

Short communication

Fast foods – are they a risk factor for asthma?

Background: Lifestyle changes over the last 30 years are the most likely explanation for the increase in allergic disease over this period.

Aim: This study tests the hypothesis that the consumption of fast food is related to the prevalence of asthma and allergy.

Methods: As part of the International Study of Asthma and Allergies in Childhood (ISAAC) a cross-sectional prevalence study of 1321 children (mean age = 11.4 years, range: 10.1–12.5) was conducted in Hastings, New Zealand. Using standard questions we collected data on the prevalence of asthma and asthma symptoms, as well as food frequency data. Skin prick tests were performed to common environmental allergens and exercise-induced bronchial hyperresponsiveness (BHR) was assessed according to a standard protocol. Body mass index (BMI) was calculated as weight/height² (kg/m²) and classified into overweight and obese according to a standard international definition.

Results: After adjusting for lifestyle factors, including other diet and BMI variables, compared with children who never ate hamburgers, we found an independent risk of hamburger consumption on having a history of wheeze [consumption less than once a week (OR = 1.44, 95% CI: 1.06–1.96) and 1+ times a week (OR = 1.65, 95% CI: 1.07–2.52)] and on current wheeze [consumption less than once a week (OR = 1.17, 95% CI: 0.80–1.70) and 1+ times a week (OR = 1.81, 95% CI: 1.10–2.98)]. Takeaway consumption 1+ times a week was marginally significantly related to BHR (OR = 2.41, 95% CI: 0.99–5.91). There was no effect on atopy.

Conclusions: Frequent consumption of hamburgers showed a dose-dependent association with asthma symptoms, and frequent takeaway consumption showed a similar association with BHR.

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The rapid rise in the prevalence of asthma and allergic disease in developed countries over the last 30 years is largely unexplained but is almost certainly related to environmental or lifestyle changes as genetic shifts are unlikely to have occurred in this short time period. Changes in diet over this time period have been proposed as a possible explanation for at least some of this observed increase. Various hypotheses have focused on the roles of antioxidant vitamins (1, 2), unsaturated fatty acids (3, 4), saturated fats (5) and salt (6). There have been substantial increases in fast food consumption in recent years, reflected in increases in body mass index (BMI) over a similar time period (7). We hypothesize that fast food consumption may be directly linked to asthma prevalence, or may be confounded by BMI, shown to be associated with asthma symptoms in a number of studies, including a previous analysis of this data set by our group (8). By also investigating the effect of fast food consumption on the more objective measures of atopy and bronchial hyperresponsiveness (BHR), we may be in a better

position to understand the mechanisms underlying any associations with asthma symptoms.

Methods

In the year 2000, as part of the International Study of Asthma and Allergies in Childhood (ISAAC), a cross-sectional prevalence study of 1321 children attending schools in the Hastings district, New Zealand, was conducted. Standard ISAAC questions (9) were used to collect information on the prevalence of allergic disease and symptoms, and the frequency of consumption of different food groups. The food frequency questions took the form: 'How often, on average, does your child eat each the following, nowadays?', with hamburgers, takeaways, fizzy drinks, fruit juice, meat, fish, fresh fruit, raw and cooked green vegetables and fruit juice listed. No further definitions were given but in New Zealand 'takeaways' include any prepared food paid for before it is eaten. We did not collect details of the particular takeaway eaten but in the study population it would most likely have been hamburgers or deep-fried battered fish with chips (fries). A 'hamburger' refers to a beef mince patty eaten in a bread roll, which may or may not be bought from a takeaway outlet. The frequency of consumption was collected using

the following closed response options: never/seldom, less than once a week, one to two times a week, three to six times a week, once a day or more often.

