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Associated factors of behavioral problems in children at preschool age: The Hokkaido Study on Environment and Children's Health

Machiko Minatoya, Sachiko Itoh, Atsuko Araki, Naomi Tamura, Keiko Yamazaki, Shinkichi Nishihara, Chihiro Miyashita, Reiko Kishi

Center for Environmental and Health Sciences, Sapporo, Japan

Correspondence
Prof. Reiko Kishi, MD, PhD, MPH
Tel.: +81-11-706-4748
Fax: +81-11-706-4725
Email: rkishi@med.hokudai.ac.jp
Mailing address: Kita 12, Nishi 7, Kita-ku, Sapporo 060-0812, Japan

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Conflict of interest statement
All the authors have no conflicts of interest to disclose.

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Abstract

Background: Finding associated factors with childhood behavioral problems as early as preschool age is important. Studies have revealed several factors including socioeconomic factors, which may vary among different cultural background and population. However, investigation in general Japanese population of preschool age has not been well demonstrated. Thus, the objective of this study was to examine associated factors of childhood behavioral problems using Strengths and Difficulties Questionnaire (SDQ) in a prospective birth cohort study.

Methods: Total 3813 SDQ were distributed between October 2014 and December 2015 to the subpopulation of prospective birth cohort study, the Hokkaido Study on Environment and Children's Health. The subpopulation consisted of participants who had reached age 5 and were born between April 2008 and December 2010. Baseline questionnaire filled at recruitment and birth record were used to obtain participants information. Children with total difficulties score ≧ 13 were defined as likelihood of behavioral problems. 2553 children with valid answers were included into the analysis. The response rate was 67.1%.

Results: Number of children with likelihood of behavioral problems was 521 (20.4%). Boys showed more problematic scores than girls. Multivariate analysis

found that maternal pre-pregnancy BMI ≧ 30kg/m^2, primipara, maternal education lower than high school, family income during pregnancy < 3 million yen/year and boy gender were the factors associated with increased odds ratio of likelihood of child behavioral problems.

Conclusions: This study found that prenatal socioeconomic factors were associated with likelihood of child behavioral problems at preschool age in Japan.

Introduction

Developmental disabilities have increased in recent decades (Boyle et al., 2011; Pastor et al., 2012). The prevalence of childhood and adolescent mental disorders including behavioral problems has been reported around 20 % (WHO, 2005). It is important to find associated factors with childhood behavioral problems as early as preschool age since behavioral problems in childhood have influence on individual development, school performance and quality of life.

Recent epidemiological studies have suggested associations between maternal characteristics during pregnancy and childhood developmental outcomes. Several factors related to preschool developmental problems such as inattention-hyperactivity symptoms; low parental education levels, low family income, young maternal age at birth (Chittleborough et al., 2011), single parenthood (Zukauskiene et al., 2003), maternal exposure to tobacco smoking (Zhu et al., 2014), alcohol and drugs (Smidts & Oosterlaan, 2007; Willoughby et al., 2012), male sex, very preterm birth and low birth weight (Delobel-Ayoub et al., 2006) have been reported. Additionally, parental psychiatric disorder and negative life events have been reported to increase the risk of childhood behavioral problems (Harland et al., 2002; Harvey et al., 2007). Some of these previously reported

factors were socioeconomic aspects, which were strongly associated with each cultural background. However, to our knowledge, there were no previous report on these factors and childhood developmental and behavioral problems from Japan. Thus, finding associated factors within our cultural background was warranted. Additionally, most of the previous studies were cross-sectional studies thus, evidence on prenatal factors associated with postnatal child behavioral problems was needed.

In this study, we examined parental and child characteristics in association with likelihood of behavioral problems in children at preschool age using Strengths and Difficulties Questionnaire (SDQ), one of the most widely used screening tools for psychopathology in children and adolescents by using a large sample from prospective birth cohort study.

