-0.039	-0.015
>70	-0.065	0.008	-7.84	0	-0.081	-0.049
Job category (reference=no work)						
Specialist	-0.007	0.002	-4.08	0	-0.010	-0.003
Management	0.041	0.005	7.82	0	0.031	0.051
Clerical	-0.012	0.002	-7.91	0	-0.015	-0.009
Sales	0.037	0.002	17.76	0	0.033	0.042
Services	0.051	0.002	29.73	0	0.048	0.055
Seculity	0.012	0.012	1	0.318	-0.011	0.035
Agricultural and forestry	-0.032	0.003	-9.4	0	-0.039	-0.026
Production	0.019	0.002	9.81	0	0.015	0.023
Others	0.017	0.004	4.67	0	0.010	0.024
Marital status (reference=married)						
Unmarried	0.005	0.004	1.46	0.143	-0.002	0.012
Bereaved (widow)	0.016	0.004	3.95	0	0.008	0.023
Divorced	0.103	0.005	22.7	0	0.094	0.111
Living with parents (reference =0)						
Head of household's	-0.023	0.001	-16.22	0	-0.026	-0.020
Spouse's	-0.003	0.003	-1.14	0.256	-0.009	0.002
Number of smokers in household excluding husband (reference =0)						
1	0.045	0.002	24.94	0	0.042	0.049
2	0.076	0.004	18.22	0	0.068	0.084
3	0.091	0.014	6.69	0	0.064	0.117
4	0.140	0.048	2.92	0.003	0.046	0.234
5	.	(not estimable)				
Husband's smoking status (reference= no husband)						
Not smoke	-0.093	0.003	-29.42	0	-0.099	-0.086
Smoke everyday	0.042	0.004	11.76	0	0.035	0.050
Smoke sometimes	-0.055	0.005	-11.22	0	-0.064	-0.045
Ex-smoker	-0.090	0.004	-23.85	0	-0.098	-0.083

Table 5 Average marginal effects (continued)

