

Effect of dietary sodium on the severity of bronchial asthma

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Abstract

Background A high sodium intake has been found to increase bronchial reactivity in men with asthma. The effects of change in sodium intake on peak flow rate have not been determined.

Methods The effect of changing dietary salt intake for two weeks on the severity of asthma as measured by peak expiratory flow (PEF) was studied in 17 patients with mild asthma in an open randomised crossover trial. PEF measurements were made by the patients in their own homes. Patients were placed on three levels of dietary sodium intake: normal, low, and high. Sodium intake was assessed by 24 hour urine collection.

Results The mean (SD) urine sodium was 147 (45), 84 (32), and 201 (73) mmol/24 hours in the normal, low, and high sodium intake periods respectively. There were no significant differences in PEF or PEF amplitude (highest-lowest PEF), an index of asthma lability, between the three dietary salt periods.

Conclusion A low and high dietary salt intake for two weeks has no effect on peak expiratory flow in patients with mild asthma.

asthma as measured by peak expiratory flow (PEF) and the diurnal variation in PEF as measured by PEF amplitude (the difference between the highest and lowest value each day).

Patients and methods

Seventeen patients with mild asthma (nine men and eight women) who attend the pulmonary outpatient clinic at the Soroka Medical Center regularly participated in the study. Their mean age was 43 (range 27-62) years. All patients were normotensive and non-smokers, had a history of intermittent wheezing and a greater than 15% change in FEV₁ either spontaneously or after inhalation of a β_2 agonist. All patients inhaled a β_2 agonist as needed. Five of the patients used inhaled corticosteroids (beclomethasone dipropionate 400 μ g/day). None had used oral corticosteroids in the three months before the study. Ten patients were taking a sustained release theophylline preparation (300 mg twice daily). The study was approved by the local human experimentation committee and written consent was obtained from all patients. To minimise bias, patients were told that the response of an individual to a change in dietary salt intake was unpredictable.

DIETS

Three regimens of dietary salt were tested, each for two weeks: normal diet—the patients were asked to continue their regular diet without any deliberate change in salt intake; low salt diet—the participants were put on a standard low salt diet used for hypertensive patients; high salt diet—the patients were asked to add as much salt as possible to their regular diet and to take four tablets of sodium chloride (500 mg) daily.

PEAK FLOW MEASUREMENT

Peak expiratory flow was measured at home with a mini peak flow meter (mini Wright). After instruction and training, patients were told to measure PEF three times daily throughout the study. The measurements were performed immediately after getting up in the morning, at noon, and before retiring at night, and the highest of three measurements was recorded. All measurements were performed before the use of a β_2 agonist. The mean values were calculated for each of the three daily measurements (morning, noon and night), for the whole day and for each 14 day period. The maximum difference between the

A low prevalence of asthma is found in some of the world's poorest areas, and low dietary salt intake has been implicated.¹⁻³ A correlation between regional mortality from asthma and purchase of table salt per person has been reported in England and Wales.⁴ These two epidemiological observations triggered a search for the possible association between salt intake and bronchial reactivity. Burney *et al*⁵ reported that bronchial reactivity, as determined by a histamine challenge test, correlated strongly with 24 hour urinary sodium excretion in a community population after allowing for smoking and atopy. Javid *et al*⁶ found an increase in bronchial reactivity with increasing salt intake in asthmatic patients of both sexes but not in healthy subjects. In a recent controlled study, Burney *et al*⁷ found an increase in bronchial reactivity in association with a high salt intake in asthmatic men but not women. The correlation between bronchial reactivity measured by a bronchial challenge test and clinical severity of asthma is variable.⁸⁻¹⁰ We have tested the hypothesis that the amount of daily salt intake influences the severity and lability of clinical

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Table 1 Mean (SD) peak expiratory flow (PEF) in litres/min during the three dietary periods

	Normal diet	Low salt diet	High salt diet
Morning	370 (137)	372 (139)	368 (129)
Noon	411 (137)	410 (140)	408 (138)
Night	388 (136)	399 (137)	389 (134)
Daily mean	389 (136)	393 (138)	388 (133)
% of predicted	71 (19)	72 (19)	71 (19)
PEF amplitude	47 (24)	44 (30)	49 (30)
Inhaled β_2 agonist (puffs)	3.1 (1.9)	3.2 (2)	3.6 (2.3)

All differences were non-significant.

