

Review Article

Relationship between the concentration of formaldehyde in the air and asthma in children: a meta-analysis

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Received March 14, 2015; Accepted May 20, 2015; Epub June 15, 2015; Published June 30, 2015

Abstract: The aim of our study is to systematically assess the impact of formaldehyde in the air on asthma. Publications from year 1995 to 2014 on asthma were retrieved from PubMed, online Chinese periodical full-text databases of Chongqing VIP, China National Knowledge Index (CNKI) and Wan fang. Meta-Analyst was used to analyze the relationship between the concentration of formaldehyde and asthma in children. After evaluating the quality of the literature, 8 papers were finally included in our study, and the total sample sizes were 718, including the case group 362 and control group 356. The heterogeneous test display $P=0.000$, $I^2=0.876$, $Q=40.451$, Meta-analyst finding showed that the pooled weighted mean difference (WMD) in concentration of formaldehyde is 0.021 (95% CI: 0.009-0.033). Children will have a larger probability to get asthma due to the higher level of formaldehyde. Therefore, we should reduce the level of formaldehyde in the air, which can protect our children.

Keywords: Asthma, formaldehyde, children, meta-analysis

Introduction

Asthma is a common airway inflammatory disease, the host and the environment are the two risk factors for asthma. Host factors are predisposing factors including genetic factors, asthma, allergic constitution, obesity etc. Environmental factors are very important causative factor for the occurrence and development of asthma which include allergen, smoking, air pollution, infection and so on. Recently, the prevalence of asthma is rising rapidly [1-3]. Asthma has developed into a serious public-health problem in the world, with an estimated 300 million people affected, especially in children [4]. Although the morbidity of asthma is not high in some developing countries or regions, it is still in an accelerated state [1, 2, 5]. Children exposed to formaldehyde in excess of $60 \mu\text{g}/\text{m}^3$ in indoor air have an increased risk of asthma [6]. With increasing of asthma morbidity and mortality in children, we have paid more attention to the risk factors of asthma in children, Children with asthma have become a serious public health issue in China [7].

WHO reported that 100000 people die of asthma due to indoor air pollution around the world each year, 35% of them are children [7, 8]. Therefore, the relationship between indoor air pollutants and children with asthma has become a hot research field. Because of too much upholstery material, so many organic pollutants occurred which contain formaldehyde. Formaldehyde is a non allergenic pollutant in the air [9]. Relevant epidemiological material display [10] that there is significant relationship between the concentration of inhaled formaldehyde and allergic asthma. However, the impact of formaldehyde in the air on asthma is still under debate.

Thus, we conduct this Meta-analysis to explore the relationship between the concentration of formaldehyde and asthma in children.

Materials and methods

Search strategy

Literature from year 1995 to 2014 on asthma was retrieved from PubMed, online Chinese

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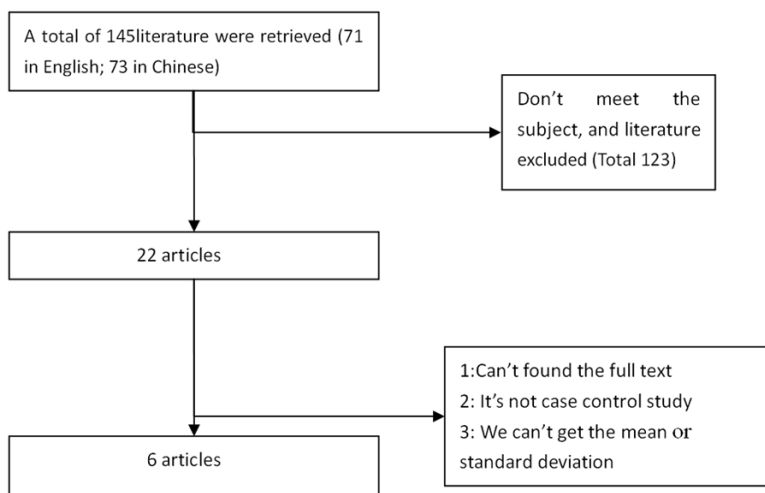


Figure 1. Flow Chart for the literature Screening.

periodical full-text databases of Chongqing VIP, China National Knowledge Index (CNKI) and Wan fang. We used medical subject headings (MeSH): ((asthma) AND formaldehyde) AND (children OR childhood) to search in Chinese for Chinese database and in English for Pubmed. Full-texts were eligible to retrieve manually from the previous data.

Criteria

The entry criteria for the literature was listed: 1) the researches are case control studies and published from 1995 to 2014 in the world. 2) The aim of study was to evaluate the relationship between the concentration of formaldehyde and asthma. 3) The object of the study is children. Exclusion criteria included: 1) the literature we can't get the mean concentration of formaldehyde and standard deviation. 5) Repeated literature must be excluded.