Following parental consent, eligible children underwent an exercise challenge indoors at school, as previously outlined (10), to test for BHR. Height was measured to the nearest 0.1 cm using a portable field instrument that has been shown to be accurate by comparison with a standard rule. Each child ran briskly for 6 min, radial pulse rate was recorded at rest and immediately after the run. Five peak flow recordings were made before and 5 min after exercise ceased using a Standard (clockface) Wright PEFR meter (Airmed Ltd, Harlow, UK). The change in peak flow after exercise was calculated as the mean of the highest three postexercise peak flow measurements as a percentage of the mean of the highest three pre-exercise peak flow measurements. Exercise-induced asthma was defined as a drop in peak flow of more than 15%. If children had received short acting β_2 -agonists within 6 h of the exercise challenge they were exercised, and if their PEFR decreased by <15% from the baseline they were re-exercised on another occasion without prior β_2 -agonist exposure.

Temperature and humidity were measured using a whirling hygrometer just prior to each exercise challenge.

Skin prick testing used ALK allergens (ALK Allergologisk Laboratorium A/s, Horsholm, Denmark; *Dermatophagoides pteronyssinus*, *D. farinae*, *Felis domesticus*, *Alternaria*, mixed grasses, mixed trees) and positive and negative controls. A positive reaction was defined as a mean wheal diameter of 3 mm or greater to any allergen, with atopy defined as any positive reaction.

Ethical approval was obtained from the Hawkes Bay Ethics Committee.

Statistical analysis

Data analysis were conducted using SAS version 8 (SAS Institute Inc., Cary, NC, USA). The BMI was calculated as weight/height² (kg/m²) and further classified into underweight, normal weight, overweight and obese according to a standard international definition, which used pooled international BMI data and is linked to the widely used adult overweight (25 kg/m²) and obesity (30 kg/m²) definitions (11).

Logistic regression analysis was used to determine the effects of the frequency of fast food consumption (hamburgers, takeaways, fizzy drinks) on the dependent variables (the prevalence and history of wheeze, asthma, atopy and BHR) before and after adjustment for the potential confounding effects of all food frequency variables, the interaction of gender with hamburgers and takeaways (based on an *a priori* hypothesis concerning the role of salt in asthma predominantly among boys), BMI, mother or father with a family history of allergic disease (asthma, eczema or hay fever), family size, birth weight, current smoking in the home, father's years of postprimary education, exercise frequency, gender, ethnicity and year born. After the exclusion of respondents with missing data for family size, birth weight, ethnicity, exercise frequency, BMI and any of the food frequency variables, there were 1234 (93%) respondents included in these models.

Results

All school principles agreed to participate in the study, and among the children approached, 1321 (84%) of them completed the questionnaire. Of these, 1284 (97.2%) completed the exercise challenge and 1281 (97.0%) completed skin prick tests.

As shown in Table 1 and previously reported in a restricted population from this data set (8), the prevalence of asthma and atopy in this population is high and 28% of the population were overweight or obese. Children with asthma symptoms were much more likely to respond to exercise (OR = 4.23, 95% CI: 2.80–6.40). Table 2 shows that most children consume takeaway foods and fizzy drinks, with hamburgers a major source of takeaway consumption.

In the univariate analysis (Table 3) frequent hamburger, takeaway and fizzy drink consumption were associated with increased risk of having asthma or asthma symptoms. There was no effect on atopy or BHR to exercise. The consumption of meat, fish, raw or cooked vegetables, fresh fruit or fruit juice was not associated with any outcome (data not shown). Table 4 shows that after controlling for the interrelationship between all foods, BMI and other potential confounders, including father's years of postprimary education (< or ≥ 5.5 years) as a marker of socio-economic status, the positive association between hamburger consumption and asthma symptoms remained. The positive association for takeaway consumption at least once a week and BHR strengthened ($P = 0.054$), but reduced for all other outcome measures. Associations for fizzy drink consumption also reduced becoming nonsignificant. Replacing father's education level with mother's education level led only to marginal differences in the effect estimates.

