

The Association Between Maternal Employment and Prevalence of Asthma in Children

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The results of previous studies on the association of maternal work status with the prevalence of asthma in children were not consistent. The purpose of this study was to evaluate whether maternal work status is associated with their child's asthma prevalence in a population-based sample in Japan. The study involved a secondary analysis of data from a population-based survey in the greater metropolitan area of Tokyo. One-year prevalence of asthma in children was assessed using the primary caregiver's report based on the International Study of Asthma and Allergies in Childhood score. The prevalence rate ratio (PRR) was calculated using multivariable Poisson regression analysis. Of 1,245 participants aged 3–11 years, 14% had suffered from asthma in the previous year. Compared with maternal nonworking status, full-time and self-employed/other work status was associated with a higher PRR for 1-year prevalence of asthma, after adjusting for confounders (PRR [95% confidence interval]: 1.52 [1.06, 2.18] and 1.62 [0.96, 2.75]), respectively), whereas part-time employment had no significant effect. *Ad hoc* analyses limited to working mothers indicated that weekly working hours, maternal childcare time, or work–life balance did not mediate the association between full-time/self-employed work and asthma prevalence in children. Maternal full-time/self-employment was related to higher prevalence of asthma in children, which was not seen with part-time work. Further investigation of working conditions of full-time and self-employed mothers is required to explain this association.

Introduction

ASTHMA IS ONE of the major chronic conditions in childhood, affecting the quality of life of both patients and caregivers.^{1,2} The prevalence of pediatric asthma has increased in the past few decades in both developing and developed countries, and determining the causes of this increase is recognized as a public health priority.³

Previous studies have identified multiple factors associated with the incidence of childhood asthma, including genetic background, prenatal and postnatal environment, and the socioeconomic status of the household.^{4–7} The contribution of maternal behavior, for example, smoking and breast feeding, has attracted research attention to identify modifiable intervention leverage for childhood asthma prevention and control. Compared with these behaviors, the impact of maternal work status on asthma incidence in children has been studied very little, and available evidence is not conclusive.^{7–10} Given the increasing number of mothers participating in the formal labor force, especially in industrialized countries,^{11,12} the question of whether there is an association between maternal work status and their child's asthma and its potential mechanism are worthy of study.

The inconsistencies observed in previous studies could be at least partially attributed to the measurement of asthmatic

conditions. Many of the surveys relied on asthma diagnoses by physicians, but reported by primary caregivers,^{7–9,13} which may be vulnerable to report bias¹⁴ and accessibility to medical care.^{15,16}

Two previous studies have collected both parent-reported physician diagnoses and asthma diagnoses based on validated screening tests such as the International Study of Asthma and Allergies in Childhood (ISAAC) measure.^{17–19} A United Kingdom study found that the prevalence of self-reported physician diagnoses of asthma did not differ across socioeconomic conditions, but using the ISAAC measure, asthma was more prevalent in children living in deprived areas.¹⁸ A US study also found that undiagnosed asthma, defined as a gap between self-reported physician diagnosis and ISAAC score, was significantly more prevalent in children with lower socioeconomic status.¹⁹ These studies, however, did not measure parental education, occupation, and household income and only used proxy measures for socioeconomic status. They could not, therefore, test the impact of maternal employment on asthma prevalence and underdiagnosis.

To overcome the limitations of previous studies, we used a dataset from a population-based study in Japan that covers younger children (3–11 years) and their parents and contains detailed data about parental socioeconomic conditions, physician visits, and ISAAC scores of children. The aim of this

study was to investigate the association between maternal labor force participation and asthma prevalence in children to identify possible leverage points for better prevention and control of asthma in younger children.

Materials and Methods

Participants

This study used a dataset from a population-based study, the Japanese Study on Stratification, Health, Income, and Neighborhood (J-SHINE).²⁰ J-SHINE recruited a random sample of 4,357 adults aged 25–50 years living in 4 municipalities in the Greater Tokyo metropolitan area, Japan, in 2010 (response rate of 31.3%). In 2011, their spouses and any children aged 18 years or under were invited to participate in a supplementary survey (response rate of 67.7%).

We excluded children younger than 3 years old for 2 reasons. First, the reliability of the ISAAC questionnaire for this age group has been reported as low.²¹ Second, the pathogenesis of wheezing and asthma may be different in children before the age of 3 years compared with older children.²² We therefore included 1,245 children aged 3–11 years with valid information on ISAAC scores.

