

6. Results

6.1. Interaction effects of couple's domestic work participations and wife's employment status

The first set of estimation results are shown in Table 5. In Table 5, only both main and interaction effects of couple's domestic work participations and wife's employment status are shown in the form of hazard ratio, the exponential b. The estimation results of the full models including control variables are shown in Table A-4 in Appendix.

Table 5. Hazard ratios of the transition to second birth: Interaction effects

	Model 1	Model 2	Model 3	Model 4	Model 5
Covariates	exp(b)	exp(b)	exp(b)	exp(b)	exp(b)
Couple's participation in housework and child-rearing					
Husband's childcare frequency (Ind. fixed effect)	1.08 ***	1.08 ***	1.08 ***	1.08 ***	1.08 ***
Husband's housework frequency (Ind. fixed effect)	0.99	0.99	0.98	0.99	0.99
Wife's childcare frequency (Ind. fixed effect)	1.01	1.01	1.01	1.01	1.01
Wife's housework frequency (Ind. fixed effect)	1.06 ***	1.06 ***	1.06 ***	1.05 ***	1.11 ***
Wife's employment status					
(Reference: Not employed or students)					
Not employed or students	1	1	1	1	1
Self-employed or family businesses	0.86 **	0.86 **	0.87 **	0.86 **	0.86 **
Full-time employees	0.86 ***	0.87 ***	0.87 ***	0.86 ***	0.86 ***
Part-time employees	0.67 ***	0.67 ***	0.67 ***	0.67 ***	0.67 ***
Husband's employment status					
(Reference: Not employed or students)					
Not employed or students	1	1	1	1	1
Self-employed or family businesses	1.50 ***	1.50 ***	1.51 ***	1.50 ***	1.49 ***
Full-time employees	1.45 ***	1.46 ***	1.46 ***	1.46 ***	1.45 ***
Part-time employees	1.18	1.18	1.18	1.18	1.17
Interaction effects:					
Wife's employment status					
* H usband's child-rearing / housework frequencies (Fixed Effect)					
Not employed or students		Husband's child-rearing	Husband's housework		
Self-employed or family businesses		1	1		
Full-time employees		1.08	1.25 ***		
Part-time employees		0.98	0.99		
Wife's employment status					
* W ife's child-rearing / housework frequencies (Fixed Effect)					
Not employed or students				Wife's child-rearing	Wife's housework
Self-employed and family businesses				1	1
Full-time employees				1.04	1.09
Part-time employees				1.01	0.89 ***
				0.92	0.95
Constant	0.015 ***	0.015 ***	0.015 ***	0.015 ***	0.015 ***
Number of person-period	68503	68503	68503	68503	68503
Number of samples	10808	10808	10808	10808	10808
Number of events	7580	7580	7580	7580	7580
Chi-square values	3371.174	3371.498	3379.055	3375.922	3378.800
Degree of freedom	39	42	42	42	42

*, p<.10, **, p<.05, ***, p<.01

First, Model 1 serves as a base model and the estimated results are interpreted as follows. The model indicates that husband's greater participation in childcare as well as wife's greater commitment to

housework contributes to the higher hazard of the transition to the second child. Whereas wife's employment leads to lower hazard of the second birth, husband's stable employment which is indicated as a full-time employment or self-employment positively relates to the second birth hazard. Therefore, gender equality in the market labor measured by wife's employment relates negatively to the second birth hazard. However, gender relations in domestic sphere have mixed effects on the second birth hazard.

Model 2 through Model 5 shows the interaction effects between wife's employment status and each measure of couple's domestic work participations. Only one set of the interaction effects are estimated in each model to avoid complexity in the interpretation. The results indicate that both husband's and wife's housework participations have the interaction effects with wife's employment status. In Model 3, husband's greater participation in housework can compensate negative effects of the wife's self-employment on the transition to the second birth. Self-employed wives are highly likely to be involved with family businesses of her husband. In our analytical sample, 53% of their husbands are also self-employed. It is also likely that these self-employed couples spend a time together both at home and workplace. The result indicates that only in such a situation, husband's greater participation in housework has a positive effect on the second birth hazard in Japan. In Model 5, a full-time employed wife further declines her chance of having the second child when she has a greater commitment to housework. This effect is considered as a negative consequence of the "second shift" among full-time employed wives on fertility outcomes.

In sum, this first set of the analysis suggests that second birth hazard is in general high among the families with traditional gender role division where a husband works outside and a wife stays at home for home making and childrearing. However, husbands' greater participations in childcare can further increase the chance of the second birth irrespective of wife's employment statuses. In terms of couple's participation in housework, we find significant interaction effects with wife's employment status. First, husband's greater participation in housework boosts the second birth hazard of self-employed wives. Second, wife's greater commitment to housework reduces a chance of the second birth among

full-time employed wives. For the former relationship, it is not clear from our analysis what aspects of self-employed couples lead to the higher chance of the second birth. However, such factors as the proximity of home and workplace, flexible work hour arrangement and higher gender equality at workplace can be possible conditions to make husband's greater housework commitment increase fertility of working wives. The latter relationship confirms the negative fertility response to the "second shift" among full-time employed wives.