Table 2 Confidence limits of differences

	Difference	SD	95% Confidence limits
Peak flow			
ND v LSD	3.88	19.05	(-34.22, +41.98)
LSD v HSD	-4.18	25.72	(-55.62, +47.26)
HSD v ND	-0.29	21.63	(-43.55, +42.97)
β_2 Agonist usage			
ND v LSD	-0.15	1.04	(-2.23, + 1.93)
LSD v HSD	-0.33	1.39	(-3.11, + 2.45)
HSD v ND	-0.5	2.05	(-4.6, + 3.6)

ND—normal diet; LSD—low salt diet; HSD—high salt diet.

highest and lowest measurement of PEF each day (PEF amplitude) was used as an index of diurnal variation and asthma lability.

URINE COLLECTION

All participants were given verbal and written instruction on how to perform a 24 hour urine collection. The urine was collected on one of the last three days of each study period and brought to the chemical laboratory the following morning, where the volume was recorded and the sodium, potassium and creatinine concentration determined. Creatinine was measured by a modified Jaffe rate reaction. Sodium and potassium were measured by ion specific electrodes.

STUDY PROTOCOL

This was a randomised crossover open trial over six consecutive weeks. It was divided into three diet periods, each of two weeks, with no washout periods between the diet periods. Patients were assessed on entry into the study and at the end of each diet period. All participants started the study with the normal diet period, after which they were assigned at random to the low or high salt diet for the next two weeks. Thereafter they changed to the alternative diet for another two weeks. The remaining sodium chloride tablets were counted at the end of the high salt diet period as a measure of compliance. All participants had stable asthma during the month before the start of the study. The patients

were instructed not to change their usual medication during the study; β_2 agonist inhalers were used as needed and the number of puffs documented.

ANALYSIS

The measurements obtained from the three different diet periods were subjected to analysis of variance. Those which showed a significant difference were further tested by the paired *t* test. A *p* value of < 0.05 was regarded as significant. The 95% confidence intervals of the differences between mean values were calculated. The power of the study (17 subjects) to detect a 15% change in mean daily PEF was 24% based on a 5% statistical significance.

Results

No significant differences were found between the mean PEF values in the three periods (tables 1 and 2). No significant change was found when men and women were analysed separately. PEF amplitude did not differ between the three diet periods. The mean amplitude was about 12% of mean PEF (table 1).

The numbers of β_2 agonist inhalations were similar over the three diet periods (table 2).

Sodium excretion fell significantly from a mean (SD) of 147 (45) mmol/24 hours during the normal diet to 84 (32) mmol/24 hours on the low salt diet ($p < 0.001$) and increased significantly to 201 (73) mmol/24 hours on the high salt diet ($p < 0.001$) (table 3). Potassium and creatinine excretion did not differ between the three diet periods. More than 85% of the tablets were used by the patients during the high salt diet period.

Discussion

In our study salt intake did not affect the severity of asthma in a small group of patients with stable asthma as measured by self monitoring of PEF. Our study was not blind as it is difficult to consume a high salt diet without the subject's awareness of the change. We tried to minimise directional expectations by explaining to the patients that the response to a low or high salt diet is individual and unpredictable. The measurements of sodium excretion indicate good compliance with the different diet protocols. The changes in salt excretion in our group are higher than those described by Burney *et al.*⁷ The trigger to our study was the observation that a high salt diet caused an increase in bronchial reactivity as measured by histamine challenge in men but not in women.^{6,7} In our study disease activity was measured on the basis of home PEF and not bronchial reactivity. Although there is some correlation between measures of reactivity and clinical disease severity,^{8,9} the two indices are not identical; a recent study reported poor correlation between these two indices.¹⁰ Diurnal variation of PEF can be used as an index of disease activity and bronchial lability.^{9,11} Self monitoring of disease

Table 3 Mean (SD) concentrations of sodium, potassium and creatinine in 24 hour urine collections obtained in the three diet periods

	Normal	Low salt	High salt
Sodium (mmol/24 hours)	147 (45)	84 (32)*	201 (73)*
Potassium (mmol/24 hours)	69 (20)	75 (23)	69 (20)
Creatinine (mg/24 hours)	1371 (496)	1411 (523)	1384 (474)

* $p < 0.001$.

activity with PEF has been shown to be a valuable and reliable tool.¹² Our patients had mild asthma and were in a stable condition. This was confirmed by the relatively high PEF and the relatively low PEF amplitude, which represents the diurnal variation (about 12% of the mean).

Our study does not permit conclusions about the response of asthmatic patients with active disease or with more severe asthma. Possibly patients with more severe disease will have a greater sensitivity to the amount of salt intake. Increasing the power of the study by testing a larger group of patients might have detected small but significant changes in patients with mild asthma. However, the even distribution of the 95% confidence intervals of the differences in PEF and β_2 agonist usage around zero suggests that the likelihood of finding a difference between the three diets is very small.

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