Repeating this adjusted analysis on a subgroup of children with wheeze in the past 12 months but no

Table 1. Study characteristics ($N = 1321$)

Male sex (%)	50.4
Age (years), mean (range)	11.4 (10.1–12.5)
Father's ≥ 5.5 years postprimary education (%)	42.9
Mother or father with a family history of allergic disease (%)	63.3
Mean number of children in family	3.4 (1–18)
Birth weight <2500 g (%)	5.1
Current smoking in home (%)	27.7
Ethnicity (%)	
Maori	30.7
European	62.2
Pacific Island	4.8
Other	1.6
Missing	0.8
Outcome measures (%)	
Wheeze ever	43.8
Wheeze last 12 months	21.9
Asthma ever	35.4
Atopy	34.6
BHR to exercise	8.4
Body mass index (%)	
Obese	7.9
Overweight	20.4
Normal weight	66.4
Underweight	2.7
Missing	2.6

BHR, bronchial hyperresponsiveness.

Table 2. Prevalence (%) of frequency of consumption of food groups and frequency of exercise ($N = 1321$)

	Never	Less than once a week	1+ times a week	Missing	
Hamburger	26.4	56.1	16.6	0.9	
Takeaway	16.4	50.5	32.3	0.8	
Fizzy drink	20.7	33.9	44.7	0.8	
Fish	17.0	35.7	46.6	0.8	
Fruit juice	17.0	18.9	63.4	0.8	
	≤ twice a week	3–6 times a week	≥ once a day	Missing	
Raw or cooked vegetables	14.7	43.8	40.7	0.8	
Meat	12.3	56.7	30.2	0.8	
Fresh fruit	9.5	22.6	67.2	0.8	
	Once a week or less	2–3 times a week	4–6 times a week	Every day	Missing
Exercise frequency	9.2	16.1	16.4	57.9	0.5

Table 3. Univariate odds ratios (95% confidence intervals) showing associations for fast food consumption with outcome variables ($N = 1321$)

	Wheeze ever	Wheeze last 12 months	Asthma ever	Atopy	BHR to exercise
Hamburger					
Never	1.00	1.00	1.00	1.00	1.00
Less than once a week	1.37 (1.06–1.78)*	1.17 (0.85–1.62)	1.19 (0.91–1.56)	1.22 (0.93–1.61)	1.53 (0.92–2.55)
1+ times a week	1.98 (1.41–2.79)**	1.73 (1.16–2.57)**	1.75 (1.23–2.48)**	1.32 (0.92–1.90)	1.51 (0.79–2.89)
Takeaways					
Never	1.00	1.00	1.00	1.00	1.00
Less than once a week	1.13 (0.83–1.55)	1.31 (0.88–1.94)	0.98 (0.71–1.35)	1.23 (0.88–1.71)	1.53 (0.81–2.92)
1+ times a week	1.58 (1.13–2.20)**	1.50 (0.99–2.27)	1.43 (1.01–2.01)*	1.31 (0.92–1.87)	1.76 (0.90–3.43)
Fizzy drinks					
Never	1.00	1.00	1.00	1.00	1.00
Less than once a week	1.16 (0.85–1.58)	1.21 (0.82–1.78)	1.21 (0.87–1.67)	0.92 (0.67–1.27)	1.43 (0.83–2.47)
1+ times a week	1.56 (1.17–2.10)**	1.54 (1.07–2.22)*	1.51 (1.11–2.05)**	0.96 (0.71–1.30)	0.93 (0.53–1.62)

* $P < 0.05$, ** $P < 0.01$.

BHR, bronchial hyperresponsiveness.

Table 4. Multivariate odds ratios (95% confidence intervals)† showing associations for food consumption with outcome variables ($N = 1234$)