6.2. A comparison of full-time wives and housewives on the correlates of the second births

In the second set of the analysis, we compare the effects of couples' employment status, domestic work participations as well as other covariates on the second birth hazard between full-time employed wives and housewives. The analytical sample is divided by wives' employment status at wave 1 survey. The estimation results are shown in Table 6.

Correlates of the second birth hazard are substantially different across two sub-samples. In fact, the estimation result of the housewife sample is much the same as the all sample results in Table 5 (or Table A-4). This is because housewives are the majority after giving the first birth in Japan as shown in Figure 2. Therefore, we mainly interpret correlates of the second birth hazard for the sample of full-time employed wives and contrast them to those of the housewife sample.

First, wife's deeper commitment to housework leads to higher second birth hazard only among housewives. Contradicting our expectation, the effect of wife's housework commitment was not negative in the full-time worker sample as shown in Table 5. We suspect that this was because some of the wives resigned their full-time employment after the wave 1 survey. For example, we have 13% of wives who resigned her full-time employment and 7% of wives turned their employment to part-time jobs in the full-time worker sample. In addition, these wives who resigned a full-time employment have higher hazard of second birth than the other wives. The family situations of these resigned wives are supposed to become much resemble to the housewife sample where effect of wife's housework

Table 6. Hazard ratios of the transitions to second birth: Full-time wives and housewives

Covariates	Wife's employment status at wave 1	
	Full-time employee	Not employed
	exp(b)	exp(b)
Couple's participation in housework and child-rearing		
Husband's childcare frequency (Ind. fixed effect)	1.09 **	1.07 ***
Husband's housework frequency (Ind. fixed effect)	0.98	0.98
Wife's childcare frequency (Ind. fixed effect)	1.04	1.01
Wife's housework frequency (Ind. fixed effect)	1.00	1.08 ***
Wife's employment status (Reference: Not employed or students)		
Not employed or students	1.48 ***	1
Self-employed or family businesses	1.54	0.81 **
Full-time employees	1	0.68 ***
Part-time employees	1.01	0.64 ***
Husband's employment status (Reference: Not employed or students)		
Not employed or students	1	1
Self-employed or family businesses	1.22	1.51 ***
Full-time employees	1.36	1.45 ***
Part-time employees	0.72	1.28
Wife's education level (Reference: High school)		
Junior high school	0.64	0.98
High school	1	1
Vocational school/Junior college/Technical college	1.24 ***	1.11 ***
University/Graduate school	1.17 *	1.15 ***
Coresidence with parents (Reference: Not living together)		
Living together	1.18 **	1.04
Wife's take-up of childcare leave		
Did not take childcare leave	1	-
Took childcare leave from a company of 1-99 regular employees	1.01	-
Took childcare leave from a company of 100-499 regular employees	1.10	-
Took childcare leave from a company of over 500 regular employees	1.01	-
Took childcare leave from public office (inc. public schools)	1.30 ***	-
Wife's anxiety and feelings of burden over child-rearing		
Anxiety or distress over child-rearing		
Feel a lot	0.89	0.76 ***
Feel a bit	1	1
Feel almost none	1.13 *	1.12 ***
Score on feelings of burden over child-rearing (Reference: 0 point)		
0 point	1	1
1-2 points	1.07	1.00
3-4 points	1.14	0.97
5-8 points	0.87	0.81 **
First child characteristics		
Sex of the first child (Reference: Male)		
Female	0.90 **	1.00
Premature, underweight baby (Reference: No)		
Yes	0.72	0.62 ***
Premarital pregnancy (Reference: No)		
Yes	1.14 *	1.16 ***
Month of birth (Reference: Born in January)		
Born in July	0.96	1.06 **

*: p<.10, **: p<.05, ***: p<.01

Table 6. continued

Covariates	Wife's employment status at wave 1	
	Full-time e employee	Not employed
	exp(b)	exp(b)
Demographic Characteristics		
Birth interval spline (Base point: 0 year)		
0-3 year	2.27 ***	2.18 ***
3-4 year	0.68 ***	0.63 ***
4-6 year	0.70 ***	0.63 ***
Wife's age at first birth (Reference: Age 25-29)		
Age -24	1.04	1.19 ***
Age 25-29	1	1
Age 30-34	0.78 ***	0.71 ***
Age 35-	0.38 ***	0.30 ***
Area of residence (Reference: Kanto)		
Hokkaido	0.89	0.99
Tohoku	1.02	1.12 **
Kanto	1	1
Hokuriku	1.06	1.03
Chubu	0.96	1.16 ***
Kinki	1.06	1.15 ***
Chugoku	0.97	1.17 ***
Shikoku	1.18	1.15 *
Kyusyu and Okinawa	1.25 **	1.27 ***
Size of the municipality where the respondent resides (Reference: Other cities)		
14 Largest cities	0.87 *	0.93 **
Other cities	1	1
Rural districts	1.24 ***	1.12 ***
Constant	0.011 ***	0.015 ***
Number of person-period	12305	52492
Number of samples	1896	8327
Number of events	1349	5844
Chi-square values	665.057	2657.645
Degree of freedom	43	39

*: p<.10, **: p<.05, ***: p<.01

participation is positive. Thus, the effects of wife's housework participation on the second birth hazard are likely to be canceled out due to wives' employment changes. Therefore, we could conclude that the positive effect of wife's housework commitment on the second birth was largely observed phenomenon among gender traditional couples.