Literature screening and quality assessment

Each study was evaluated by two investigators independently, and the disagreements were resolved by them and when necessary a third reviewer was consulted. Blind method was used to ensure quality. The related literature was retrieved on the basis of MeSH described previously, and initially selected through the title appraisal and scanning the abstracts. Full-text appreciation was the secondary selections for us. We must ensure the accuracy of the data. Evaluation of the article quality was made as meta-analysis of observational studies in epidemiology proposed Stroup DF, et al [11].

Statistical analysis

Meta-Analyst for windows [12] was used to performing meta-analysis. Meta-Analysis and sensitivity analyses were carried out to identify key studies with a substantial impact on inter-study heterogeneity. By heterogeneity test, the random-effect model was applied to the data analysis. Risk of publication bias was assessed using funnel plot graphics. The final data was showed by statistical analysis and chart description.

Results

Basic information and quality assessment of the literature

A total of 145 literature were retrieved including Chinese academic periodical full text database (34), Wan fang medical database (10), Chongqing VIP database (28) and Pub Med (73). After some literature was removed by criteria, 6 articles were included, the total sample sizes was 718, including the case group 362 and control group 356. **Figure 1** shows the process of literature screening, the basic information on the final articles is showed in **Table 1**.

We analyzed the data and obtained the following results. Heterogeneity test was carried out on concentration of formaldehyde, with a result of $P=0.000$, $I^2=0.876$, $Q=40.451$, suggesting that the result of this research in the 6 articles were heterogeneous. Therefore, random-effect model was used to meta-analysis. As is shown by the forest plots (**Figure 2**), the results suggested that pooled weighted mean difference (WMD) in concentration of formaldehyde is 0.021 (95% CI: 0.009-0.033).

Publication bias

Publication bias refers to the similar researches which have positive results are easier be accepted than negative results. It may be influenced by editors, authors or reviewers. Even though a potential threat in meta-analysis, it may be verified with funnel plots, which was applied to modifying the possible bias in our literature selection. This could be showed in **Figures 3, 4**.

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Table 1. Main characteristic of the studies

Author	Year	Region	Case				Control					
			N	Mean	SD	Male	Female	N	Mean	SD	Male	Female
Leina Jia [13]	2012	Ningxia	50	0.07	0.036	38	12	50	0.036	0.045	32	18
Xiao Kaiti [14]	2008	Xinjiang	50	0.13	0.041	35	15	50	0.085	0.022	27	23
Shan Lou [15]	2010	Xinjiang	61	0.052	0.024	NA	NA	61	0.025	0.062	NA	NA
Jingui Wu [16]	2010	Shanghai	98	0.064	0.024	53	45	99	0.058	0.023	42	57
Norback D [17]	1995	Uppsala	47	0.029	0.041	NA	NA	41	0.017	0.021	NA	NA
M Hualin [18]	2010	France	56	0.030	0.017	NA	NA	55	0.022	0.012	NA	NA

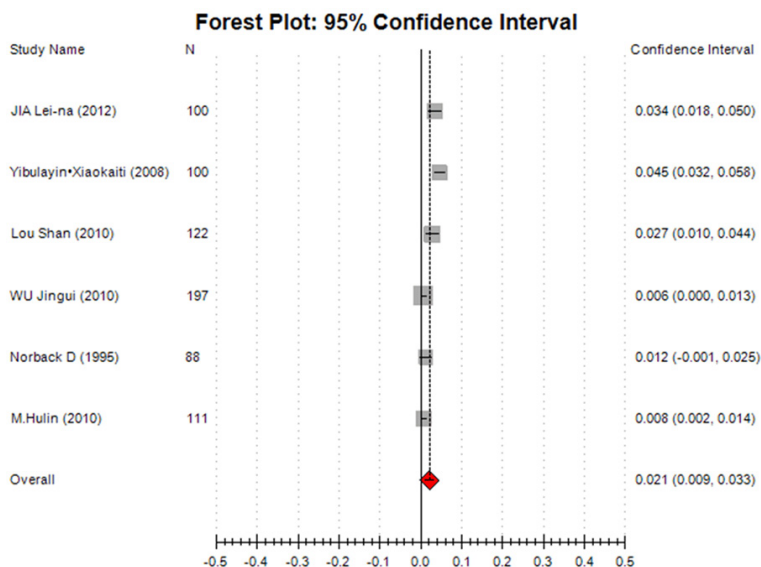


Figure 2. Forest plot about the concentration of formaldehyde.

