



Short communication

## Onion consumption is protective against asthma risk in children: ROAD to health population-based cohort study

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### To the Editor

Asthma is an inflammatory, heterogeneous lung disease with airway obstruction, hyperresponsiveness to allergens, and wheezing. The etiology of asthma involves multifactorial underlying mechanisms and inflammatory pathways. There is an unmet, urgent need to identify effective treatments for prevention of asthma [1].

Quercetin-rich apples and onions may be medicinal foods associated with reduced risk of asthma. Quercetin is a major dietary polyphenol flavonoid shown to have anti-inflammatory, antioxidant, and antiviral activity involved in asthma disease development [2]. Animal studies support a therapeutic role of quercetin in lung health [3]. Apples and onions may also play a protective role in increasing microbiota diversity, immunoregulation, and immune maturation in childhood to prevent asthma development [4].

The study aims were to examine the relationship between apple and onion consumption and asthma prevalence and to explore any moderating effect of age. We hypothesized that more frequent apple and onion consumption are associated with reduced odds of prevalent asthma and that age moderates this relationship.

### 1. Methods

In this cross-sectional study, we used the National Health and Nutrition Examination Survey (NHANES) 2005–2006 database of a United States (US) population. This study was exempt by the Institutional Review Board (# IRB-AAAU0694). The primary outcome was prevalent asthma, measured with the Medical Conditions Questionnaire item, “Has a doctor or other health professional ever told you that you have asthma?” Apple and onion intake data were obtained from 12-month food frequency questionnaire items, “How often did you eat apples?” and “How often did you eat onions?” We condensed frequency responses to two categories [1]: never or rarely [2], occasionally or more

frequently. We used the allergic rhinitis item, “Has a doctor or other health professional ever told you that you have hay fever?”

The main exposures of interest were apple and onion consumption. Descriptive statistics were presented in mean (SD) and frequency (percentages). Unconditional logistic regression was used to estimate odds ratios (ORs) as measures of relative risk. Factors found to be univariately associated with asthma or clinically important were selected for multivariate logistic regression models. Subgroup analyses of age ( $\leq 18$  years vs  $> 18$  years) explored explanations for heterogeneity. Missing covariate data were imputed through multivariate imputations by chained equations based on the observed data [5]. Analyses were performed using R, version 4.0.2 (R Project for Statistical Computing), and 95 % CIs not crossing 1.00 with  $p < 0.05$  were considered statistically significant.

### 2. Results

Our cohort was 9809 participants; 4781 (49 %) were male and 57 % ( $n = 5554$ ) were adults 18 years or older. The mean age was 30 (SD = 24) years for non-asthmatic participants and 27 (SD = 22) for asthmatic participants. An estimated 3509 (60 %) individuals ate apples, and 3663 (63 %) people ate onions at least occasionally or more frequently. We identified 1389 individuals (14 %) who self-reported an asthma diagnosis. Allergic rhinitis (hay fever) was present in 6.6 % ( $n = 645$ ) of cohort.

Individuals with asthma were less likely to eat onions: 59 % of those with asthma ate onions vs 63 % of individuals without asthma ate onions ( $p = 0.049$ ); repository, <https://osf.io/3rqhb>. Controlling for socio-demographic and clinical characteristics, occasional-to-daily onion consumption was associated with 14 % lower risk of prevalent asthma (aOR 0.86; 95 % CI, 0.76–0.98,  $p = 0.02$ ); Table 1. Adult age group was associated with 40 % less risk of prevalent asthma than childhood age ( $p < 0.001$ ). Obesity was associated with a 32 % increased risk of asthma

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(p = 0.001). Being less active was associated with a 39 % increased risk of asthma (p < 0.001).

Individuals with asthma were also less likely to eat apples (p = 0.001). Without adjustment, apple intake was protective of asthma (OR 0.78; 0.68–0.91, p = 0.001). After adjustment, however, a relationship between apple consumption and asthma was no longer significant, p = 0.09.

Age group moderated a protective association of onion consumption (Table 1). Onion consumption in children (but not adults) was associated with 18 % reduced odds of prevalent asthma (aOR 0.82; 95 % CI, 0.69–0.98, p = 0.03). In children, allergic rhinitis was associated with over 4-fold increase in asthma risk (p < 0.001). Female gender in children was associated with a 35 % reduced risk of asthma (p < 0.001).

### 3. Discussion

This is the first study to use NHANES national data to rigorously examine whether onion and apple consumption is protective of prevalent asthma in both children and adults. We found onion consumption was negatively associated with probability of asthma; in sub-group analysis this association was significant only in children under 18 years old. We also found apple consumption was negatively associated with asthma prevalence, but this association was not statistically

significant after adjustment. Other studies have similarly supported a protective role of vegetable consumption in lung disease prevention [6] and improvement in lung function in children with asthma [7]. Similarly, Western diets (low in plant-based fiber) were associated with increased asthma prevalence [8]. Before age 3–4, may be an important window for nutritious onion intake to prevent asthma [9].

Mexican American ethnicity (with traditionally higher intake of onions) was associated with 45 % reduced risk of asthma in adults (but not children). Non-Hispanic Black race in children was associated with 34 % increased odds of asthma disease (p = 0.01). Children of Other Hispanic race had a 63 % increased risk of asthma (p = 0.03). More research is needed to reduce these health disparities.