Second, we expect that a husband's participation in housework would reduce wife's burden of the "second shift" and, thus, contributes to sustaining fertility of full-time working wives. However, this effect was not found. Instead, living with either a wife's or husband's parent(s) are positively relating to

the second birth hazard of working wives. In fact, this positive effect is not found in housewife sample. Therefore, it is possible that wife's double burden of work and household chores is, in large part, mitigated by the help from the couple's parents rather than by the hands of husbands.

It is noteworthy that husband's employment status does not affect the likelihood of the second births in the full-time worker sample, while it does strongly affect likelihood of the second birth in the housewife sample. Wife's economic independence may reduce the importance of husband's breadwinning role in deciding whether to have a second child. Oppenheimer (1997) pointed out that dual-earner couples are more durable to the risk of a spouse's job loss than single-earner couples. The result confirms her statement on dual-earner household in relation to its effects on the second birth.

Effects of other covariates on the second birth hazards also exhibit interesting difference between full-time working wives and housewives. For example, psychological factors are more important for the birth decisions of housewives than those of working wives. Previous study found that negative childrearing experiences of the first child reduce the likelihood of additional childbirths (Yamaguchi 2005). Our result confirms that fertility outcomes of housewives are also more sensitive to her psychological assessment of childcare burdens than working wives.

Another interesting contrast is the effects of the sex of the first child. The sex of the first child matters for the full-time working wives while it does not for housewives. It is reported that daughter preference is more common than son preference among Japanese couples since the mid-1980s (National Institute of Population and Social Security Research 2011). Although it has to be confirmed in further study, it is possible that among couples who are under the strong constraint of having two children, they tend to stop bearing a second child when the first baby meets their preference on the sex of the child.

Finally, our result shows that regional differences in the second birth hazards are observed only in housewife couples. Among full-time working wives, regional differences are remarkably negligible except for the high second birth hazard in Kyushu and Okinawa region. It is assumed that in Kyushu and Okinawa region, there are some unobserved factors which facilitate second births of working wives. To

identify such factors through either qualitative or quantitative studies focusing on this topic is potentially important to understand how constraints of working wives can be reduced and to examine if those identified factors would be extendable to other regions by some forms of policy measure.

7. Conclusion

How gender equality relates to fertility in the highly developed countries and what are the causal linkage between the two become a growing concern for not only population scholars but also policy makers. In this paper, we examined the relationship between couples' domestic work participations and the transitions to the second birth in the beginning of the 21st century Japan by using a newly available nationally representative panel data of LSN21. The data we have used is the highest quality panel data in Japan as LSN21 data is collected by the statistics department of the Ministry of Health, Labour and Welfare as a government statistics and known for its large sample size and the minimum rates of attrition. Our analysis was benefitted from the use of LSN21 data and provided a new insight of the relationship between couples' gender relations and fertility in Japan.

Our analysis revealed that the transition rates from first to second birth are higher in Japan among gender traditional families which are single earner households with husbands' stable employments and wives' great commitments to housework, than gender equal families of dual-earner households. However, husband's greater participation in childcare can contribute to higher chance of the second birth, irrespective to the wife's employment status. Men's greater concern to childrearing is positively relating to fertility outcomes in Japan. In terms of the social role expectation, men's participation in childrearing may be highly demanded by wives and meeting with such expectation affects transitions to the second birth.

We also find a strong negative effect of wife's higher commitment to housework on the second birth hazard when the wife works full-time. We interpret this as a negative fertility response to the "second shift". However, our analyses consistently reveal that husbands' supports in housework do not

remedy the negative consequence on fertility. Instead, our analysis suggests that a large part of the physical and psychological burdens of the full-time employed wives is, in fact, mitigated by coresident parents. The only exception for this relationship seems to be a situation where a wife is self-employed. Husband's greater participation in housework has a positive effect on the transitions to the second birth only when the wife is self-employed. As more than a half of the self-employed wives' husbands are also self-employed, this relationship is considered to be a specific to self-employed couples. However, it is not clear from our analysis on which aspects of the self-employment make husband's housework participation a driving force of the second births. Thus, further study is necessary to search for key factors to extend the observed relationship to a majority of couples whose husbands are employed by a company. In this paper, we only speculate that such work conditions of self-employment as flexible work arrangement, proximity of home and workplace or small gender gap in the workplace may explain the positive link.

