



Household incense burning and infant gross motor development: Results from the Taiwan Birth Cohort Study



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ABSTRACT

Background: Air pollution from biomass burning were associated with neurodevelopmental deceleration, but limited studies concerned about the effect of indoor biomass burning. Incense burning is a common household ritual practice in Taiwan, while past studies mainly focused on birth weight and allergic disease.

Objectives: We aimed to find the association between incense burning exposure and children's neurodevelopment.

Methods: In Taiwan Birth Cohort Study (TBCS), a nationwide representative birth cohort study, children were assessed upon home interview with structured questionnaires upon six and eighteen months old. Multivariate logistic and Cox proportional hazard regression adjusting confounding factors were applied to explore the odds ratio (OR) and hazard ratio (HR) between household incense burning exposure and caregiver-reported neurodevelopment milestones.

Results: In this study, 15,310 term singletons were included, and household incense burning was associated with delay in gross motor neurodevelopment milestone, such as walking with support (Occasional incense burning: OR = 1.26, 95% confidence interval (CI): 1.08 to 1.47, HR = 1.07, 95% CI: 1.03 to 1.11; persistent incense burning: OR = 1.44, 95% CI: 1.22 to 1.69, HR = 1.11, 95% CI: 1.07 to 1.16) and walking steadily (Occasional incense burning: OR = 1.14, 95% CI: 0.98 to 1.32, HR = 1.07, 95% CI: 1.03 to 1.11, persistent incense burning: OR = 1.24, 95% CI: 1.06 to 1.45, HR = 1.09, 95% CI: 1.04 to 1.13).

Conclusions: Our study suggested household incense burning exposure was associated with delay in gross motor neurodevelopmental milestones. Further research is warranted to elucidate the possible mechanism and causal relationship.

1. Introduction

Incense burning is a widely accepted practice in the Asia-Pacific (Chen and Ho, 2016; Friberg et al., 2008; Pan et al., 2014) and Middle East regions (Cohen et al., 2013; Yeatts et al., 2012). This ritual worship in the Asia-Pacific region occurs both in Buddhist and Taoist temples and in the homes of believers (Chen and Ho, 2016; Friberg et al., 2008; Pan et al., 2014). In Taiwan, approximately half of the population burns incense at home, and, for children, this practice may contribute to the

emerging hazards of indoor air pollution (Ashmore and Dimitroulopoulou, 2009; Han et al., 2009; Lin et al., 2008). Incense burning produces substantial emissions of particulate matter, polycyclic aromatic hydrocarbon (PAH), and other toxic chemical compounds during the slow and incomplete combustion process (Chiang and Liao, 2006; Lin et al., 2007; Lin et al., 2008).

Previous studies have suggested the possible health hazards of incense burning, such as cardiovascular mortality (Pan et al., 2014), respiratory tract symptoms (Ho et al., 2005) and cancer in adults (Friberg

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et al., 2008; Navasumrit et al., 2008). In children, the associations between incense burning and respiratory system health hazards and decreased birth weight and head circumference have also been previously reported (Chen and Ho, 2016; Lee et al., 2003; Wang et al., 2011). Animal studies also revealed increased oxidative stress with cytochrome induction (Hussain et al., 2014) and possible cytotoxicity and genotoxicity (Chuang et al., 2013; Zhou et al., 2015). Cumulative evidence has indicated an association between air pollution from biomass burning and child neurodevelopment problems (Block et al., 2012; Calderon-Garciduenas et al., 2016). In previous studies, the contents of ambient air pollution, such as particulate matter (Basagana et al., 2016; Harris et al., 2015; Harris et al., 2016; Yorifuji et al., 2016) and PAHs (Jedrychowski et al., 2015; Perera et al., 2006; Perera et al., 2009; Peterson et al., 2015), were found to be associated with developmental delays and inferior cognitive functional performance in children.

However, the effect of incense burning on neurodevelopment has been less studied, and longitudinal study data are not available. By using the national representative data from the Taiwan Birth Cohort Study, we examined the association between household incense burning and neurodevelopmental outcomes at eighteen months.