The survey asked the respondents to answer a questionnaire through the Internet or on a laptop computer provided for their convenience.²⁰

Outcome measurement

One-year prevalence of asthma was measured using parent-reported ISAAC scores.^{17,22} Following the recommended criterion by Okabe et al.,²¹ a child was categorized as having an asthmatic condition in the past year if there were positive responses to both the following questions: (1) “Has your child ever had wheezing or whistling in the chest at any time in the past?” and (2) “Has your child had wheezing or whistling in the chest in the past 12 months?”

Maternal employment status

Information about maternal employment status was extracted from the main survey in 2010 and the spouse survey in 2011. We asked mothers whether, at the time of the survey, they had joined the labor force. We originally categorized them into full-time, part-time, self-employed, other work status, and homemakers. Other work status included any paid work, but not categorized as full-time, part-time, or self-employed status. We recategorized self-employed and other work status into 1 category because of the relatively small sample sizes.

Socioeconomic status of parents and households

Socioeconomic status of the family was considered to include parental education attainment, annual household equivalent income, and maternal employment status. Parental education attainment was recategorized into high (completed university or postgraduate study), medium (vocational school or junior college graduate), and low (high school graduate or less). Annual household income was separated into 15 categories of income ranges. Using the median of the category range and dividing by the square root of the number of household members, equivalent annual household income

was obtained with a median of 35,000 USD (1USD=90 JPY in 2010). Finally, equivalent income was grouped into high (equal to or higher than median income), low (between median and 50% of median income), and very low (<50% of median income). We chose to use the median and 50% of the median as categorical thresholds in accordance with the definition of relative poverty in previous reports.²³ About 15% of parents refused to indicate their household income, and we therefore included a category of not indicated.

Children's characteristics and asthma-related confounding factors

The following factors were included as covariates commonly recognized to correlate with asthma incidence in children: age of child, being male,²² parental history of asthma,²⁴ coexistence of atopic dermatitis,^{4,22} history of respiratory failure at birth,²⁵ existence of older siblings,²⁶ current exposure to parental smoking,²² Cesarean section,⁵ and low birth weight (<2,500 g).⁵

Ethical considerations

Written consent was obtained from all participants and parents of children enrolled in the study, and the protocol and informed consent procedure of this study were approved by the ethics committee of the Graduate School of Medicine of The University of Tokyo (No. 3073). The secondary data used for this analysis were approved by the J-SHINE Data Management Committee.

Statistical analysis

Following descriptive analysis of the variables, we performed univariate Poisson regression analysis to calculate the prevalence rate ratio (PRR) of 1-year prevalence or underdiagnosis of asthma for each variable. We used robust estimation to correct the error estimation for clusters by households because more than 1 child was observed in some households.

Based on the results of the univariate analyses, we constructed hierarchical multivariable analysis models. Model 1 included sex and age of the child and socioeconomic conditions of households/parents. Model 2 further added asthma-related confounding factors that were statistically significant in the univariate analyses.

Finally, we performed *ad hoc* analyses limited to working mothers to find mediating factors of the observed associations between maternal employment and asthma in children. By referring to previous studies,^{7,27} we considered that negative maternal work–life balance, weekly working hours, and weekly hours of maternal childcare were possible mediators. A negative work–life balance refers to the time pressure and stress that working life confers on mothers. It was assessed based on responses to 2 related questions, “I occasionally miss activities with my family because my work duties require too much time” and “I am often too exhausted to do anything for my family when I am home from my work.” Each question used a 5-point Likert scale consisting of the following answers: Almost always, Often, Sometimes, Seldom, and Never, with a higher score suggesting a larger imbalance. The sum of responses ranging from 2 to 10 points was dichotomized, and a score higher than the midpoint of 5 points was taken to indicate a greater

imbalance. Maternal hours per week spent working and on childcare were dichotomized at 40 and 35 h/week. Weekly childcare time was dichotomized at the midpoint of 35 h/week, which was the mean time spent on childcare according to a national survey conducted by the government cabinet office.²⁸ In these *ad hoc* analyses, sex and age of the child and socioeconomic conditions of households/parents were adjusted in model 1, and in addition to these variables, working hours were included in model 2, and maternal childcare time was included in model 3. The impact of possible mediating factors was assessed by the diminishing change of PRR of maternal employment status after inclusion of these factors into the model.

We used a 5%, 2-tailed significance level. All analyses were performed using the computer software STATA14 for Macintosh (STATA Corp., College Station, TX).

Results

Table 1 shows the characteristics of 1,245 participating mother-child pairs. By use of the ISAAC criteria, 13.9% of children (173/1,245) had asthma.