Finally, the policy implications of our study will be the followings; First, our analyses consistently reveal that wives' employments relate negatively to the second birth intensities. Therefore, strong policy measures for reducing women's worker-mother conflicts are necessary to establish the positive linkage between gender equality in labor market and fertility as observed in some western countries. However, one remark is that our analysis is based on the first five years of the 21st century Japan where formal introductions of the childcare support policies such as childcare leave system, sick/injured child care leave and reduced work hours for childcare were only its onset. Therefore, using data which covers more recent period may already see some improvement in the negative relationship as indicated in Figure 2. Therefore, the continuous monitoring of the relationship between women's employment and fertility outcomes will be particularly important to evaluate the policy effects as well as future levels of fertility.

Second, our analysis indicates that gender equality at home has some mixed effects on fertility outcomes. Men's participation in childcare seems to be a universally required social role in contemporary Japanese couples and the degree to meeting with such expectation, in fact, affects fertility outcomes. In

this respect, the gender equality in childcare can lead to higher fertility in Japan as similar to some of other European countries (Puur et al. 2008 Miettinen, Basten and Rotkirch 2011). On the other hand, work hours are, in general, very inflexible in Japan. Previous studies suggest this inflexibility, in large part, explains very low levels of husband's participation in housework in Japan (Nishioka 1998, Matsuda 2002, Suruga 2010). Our results, however, shows that husband's greater participation relates positively to the second birth hazard in the self-employed couples who are likely to share both home and work place. Therefore, it is possible that more flexible work arrangement as well as proximity of home and workplace contribute to establish a positive link between the gender equality within the family life and fertility.

APPENDIX :

Table A-1. Fixed Effect Models on Husband's Participations in Housework and Childcare

Fixed effect regression on husband's frequencies in housework and childcare

	All couples		By wife's employment status at wave 1			
	Housework b	Childcare b	Full-time employee		Staying at home	
			Housework b	Childcare b	Housework b	Childcare b
Couple's participation in housework and childcare						
Husband's childcare frequency (Factor score)	0.207 ***	-	0.258 ***	-	0.191 ***	-
Husband's housework frequency (Factor score)	-	0.298 ***	-	0.384 ***	-	0.265 ***
Wife's childcare frequency (Factor score)	-0.015 ***	0.030 ***	-0.004	0.035 ***	-0.014 ***	0.025 ***
Wife's housework frequency (Factor score)	-0.027 ***	0.015 **	-0.032 **	0.024	-0.014 **	0.019 ***
Couple's income						
Husband's income	0.000	-0.030 *	-0.036	-0.006	-0.019	-0.031
Wife's income	-0.017 ***	-0.008	0.000	-0.014	-0.006	-0.005
(Wife's income / Couple's income)*10	0.052 ***	0.016	0.027 *	0.025	0.021	0.013
Wife's employment status (Reference: Not employed or students)						
Self-employed or family businesses	-0.025	-0.066	0.000	0.063	-0.028	-0.110 *
Full-time employees	0.126 ***	0.007	0.199 ***	-0.041	0.380 ***	0.087
Part-time employees	0.061 **	0.000	0.007	-0.124	0.192 ***	0.014
Husband's employment status (Reference: Full-time employee/Self-employed or family businesses)						
Not employed/students/Part-time employees	0.148 ***	0.144 ***	0.037	0.114	0.190 ***	0.164 ***
Pregnancy	0.197 ***	0.076 ***	0.146 ***	0.040	0.227 ***	0.091 ***
Childbirth	-0.071 ***	0.059 ***	-0.167 ***	0.043	-0.057 ***	0.064 ***
Coresidence with parents (Reference: Not living together)	-0.380 ***	0.013	-0.477 ***	0.092	-0.360 ***	0.001
Use of Childcare	0.226 ***	0.126 ***	0.165 ***	0.193 ***	0.096 ***	0.075 ***
Survey wave (Reference: 1st wave)						
2nd wave	-0.127 ***	0.210 ***	0.025	0.230 ***	-0.171 ***	0.199 ***
3rd wave	-0.185 ***	0.265 ***	-0.024	0.233 ***	-0.212 ***	0.266 ***
Constant	0.073	-0.018	0.005	-0.211	0.248 **	0.005
Number of person-period	33597	33597	5871	5871	25845	25845
Number of samples	11199	11199	1957	1957	8615	8615
Within R2	0.112	0.136	0.204	0.233	0.096	0.117
Between R2	0.293	0.288	0.356	0.34	0.227	0.254
Overall R2	0.247	0.233	0.316	0.302	0.187	0.201
Degree of freedom	11214	11214	1972	1972	8630	8630

*: p<.10, **: p<.05, ***: p<.01

Table A-2. Fixed Effect Models on Wife's Participations in Housework and Childcare