2. Methods

2.1. Study population and data collection

The Taiwan Birth Cohort Study (TBCS) was the first nationwide birth cohort study in Taiwan, and it was performed to follow 24,200 representatively sampled mother-infant pairs in the year 2005. Case selection was performed with a two-stage stratified random sampling method. Parental health conditions, conditions during pregnancy, infant birth outcomes, and other demographic factors were obtained by home interview with structured questionnaires when the infant was six and eighteen months old. The TBCS study was approved by the Institutional Review Board of the Bureau of Health Promotion, Ministry of Health and Welfare, Executive Yuan, Taiwan. Informed consent was obtained from the parent or main caregiver of the participants. Infants with incomplete questionnaires were excluded from the cohort, and 2952 and 1076 cases were lost to follow-up from the first and second interviews, respectively. A total of 20,172 (83.4%) cases completed the two rounds of interviews. Term singletons were included in this study, and cases with incomplete exposure and outcome information were excluded from this study. Therefore, a total of 15,310 cases were included for further data analysis.

2.2. Exposure measurement and definitions

Questions concerning the household incense burning status were asked during the six- and eighteen-month TBCS surveys by trained interviewers. The exposure status at six months was ascertained via the following question: “Does your household have the habit of burning incense for religious purposes?” The responses were re-categorized as 0.never, 1.yes but only for festivals or on the first and the fifteenth days of each lunar month, 2.almost every day (upon the morning and evening), and 3.almost every day (entire day).

The exposure status at eighteen months was ascertained by the following question: “Does your (mother/father of the child) household have the habit of burning incense for religious purposes?” The responses were categorized as 0.never, 1.every day, and 2.on the first and fifteenth days of each lunar month and 3.less than once a month or for an important festival. As there are slight difference in the questions in the two waves of survey, exposure conditions were further categorized as 0.never, 1.occasional, including only for festivals or on the first and the fifteenth days of each lunar month, and 2.almost every day.

By combining the results of incense burning conditions for the two waves of survey, the exposure variable for incense burning was coded with a value of 0 for no household habit of incense burning during the

six- and eighteen-month surveys, 2 for those who reported almost daily household incense burning in both the six- and eighteen-month surveys, and 1 otherwise. The three groups were defined as never, occasional and persistent household incense burning exposure.

2.3. Neurodevelopmental outcomes and milestones

At the eighteen-month follow-up, questions concerning gross motor functions, fine motor functions, language and personal/social skills were included in the questionnaire with the Mandarin adaptation derived from the Denver Developmental Screening Test (Frankenburg et al., 1987). The caregivers were asked whether the child had reached developmental milestones, including walking with support, walking steadily, clapping hands, drawing arbitrarily, waving goodbye, calling a parent meaningfully, coming when called, and drinking with both hands. If yes, the earliest age at which the milestone was achieved was recorded. If not, the age at which the development milestone was achieved was imputed as the age at one month after the interview. The 90th percentile of age of reaching developmental milestones were then calculated in priori, and the cut-off value for the 90th percentile of age of walking with support and clapping hands was 13 months; age of walking steadily, waving goodbye and coming when called was 15 months; age of drawing arbitrarily, calling a parent meaningfully and drinking with both hands was 17 months. Infants achieving the developmental milestone later than the 90th percentile of age were coded as possible developmental delay in that domain (Chiu et al., 2011).

2.4. Confounding variables

The birth weight of the cases was collected from the birth registry, and small for gestational age was defined as a birth weight below the tenth percentile of the national data for singletons. Information on other confounders was collected from the face-to-face interviews during the two rounds of surveys at six and eighteen months. The selected factors were categorized as infant related, maternal condition related and household condition related. Infant-related factors included the gender of the new-born (male/female), small for gestational age (yes/no), and parity (first, second or more). Maternal condition-related factors included the maternal age (> 35 years old or not), maternal smoking (ever/never), breastfeeding (yes/no) and maternal education level (junior high school and below/senior high school/university and above). Household-related factors included environmental tobacco smoke exposure (persistent/ever/never), family income (above/below the median during the surveillance), and caregiver status (parents only/grandparents/others).

2.5. Statistical analysis

Descriptive characteristics were analysed after excluding missing and implausible extreme values. Continuous data were presented as the mean and standard deviation, and categorical data were presented as numbers and percentages. The chi-square test was used for the comparison of categorical data, whereas an analysis of variance was used to compare continuous data.

Simple and multiple logistic regressions were performed to calculate the crude and adjusted odds ratios of possible developmental delays among different household incense burning conditions. The Cox proportional hazards model was used to estimate the hazard ratio (HR) for different household incense burning conditions on the timing of neurodevelopmental milestone achievement. The never exposed group was selected as the reference group, and the confounding variables mentioned above were included in the multiple regression model.

Household incense burning conditions at the six- and eighteen-month interviews were also analysed separately with developmental milestones to ascertain the temporal effect. Furthermore, a sensitivity

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