		Delta-method dy/dx	SE	Z	P>|z|	95% CI	
Health check-up		-0.024	0.001	-21.12	0	-0.026	-0.022
Cancer check-ups							
Stomach cancer		-0.004	0.002	-2.05	0.04	-0.007	0.000
Uterus cancer		-0.019	0.001	-13.45	0	-0.022	-0.016
Breast cancer		-0.028	0.002	-16.06	0	-0.031	-0.024
Colon cancer		-0.022	0.002	-11.39	0	-0.026	-0.018
House-type (reference=owner-occupied housing)							
Rented housing		0.039	0.002	22.46	0	0.035	0.042
company-provided housing		-0.021	0.002	-8.56	0	-0.026	-0.016
Rented housing (public)		0.058	0.002	23.83	0	0.053	0.063
Others		0.036	0.003	10.82	0	0.029	0.042
Area of floor -quintile (reference=lowest)							
2		-0.007	0.001	-4.82	0	-0.010	-0.004
3		-0.012	0.002	-7.14	0	-0.016	-0.009
4		-0.020	0.002	-10.57	0	-0.023	-0.016
5		-0.030	0.002	-15.36	0	-0.034	-0.027
Household expenditure-quintile (reference=lowest)							
2		-0.005	0.002	-3.19	0.001	-0.008	-0.002
3		-0.007	0.002	-4.31	0	-0.010	-0.004
4		-0.008	0.002	-5.1	0	-0.012	-0.005
5		-0.003	0.002	-1.73	0.083	-0.006	0.000
Omit region dummy							
Child age	Parity						
0-2month	1st	-0.141	0.014	-10.33	0	-0.168	-0.115
	2nd	-0.053	0.012	-4.63	0	-0.076	-0.031
	3rd	-0.008	0.014	-0.58	0.56	-0.035	0.019
3-5month	1st	-0.115	0.010	-11.04	0	-0.135	-0.094
	2nd	-0.042	0.009	-4.48	0	-0.060	-0.024
	3rd	-0.026	0.014	-1.86	0.063	-0.054	0.001
6-8month	1st	-0.103	0.009	-10.83	0	-0.121	-0.084
	2nd	-0.041	0.009	-4.48	0	-0.059	-0.023
	3rd	-0.020	0.013	-1.5	0.133	-0.047	0.006
9-11month	1st	-0.069	0.008	-8.26	0	-0.086	-0.053
	2nd	-0.042	0.009	-4.51	0	-0.060	-0.024
	3rd	-0.028	0.013	-2.18	0.029	-0.053	-0.003
One	1st	-0.054	0.004	-12.61	0	-0.063	-0.046
	2nd	-0.026	0.005	-5.6	0	-0.036	-0.017
	3rd	-0.008	0.006	-1.19	0.235	-0.020	0.005
Two	1st	-0.037	0.004	-8.96	0	-0.045	-0.029
	2nd	-0.017	0.004	-3.94	0	-0.026	-0.009
	3rd	0.000	0.006	0.06	0.951	-0.012	0.013
Three	1st	-0.035	0.004	-8.31	0	-0.043	-0.027
	2nd	-0.014	0.004	-3.33	0.001	-0.023	-0.006
	3rd	0.001	0.006	0.14	0.89	-0.011	0.013
Four	1st	-0.022	0.004	-5.5	0	-0.030	-0.014
	2nd	-0.008	0.004	-2.02	0.043	-0.016	0.000
	3rd	0.000	0.006	-0.05	0.964	-0.013	0.012
Five	1st	-0.010	0.004	-2.58	0.01	-0.018	-0.002
	2nd	-0.002	0.004	-0.5	0.615	-0.010	0.006
	3rd	0.006	0.006	0.92	0.357	-0.006	0.018
6-12 year		-0.001	0.001	-0.7	0.483	-0.003	0.001
13-18 year		-0.003	0.001	-2.94	0.003	-0.005	-0.001

Table 6 Average marginal effect of age(month) and parity by year

	1st Child				2nd Child				3rd Child			
age(month)	0-2	3-5	6-8	9-11	0-2	3-5	6-8	9-11	0-2	3-5	6-8	9-11
2001	-9.2% ***	-9.1% ***	-9.9% ***	-4.7% ***	-2.1%	-3.8% *	-2.5%	-4.5% **	-0.6%	-2.1%	-6.4% *	-5.6% *
2004	-12.3% ***	-13.0% ***	-7.5% ***	-5.7% **	-6.4% *	-2.8%	-4.0% *	-2.8%	-1.9%	-2.2%	1.4%	0.6%
2007	-18.7% ***	-9.7% ***	-10.5% ***	-7.4% ***	-6.7% **	-4.7% *	-3.2%	-3.3%	-2.1%	-6.7% *	-2.6%	-1.6%
2010	-16.5% ***	-14.9% ***	-12.7% ***	-10.1% ***	-6.7% *	-5.2% *	-7.1% **	-6.0% **	1.2%	0.7%	0.9%	-3.7%
Average	-14.1% ***	-11.5% ***	-10.3% ***	-6.9% ***	-5.3% ***	-4.2% ***	-4.1% ***	-4.2% ***	-0.8%	-2.6%	-2.0%	-2.8% *

Table 7 Smoking rate by children's age(month) and parity

Smoking rate

	1st Child				2nd Child				3rd Child			
age(month)	0-2	3-5	6-8	9-11	0-2	3-5	6-8	9-11	0-2	3-5	6-8	9-11
2001	13.6%	13.8%	13.5%	18.6%	18.2%	17.2%	18.8%	15.0%	20.3%	16.5%	12.3%	13.9%
2004	8.1%	8.1%	12.6%	14.5%	10.4%	14.4%	14.0%	15.4%	15.7%	17.6%	22.2%	20.0%
2007	4.3%	9.5%	9.5%	11.4%	9.5%	11.5%	11.8%	12.4%	15.6%	12.4%	16.0%	18.8%
2010	3.9%	4.4%	5.7%	7.2%	6.6%	9.1%	8.1%	9.0%	15.5%	15.9%	17.6%	13.0%
Average	7.9%	9.3%	10.6%	13.2%	11.8%	13.3%	13.5%	13.1%	16.9%	15.5%	16.6%	16.2%