	All couples		By wife's employment status at wave 1			
	Housework b	Childcare b	Full-time employee		Staying at home	
			Housework b	Childcare b	Housework b	Childcare b
Couple's participation in housework and childcare						
Husband's childcare frequency (Factor score)	0.015 **	0.057 ***	0.024	0.062 ***	0.021 ***	0.054 ***
Husband's housework frequency (Factor score)	-0.040 ***	-0.042 ***	-0.046 **	-0.009	-0.022 **	-0.042 ***
Wife's childcare frequency (Factor score)	0.110 ***	-	0.146 ***	-	0.081 ***	-
Wife's housework frequency (Factor score)	-	0.206 ***	-	0.263 ***	-	0.156 ***
Couple's income						
Husband's income	-0.033 **	-0.077 ***	0.019	-0.130 ***	-0.013	-0.077 ***
Wife's income	0.030 ***	0.015	0.019	0.024	0.019 **	0.021
(Wife's income / Couple's income)*10	-0.087 ***	-0.068 ***	-0.062 ***	-0.056 **	-0.060 ***	-0.084 ***
Wife's employment status (Reference: Not employed or students)						
Self-employed or family businesses	-0.032	0.005	-0.249	0.495 **	-0.093	-0.094
Full-time employees	-0.156 ***	-0.102 **	-0.157 ***	-0.098	-0.603 ***	-0.461 ***
Part-time employees	-0.034	-0.051	-0.042	-0.027	-0.072 *	-0.027
Husband's employment status (Reference: Full-time employee/Self-employed and family businesses)						
Not employed/students/Part-time employees	-0.093 **	-0.086 *	0.117	-0.189	-0.146 ***	-0.098
Pregnancy	-0.113 ***	-0.001	-0.131 ***	-0.061	-0.118 ***	0.015
Childbirth	0.071 ***	-0.035	0.191 ***	0.058	0.032	-0.068 **
Coresidence with parents (Reference: Not living together)	-0.761 ***	0.052	-0.736 ***	-0.130	-0.882 ***	0.122 ***
Use of Childcare	-0.172 ***	-0.120 ***	-0.121 ***	0.033	-0.082 ***	-0.219 ***
Survey wave (Reference: 1st wave)						
2nd wave	0.126 ***	-0.050 ***	-0.004	-0.154 ***	0.191 ***	-0.018
3rd wave	0.215 ***	-0.298 ***	0.088 ***	-0.319 ***	0.267 ***	-0.310 ***
Constant	0.331 ***	0.651 ***	0.324	1.110 ***	0.123	0.596 ***
Number of person-period	33597	33597	5871	5871	25845	25845
Number of samples	11199	11199	1957	1957	8615	8615
Within R2	0.084	0.065	0.117	0.086	0.085	0.06
Between R2	0.264	0.13	0.349	0.196	0.17	0.04
Overall R2	0.21	0.095	0.283	0.144	0.142	0.052
Degree of freedom	11214	11214	1972	1972	8630	8630