	Wheeze ever	Wheeze last 12 months	Asthma ever	Atopy	BHR to exercise
Hamburger					
Never	1.00	1.00	1.00	1.00	1.00
Less than once a week	1.44 (1.06–1.96)*	1.17 (0.80–1.70)	1.25 (0.90–1.72)	1.23 (0.90–1.70)	1.25 (0.70–2.26)
1+ times a week	1.65 (1.07–2.52)*	1.81 (1.10–2.98)*	1.27 (0.82–1.98)	1.04 (0.66–1.61)	1.13 (0.52–2.46)
Takeaways					
Never	1.00	1.00	1.00	1.00	1.00
Less than once a week	0.96 (0.66–1.40)	1.06 (0.67–1.70)	0.80 (0.54–1.19)	1.13 (0.76–1.68)	1.80 (0.79–4.06)
1+ times a week	1.18 (0.77–1.81)	1.08 (0.63–1.83)	1.09 (0.70–1.69)	1.19 (0.76–1.87)	2.41 (0.99–5.91)
Fizzy drinks					
Never	1.00	1.00	1.00	1.00	1.00
Less than once a week	1.01 (0.71–1.44)	1.01 (0.65–1.56)	1.16 (0.79–1.68)	0.75 (0.52–1.08)	1.11 (0.60–2.06)
1+ times a week	1.30 (0.91–1.85)	1.27 (0.83–1.96)	1.32 (0.91–1.93)	0.74 (0.52–1.07)	0.58 (0.30–1.10)

* $P < 0.05$.

†Adjusted for body mass index (obese or overweight or underweight or normal), mother or father with history of allergic disease (asthma, eczema or hay fever), family size (as a continuous variable), birth weight (< or ≥2500 g), current smoking in the home, father's years of postprimary education (< or ≥5.5 years), frequency of hamburger, takeaway, fizzy drink, fish, fruit juice consumption (1+ times a week or less than once a week or never), frequency of raw or cooked vegetable, fruit, meat consumption (≤ twice a week or three to six times a week or ≥ once a day), the interaction of gender with hamburgers and takeaways, exercise (≤ once a week or two to three times a week or four to six times a week or everyday), gender, ethnicity (Maori/Polynesian or European/other) and year born (1988 or 1989).

BHR, bronchial hyperresponsiveness.

previous symptoms showed similar associations to those with earlier symptoms. When compared with those who never consumed hamburgers, the ORs were 1.28 (95% CI: 0.87–1.90) for less than once a week consumption and 1.95 (95% CI: 1.15–3.30) for more frequent consumption. For takeaway consumption, ORs were 1.05 (95% CI: 0.65–1.71) when consumed less than once a week and 1.18 (95% CI: 0.68–2.05) when consumed more frequently. Fizzy drink consumption showed ORs of 1.02 (95% CI: 0.65–1.60) for less than once a week consumption and 1.37 (95% CI: 0.87–2.14) for more frequent consumption.

We tested the gender interaction for hamburgers and takeaways with each outcome among the total study population. The only significantly different association was between hamburger consumption and having a history of asthma symptoms ($P = 0.006$) where boys only showed an increased risk: less than once a week consumption: OR = 2.00 (95% CI: 1.30–3.07; 1+ times a week: OR = 3.19 (95% CI: 1.76–5.78). Corresponding ORs for girls were: less than once a week consumption – OR = 1.04 (95% CI: 0.67–1.60; 1+ times a week – OR = 0.85 (95% CI: 0.47–1.54).

Hamburger consumption more than once a week was associated with an increased risk of being overweight (OR = 1.62, 95% CI: 1.07–2.45) and obese (OR = 2.41, 95% CI: 1.37–4.23) with little difference in these associations between girls and boys. The association of takeaways with being overweight and obese was weaker and nonsignificant.

Discussion

This study has shown that after controlling for potential confounders the frequent consumption of hamburgers showed a dose-dependent association with asthma symptoms and frequent takeaway consumption showed a similar association with BHR. These associations were independent of BMI, suggesting that our findings of increased symptoms in association with fast foods were not due to obesity-related factors. We did not adjust the criteria for significance for multiple comparisons. Given the number of comparisons performed the results may have been due to chance more often than the P -value suggests.

One explanation is that the frequent consumption of hamburgers, takeaways and fizzy drinks may all be markers for socio-economic or lifestyle factors, some of which (passive smoking, father's education level) we were able to control for but there are likely to be other lifestyle factors associated with poor diet that are unmeasured. Furthermore, in the measurement of socio-economic status, based solely on father's education level, there is likely to be residual confounding.