Methods

Study population

This study formed part of a prospective birth cohort study, the Hokkaido Study on Environment and Children's Health. The details of cohort profile can be found in elsewhere (Kishi et al., 2013). The main purpose of the cohort was to

investigate the effects of various environmental exposures in development and health in prenatal and childhood in general population of Japanese pregnant women. Briefly, early pregnant women who visited one of thirty-seven associated hospitals in Hokkaido prefecture, the second largest island in Japan, were recruited. The subpopulation consisted of cohort study participants who had reached age 5 year-old and were born between April 2008 and December 2010 were included in this study as the particular focus on this study was to examine likelihood of child behavioral problems at preschool age in association with prenatal factors (Supplemental Figure 1). The basic characteristics obtained from baseline questionnaire which was filled at early pregnancy (< 13 weeks) and birth record were compared between subpopulation included in this study and whole cohort population. Percentage of non-smokers and parental education levels were higher among those who included in this study (Supplemental Table 1). Thus, interpretation of results should be carried out with caution. Total 3813 SDQ were distributed via mail between October 2014 and December 2015 to the subpopulation as follow-up study. Child sex, gestational age and birth weight were obtained from medical record.

The protocol used in this study was approved by the Institutional Ethical

Board for epidemiological studies at the Hokkaido University Graduate School of Medicine and Hokkaido University Center for Environmental and Health Sciences. This study was conducted with the informed consent of all participants in written forms.

Study instruments

Japanese parent-report version of SDQ (Matsuishi et al., 2008) were distributed via mail to the participants. Parents were asked to fill SDQ, which included 25 items on specific strengths and difficulties with an overall rating of whether their child had behavioral problems. Each item has three response categories (0) not true, (1) somewhat true, (2) certainly true. It includes five subscales (conduct problems, hyperactive/inattention, emotional problems, peer problems and prosocial behavior). All subscales excluding pro-social behavior were summed to assess the behavioral problems and the total difficulties score ranged from 0 to 40 (Goodman, 2001). Higher scores denote greater problems. SDQ was designed for a broad range of children, age 3 to 16 years and well validated tool of childhood mental health (Goodman, 1997, 2001).

We applied score bandings of the Japanese version of SDQ, children with total difficulties score 0-12 were defined as normal, 13-15 were as borderline, and

16-40 were as clinical. In this study, children scored ≧ 13 were defined as likelihood of behavioral problem (Matsuishi et al., 2008).

Parental factors

Parental factors including ages, educational levels, maternal pre-pregnancy body mass index (BMI), parity, drinking habit during pregnancy, family income were obtained from baseline questionnaire which was filled by participants during their pregnancy. Additionally, maternal smoking status was examined from cotinine levels of third trimester maternal blood measured by using high-sensitive enzyme-linked immunosorbent assay (ELISA). The limit of detection (LOD) was 0.12 ng/ml. According to previous finding (Sasaki et al., 2011), we defined cotinine levels ≦ 0.21 ng/ml as non-smokers, 0.22-11.48 ng/ml as passive smokers, and ≧ 11.49 ng/ml as active smokers.

Data analysis

2553 children with valid answers (response rate = 67.1%) were included into the analysis. Univariate analyses were conducted followed by multivariate analysis to estimate odds ratio of likelihood of behavioral problems. The model was adjusted for all the variables with statistical significance in univariate analyses ($p < 0.050$) and for SDQ testing age. Missing information was replaced as follows;

continuous variables were replaced by the mean value and categorical variable were replaced by the most frequent answer. Results were considered significant at $p < 0.05$. All analyses were performed with SPSS 22.0J (IBM Japan, Tokyo, Japan).

Results

Basic characteristics of participants were shown in Table 1. More than half had family income below 5 million yen/year. More than half had parental education levels higher than high school graduate. The average age of children was 65.3 months old and the mean total difficulties score was 8.73 ± 5.06. Total difficulties score and subscale scores except prosocial behavior were positively correlated with each other (Table 2). Parental ages, maternal pre-pregnancy BMI, parity, maternal cotinine levels, parental education levels, family income during pregnancy and marital status significantly differed between normal (n=2032) and borderline/clinical groups (n=521). Percentage of children defined likelihood of behavioral problems was 20.4%.

