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# The association between cooking oil fume exposure during pregnancy and birth weight: A prospective mother-child cohort study

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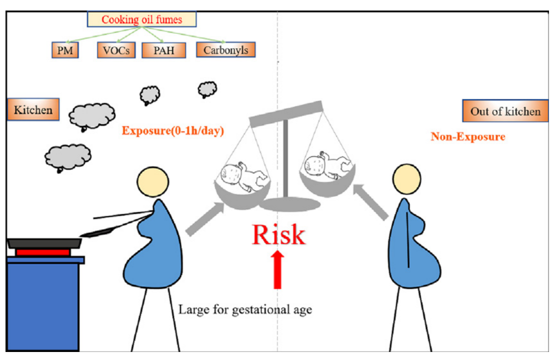
## HIGHLIGHTS

- We examined the association between cooking oil fume exposure during pregnancy and birth weight.
- Maternal exposure to cooking oil fumes during pregnancy was associated with LGA newborns.
- Compared to pregnant women who were not exposed to cooking oil fumes, 0-1 hour/day exposure can increase the risk of LGA.
- Compared to those who were not exposed to cooking oil fumes, >1 h/day exposure can increase the risk of SGA, but were not statistically significant.

## GRAPHICAL ABSTRACT

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## ABSTRACT

Effects of indoor air pollution on neonatal birth weight has been studied for many years. In China, cooking oil fumes are important parts of indoor air pollution. However, whether cooking oil fume exposure during pregnancy affects birth weight in China remains poorly understood. The objective of this study was to examine the association between pregnancy exposure to cooking oil fumes and birth weight in a newly established prospective mother-child cohort in China. We finally included 1420 pregnant women from 2013 to 2015 and follow up for one year until the offspring was born. According to self-reported exposure status, we categorized mothers into non-exposure group and exposed group or three exposure time subgroups, including 0 h/day, 0–1 h/day and >1 h/day respectively. By using multinomial logistics regression models, we found that pregnancy exposure to cooking oil fumes significantly increased the risk of large for gestational age (LGA, OR = 1.58, 95% CI = 1.15–2.18, $P = 4.88 \times 10^{-3}$). Additionally, compared to pregnant women who were in non-exposure group, 0–1 h/day exposure elevated the risk of LGA (OR = 1.69, 95% CI = 1.22–2.33, $P = 1.63 \times 10^{-3}$), while >1 h/day exposure elevated the risk of small for gestational age, but were not significant (SGA, OR = 2.15, 95% CI = 0.61–7.66, $P = 0.24$). In the stratification analysis, women aged 25–29 years and ≥30 years were predisposed to the influence of cooking oil fumes and have LGA newborns (OR = 1.73, 95% CI = 1.09–2.75, $P = 0.02$; OR = 1.72, 95% CI = 1.07–2.77, $P = 0.02$, respectively).

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In conclusion, the present study suggests inverse U-shape dose response association between maternal exposure to cooking oil fumes during pregnancy and birth weight, and further studies are needed to verify the effect of cooking oil fumes on the birth weight.



## 1. Introduction

Indoor air pollution, have become a global public health problem (Bruce et al., 2000). It is well established that there is an association between indoor air pollution and human health, like respiratory diseases, stroke, cardiovascular disease, lung cancer, etc., (Kim et al., 2011; Kurmi et al., 2012; Svedahl et al., 2009; Tsai et al., 2003; Uzoigwe et al., 2013). And approximately 4.3 million people a year die from the exposure to indoor air pollution (WHO, 2014a). To our knowledge, intrauterine and early-life environmental experience will affect individuals' health over the rest of life. This is in line with the Developmental Origins of Health and Disease (DOHaD) theory, which indicates that a poor start is closely related to an elevated risk of many disorders, i.e. developmental problems, cardiovascular disease, obesity, type 2 diabetes, cancer, etc. (Gluckman and Hanson, 2004; Silveira et al., 2007). In fact, several studies focusing on the air pollution exposure during in utero life suggest it is related to adverse fetal outcomes including premature birth, stillbirth, neonatal death, etc., (Estarlich et al., 2016; Hwang et al., 2011; Naz et al., 2016). However, as one source of indoor air pollution, whether maternal exposure to cooking oil fumes during pregnancy will affect offspring health still remains poorly understood. As an indicator of offspring health, the average birth weight in babies of Chinese was 3232 ± 555 g (Zhu et al., 2015). There have been several epidemiologic studies shown that abnormal birth weight, like low birth weight (LBW) and macrosomia, is associated with an array of developmental diseases, such as neurodevelopmental disorders, type 2 diabetes and cardiovascular disease (Andersen et al., 2010; Jornayvaz et al., 2016; Schieve et al., 2016). Some environmental factors, such as indoor air pollution and maternal smoking, have recently been implicated in the occurrence of abnormal birth weight (Basu et al., 2014; Ko et al., 2014). In China, due to the traditional food culture, people are used to cooking foods in the kitchen by means of frying, stir-frying, stew, etc., resulting in an important source of indoor air pollution including particulate matter (PM), polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and carbonyls (Gao et al., 2013; Ho et al., 2006; Mugica et al., 2001; Yao et al., 2015). Although a few studies demonstrate a connection between pregnancy exposure to PAHs, PMs and VOCs and abnormal birth weight (Forand et al., 2012; Perera et al., 2002; Sapkota et al., 2010), compelling epidemiological evidence on whether cooking oil fumes are associated with birth weight in this regard is currently lacking in China.