*: p<.10, **: p<.05, ***: p<.01

Table A-3. Definition of Covariates

Names of variables	Definitions
Participation by each spouse in housework and child rearing	
Individual fixed effect on participation in housework (both for husband and wife)	An estimated fixed effect of factor scores based on either husband's or wife's participation in housework measured at wave 1 through wave 3. The factor score is calculated from the following 6 items: (1) Cooking, (2) Doing dishes, (3) Cleaning a house, (4) Washing laundry, (5) Taking out garbage, and (6) Doing daily shopping using a pooled data of wave 1 through wave 3. 0 points are given if the husband "never" does such activity, 1 point if the husband "rarely" does such activity, 2 points if the husband "sometimes" does such activity, and 3 points if the husband "always" does such activity.
Individual fixed effect on participation in child rearing (both for husband and wife)	An estimated fixed effect of factor score based on both husband's and wife's participations in childcare measured at wave 1 through wave 3. The factor score is calculated from the following 3 items: (1) Feeding, (2) Changing diapers, and (3) Bathing using a pooled data of wave 1 through wave 3. 0 points are given if the husband "never" does such activity, 1 point if the husband "rarely" does such activity, 2 points if the husband "sometimes" does such activity, and 3 points if the husband "always" does such activity.
Couple's employment status	
Wife's employment status	Based on the question about the wife's employment status, as asked in each survey, the following 4 categories are created: "1: Not employed or students," "2: Self-employed or family business workers," "3: Regular employment," and "4: Employment other than 2 and 3." * "Self-employed or family business workers" includes the cases where the employment status belongs to "Others." * By using the employment status at t-1, the influence over the birth of a second child occurred during the period from t-1 to t is estimated.
Husband's employment status	Based on the question about the wife's employment status, as asked in each survey, the following 4 categories are created: "1: Not employed or students," "2: Self-employed or family business workers," "3: Regular employment," and "4: Employment other than 2 and 3." * "Self-employed or family business workers" includes the cases where the employment status belongs to "Others." * By using the employment status at t-1, the influence over the birth of a second child occurred during the period from t-1 to t is estimated.
Social variables	
Wife's education level	Based on the question about the wife's education level with respect to the "school that the wife last graduated (or is attending)," as asked in the 2nd wave survey, the following 4 categories are created: "1: Junior high school, special training school, or vocational school (after graduation from junior high school)," "2: High school," "3: Special training school, vocational school (after graduation from high school), junior college, or technical college," or "4: University or graduate school." * The analysis excludes the case where the wife's education level belongs to "Others."
Coresidence with parents	Based on the question about the household member of the first child, the dummy variables are created on whether or not the parents of either the wife or the husband are living together.
Wife's anxiety and feelings of burden over child rearing	
Anxiety and distress over child rearing	For the question "Do you feel anxiety or distress over child rearing? Please check one number that applies," the following response alternatives are provided: "1: Feel a lot," "2: Feel a bit," and "3: Feel very little." These responses are used as category variables. The values at the 1st wave survey are used.
Score on feeling of burden over child rearing	For the question "What makes you feel burdened after you had a child?", the following choices are provided (multiple choices allowed): (1) Physical burden is heavy, (2) Expenses for child rearing is high, (3) Unable to have own free time, (4) Unable to have time for enjoyment for a couple, (5) Unable to have enough time for work, (6) People around do not understand how difficult it is to raise a child, (7) My child is sickly, and (8) Others. We have used the number of selected choices. The values at the 1st wave survey are used.
First child characteristics	
Sex of the first child	0: Male, 1: Female
Premature and underweight baby	Whether first baby was a premature and underweight baby or not. 0: Not premature baby 1: Premature baby (a baby whose weight at the time of birth was less than 2500 g AND who was born in less than 37 weeks of pregnancy).
Premarital pregnancy	Whether first birth is consequence of a premarital pregnancy or not. 0: Not premarital pregnancy 1: Premarital pregnancy (The first birth took place less than 9 months after the father and mother started to live together).
Month of birth	Whether the first child was born in either January or July. 0: January 1: July
Demographic characteristics	
Birth interval	The duration measured in months since the birth of the first child is used as the spline function.
Wife's age at first birth	The dummy variables for the wife's age at the time of giving birth to the first child.
Area of residence	Based on the domicile information obtained in each survey, the following 9 local block categories are created: "1: Hokkaido" "2: Tohoku (Aomori, Iwate, Miyagi, Akita, Yamagata, and Fukushima)" "3: Kanto (Ibaraki, Tochigi, Gunma, Saitama, Chiba, Tokyo, and Kanagawa)" "4: Hokuriku (Niigata, Toyama, Ishikawa, and Fukui)" "5: Chubu (Yamanashi, Nagano, Gifu, Shizuoka, Aichi, and Mie)" "6: Kinki (Shiga, Kyoto, Osaka, Hyogo, Nara, and Wakayama)" "7: Chugoku (Tottori, Shimane, Okayama, Hiroshima, and Yamaguchi)" "8: Shikoku (Tokushima, Kanagawa, Ehime, and Kochi)" "9: Kyusyu and Okinawa (Fukuoka, Saga, Nagasaki, Kumamoto, Oita, Miyazaki, Kagoshima, and Okinawa)"
Size of municipality where the respondent resides	Based on the domicile information obtained in each survey, the following 3 categories are created with respect to the size of the municipality: "1: Large cities," "2: Other cities," and "3: Rural districts" * "Large cities" means the Tokyo Metropolitan Area and the government-ordinance-designated cities as of the time of each survey.