After the adjustment, maternal pre-pregnancy BMI ≧ 30 kg/m^2, primipara, maternal education lower than high school, family income during pregnancy < 3 million yen/year and being a boy were the factors to increase ORs. Maternal

education lower than high school and primipara and family income < 3 million yen/year were the remained factors of increased ORs for boys and girls, respectively (Supplemental Table 2).

Discussion

This study examined factors associated with likelihood of child behavioral problems using SDQ, an internationally validated tool. In this study boys showed more problematic scores compared to girls, which were also observed other studies using parent-rated SDQ (Barriuso-Lapresa et al., 2014; Matsuishi et al., 2008; Moriwaki & Kamio, 2014). Previous study of 5-10 year-old children in UK and of 4-6 year-old in Japan showed similar total difficulties score to ours, 8.6 and 8.27, respectively (Matsuishi et al., 2008; Marryat et al., 2015).

The multivariate analysis found that maternal pre-pregnancy BMI ≧ 30 kg/m^2, primipara, maternal education lower than high school, family income during pregnancy < 3 million yen/year and boy gender were the factors to increase ORs.

Previous studies revealed that maternal obesity was associated with various adverse developmental outcomes in children (Jo et al., 2015; Heikura et al., 2008; Mann et al., 2013; Basatemur et al., 2013; Hinkle et al., 2012; Buss et al., 2012; Chen et al., 2014; Krakowiak et al., 2012) and we added the evidence.

Previous studies from the U.S. (Durkin et al., 2008), Canada (Burstyn et al., 2010) and Australia (Glasson et al., 2004) suggested that the risk of autism was found to be high among firstborn. Having no older siblings is a predictor of internalizing problems (Bayer et al., 2012) and additionally externalizing and total problems in Taiwanese study (Wu et al., 2012). Our observation agreed to previous reports.

We added the evidence that maternal education and family income were contributing factors of child behavioral problems. Further, low maternal education in boys and low family income during pregnancy and being firstborn in girls were associated with increased likelihood of child behavioral problems (Supplemental Table 2). Education and income are usually considered the main indicators of socioeconomic status (SES) (Conger & Donnellan, 2007; Sirin et al., 2008) and often these two factors were analyzed together. Although education and income correlate each other, they may have independent influences on children's development. Parental income relates to economic or materials including health care and food and is associated with a wide range of mental health problems, whereas parental education is directly linked to more behavioral influences such as quality of parenting, lifestyle on child development (Boe et al., 2012; Conger & Donnellan, 2007;

Huisman et al., 2010; Sirin et al., 2008). In this study, multivariate model was adjusted for both maternal education and family income, which highly correlated to each other, and thus interpretation of results should be carried out cautiously. We should note that we were unable to distinguish the effects of these two factors on likelihood of child behavioral problems.

It has been reported that boy gender was a risk factor for child behavioral problems, particularly autism (Burstyn et al., 2010). Additionally, study of school children in China observed more externalizing problems in boys than in girls, evaluated by both parents and teachers (Yang et al., 2008), similarly both externalizing and total problems scores were higher in boys in Taiwanese study (Wu et al., 2012). In our study, total difficulties score was significantly higher, which indicated more problems in boys. Even the previous studies used different testing tools to evaluate child behavioral problems, our finding on child gender was consistent with their results.

A major strength of this study was that this was the first study to investigate multiple factors, particularly SES, in association with child behavioral problems at preschool age in Japan with relatively large number using prospective cohort.

We should note that our study has some limitations. First of all, despite

sufficient data of prenatal factors, postnatal factors were not considered. It was possible that postnatal factors such as life event, parental mental health and nutrition may have influence on child behavioral problems as previously reported (Jacka et al., 2013; van der Waerden et al., 2015; Wang et al., 2014). Using parent-report version of SDQ may have been influenced by parental state of mind. The obtained SDQ scores may not accurately reflect parental point of view to evaluate their child. Unfortunately, we were unable to investigate this as a potential source of bias as no data on parental state of mind when SDQ was completes was available in this study. Lastly, replacing missing values may have caused underestimate. The results excluded participants with any missing values were shown in Supplemental Tables 3. Maternal active smoking was found to be significant. This could be due to misclassification; missing values were treated as non-smokers as it was the most frequent answer, however, there was a chance that missing value actually contained higher ratio of active smokers than we estimated.

