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Vegetable consumption and acute appendicitis in 59 areas in England and Wales

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Abstract

Rates of acute appendicitis in 59 areas of England and Wales were correlated with consumption of different foods per caput, measured from household food purchases. There was a statistically significant positive correlation with potato consumption and a negative correlation with non-potato vegetables. This negative correlation depended mainly on green vegetables and tomatoes. There was no consistently significant correlation with any other main food group. In particular the correlations with cereal foods, cereal fibre, and total dietary fibre were small and not significant.

Green vegetables and tomatoes may protect against appendicitis, possibly through an effect on the bacterial flora of the appendix.

Introduction

Lack of dietary fibre (from cereals, vegetables, or fruit) is suspected to be a cause of acute appendicitis.^{1,2} Other suggested causes include excess intakes of sugar and meat.³ Supportive evidence, however, comes largely from international comparisons and is inconclusive.

Within England and Wales there are geographical variations in hospital admission rates for acute appendicitis.⁴ We have correlated the rates in 59 areas with per caput consumption of different foods, measured from household food purchases.

Method

The National Food Survey provided data on household food purchases during 1979-81. Each year this survey records food purchases within a sample of parliamentary constituencies.⁵ In around 150 households within

each constituency the person principally responsible for domestic management records every item of food brought into the home over seven days. Recording periods in a constituency are spread throughout the year. The survey excludes sweets, alcoholic and soft drinks, and meals bought and eaten outside the home. The results are expressed as average consumption per person in the households surveyed.

Hospital Activity Analysis data on admissions for appendicitis during 1978-82 were obtained for each health region in England and Wales other than the four Thames regions, which comprise London and the Home Counties. In the data, a patient's residence was coded by county district. Hence these and National Food Survey data could be matched only when district and constituency boundaries were similar. Ninety constituencies in England and Wales outside London and the Home Counties were surveyed in the National Food Survey during 1979-81. Sixty eight could be matched with county districts. The boundaries of 21 corresponded exactly with those of 20 districts. In 24 the constituency comprised more than 70% by population of one district. Twenty three constituencies fell within the boundaries of 15 cities and made up 40% of their total populations. The resulting number of "matched areas" was 59.

Appendicitis rates for the matched areas were calculated from the numbers of patients resident in the areas who had (a) been discharged from hospital with the diagnosis of appendicitis (ICD (8th revision) codes 540, 541), (b) been admitted as emergencies, and (c) undergone appendicectomy (Office of Population Censuses and Surveys numbers 441, 444). Use of these criteria was intended to exclude patients with non-acute appendicitis. Rates were standardised for age and sex using the mean population of England and Wales during 1978-82 as standard.

Results

During the five years 49 690 patients resident in the 59 matched areas were discharged from hospital after acute appendicitis. The numbers of patients with appendicitis in an area ranged from 166 to 5002, with an average of 840. Standardised average yearly discharge rates per 10 000 population ranged from 6.6 in Portsmouth to 20.6 in Anglesey.

Table I shows the average daily consumption of the main food groups per person in the 59 areas together with the ranges and standard deviations. For each food group we calculated the product moment correlation coefficient between average intake in each area and appendicitis rates, using the logarithmic values of the rates because their distribution was skewed. Table I also shows correlation coefficients for the 20 areas in England and Wales in which constituency and county district boundaries corresponded exactly.

The correlation between appendicitis rates and the total weight of vegetables consumed per person was small and not statistically significant.

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There was, however, a significant positive correlation ($r=0.31$; $p=0.02$) with potatoes, which made up about half of the total weight, and a significant negative correlation ($r=-0.41$; $p=0.002$) with all other vegetables combined (figure). Both correlation coefficients were also significant in the 20 exactly matched areas. Table II shows that the negative correlation with non-potato vegetables depended mainly on correlations with fresh and frozen green vegetables ($r=-0.33$; $p=0.01$) and fresh and processed tomatoes ($r=-0.40$; $p=0.002$). The correlation with green vegetables was also significant in the exactly matched areas ($r=-0.52$; $p=0.03$). Ninety five per cent of green vegetables consumed were cabbages, cauliflowers, peas, beans, Brussels sprouts, and leafy salad vegetables. All except leafy salads correlated negatively with appendicitis.

