

Dietary factors associated with physician-diagnosed asthma and allergic rhinitis in teenagers: analyses of the first Nutrition and Health Survey in Taiwan

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Summary

Background The occurrence of asthma and allergy are related to lifestyle factors, and dietary pattern may be one of the contributing factors.

Objective To examine the possible association between dietary intake and the prevalence of asthma and allergic rhinitis in teenagers.

Methods In a population-based cross-sectional survey, the relationship was sought between food frequency and physician-diagnosed asthma and allergic rhinitis in 1166 adolescents aged 13–17.

Results The prevalence was 4.0% for asthma and 12.4% for rhinitis. Living in an urbanized area was a significant predictor of asthma and rhinitis. In univariate analysis, higher frequencies of oily fish, butcher's meat, liver and deep-fried foods were associated with asthma. Relevant food frequency variables were dichotomized at the 75th percentile for multivariate logistic regression analysis, which included adjustment for two levels of urbanization. Asthma was associated with intakes of liver (OR = 2.32, 95%CI 1.11–4.80), deep-fried foods (OR = 2.13, 95%CI 1.06–4.30) and butcher's meat (OR 1.84, 95%CI 0.89–3.80). In a similar analysis, allergic rhinitis was associated with liver (OR = 1.67, 95%CI 1.06–2.63). No protective effect was demonstrated for any of the food items examined.

Conclusion Protein-rich and fat-rich foods of animal origin were associated with a higher prevalence of asthma in teenagers.

Keywords: diet, allergy, rhinitis, asthma, food frequency, population-based

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Introduction

The prevalence of childhood asthma in many parts of the world, including Taiwan, has increased dramatically in recent decades [1]. Investigations have found associations between higher risk of allergic symptoms and a more affluent lifestyle [2,3]. However, the elements in the lifestyle that actually pose risks have been elusive to investigators. Dietary factors may explain part of the

variations in the prevalence of asthma in different countries. For example, the consumption of linoleic acid and *trans* fatty acids has been correlated to allergy and asthma prevalence in developed countries [4,5].

Few population-based studies have addressed the dietary effect on allergy and asthma. In the Second National Health and Nutritional Examination Survey of the USA, high calorie intake and obesity were identified as risk factors for wheezing in children. Other measures of nutritional status, including dietary intake of protein, calcium and fish, were not found to be associated with wheezing or asthma [6]. In a prospective study of a large nurse cohort, no protective

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effect of antioxidant supplementation or ω -3 fatty acids against adult-onset asthma could be demonstrated [7]. Case-control and clinical studies have yielded inconsistent results. Oily fish was suggested to have a protective effect against childhood asthma [8], but this was not confirmed in a study among young adults [9]. Inconsistency among studies suggests that dietary effect on asthma may differ according to age, sex, the severity of symptoms, and the dietary pattern of the population under study.

The Nutrition and Health Survey in Taiwan is a government-sponsored programme. The investigation included a 24-h dietary intake record and a food frequency questionnaire completed by household interviews. Here we report the relationship between food frequency and physician-diagnosed asthma and allergic rhinitis in adolescents aged between 13 and 17.

Materials and methods

Study design

The National Nutrition Survey has been carried out in approximately 5-year intervals in Taiwan since 1980. The cross-sectional data in this report were from the third survey, which was the first Nutrition and Health Survey done during 1993–1996. A stratified, multiple-staged, probability sampling design was used [10]. All the 365 townships and city districts in Taiwan were stratified into seven strata according to degree of urbanization and geographical regions. By the method of probability proportional to size, three townships or districts in each stratum were selected, within which three villages or city blocks were chosen. In each sampled area, a series of computer-generated random two-dimensional points were used to select an area including 75 households within 200 square meters.

All residents aged 4 years and above who did not live in institutions were eligible. Door-to-door visits were carried out to interview a designated number of people in each of the 14 age-sex groups. The target sample size was 10 080, and the final sample size was 9962. The response rate for the household interviews was 86%. Data from two strata (offshore islands and mountain villages) were excluded because of their unusual dietary patterns. The remaining five strata were grouped by level of urbanization into high (two cities with population > 1.5 million), intermediate (population density > 3,000/km²) and low (others). At the end of each household interview period, all respondents were invited to participate in a health examination. The response rate for the health examination was 57% in the age group covered in this report.