Table A-4. Hazard ratios of the transition to second birth: All covariates

Covariates	Model 1	Model 2	Model 3	Model 4	Model 5
	exp(b)	exp(b)	exp(b)	exp(b)	exp(b)
Couple's participation in housework and child-rearing					
Husband's childcare frequency (Ind. fixed effect)	1.08 ***	1.08 ***	1.08 ***	1.08 ***	1.08 ***
Husband's housework frequency (Ind. fixed effect)	0.99	0.99	0.98	0.99	0.99
Wife's childcare frequency (Ind. fixed effect)	1.01	1.01	1.01	1.01	1.01
Wife's housework frequency (Ind. fixed effect)	1.06 ***	1.06 ***	1.06 ***	1.05 ***	1.11 ***
Wife's employment status (Reference: Not employed or students)					
Not employed or students	1	1	1	1	1
Self-employed or family businesses	0.86 **	0.86 **	0.87 **	0.86 **	0.86 **
Full-time employees	0.86 ***	0.87 ***	0.87 ***	0.86 ***	0.86 ***
Part-time employees	0.67 ***	0.67 ***	0.67 ***	0.67 ***	0.67 ***
Husband's employment status (Reference: Not employed or students)					
Not employed or students	1	1	1	1	1
Self-employed or family businesses	1.50 ***	1.50 ***	1.51 ***	1.50 ***	1.49 ***
Full-time employees	1.45 ***	1.46 ***	1.46 ***	1.46 ***	1.45 ***
Part-time employees	1.18	1.18	1.18	1.18	1.17
Interaction effects:					
Wife's employment status * Husband's child-rearing / housework frequencies (Fixed Effect)		Husband's child-rearing	Husband's housework		
Not employed or students		1	1		
Self-employed or family businesses		1.08	1.25 ***		
Full-time employees		0.98	0.99		
Part-time employees		0.98	1.03		
Wife's employment status * Wife's child-rearing / housework frequencies (Fixed Effect)				Wife's child-rearing	Wife's housework
Not employed or students				1	1
Self-employed or family businesses				1.04	1.09
Full-time employees				1.01	0.89 ***
Part-time employees				0.92	0.95
Wife's education level (Reference: High school)					
Junior high school	1.00	1.00	0.99	0.99	1.00
High school	1	1	1	1	1
Vocational school / Junior college / Technical college	1.13 ***	1.13 ***	1.13 ***	1.13 ***	1.13 ***
University / Graduate school	1.17 ***	1.17 ***	1.17 ***	1.17 ***	1.17 ***
Coresidence with parents (Reference: Not living together)					
Living together	1.09 ***	1.09 ***	1.09 ***	1.09 ***	1.07 **
Wife's anxiety and feelings of burden over child-rearing					
Anxiety or distress over child-rearing					
Feel a lot	0.79 ***	0.79 ***	0.79 ***	0.79 ***	0.79 ***
Feel a bit	1	1	1	1	1
Feel almost none	1.11 ***	1.11 ***	1.11 ***	1.11 ***	1.11 ***
Score on feelings of burden over child-rearing (Reference: 0 point)					
0 point	1	1	1	1	1
1-2 points	1.01	1.01	1.01	1.01	1.01
3-4 points	0.99	1.00	0.99	0.99	1.00
5-8 points	0.80 ***	0.80 ***	0.80 ***	0.80 ***	0.80 ***
First child characteristics					
Sex of the first child (Reference: Male)					
Female	0.98	0.98	0.98	0.98	0.98
Premature, underweight baby (Reference: No)					
Yes	0.66 ***	0.65 ***	0.66 ***	0.65 ***	0.66 ***
Premarital pregnancy (Reference: No)					
Yes	1.14 ***	1.14 ***	1.14 ***	1.14 ***	1.14 ***
Month of birth (Reference: Born in January)					
Born in July	1.04 *	1.04 *	1.04 *	1.04 *	1.04 *
Demographic Characteristics					
Birth interval spline (Base point: 0 year)					
0-3 year	2.17 ***	2.17 ***	2.17 ***	2.17 ***	2.17 ***
3-4 year	0.62 ***	0.62 ***	0.62 ***	0.62 ***	0.62 ***
4-6 year	0.65 ***	0.65 ***	0.65 ***	0.65 ***	0.65 ***
Wife's age at first birth (Reference: Age 25-29)					
Age <24	1.17 ***	1.17 ***	1.17 ***	1.17 ***	1.17 ***
Age 25-29	1	1	1	1	1
Age 30-34	0.72 ***	0.72 ***	0.72 ***	0.72 ***	0.72 ***
Age 35-	0.32 ***	0.32 ***	0.31 ***	0.32 ***	0.31 ***
Area of residence (Reference: Kanto)					
Hokkaido	0.99	0.99	0.98	0.99	0.99
Tohoku	1.09 *	1.09 *	1.09 *	1.09 *	1.08
Kanto	1	1	1	1	1
Hokuriku	1.08	1.08	1.08	1.08	1.08
Chubu	1.14 ***	1.14 ***	1.14 ***	1.14 ***	1.14 ***
Kinki	1.13 ***	1.13 ***	1.13 ***	1.13 ***	1.13 ***
Chugoku	1.14 ***	1.14 ***	1.14 ***	1.14 ***	1.14 ***
Shikoku	1.16 **	1.16 **	1.16 **	1.16 **	1.16 **
Kyusyu and Okinawa	1.27 ***	1.27 ***	1.27 ***	1.27 ***	1.27 ***
Size of the municipality where the respondent resides (Reference: Other cities)					
14 Largest cities	0.91 ***	0.91 ***	0.91 ***	0.91 ***	0.91 ***
Other cities	1	1	1	1	1
Rural districts	1.14 ***	1.14 ***	1.14 ***	1.14 ***	1.14 ***
Constant					
Constant	0.015 ***	0.015 ***	0.015 ***	0.015 ***	0.015 ***
Number of person-period	68503	68503	68503	68503	68503
Number of samples	10808	10808	10808	10808	10808
Number of events	7580	7580	7580	7580	7580
Chi-square values	3371.174	3371.498	3379.055	3375.922	3378.800
Degree of freedom	39	42	42	42	42

*: p<.10, **: p<.05, ***: p<.01

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縦断調査を用いた出生力の規定要因分析

父母の喫煙習慣効果を検証するモデル比較

岩澤美帆¹ 鎌田健司²

目的 本研究では 2001 年に子どもをもった夫妻を追跡した縦断調査データを用い、出生力の規定要因を様々なモデルによって検証した。先行研究で指摘されている父母の喫煙習慣の出生に対するネガティブな効果に着目し、当該出生児出産半年後の父母の喫煙習慣が出生力に与える影響を検証した。

方法 厚生労働省統計情報部が実施した「21 世紀出生児縦断調査（平成 13 年出生児）」を用い、第 6 回時調査の出生児数を従属変数としたポアソン回帰モデル、第 6 回時調査までの追加出生の有無をモデル化したロジスティック回帰モデル、第 6 回までの脱落データを含まない場合と含んだ場合の次子出生タイミングについてのコックス回帰モデルを推定し、父母の喫煙習慣による効果を検証した。