In total, 71.8% of mothers and fathers had more than high school education and 5.8% of mother-child pairs were categorized as very poor. Half of the mothers were homemakers and one-third were part-time workers.

Table 2 describes the association between 1-year prevalence of asthma in children and maternal work status. In the univariate analysis, full-time work status of mothers showed significantly higher PRR for asthma than a homemaker (PRR [95%CI]: 1.67 [1.14, 2.43]). Self-employed/other work status also showed a higher PRR, although it did not reach significance (1.47 [0.84, 2.57]). A lower and medium level of maternal education was negatively associated with asthma prevalence compared with higher education (0.71 [0.48, 1.05] and 0.71 [0.51, 0.98], respectively). Neither paternal education nor annual household income showed any significant association with prevalence.

The significance of full-time work status remained in model 1 (1.75 [1.20, 2.57]) after adjusting for the characteristics of the child and household socioeconomic conditions and even in model 2 (1.52 [1.06, 2.18]) after adjusting for the known risk factors that were significant in the univariate analyses. In model 2, self-employed/other work status also showed a higher PRR with marginal significance (1.62 [0.96, 2.75]).

Because the targeted outcome was significantly associated with maternal full-time/self-employed, but not part-time, work, we conducted *ad hoc* analyses limited to working mothers. Full-time working mothers were more likely to have a negative work-life balance and to work for 40 h/week or longer, compared with those working part-time (full-time vs. part-time vs. self-employed/other: 63.9% vs. 43.2% vs. 39.1%, $P < 0.001$; 42.0% vs. 3.91% vs. 9.41%, $P < 0.001$ by chi-square test). No significant difference was observed in terms of the proportion of mothers who spent 35 h/week or more on childcare (28.7% vs. 24.0% vs. 28.2%, $P = 0.45$).

Compared with the children of part-time working mothers, those of full-time working mothers and those of self-employed/other work status mothers had a higher PRR for asthma prevalence (1.73 [1.09, 2.75] and 1.84 [1.03, 3.27], respectively; Table 3, model 1). Inclusion of working for at least 40 h/week (model 2) and spending at least 35 h/week

TABLE 1. CHARACTERISTICS OF PARTICIPATING MOTHER-CHILD PAIRS ($N = 1,245$)

Factors	n (%)
Child's characteristics	
Male	639 (51.3)
Age (months): mean, SD	88 (32)
Asthma prevalence	
1-year asthma prevalence	173 (13.9)
Parental socioeconomic conditions	
Maternal education ^a	
Low	328 (26.3)
Medium	564 (45.3)
High	336 (27)
Missing	17 (1.4)
Paternal education ^a	
Low	311 (25)
Medium	210 (16.9)
High	679 (54.5)
Missing	45 (3.6)
Annual household equivalent income ^b	
Very low	72 (5.8)
Low	316 (25.4)
High	669 (53.7)
Not indicated	188 (15.1)
Missing	0 (0)
Maternal work status	
Full-time worker	150 (12.0)
Part-time worker	384 (30.8)
Self-employed/others	85 (6.8)
Homemaker	617 (49.6)
Missing	9 (0.7)
Risk factors for asthma incidence	
Parental history of asthma	
Yes	168 (13.5)
Missing	0 (0)
Coexistence of atopic dermatitis	
Yes	241 (19.4)
Missing	15 (1.2)
History of respiratory failure at birth	
Yes	16 (1.3)
Missing	7 (0.6)
Older siblings	
Yes	596 (47.9)
Missing	0 (0)
Current exposure to smoking	
Yes	479 (38.5)
Missing	0 (0)
Cesarean section	
Yes	220 (17.7)
Missing	2 (0.2)
Low birth weight <2,500 g	
Yes	123 (9.9)
Missing	35 (2.8)

^aLow: junior high school or high school graduate; Medium: vocational school or junior college graduate; High (reference): completed university or postgraduate study.

^bVery low: <17,500 USD; Low: ≥17,500 USD and <35,000 USD; and High: ≥35,000 USD.

on childcare (model 3) did not substantially change the magnitude of the PRR for asthma prevalence associated with full-time and self-employed/other work status. Negative work-life balance had no associations with prevalence of child's asthma.

