



# Cross-sectional associations of dietary habits with asthma and wheeze in childhood: confounding for avoidance behaviors

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The prevalence of childhood asthma has increased rapidly in China [1]. In Shanghai, the prevalence has increased from 2.1 % in 1990 to 10.2 % in 2011 in 3- to 7-year-old children [2]. Various environmental and lifestyle factors have been suspected of association with the increasing prevalence of asthma in childhood [3, 4]. Numerous studies have investigated possible associations between dietary habits and prevalence of childhood asthma, but no consistent patterns or individual findings have been observed [5–9]. The International Study of Asthma and Allergies in

Childhood (ISAAC) [6, 7] found that high hamburger consumption was associated with higher lifetime asthma prevalence and that the frequency of hamburger consumption had a positive dose-dependent relationship with asthmatic symptoms. However, studies found no significant association between fast foods and asthma [8, 9]. In China, dietary habits have dramatically changed during recent years, as the availability and consumption of western style foods, including fast foods from Kentucky Fried Chicken (KFC) and McDonald's, sweet foods, and sugared beverages, have increased [10]. It is possible that these changes could be associated with the increase in childhood asthma [3, 4].

From April 2011 to April 2012, we conducted a cross-sectional study (the China, Children, Homes, Health (CCHH) study phase one) in 72 randomly chosen kindergartens from five districts of Shanghai, China. We distributed 17,898 questionnaires to the children's parents or guardians and selected 13,335 questionnaires for 4- to 6-year-old children for analysis because the number of questionnaires from younger and older children was small. The Ethical Committee of the School of Public Health, Fudan University approved this study. More information about the study is provided in our previous articles [1, 2, 11, 12]. According to data from this study, we used multivariate logistic regression models with adjustment for known or potential confounders to analyze associations of dietary habits and childhood asthma and wheeze (questionnaire for these studied items were presented in the previous article [1]). Unexpectedly, we found that: (1) More frequent consumption of fast foods and sugared beverages was significantly associated with a reduced risk of asthma and (2) ice cream was consistently and significantly associated with reduced risk of both asthma and wheeze, but (3) more frequent consumption of fast foods

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was significantly associated with increased risk of wheeze (Table S1). We also found that these associations were more significant in boys, in children with family history of atopy (FHA), and in children whose families owned the current residence, which is an indicator of higher socio-economical status.

Our finding that some foods are associated with a risk of wheeze is not consistent with their associations with the reduced risk of asthma. One possible explanation is that wheeze is frequent due to a respiratory infection, especially in children, and wheeze is an important symptom of asthma only when there is no respiratory infection [13]. In the Shanghai CCHH study, we found that 21.5 % and 16.2 % of children with parent-reported wheeze (ever) and wheeze (in the last year), respectively, did not have doctor-diagnosed asthma. We also found that the associations of foods with common cold wheeze (respiratory infection) and other cause wheeze were essentially the same. These findings indicate that fast foods and frozen foods may be part of the etiology of wheeze in children, as suggested in the ISAAC study [6, 7].

It is unlikely that eating more fast foods, sugared beverages, ice cream, and some other kinds of foods reduces the risk of asthma. A possible explanation is that children with asthma or with FHA avoid eating these foods (Table S2), a behavior analogous to pet avoidance behavior [12]. Consequently, parents of children with asthma and/or FHA reported less consumption of these foods. This explains, at least partially, the “unexpected” reverse association between fast foods and childhood asthma. Although our questionnaire did not specifically ask about food avoidance behaviors as it did about pet-keeping [12], we did find that those children with changed behavior in pet-keeping and home-cleaning also consumed fewer fast foods (Table S3). Thus, we suggest that avoidance behaviors for different foods should be considered in the study of associations of dietary behaviors with both asthma and wheeze. These behaviors may explain the inconsistent findings in studies of dietary behaviors and childhood diseases/symptoms with different study design and/or from different regions [5–7]. Generally speaking, most of the birth-cohort studies that were unlikely to have been confounded by avoidance behaviors found consumption of fast and/or processed foods to be a risk factor for childhood asthma [8, 9]. However, retrospective cross-sectional questionnaire studies similar to the present study found that consumption of fast and/or processed foods had no significant associations with childhood asthma [5, 8, 9]. Specifically, the finding in the Swedish cross-sectional study [4] that fruit consumption was significantly and positively associated with doctor-diagnosed asthma, could be logically explained by the asthmatic children’s avoidance behaviors with respect to “unhealthy foods” and a

greater consumption of “healthy foods”. In other words, children in the retrospective study with doctor-diagnosed asthma consumed more fresh fruit and vegetables.

Our finding about the interaction of heredity and family socioeconomic status with dietary habits with respect to the risk of childhood asthma and wheeze is also novel. We found that children without FHA but consumed fast foods and sweets frequently had greater risk of wheeze than children with FHA. This difference might also be explained by avoidance behaviors with respect to fast foods by children with FHA (Table S2). On the other hand, although children from families with higher socioeconomic status (as indicated by ownership of the current residence) ate less fast foods (Table S2), they still had higher risk of wheeze than other children. It may also indicate that fast foods consumption is a risk factor for childhood wheeze.

Although this study had some limitations, for example, we cannot make causal inference about associations of dietary habits with childhood asthma and wheeze, and the prevalence of asthma and wheeze, as well as dietary behaviors, was obtained from children’s parents or guardian responses to questionnaires, and we cannot deduce parental avoidance behaviors with certainty, this study of 13,335 multistage hierarchical sampled preschool children is one of the largest cross-sectional studies of children’s asthma and allergies in China [1]. The questionnaire we used also has been validated in several other countries [6, 7] and in other cities of China [1]. Our high response rate (85.3 %) makes it probable that the present study gives a valid, reliable picture of dietary habits in current Shanghai preschool children.

In conclusions, we suggest that children with asthma and/or FHA may exhibit avoidance behavior with respect to fast foods and sugared beverages. Fast foods and frozen foods might possibly be part of the etiology of childhood wheeze. Avoidance behaviors with respect to different kinds of foods should be considered when associations of dietary habits with childhood asthma and wheeze are investigated in the retrospective observational studies.

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**Conflict of interest** The authors declare that they have no conflict of interest.

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