結果 第 2 子出生への母の喫煙習慣の影響については、ポアソン回帰、ロジスティック回帰、コックス回帰のいずれでも大きなマイナスの効果があり、第 2 子出生ハザード比で言えば 25%減であった。第 3 子についてはロジスティック回帰、コックス回帰でのみ 5%の水準でマイナスの効果を確認された。父の喫煙効果は母に比べて小さくモデルによっては有意にならないが、脱落を含んだコックス回帰では第 2 子で 1%、第 3 子で 5%の水準でハザードを 1 割程度引き下げる効果が示された。

結論 要因によってはモデルや脱落ケースを含むかどうかで結果が異なるので、複数のモデルを試し結果の安定性を確認することが重要である。父母の喫煙習慣のマイナスの効果は働き方など他の社会経済的条件と比べても小さくなく、妊娠中の喫煙を抑制する取り組みは母子の健康増進のみならず出生数の増加そのものにも効果があることが期待できる結果が得られた。なお喫煙者は非喫煙者に比べ属性に偏りがあるといったことが結果に影響していないか、また今回統制できなかった時間変化変数の影響を検証することについては今後の課題としたい。

I はじめに

同一の個人を長年にわたって追跡する縦断調査は、時間的に前に経験されたことのその後の影響について、両方の情報を正確に把握できる利点を持っている。出生力の規定要因をさぐる上で、妊娠前の情報とその後の出生過程が把握できる縦断調査は極めて貴重であると言える。本研究では、「21 世紀出生児縦断調査（平成 13 年出生児）」における対象児の父母（夫妻）の情報を用い、父母の妊娠前の行動とその後の出生過程との関係を検証する。今回は、父母の妊娠前の喫煙習慣に着目する。妊娠前や妊娠中の女性の

¹ 国立社会保障・人口問題研究所人口動向研究部 第 1 室長

² 国立社会保障・人口問題研究所人口構造研究部 研究員

喫煙やパートナーの喫煙による受動喫煙は、疫学的な研究により、妊孕力低下や胎児死亡（流産）のリスク要因になることが知られている(Augood et al. 1998, Dechanet et al. 2011)。今日の再生産年齢にある父母の喫煙行動が実際に日本の出生力にマイナスの影響を与えているかどうかを検証するにあたっては、出生力の指標を何にするかによっていくつかのモデルが考えられる。本研究では様々な出生力指標とそれに適したモデルを整理し、結果の比較およびそれぞれのモデルのメリットやデメリットについて論じることで、縦断調査を用いた出生力の規定要因分析に適した手法に関する知見を提供したい。

II 先行研究における出生力指標

これまでの疫学的な研究により、喫煙は、妊孕力の低下、有害な生殖結果といった様々なリスクを高めることが確認されている(Dechanet et al. 2011)。こうしたリスクには流産、前置胎盤、早期破水、早産、低体重児などが含まれる。

喫煙がネガティブな影響をあたえる生殖に関する指標には、以下のようなものが含まれる。

(1) 受胎待ち時間・不妊

女性の能動喫煙や男性の喫煙による受動喫煙は、受胎待ち時間を長期化させることが分かっている。1日21本以上(Hull et al. 2000)、1日16本以上(Hassan and Killick 2004)のタバコ喫煙が受胎待ち時間を有意に長くするといった結果が得られている。また、喫煙と受胎待ち時間との関係に着目したメタアナリシス(過去に報告された多数の研究結果を、統合して再分析する方法)によれば、12の研究に基づき、受胎待ち時間が一定以上になる不妊に関するオッズを喫煙者と非喫煙者で比べたオッズ比は、コホート調査で1.42、ケース・コントロール研究で2.27、全体で1.60であった(Augood et al. 1998)。

(2) 流産確率

受胎待ち時間の長期化・不妊の他に母親の喫煙は子宮外妊娠、流産、胎盤剥離、周産期死亡、死産、先天性形成異常のリスクを高めることが知られている(Cnattingius 2004)。Kline et al.(1995)は、1日14本以上の喫煙で、染色体異常のない胎児の死亡リスクを上げることが示している。夫の喫煙による受動喫煙も、妊娠初期の胎児死亡に影響(Venners et al. 2004)。

出生動向基本調査によると、近年の日本における1妊娠あたりの流産確率は30歳で0.094であった(岩澤 2012)(図1)。Chatenoudら(1998)は、イタリアの医療施設ベースのケース・コントロール研究をもとに、喫煙していた妊婦の流産のオッズ比が非喫煙者に対し1.3倍であることを示している。仮に出生動向基本調査の0.094を非喫煙者の流産確率と見なすと、オッズ比が1.3倍となる喫煙者の流産確率は0.119となる。すなわち、非喫煙者の出生数を100%とすると、喫煙者の出生数は97.3%に抑制される計算となる。これは非喫煙者の出生数が2.0であった場合、喫煙者の出生数は1.95しか実現しないことを意味する。