TABLE 2. PREDICTORS OF 1-YEAR PREVALENCE OF ASTHMA IN CHILDREN

	<i>Crude</i>	<i>Model 1^a</i>	<i>Model 2^b</i>
	<i>PRR [95% CI]</i>	<i>PRR [95% CI]</i>	<i>PRR [95% CI]</i>
Maternal work status ^c			
Full-time	1.67 [1.14, 2.43]	1.75 [1.20, 2.57]	1.52 [1.06, 2.18]
Part-time	0.87 [0.61, 1.25]	1.03 [0.70, 1.50]	1.05 [0.72, 1.54]
Self-employed/others	1.47 [0.84, 2.57]	1.73 [0.98, 3.03]	1.62 [0.96, 2.75]
Child's characteristics			
Male	1.33 [1.01, 1.76]	1.44 [1.07, 1.93]	1.39 [1.04, 1.85]
Age	0.99 [0.99, 0.99]	0.99 [0.99, 0.99]	0.99 [0.99, 1.00]
Parental socioeconomic conditions			
Maternal education ^d			
Low	0.71 [0.48, 1.05]	0.73 [0.47, 1.14]	0.73 [0.47, 1.14]
Medium	0.71 [0.51, 0.98]	0.77 [0.54, 1.08]	0.78 [0.56, 1.09]
Paternal education ^d			
Low	1.01 [0.71, 1.43]	1.1 [0.75, 1.62]	1.16 [0.78, 1.72]
Medium	0.88 [0.58, 1.35]	0.93 [0.59, 1.46]	0.91 [0.60, 1.39]
Annual household equivalent income ^e			
Very low	1.00 [0.52, 1.93]	0.96 [0.43, 2.15]	0.86 [0.36, 2.07]
Low	0.98 [0.69, 1.39]	1.06 [0.75, 1.51]	0.98 [0.68, 1.41]
Not indicated	1.03 [0.69, 1.55]	0.97 [0.63, 1.52]	0.99 [0.66, 1.49]
Risk factors for asthma incidence			
Parental history of asthma	2.46 [1.82, 3.32]		2.31 [1.73, 3.08]
Coexistence of atopic dermatitis	2.80 [2.14, 3.68]		2.52 [1.93, 3.29]
History of respiratory failure at birth	2.76 [1.38, 5.51]		1.92 [0.96, 3.87]
Older siblings	0.78 [0.59, 1.02]		
Current exposure to smoking	0.96 [0.72, 1.29]		
Cesarean section	1.02 [0.70, 1.47]		
Low birth weight	1.07 [0.69, 1.66]		

^aAdjusted by sex and age of the child, maternal and paternal education, and annual household income; $n=1,188$.

^bAdjusted by sex and age of the child, maternal and paternal education, annual household income, and risk factors significant in univariate analyses; $n=1,169$.

^cHomemaker as reference level.

^dLow: junior high school or high school graduate; medium: vocational school or junior college graduate; high (reference): completed university or postgraduate study.

^eVery low: <17,500 USD; low: ≥17,500 USD and <35,000 USD; high (reference): ≥35,000 USD.

PRR, prevalence rate ratio; 95% CI, 95% confidence interval.

Discussion

We found that maternal work status of full-time and self-employed/other work status was associated with higher 1-year prevalence of asthma in children.

A recent study using a large US national representative survey also found that maternal employment significantly

increased asthma prevalence in children.⁹ The study used the instrumental variable method to avoid reverse causation from the child's asthma to the mother's work status and to isolate the causal impact of maternal employment on child health. However, the study did not distinguish between different types of maternal employment. In this study, we found no association between maternal part-time work and asthma prevalence

TABLE 3. ASSOCIATION BETWEEN MATERNAL EMPLOYMENT AND ASTHMA PREVALENCE IN CHILDREN (WORKING MOTHERS ONLY)

	<i>Model 1^a</i>	<i>Model 2^a</i>	<i>Model 3^a</i>
	<i>PRR [95% CI]</i>	<i>PRR [95% CI]</i>	<i>PRR [95% CI]</i>
Maternal employment ^b			
Full-time	1.73 [1.09, 2.75]	1.68 [1.01, 2.80]	1.78 [1.12, 2.83]
Self-employed/others	1.84 [1.03, 3.27]	1.86 [1.03, 3.34]	1.88 [1.06, 3.32]
Working hours ^c			
≥40 h/week		1.05 [0.59, 1.87]	
Maternal childcare time ^d			
≥35 h/week			1.97 [1.97, 3.69]

^aAdjusted by sex, age, maternal and paternal education, and annual household income; $n=582$.

^bPart-time is defined as reference.

^c<40 working hours/week is defined as reference.

^d<35 h maternal childcare/week is defined as reference.

in children, while full-time/self-employed work status significantly increased the prevalence compared with nonworking mothers. Our results imply that maternal labor force participation *per se* does not have a detrimental effect on children's health, but that the conditions of maternal work matter.