Conclusion

We have found that maternal pre-pregnancy BMI ≧ 30kg/m^2, primipara, maternal education lower than high school, family income during pregnancy < 3 million yen/year and boy gender were the factors to increase ORs of likelihood of

child behavioral problems. Results from this study suggested that disadvantages in SES during prenatal period may lead child behavioral problems at preschool age.

Key messages

- This study found that family maternal pre-pregnancy BMI ≧ 30kg/m^2, income during pregnancy < 3 million yen/year, maternal education lower than high school and being firstborn and boy gender increased ORs of likelihood of child behavioral problems.
- In Japan as elsewhere, SES and gender are major risk factors for the likelihood of higher total difficulties score on the SDQ.

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Table 1 Basic characteristics of participants.

Characteristics		N （%） or mean ± S.D.
Maternal age（years）		30.9 ± 4.7
Paternal age（years）		33.0 ± 5.6
Maternal pre-pregnancy BMI（kg/m^2）		21.1 ± 3.3
Parity	Primipara	959 (37.6)
	Multipara	1310（51.3）
	Missing	284 (11.1)
Maternal drinking during pregnancy	Yes	271 （10.6）
	No	2193 (85.9)
	Missing	89 (3.5)
Maternal cotinine levels (ng/ml)	≦ 0.21 (non-smokers)	1210 (47.4)
	0.22-11.48 (passive smokers)	776 (30.4)
	≧ 11.48 (active smokers)	199 (7.8)
	Missing	368 (14.4)
Maternal education	Middle school	87（3.4）
	High School	921（36.1）
	Community college, vocational school	1108（43.3）
	College or above	383（15.0）
	Missing	54 (2.1)
Paternal education	Middle school	122（4.8）
	High School	939（36.8）
	Community college, vocational school	611（23.9）
	College or above	815（31.9）
	Missing	66 (2.6)
Family income during pregnancy (million yen/year)	< 3	451（17.7）
	3-5	952（37.3）
	5-8	643（25.2）
	≧ 8	186（7.3）
	Missing	321 (12.6)
Family income at preschool age (million yen/year)	< 3	334 (13.1)
	3-5	892 (34.9)
	5-8	884 (34.6)
	≧ 8	313 (12.2)
	Missing	130 (5.1)
Marital status at preschool age	Married	2375 (93.0)
	Single parent	165 (6.5)
Infant sex	Boy	1283 （50.3）
Gestational age (days)		274 ± 11
Birth weight （g）		3014 ± 419
Age at SDQ (months)		65.3 (6.1)

Table 2 SDQ scores of participants.

	mean ± S.D.			p-value
	All（N＝2553）	Boys（N＝1283）	Girls（N＝1270）	
Total difficulties score	8.73 ± 5.06	9.39 ± 5.28	8.06 ± 4.72	<0.001
Subscales				
Conduct problems	2.16 ± 1.60	2.31 ± 1.65	2.02 ± 1.53	<0.001
Hyperactivity/inattention	3.17 ± 2.18	3.59 ± 2.27	2.76 ± 2.00	<0.001
Emotional symptoms	2.00 ± 1.84	1.99 ± 1.86	2.01 ± 1.81	0.783
Peer problems	1.39 ± 1.43	1.51 ± 1.51	1.28 ± 1.33	<0.001
Prosocial behavior	7.21 ± 1.96	6.92 ± 2.04	7.50 ± 1.83	<0.001

Mann-Whitney’s U-test.

Table 3 Number of children in normal and borderline/clinical groups and odds ratio of likelihood of behavioral problems.

