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Association of air purifier usage during pregnancy with adverse birth outcomes: the Japan Environment and Children's Study

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Abstract

Objective Previous studies have reported that ambient air pollutants such as PM_{2.5} can increase the risk of adverse birth outcomes. The objective of this study was to ascertain whether air purifier usage during pregnancy is associated



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influencing factors and to identify effective interventions or potential countermeasures.

Although the causes of ABOs remain to be clarified, one possibility is intrauterine exposure to air pollutants. Fine particulate matter has attracted special attention because of its unique characteristics, including small diameter, large surface area, long suspension time in the air, and toxic effects on the human body [5]. Air pollutants are hypothesized to cross the placental barrier, disrupting fetal–maternal circulation and affecting fetal growth. For example, fine particulate matter with an aerodynamic diameter of 2.5 μm or less (PM_{2.5}) can enter the blood circulation, pass through the placental barrier, and trigger the disturbance of homeostasis *in utero*, causing abnormal fetal development [6, 7]. PM_{2.5} can cause systemic inflammation, oxidative stress, and endothelial dysfunction, leading to ABOs [8, 9]. Indeed, observational studies have reported an association of perinatal exposure to PM_{2.5} with ABOs, including PTB, SGA, and LBW [10, 11]. Interestingly, the Chinese government successfully reduced pollutant concentrations in the air during the 2008 Summer Beijing Olympics and Paralympics and there was a subsequent increase in BW [12]. Another natural experiment revealed a decreased risk of PTB in women who were pregnant following the closure of a local steel mill compared with those who were pregnant while it was still operating [13]. Taken together, these findings suggest that reducing maternal exposure to air pollutants during pregnancy can reduce the prevalence of ABOs.

In Japan, pregnant women tend to spend more time at home and are thus exposed to pollutants from indoor air for long periods.

Table 1 Characteristics of the participants and dwelling environments

Variable	Category	Air purifier use			
		Yes		No	
		n	(%)	n	(%)
Subtotal		46,067	(50.8)	44,626	(49.2)
Age, y	< 25	4,273	(9.3)	5,251	(11.8)
	25–<30	13,420	(29.1)	12,274	(27.5)
	30–<35	16,817	(36.5)	15,044	(33.7)
	35	11,557	(25.1)	12,058	(27.0)
Body mass index, kg/m ²	< 18.5	7,465	(16.2)	7,231	(16.2)
	18.5–<25	34,016	(73.8)	32,453	(72.7)
	25	4,586	(10.0)	4,943	(11.1)
Parity	Primipara	18,181	(39.5)	20,830	(46.7)
	Multipara	27,886	(60.5)	23,796	(53.3)
History of allergy	No	21,601	(46.9)	23,755	(53.2)
	Yes	24,466	(53.1)	20,871	(46.8)
Kessler Psychological Distress Scale score	< 5	32,825	(71.3)	31,470	(70.5)
	5–12	11,834	(25.7)	11,592	(26.0)
	13	1,408	(3.1)	1,564	(3.5)
Maternal smoking status	Never	26,544	(57.6)	25,848	(57.9)
	Former	17,640	(38.3)	16,508	(37.0)
	Current	1,883	(4.1)	2,270	(5.1)
Maternal secondhand smoking status	Almost never or never	28,949	(62.8)	27,255	(61.1)
	Once a week	5,652	(12.3)	5,198	(11.7)
	2–3 times a week	3,696	(8.0)	3,780	(8.5)
	4–6 times a week	2,150	(4.7)	2,316	(5.2)
	Everyday	5,619	(12.2)	6,077	(13.6)
Alcohol intake	Never	15,316	(33.3)	14,983	(33.6)
	Former	29,575	(64.2)	28,293	(63.4)
	Current	1,176	(2.6)	1,350	(3.0)
Number of hours spent outdoors per day	< 1	8,639	(18.8)	9,163	(20.5)
	1–<2	21,630	(47.0)	20,591	(46.1)
	2–<3	7,541	(16.4)	6,836	(15.3)
	3	8,257	(17.9)	8,036	(18.0)
Physical activity	No	10,240	(22.2)	10,742	(24.1)
	Yes	35,827	(77.8)	33,884	(75.9)

Table 1 (continued)