In conclusion, we found a significant dose response for onion consumption. More research focused on primary prevention of asthma in children through onion consumption and quercetin-rich dietary interventions is needed. Growing evidence supports the need for pediatric public health asthma prevention and produce prescription programs to help prevent diet-related asthma and health disparities in children.

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**Table 1**

Multivariate regression models showing a moderation effect (interaction) of age group on the relationship between apple and onion consumption and prevalent asthma.

Characteristic	Multivariate <sup>c</sup>			Adult (n = 5554)			Child (n = 4255)		
	aOR <sup>b</sup>	95 % CI <sup>b</sup>	p-value	aOR <sup>a</sup>	95 % CI <sup>a</sup>	p-value	aOR <sup>a</sup>	95 % CI <sup>a</sup>	p-value
<b>Apple intake</b>									
No (never or rarely)	–	–	–	–	–	–	–	–	–
Yes (Occasionally, frequently, daily)	0.90	0.80, 1.02	0.090	0.88	0.75, 1.03	0.120	0.93	0.77, 1.12	0.421
<b>Onion intake</b>									
No (never or rarely)	–	–	–	–	–	–	–	–	–
Yes (Occasionally, frequently, daily)	0.86	0.76, 0.98	<b>0.020</b>	0.91	0.76, 1.09	0.301	0.82	0.69, 0.98	<b>0.030</b>
<b>Allergic Rhinitis (Hay fever) (AGQ010)</b>									
No	–	–	–	–	–	–	–	–	–
Yes	3.50	2.91, 4.19	<b>&lt;0.001</b>	3.27	2.65, 4.03	<b>&lt;0.001</b>	4.11	2.80, 5.98	<b>&lt;0.001</b>
<b>Gender</b>									
Male	–	–	–	–	–	–	–	–	–
Female	0.88	0.78, 0.99	<b>0.032</b>	1.13	0.96, 1.33	0.139	0.65	0.55, 0.78	<b>&lt;0.001</b>
<b>Age group</b>									
0–18 years	–	–	–	–	–	–	–	–	–
>18 years	0.60	0.52, 0.71	<b>&lt;0.001</b>	–	–	–	–	–	–
<b>BMI</b>									
Normal	–	–	–	–	–	–	–	–	–
Underweight	0.76	0.64, 0.90	<b>0.002</b>	1.33	0.74, 2.24	0.316	0.71	0.58, 0.86	<b>&lt;0.001</b>
Overweight	0.91	0.76, 1.08	0.263	0.98	0.79, 1.21	0.860	0.87	0.64, 1.18	0.393
Obese	1.32	1.12, 1.55	<b>0.001</b>	1.36	1.12, 1.66	<b>0.002</b>	1.28	0.93, 1.75	0.129
<b>Race</b>									
Non-Hispanic White	–	–	–	–	–	–	–	–	–
Mexican American	0.67	0.57, 0.80	<b>&lt;0.001</b>	0.55	0.43, 0.71	<b>&lt;0.001</b>	0.83	0.65, 1.06	0.140
Other Hispanic	1.16	0.84, 1.58	0.356	0.88	0.53, 1.39	0.591	1.63	1.04, 2.50	<b>0.029</b>
Non-Hispanic Black	1.18	1.02, 1.36	<b>0.026</b>	1.10	0.91, 1.33	0.308	1.34	1.07, 1.68	<b>0.012</b>
Other Race - Including Multi-Racial	1.04	0.78, 1.35	0.805	1.00	0.66, 1.46	0.991	1.15	0.77, 1.68	0.493
<b>Family Income Index</b>									
Less than \$25,000	–	–	–	–	–	–	–	–	–
\$25,000 to \$75,000	0.89	0.78, 1.02	0.108	0.83	0.69, 1.00	<b>0.048</b>	0.98	0.80, 1.20	0.823
\$75,000 or over	0.99	0.84, 1.16	0.865	0.89	0.71, 1.10	0.291	1.13	0.89, 1.43	0.312
<b>Physical Activity</b> Compare activity others same age, PAQ520									
More active	–	–	–	–	–	–	–	–	–
Less active	1.39	1.17, 1.63	<b>&lt;0.001</b>	1.44	1.16, 1.78	<b>&lt;0.001</b>	1.30	0.99, 1.70	0.056
About the same	0.93	0.82, 1.07	0.317	1.02	0.84, 1.24	0.829	0.86	0.71, 1.05	0.131
<b>Stress</b>	1.01	1.01, 1.02	<b>&lt;0.001</b>	1.01	1.00, 1.02	<b>0.004</b>	1.01	1.00, 1.02	<b>0.003</b>
<i>Days mental health not good, HSQ480</i>									
<b>No insurance in past year, HIQ210</b>									
Yes	–	–	–	–	–	–	–	–	–
No	1.13	0.92, 1.41	0.259	1.06	0.81, 1.42	0.671	1.24	0.90, 1.75	0.194

<sup>a</sup> OR = Odds Ratio, CI = Confidence Interval.

<sup>b</sup> aOR = adjusted Odds Ratio, CI = Confidence Interval.

<sup>c</sup> Missing values were imputed.

**CRedit authorship contribution statement**

**Anna Norweg:** Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Writing – original draft. **Cheongeun Oh:** Data curation, Formal analysis, Investigation, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Anna Nolan:** Investigation, Methodology, Validation, Writing – review & editing.

**Declaration of competing interest**

The authors have no competing interests to declare.

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