Discussion

With the development of modern science and technology, there are more and more decoration materials in the room. Many of them are volatile organic compounds which has become an important source of indoor air pollution. The common Volatile organic compounds are benzene, formaldehyde, toluene, trichloroethylene and two isocyanate etc., which come from paint, plywood and carpet. Formaldehyde is a vital allergen of allergic disease which can lead to symptoms of cough, asthma and induce allergic reaction [19]. Therefore, formaldehyde has become one of the main indoor air pollutants [20, 21].

This Meta-analysis is a systematic review based on 6 articles, the heterogeneous text display $P=0.000$, $I^2=0.876$, $Q=40.451$, suggesting that the results of this research in the 6 articles were heterogeneous. Therefore, ran-

dom-effect model was used to data analysis. As is shown by the forest plots (**Figure 2**), the results suggested that pooled WMD in concentration of formaldehyde is 0.021 (95% CI: 0.009-0.033). It means that the average concentration of asthma group is higher than the average concentration of control group in the environment. Formaldehyde is a risk factor for children and the high level of formaldehyde will increase the morbidity of asthma from the perspective of statistics. Lots of researches proposed that these allergen like the traditional pollen, smoking, animal fur etc are the main inducement for asthma,

however, there is another view that the formaldehyde may be another high risk factors of asthma. The function of formaldehyde may just play a role in the initial stage of asthma [6], the induced mechanism is still not clear which need to research further. According to some researches, formaldehyde can damage the body's antioxidant system, which can increase the level of free radicals in our bodies. Free radical can also oxidize the mast cells and basophilic cells, which can lead to bursting of cell membranes and causing allergic reaction. Some researchers indicate that children with asthma are associated with the concentration of formaldehyde, and continuous exposure to formaldehyde has significant effect on the development of airway hyper reactivity [6, 22].

Therefore, the governments and parents should draw attention to the level of formaldehyde. We also need to reduce the level of air pollutant to keep children healthy, such as the low toxicity

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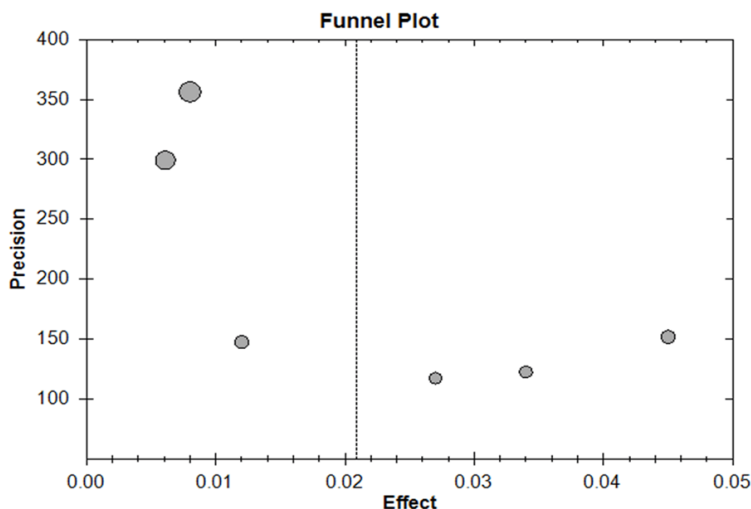


Figure 3. Funnel Plot about the concentration of formaldehyde.

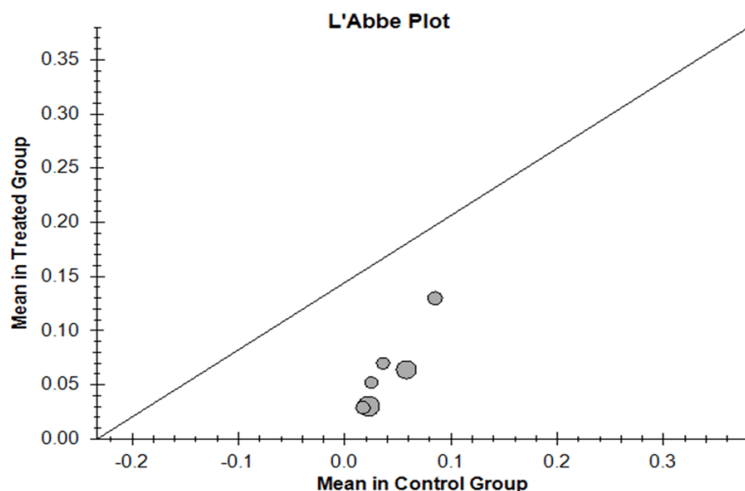


Figure 4. L'Abbe Plot about the concentration of formaldehyde.

of decoration materials should be used, the times of ventilation should be increased and more green plants should be planted in the room.

Conclusion

The formaldehyde in the air is a risk factor which has significant relationship with asthma. Children will have a larger probability to get asthma due to the higher level of formaldehyde. Therefore, we should reduce the level of formaldehyde in the air, which can protect our children.

Disclosure of conflict of interest

None.

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