Table 8 Average marginal effect of age and parity by year

		Age					
		Zero	One	Two	Three	Four	Five
1st child	average	-10.1% ***	-5.4% ***	-3.7% ***	-3.5% ***	-2.2% ***	-1.0% *
	2001	-8.0% ***	-3.4% ***	-2.1% **	-2.6% ***	-1.8% *	-0.3%
	2004	-9.0% ***	-4.6% ***	-3.6% ***	-4.1% ***	-2.5% **	0.3%
	2007	-10.5% ***	-7.4% ***	-5.0% ***	-5.0% ***	-2.5% **	-1.8% *
	2010	-12.9% ***	-6.4% ***	-4.3% ***	-2.4% **	-2.2% **	-2.1% *
2nd child	average	-4.3% ***	-2.6% ***	-1.7% ***	-1.4% **	-0.8% *	-0.2%
	2001	-3.3% ***	-4.1% ***	-1.3%	-2.1% **	-0.2%	-1.9% *
	2004	-3.7% **	-0.9%	-2.7% **	-1.2%	-0.3%	0.1%
	2007	-4.3% ***	-2.3% *	-0.9%	-1.0%	-0.6%	0.7%
	2010	-6.2% ***	-2.7% **	-2.3% *	-1.2%	-2.2% *	0.7%
>3rd child	average	-1.9% **	-0.8%	0.0%	0.1%	0.0%	0.6%
	2001	-3.6% **	-1.1%	-0.1%	1.5%	1.6%	0.5%
	2004	-0.3%	-0.2%	1.2%	-1.3%	1.5%	0.2%
	2007	-3.0% *	-1.3%	1.2%	0.6%	-2.7% *	-0.5%
	2010	-0.2%	-0.2%	-2.0%	-0.9%	-0.3%	2.1%

* p < 0.05 ** p<0.01 *** p<0.001

Table 9 Smoking rate by children's age and parity

		Age					
		Zero	One	Two	Three	Four	Five
1st child	average	10.5%	15.0%	15.7%	15.1%	16.3%	17.6%
	2001	15.0%	20.4%	20.6%	18.6%	18.9%	20.4%
	2004	11.1%	16.2%	16.7%	15.3%	16.7%	20.2%
	2007	9.1%	11.4%	12.9%	13.0%	15.5%	16.5%
	2010	5.5%	10.1%	11.1%	12.7%	13.4%	12.9%
2nd child	average	13.0%	15.2%	16.4%	17.3%	18.6%	19.0%
	2001	17.2%	16.2%	19.4%	18.9%	21.4%	18.8%
	2004	13.9%	18.1%	16.2%	18.3%	19.9%	19.5%
	2007	11.4%	14.1%	16.4%	17.2%	18.6%	20.1%
	2010	8.3%	12.4%	13.1%	14.7%	13.7%	17.5%
>3rd child	average	16.3%	18.8%	19.5%	19.5%	19.3%	19.7%
	2001	15.6%	20.1%	20.9%	21.7%	21.6%	20.1%
	2004	19.1%	19.6%	19.8%	18.0%	21.5%	18.7%
	2007	15.8%	18.2%	21.8%	20.4%	16.1%	18.8%
	2010	15.6%	17.2%	15.8%	16.5%	17.4%	20.8%

* p < 0.05 ** p<0.01 *** p<0.001

Figure 1 Smoking rate by 3 survey