Several pathways are plausible to link maternal work conditions and asthma in children, for example, lower quality of childcare due to poorer attention and less time spent with the children⁷ and the psychological distress of mothers due to a negative work–life balance.²⁷ Our *ad hoc* analyses, however, suggest that neither is the cause of asthma prevalence. We did find that full-time/self-employed working mothers were more likely to suffer from time pressure and stress caused by work duties, with decreased time spent with their children, and to work longer hours than those working part-time, but these factors were not associated with children's 1-year asthma prevalence. Maternal childcare time was almost identical between the 2 groups, contrary to a prevailing view of a trade-off between childcare and labor participation. Closer analysis of our sample revealed that full-time/self-employed working mothers did have less time for childcare during weekdays, but they compensated for that by spending more time caring for children at the weekend.

More time spent on childcare by mothers was associated with higher asthma prevalence, which may require careful discussion. This finding may have resulted from reverse causation, that is, an asthmatic child requires more maternal care. Inclusion of the variable did not, however, affect the PRR for asthma prevalence associated with maternal full-time/self-employed work status, which suggests that the impact was independent.

Neither longer working hours nor childcare time mediated the association, and negative work–life balance among full-time/self-employed workers was not related to the asthma prevalence in children.

These findings imply that unmeasured factors related to full-time/self-employed work, other than working hours, childcare time, and work–life balance, may mediate the impact of maternal work on their child's asthma. Although it is only speculative, inflexibility of working hours among full-time/self-employed workers who are likely to have heavier responsibilities in worksites may prevent mothers from responding in a timely way to the changing health needs of their children.

Another study from Japan found a significant association between asthma prevalence in children and higher maternal educational attainment, but not maternal employment status.¹⁰ The prospective cohort study started from the time of pregnancy and adopted self-reported healthcare use and ISAAC measurement to define asthma prevalence. However, information on parental socioeconomic status was only measured at baseline. Because more highly educated women were more likely to be engaged in full-time work status before pregnancy, and to resume their former work afterward, this study's estimation of maternal education may be seriously confounded by unmeasured employment status after childbirth.

In our study sample, equivalent household income was not significantly associated with child asthma prevalence, which is in contrast to previous studies conducted in other countries such as the United States. In our sample, full-time working mothers were more likely to belong to the high-income category, compared with other mothers. We additionally conducted analysis using income quintiles and also found nonsignificant

odds ratios across the categories (data not shown). This may be a result of universal access to medical care guaranteed by the Japanese public health insurance system and a subsidy given to cover child copayments.

Our study, however, also has limitations. First, like previous studies, we relied on self-reported questionnaire responses to determine the asthma status of children, which may be susceptible to report bias. However, there were no plausible reasons why such report bias should vary by maternal work status. Second, there were unmeasured confounders in our data that are known to affect asthma prevalence, such as having an allergen-producing pet, house dust, and history of breast feeding. Third, the cross-sectional design of this study precludes causal inference between maternal work status and asthma in children. Our findings, however, were similar to findings in a recent study using the instrumental variable method to avoid reverse causation.⁹ Finally, the generalizability of our findings should be carefully considered. The 1-year prevalence of asthma in our sample was 14%. A larger ISAAC study in Japan reported a prevalence of 17.3% in children aged 6 to 7 years.²⁹ The socioeconomic conditions of households in our sample showed an almost comparable distribution in parental education attainment with that in the Tokyo 2010 census (71.9% had more than high school education vs. 69% in the census³⁰). The median income level of our sample was 35,000 USD, which was slightly higher than the 32,000 USD reported in the national survey in 2009.³¹ These numbers would suggest that our sample fairly reflects the situation of households with children in an urban setting in Japan. However, because of the low response rate (31.3%) of the survey, there remains a possibility of sampling bias, which is a limitation of the study.

Despite these limitations, the results of this study will provide important implications for clinical practice and public health. Clinicians should regard maternal working conditions as a significant risk factor for asthma in children. Further investigation into working conditions of these mothers would be required to identify factors associated with prevalence of child's asthma. Such research will enable development of public health policy to control maternal working conditions that will improve children's health.

To summarize, maternal full-time/self-employed work status was associated with higher prevalence of asthma in children, whereas maternal part-time employment did not have any significant association. Working at least 40 h/week, weekly childcare time, and negative work–life balance did not mediate this association. To reduce the health impact for asthma in children, further investigation on working conditions of mothers is essential.

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Author Disclosure Statement

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