Consequently, in the present study, we finally recruited a total of 1420 pregnant women and their offspring to investigate the potential risk of cooking oil fume exposure on LBW and macrosomia, as well as on small for gestational age (SGA) and large for gestational age (LGA) in a prospective mother- child cohort study in China.

## 2. Materials and method

### 2.1. Study population

The present study was based on data from a prospective mother-child cohort study conducted by Nanjing Medical University in 2013, which was designed to explore the effects of early-life environmental exposures on child physical-psychological-social development and health. Six communities in the urban area of Nanjing were randomly selected to carry out our cohort study, they were Ma ying camp community, Sky flag community, Stone gateway community, Chao tian gong community, Great light road community and Zhong hua road community respectively. Pregnant women that went for registration at local Community Medical Centers in the first trimester were identified as candidates for the study. Maternity care doctors in these six Community Medical Centers determined the eligible individuals by checking the inclusion criteria, including 20 ≤ age < 45 years old, permanent residents, intention of delivery in the present city and interested in participation, then 1570 eligible women were enrolled and the response rate was 95.5%. We collected data, such as socio-economic status and demographics, family and personal medical history, parental exposure to environmental or occupational hazards, health behavior and maternal diagnoses during pregnancy, infant birth weight, infant sex, etc., by face to face questionnaires in the first trimester (12 weeks of pregnancy), 24-week antenatal (during second trimester) and 32-week antenatal (during third trimester) and obstetric records in Nanjing Maternal and Child Health Hospital. All of the questionnaires were done by trained doctors in an interview to ensure high quality. The children in the cohort were also followed up during infancy, pre-school period and at ages of 9 years. In order to ensure the authenticity and reliability of the questionnaire information, we use the two-track entry method to enter the relevant information in the questionnaires. Besides these information, biosamples of mothers' blood and urine during pregnancy were also collected for subsequent research, as well as children's when followed up. As shown in a flow chart (Fig. 1), reasons for exclusion from the statistical analysis included women who conceived by means of assisted reproductive technology ($n = 2$), miscarriage ($n = 1$), stillbirth ($n = 0$), pregnant women who do not have exposure data during pregnancy ($n = 135$), infants with no birth data ($n = 7$), perinatal infant death ($n = 0$), multiple pregnancy ($n = 5$), and infants with birth defects ($n = 0$). Eventually, 150 mother-child pairs were excluded and 1420 were finally included in the present analysis.

### 2.2. Ethical approval

The study was approved by the institutional review board (IRB) of Nanjing Medical University Ethics Committee, all participants joined in the cohort had signed the informed consent for themselves and their child before enrollment (FWA00001501).

### 2.3. Independent variables of cooking oil fume exposure assessment

Information of the cooking oil fume exposure was obtained from the early pregnancy questionnaire. In the study, we recruited the participants from urban of Nanjing, most of the families cooked foods by cleaner pipeline natural gas and most of the kitchens fume extractors or ventilators were used in the kitchen. Thus, some factors that affect the exposure assessment of cooking oil fumes were controlled before analysis, such as residence, the type of cooking fuel and presence of ventilation. The relevant questions were "Do you access to cooking oil fumes in your daily life", the options were yes and no and a subsequent one "How often are you exposed to cooking oil fumes every day", the options were '0 h/day', '0–1 h/day', '1–4 h/day' and '>4 h/day'. According to the answers of these questions, we categorized mothers into non-exposure group and exposure group. Additionally, three exposure time subgroups were defined as 0 h/day, 0–1 h/day and >1 h/day respectively.