Food frequency questionnaire

The dietary assessment included both 24-h recall and food frequency questionnaire [11]. The frequency questionnaire was administered to participants aged 13 and up. The participants were asked to estimate the frequency of intake of 36 food items within 1 month prior to the interview. The food items were major contributors and predictors of calorie, protein, carbohydrate, calcium, and vitamins A, B1, B2 and C [12,13]. In addition, intake frequencies of fishes rich in ω -3 fatty acid, raw meat and fish, smoked meat and fish, fermented foods and deep-fried foods were also assessed.

Asthma and allergic rhinitis

A health status questionnaire was included in the survey. A questionnaire about 19 major illness in youth was targeted for the age group 4–17 years. This report analysed the age group 13–17 years. Forty-seven reported having had wheezing in the past, 36 (77%) had physician diagnosis of asthma. One hundred and thirty-six subjects (11.3%) had symptoms of allergic rhinitis, defined as 'nose stuffiness, running nose, or sneezing, either in the morning or upon exposure to dust, pollen, or chemicals'. Among them, 115 (85%) had physician diagnosis of allergic rhinitis. To avoid misclassification, those with asthmatic or rhinitis symptoms but no physician diagnosis were excluded from the analyses. Six males and five females had both rhinitis and asthma, and they were included in both sets of analyses. The control group included those who had neither allergic rhinitis nor asthmatic symptoms ($n = 1030$).

Statistical analysis

The food frequency data were grouped into quartiles within each gender, and the prevalence of physician-diagnosed asthma and allergic rhinitis in each quartile was computed; the association with food variables was tested for trend by Mantel-Haenszel chi-square. For each variable significant in univariate analysis, the risk estimate was computed by logistic regression adjusting for two levels of urbanization. To enable adjustment for urbanization and examination for interactions by logistic regression, food frequency variables were dichotomized to high and low groups. The cut-off point of dichotomization was at the 75th percentile of each variable. All statistical analyses were made using the Statistical Analysis System package (SAS 6.11, SAS Institute, Cary, NC).

Results

The analyses included data from 582 males and 584 females aged 13–17, the mean age was 14.7 ± 1.4 years.

Table 1. Prevalence of physician-diagnosed allergic rhinitis and asthma in males and females 13–17 years of age, according to different levels of urbanization

	Total	Level of Urbanization			<i>P</i> *
		High	Intermediate	Low	
Male (<i>n</i>)	582	99	118	365	
Asthma <i>n</i> (%)	23 (4.0)	6 (6.1)	12 (10.2)	5 (1.4)	0.001
Rhinitis <i>n</i> (%)	72 (12.4)	24 (25.8)	20 (18.0)	28 (7.8)	0.001
Female (<i>n</i>)	584	103	117	364	
Asthma <i>n</i> (%)	12 (2.1)	4 (3.9)	3 (2.6)	5 (1.4)	0.10
Rhinitis (%)	40 (6.9)	13 (13.0)	6 (5.2)	21 (5.8)	0.031

**P*-value of Mantel-Haenszel chi-square.

The prevalence of physician-diagnosed asthma (asthma) and physician-diagnosed allergic rhinitis (rhinitis) was significantly higher in males than in females (Table 1). Neither the prevalence of asthma or rhinitis was significantly

different among years of age in either sex. The prevalence of both asthma and rhinitis was significantly associated with urbanization. The trend was more prominent for rhinitis than asthma, and more remarkable in males than in females.

Table 2. The prevalence (%) of physician-diagnosed asthma in individuals 13–17 years of age according to quartiles of intake frequency of various food items (*n* = 1057)

Variables	Quartiles				<i>P</i> *
	1	2	3	4	
All fish	2.9	3.5	3.5	3.3	0.82
Oily fish	1.5	2.5	4.6	4.9	0.01
Shellfish	2.6	2.6	3.2	5.0	0.12
Other seafood	2.9	4.9	3.0	3.2	0.99
Butcher's meats	2.1	1.6	4.3	5.3	0.016
Poultry	2.7	4.2	1.6	4.6	0.54
Egg	1.9	2.3	6.1	3.2	0.13
Milk	2.3	2.7	4.4	3.8	0.19
Liver†	2.6		2.6	5.5	0.022
Other internal organs†	3.2		5.0	2.6	0.80
Deep fried foods	1.7	2.6	2.9	6.1	0.006
Green vegetables	2.9	4.4	1.8	4.7	0.62
All vegetables	4.4	2.8	3.5	2.6	0.37
Citrus fruits	4.7	1.8	3.4	3.0	0.41
All fruits & juices	3.4	3.0	2.7	4.6	0.65
Peanut‡	2.6		4.6	4.0	0.20
Serum cholesterol‡	1.3	4.7	3.3	3.4	0.44
Serum triglyceride‡	0.7	4.5	4.8	2.6	0.36
Body mass index‡	1.9	3.8	3.1	5.0	0.17