	Normal	Borderline/ Clinical	Univariate	Multivariate
	N (%)		OR (95%CI)	
Maternal age (years)				
≦ 25	249 (73.0)	92 (27.0)	1.6 (1.2, 2.2)***	1.0 (0.7, 1.4)
26-30	654 (79.2)	172 (20.8)	1.1 (0.9, 1.5)	1.0 (0.8, 1.3)
31-35	777 (81.1)	181 (18.9)	Reference	Reference
≧ 36	352 (82.2)	76 (17.8)	0.9 (0.7, 1.3)	1.1 (0.8, 1.5)
Paternal age (years)				
≦ 25	136 (71.6)	54 (28.4)	1.7 (1.2, 2.4)**	1.2 (0.8, 1.9)
26-30	503 (76.7)	153 (23.3)	1.3 (1.0, 1.6)	1.1 (0.8, 1.5)
31-35	759 (80.5)	184 (19.5)	Reference	Reference
≧ 36	634 (83.0)	130 (17.0)	0.8 (0.7, 1.1)	0.8 (0.6, 1.1)
Maternal pre-pregnancy BMI (kg/m^2)				
< 18.5	356 (81.8)	79 (18.2)	1.1 (0.9, 1.5)	0.8 (0.6, 1.1)
18.5-25.0	1486 (79.8)	376 (20.2)	Reference	Reference
25.0-30.0	150 (76.5)	46 (23.5)	1.4 (1.0, 2.2)	1.2 (0.8, 1.7)
≧ 30	40 (66.7)	20 (33.3)	2.1 (1.1, 3.8)*	2.1 (1.2, 3.7)**
Parity				
Primipara	741 (77.3)	218 (22.7)	1.3 (1.1, 1.6)*	1.3 (1.1, 1.6)**
Multipara	1291 (81.0)	303 (19.0)	Reference	Reference
Maternal cotinine level (ng/ml)				
≦ 0.21 (non-smokers)	1277 (80.9)	301 (19.1)	Reference	Reference
0.22-11.48 (passive smokers)	611 (78.7)	165 (21.3)	1.2 (0.9, 1.4)	1.0 (0.8, 1.2)
≧ 11.49 (active smokers)	144 (72.4)	55 (27.6)	1.6 (1.2, 2.3)***	1.3 (0.9, 1.9)
Maternal education				
Middle school	54 (62.1)	33 (37.9)	2.1 (1.3, 3.3)***	1.9 (1.2, 3.1)**
High School	711 (77.2)	210 (22.8)	Reference	Reference
Community college, vocational school	950 (81.8)	212 (18.2)	0.8 (0.6, 0.9)*	0.8 (0.7, 1.1)
College or above	317 (82.8)	66 (17.2)	0.7 (0.5, 1.0)*	0.9 (0.6, 1.2)
Family income during pregnancy (million yen/year)				
< 3	312 (69.2)	139 (30.8)	1.8 (1.4, 2.3)***	1.7 (1.3, 2.1)***
3-5	1020 (80.1)	253 (19.9)	Reference	Reference
5-8	538 (83.7)	105 (16.3)	0.8 (0.6, 1.0)	0.9 (0.7, 1.1)
≧ 8	162 (87.1)	24 (12.9)	0.6 (0.4, 0.9)*	0.7 (0.4, 1.1)
Marital status				
Married	1908 (80.1)	475 (19.9)	Reference	Reference
Single parent	120 (72.7)	45 (27.3)	1.5 (1.1, 2.2)*	1.2 (0.8, 1.7)
Child sex				
Boys	966 (75.3)	317 (24.7)	1.7 (1.4, 2.1)***	1.7 (1.4, 2.1)***
Girls	1066 (83.9)	204 (16.1)	Reference	Reference

Univariate model was adjusted for age at SDQ (month). Multivariate model was adjusted for all the variates shown in the table and age at SDQ (month). Missing values were replaced by mean value (continuous variables) and by most frequent answer (categorical variables). * $p < 0.050$, ** $p < 0.010$, *** $p < 0.005$.