Variable	Category	Air purifier use			
		Yes		No	
		n	(%)	n	(%)
Type of residence	Wooden detached house	19,225	(41.7)	18,087	(40.5)
	Steel-frame detached house	3,267	(7.1)	2,470	(5.5)
	Wooden multiple dwelling house/apartment	5,330	(11.6)	5,924	(13.3)
	Steel-frame multiple dwelling house/apartment	17,810	(38.7)	17,687	(39.6)
	Other	436	(1.0)	458	(1.0)
Number of rooms in house/apartment	2	7,723	(16.8)	9,374	(21.0)
	3	14,663	(31.8)	14,633	(32.8)
	4	9,485	(20.6)	7,832	(17.6)
	5	7,403	(16.1)	6,208	(13.9)
	6	6,794	(14.8)	6,579	(14.7)
Living room flooring material	<i>Tatami</i> (Japanese straw floor covering)	4,372	(9.5)	6,088	(13.6)
	Carpet on <i>tatami</i>	3,646	(7.9)	4,593	(10.3)
	Wooden flooring/tile	17,236	(37.4)	14,919	(33.4)
	Carpet on wooden flooring/tile	19,942	(43.3)	18,280	(41.0)
	Other	871	(1.9)	746	(1.7)
Having a pet	No	34,842	(75.6)	34,831	(78.1)
	Yes	11,225	(24.4)	9,796	(22.0)
Cleaning living room floor with vacuum cleaner	–2 times a month	3,128	(6.8)	4,419	(9.9)
	Once a week	13,466	(29.2)	14,460	(32.4)
	A few times a week	20,787	(45.1)	18,902	(42.4)
	Everyday	8,686	(18.9)	6,846	(15.3)
Cleaning futon with vacuum cleaner	Almost never or never	24,130	(52.4)	26,876	(60.2)
	A few times a year	6,048	(13.1)	5,334	(12.0)
	1–2 times a month	8,345	(18.1)	6,696	(15.0)
	Once a week	7,545	(16.4)	5,720	(12.8)
Airing futon	Almost never or never	5,554	(12.1)	5,021	(11.3)
	A few times a year	8,400	(18.2)	8,743	(19.6)
	1–2 times a month	17,057	(37.0)	16,692	(37.4)
	Once a week	15,055	(32.7)	14,171	(31.8)
Using anti-mite cover for futon or bedding after becoming pregnant	No	41,514	(90.1)	41,996	(94.1)
	Yes	4,554	(9.9)	2,630	(5.9)
Age of house/apartment building, y	< 1	2,973	(6.5)	2,121	(4.8)
	1–<3	5,986	(13.0)	4,134	(9.3)
	3–<5	4,781	(10.4)	3,772	(8.5)
	5–<10	7,516	(16.3)	6,476	(14.5)
	10–<20	10,519	(22.8)	10,591	(23.7)
	20	10,528	(22.9)	12,324	(27.6)
	Unknown	3,764	(8.2)	5,208	(11.7)
House renovation/interior finishing after becoming pregnant	Yes	1,602	(3.5)	1,270	(2.9)
	No	44,466	(96.5)	43,356	(97.2)
Number of years living in current place of residence	< 1	3,495	(7.6)	3,428	(7.7)
	1–<3	19,685	(42.7)	18,490	(41.4)
	3–<5	10,755	(23.4)	9,508	(21.3)
	5–<10	8,205	(17.8)	8,267	(18.5)
	10–<20	2,344	(5.1)	2,835	(6.4)
	20	1,583	(3.4)	2,099	(4.7)

wooden multiple dwelling house/apartment, steel-frame multiple dwelling house apartment, or other); number of rooms in the house/apartment (2, 3, 4, 5, or 6); liv-

from premature male fetuses tends to be more inflamed compared with those from female fetuses, suggesting that a maternal immune reaction to fetal tissue may be more common in male fetuses [50]. It is also possible that

late pregnancy may affect BW, given that this period is critical for fetal weight gain [5, 37, 47, 54–57]. Thus, air purifier use in different trimesters may affect the prevalence of different ABOs. We examined air purifier use with a simple yes/no question and could therefore not evaluate the impact of air purifier use by trimester.

The main strengths of this study include that it was a large prospective cohort study with a high response rate under a national birth cohort [24]. The prevalence of PTB and that of LBW derived from this study were well consistent with the results from the Japanese Vital Statistics [24], which suggests that this study is highly representative of the general Japanese population. In addition, the prospective collection of exposure and outcome data minimized recall bias, and important confounders were included in the model.

We also recognize some limitations of the study. As mentioned above, we evaluated the air purifier use with a simple yes/no question. Further analyses of the performance of various air purifiers, filter types, and the frequency and duration of use should also be considered. Because the data were obtained using a questionnaire, self-reported biases may be present. Moreover, we did not measure indoor concentrations of particu-

Competing interests

The authors declare no competing interests.

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