**P*-value of Mantel-Haenszel chi-square.

†Due to ties in order, cells in each column may not represent equal number of subjects.

‡*n* = 642.

To identify dietary factors associated with asthma, food frequency data from 35 asthmatics (23 male) and 1030 normal subjects (493 male) was analysed. In univariate analysis, oily fishes rich in ω -3 fatty acids, butcher's meat, liver and deep-fried foods were significantly associated with asthma (Table 2). Pork is the most frequently consumed meat in Taiwan, followed by beef. Other food items, including milk, poultry, other animal internal organs (such as heart and intestines), beans, vegetables, green vegetables, citrus and other fruits, were not associated with the prevalence of asthma.

Logistic regression was used for multivariate analysis. For this purpose, intake frequencies of foods were dichotomized. In stepwise logistic regression including only dietary variables, liver and deep-fried foods were significantly associated with asthma (Table 3). Because asthma was associated with urbanization, another regression model included adjustment for two levels of urbanization. With this adjustment, liver and deep-fried foods remained significant; in addition, butcher's meat was selected in the model with a marginal level of significance (*P* = 0.098).

The relationship between food intake and the prevalence of allergic rhinitis was analysed by the same method. In univariable analysis, the prevalence of rhinitis was associated with intake of milk, liver, and 'all fruits and juices' (Table 4). In multivariate logistic regression including only dietary variables, liver and 'all fruits and juices' were independent predictors of rhinitis. Liver was the only significant variable after adjustment for urbanization (Table 3).

Table 3. Sex-specific logistic regression models on physician-diagnosed asthma and allergic rhinitis

Variables	Asthma		Allergic rhinitis	
	Diet only	Adjusted*	Diet only	Adjusted*
Moderate urban vs. rural		5.05 (2.21–11.5)		1.81 (1.10–3.00)
High urban vs. rural		4.41 (1.78–10.9)		3.31 (2.08–5.26)
Liver	2.13 (1.03–4.38)	2.32 (1.11–4.80)	1.53 (0.97–2.40)	1.67 (1.06–2.63)
Deep-fried foods	2.56 (1.29–5.08)	2.13 (1.06–4.30)	–	–
Butcher's meats	–	1.84 (0.89–3.80)	–	–
Fruits & juices	–	–	1.47 (0.93–2.32)	–

Initial variables included age, and diet variables for liver, deep-fried foods, oily fish, butcher's meats, fruits & juices, milk and egg. Stepwise selection procedure with significance level of 0.1 was used for the final regression model. Odds ratios and 95% confidence intervals of asthma or rhinitis in the high vs. low intake groups dichotomized at the 75th percentile of intake frequency are shown.

* Two dummy variables were included to adjust for two levels of urbanization.

–: not selected in the final model.

Table 4. The prevalence (%) of physician-diagnosed allergic rhinitis in individuals 13–17 years of age according to quartiles of intake frequency of various food items ($n = 1134$)

Variables	Quartiles				<i>P</i> *
	1	2	3	4	
All fish	9.6	7.7	11.6	10.5	0.39
Oily fish	10.0	8.0	9.9	10.9	0.65
Shellfish	9.4		9.1	11.6	0.45
Other seafood	8.7	7.2	11.3	11.3	0.15
Butcher's meats	10.5	8.7	8.6	11.7	0.68
Poultry	10.3	8.3	10.0	10.6	0.75
Egg	7.5	10.6	10.6	10.5	0.25
Milk	6.4	9.2	13.4	9.6	0.060
Liver‡	8.6		11.6	12.8	0.032
Other internal organs†	9.0		11.9	10.7	0.34
Deep fried foods	9.8	8.1	10.5	10.6	0.57
Green vegetables	8.1	9.3	10.7	10.6	0.26
All vegetables	9.9	10.0	11.6	7.8	0.58
Citrus fruits	10.1	8.3	9.2	11.3	0.58
All fruits & juices	8.5	7.3	10.6	13.3	0.039
Peanut‡	10.1		8.3	10.5	0.99
Serum cholesterol‡	10.6	11.8	11.7	9.2	0.60
Serum triglyceride‡	8.7	8.0	14.8	10.8	0.23
Body mass index‡	8.1	10.5	9.3	14.0	0.12

* *P*-value of Mantel-Haenszel chi-square.