A further shortcoming of the study is its cross-sectional design which makes it difficult to establish causal links because the outcomes (wheeze or asthma)

may have occurred before the dietary exposure. However, the effect of hamburger and takeaway consumption was similar for the subgroup of children who reported wheeze in the last 12 months but not previously as for those with earlier symptoms.

It is not surprising that, compared with normal weight children, overweight and obese children in the present study were much more likely to eat hamburgers at least weekly. However, adjusting for BMI did not alter the dose-response effect of frequent hamburger consumption on asthma symptoms, or takeaway consumption on BHR. Previously we showed that obesity was a risk for asthma symptoms independent of hamburger and takeaway consumption (8). Thus, the associations for obesity and diet are independent of each other, and some other mechanism must be explored for the increased risk associated with hamburgers and takeaways. The effect of frequent takeaway consumption on BHR, but not on atopy, suggests that this effect on the airway is direct, rather than immunoglobulin E (IgE)-mediated.

Our findings are consistent with an ecological analysis that showed a significant relationship between McDonaldsTM restaurants and the prevalence of current wheeze (12). Fast food was also a risk factor for wheezy illness among children in Saudi Arabia in the unadjusted analysis only (13) whereas deep fried food consumption (including fast foods) doubled the risk of asthma among teenagers in Taiwan after adjustment for confounding (14). As with our study, the cross-sectional nature of these studies makes these findings difficult to explain, with chance or uncontrolled confounding being possible explanations. The generalizability of these findings to western countries is also problematic given the very different diets. Nevertheless fast foods have a high fat (15) and salt content, the latter a possible risk factor for wheezy illness (16, 17). For example, at the time of this study, in one McDonalds' hamburger the level of sodium is higher (579 mg; data provided by McDonalds', New Zealand) than the United States recommended daily allowance for children (400 mg) (18). The high salt content in hamburgers may increase the risk of wheezy illness with previous studies showing an effect of table salt sales (19) and consumption (16, 17) on asthma mortality (19) and respiratory symptoms or asthma (16, 17). Experimental studies (20, 21) have also shown that low salt diets improve and high salt diets worsen postexercise pulmonary function in exercise-induced asthmatics. It is interesting to note that some of these findings are restricted to males (16, 19) suggesting that it is the salt content of hamburgers that may explain our findings for hamburger consumption with a history of wheeze in boys. However it is puzzling that, after multivariate analysis, hamburger consumption was a better predictor of wheeze or asthma than takeaways, but takeaway consumption better predicted BHR. This distinction is hard to explain in terms of the salt hypothesis as both food groups are high in salt.

We did not find any associations for the other food groups (meat, fish, raw or cooked vegetables, fresh fruit or juice consumption) most likely consumed at home. Thus, this study does not support a role for foods high in antioxidants, despite other studies showing that children with high serum vitamin C had less asthma (1), and children consuming fresh fruit five to seven times a week, compared with less than once a week, had less wheeze (22). Our study was conducted in a fruit-growing area, where fruit is readily and cheaply available. This is reflected in the high amounts of fresh fruit consumed by our study population (see Table 2). Thus, we may not have had the variability in the population to assess the effects of low fruit consumption on asthma.

The fish consumption data from this New Zealand study do not confirm findings among Australian

children where the consumption of oily fish (23), high in ω -3 polyunsaturated fatty acids, was associated with a significantly reduced risk of asthma. This lack of an association may be because our question was non-specific for oily fish and for ω -3 polyunsaturated fatty acids. However, the evidence is equivocal with a Cochrane Review of randomized-controlled trials concluding that there is little evidence to recommend that asthmatics supplement their dietary intake with ω -3 fatty acids (4).

Dietary data in this study were collected using food frequency questions. Future research into the effects of diet on allergic disease should focus on those foods where consumption has increased in recent years and include in-depth analysis of food intake based on daily diaries.

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