† Due to ties in order, cells in each column may not represent equal number of subjects.

‡ $n = 692$.

Discussion

This analysis intended to identify dietary factors that may be associated with asthma or allergic rhinitis in teenagers. For asthma, the prevalence was associated with the intake frequencies of some protein- and fat-rich foods of animal sources, including butcher's meat, liver and deep-fried foods. The prevalence of rhinitis was associated with milk, liver and fruits; multivariate analysis identified liver as the most significant predictor of rhinitis. No protective effect was demonstrable for any of the food items examined, including green vegetables, citrus fruits or oily fish.

The food frequency questionnaire used in this study has been validated in previous surveys in Taiwan, and was found to adequately represent the major foods consumed in this country [12,13]. The food frequency questionnaire was completed during face-to-face household interviews by the same group of interviewers, and may reduce food misclassification of self-administered questionnaires. The questionnaire also covered a broad range of health-related questions, so that recall bias in food frequency should be random in relation to asthma and rhinitis. To avoid case misclassification, subjects with symptoms that were not confirmed by physician diagnosis were excluded from the analyses. The results were essentially identical when the analyses were performed on asthmatic or rhinitis symptoms instead of diagnosis. However, the questionnaire was unable to identify those with current symptoms among prevalent cases.

Two indicators of lifestyle were shown to be linked with increased risk of asthma in Taiwan: higher socioeconomic status and living in urbanized areas [14]. Socioeconomic status is a potential confounder that was not adjusted for in this study, but urbanization variables were included in

logistic regression. Some food items showed regional differences in intake frequency. For example, fruits, shellfish, milk, ω -3 fish and eggs were consumed more frequently in urbanized areas. This may explain the association of 'fruits and juices' with rhinitis in the univariate analysis, but not in multivariate analysis adjusted for urbanization. It is also remarkable that the risk estimates of urbanization in logistic regression changed little with or without the inclusion of dietary variables (not shown), suggesting that diet did not explain the association between urbanization and either asthma or rhinitis.

Three food items were significantly associated with asthma after adjustment for urbanization: meat, liver and deep-fried foods. These foods may be directly linked to asthma, or may serve as surrogates for other unidentified risk factors. The data lent some support to the suggestion that these foods are not merely surrogates:

- Since rhinitis and asthma are both associated with socioeconomic status and urbanization, surrogates of lifestyle factors should be equally linked to both rhinitis and asthma. The relationship with rhinitis would be more likely to be detected, because of its higher prevalence than asthma. On the contrary, our data showed that meat and deep-fried foods were associated with asthma but not rhinitis.

- Eating animal liver was associated with both asthma and rhinitis, but this diet is less popular in westernized lifestyle, and unlikely to be a surrogate.

- Deep-frying is common way of Chinese food preparation, and the survey question regarding deep-frying included, but was not limited to, fast foods.

Because of the cross-sectional design of this study, the nature of the association between asthma and foods could not be resolved. It is possible that some food components were associated with the pathogenetic pathways of asthmatic symptoms. For example, diet of different fatty acid component and oxidized frying oil may alter lymphocyte functions [15,16]. However, other explanations should be considered. For example, parents of asthmatic adolescents may advise them to take foods that were believed to be beneficial such as meat or fruits. On the other hand, the association between foods and asthma may be due to food allergy. This explanation is not favoured because the incidence of food allergy-induced asthma is low, and it is almost always associated with cutaneous or gastrointestinal symptoms [17,18]. Thus, those with food allergy would tend to avoid the foods. Excluding subjects who claimed to have food allergy (34 males and 60 females) did not change the relationship between asthma and foods in this study (not shown).

In summary, we have identified an association of animal liver, deep-fried foods and butcher's meat with allergic airway inflammation. The cross-sectional design and the

sample size of this study limited the interpretation of the results, and the observations here have to be verified by prospective or intervention studies.

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