Correlations with the other main groups of vegetables—that is, root

Table III shows the consumption of dietary fibre derived from vegetable and cereal foods. There were statistically significant correlations of 0.31 and -0.34 for vegetable fibre from potatoes and other vegetables. The contrasting trends of potatoes and other vegetables, however, resulted in a small and non-significant correlation with total vegetable fibre. Estimates of the fibre content of cereal foods differ with the method used. Using the method of Southgate *et al.*,⁶ we found no significant correlation with fibre from bread or from other cereal foods and hence no correlation with total cereal fibre. Among the other cereal food groups listed in the National Food Survey, which include breakfast cereals, only consumption of buns, scones, and teacakes showed a significant correlation ($r=0.32$; $p=0.02$). The correlation with total dietary fibre was small and not significant.

Among the 95 individual foods included in the survey 17 showed

TABLE I—Correlation between food consumption and hospital discharge rates for acute appendicitis in 59 areas in England and Wales

Food group	Consumption (g/person/day)			Correlation coefficients	
	Mean	Range	SD	59 Areas	20 Exactly matched areas†
All vegetables (fresh, frozen, tinned)	343	264-437	35.4		
Vegetables other than potatoes	164	125-209	17.8	-0.41**	-0.51*
Potatoes	179	95-290	36.5	0.31*	0.54*
Fruit (fresh, frozen, tinned)	95.1	67-125	16.4	-0.27*	-0.22
Bread:					
White	91.4	59-126	16.1	0.21	0.36
Brown/wholemeal	21.6	11.8-34.6	4.9	-0.12	0.11
Meat	157	129-184	14.6	-0.06	-0.24
Fish	19.4	13.3-27.9	3.4	-0.13	-0.00
Sugar	46.1	35.1-59.0	5.5	0.30*	0.23

The significant levels of the product moment correlation coefficient (r) for 59 pairs of observations were: >0.26 , $p<0.05$; >0.33 , $p<0.01$; >0.43 , $p<0.001$; and for 20 pairs of observations >0.44 , $p<0.05$; >0.56 , $p<0.01$; >0.68 , $p<0.001$.

* $p<0.05$. ** $p<0.01$.

†See text.

TABLE II—Correlation between vegetable consumption and hospital discharge rates for acute appendicitis in 59 areas in England and Wales

Food group	Consumption (g/person/day)			Correlation coefficients	
	Mean	Range	SD	59 Areas	20 Exactly matched areas†
Green vegetables (fresh and frozen)	58.6	26.4-87.8	14.8	-0.33*	-0.52*
Cabbage	16.6	9.6-23.6	3.8	-0.34**	-0.36
Cauliflower	10.4	4.4-18.9	3.6	-0.17	-0.41
Peas	9.2	2.0-15.5	3.4	-0.27*	-0.35
Beans	8.4	0.8-17.6	3.9	-0.20	-0.32
Brussels sprouts	7.6	2.8-13.8	2.2	-0.48***	-0.58**
Leafy salads	5.5	2.8-10.0	1.5	0.02	-0.17
Tomatoes (fresh and processed)	21.3	15.3-30.3	3.2	-0.40**	-0.43
Root vegetables	23.0	12.7-38.2	4.9	-0.13	-0.09
Onions/leeks	13.1	8.6-19.3	2.7	-0.14	-0.07
Baked beans	16.9	8.6-24.1	2.9	0.03	0.03
Other (including tinned)	31.6	20.1-42.7	5.3	-0.05	-0.26

* $p<0.05$. ** $p<0.01$. *** $p<0.001$.

†See text.

vegetables, baked beans, onions, and leeks—were small and not statistically significant. The negative correlation with fruit consumption was significant in the 59 areas ($r=-0.27$; $p=0.04$) but not in the 20 exactly matched areas. Among individual fruits only bananas ($r=-0.32$; $p=0.02$) and stone fruit ($r=-0.27$; $p=0.04$) showed significant correlations in the 59 areas.

There was an inverse relation between consumption of potatoes and that of non-potato vegetables ($r=-0.30$). Multiple regression analysis showed that potato consumption was not significantly associated with appendicitis independently of non-potato vegetables.

Appendicitis rates did not correlate significantly with consumption of bread, either white, brown, or wholemeal (table I). Nor was there a significant correlation with meat and fish. In table I meat includes all meat products. There were no statistically significant correlations with any commonly used group of fresh, frozen, or cooked meats, nor with fresh or frozen fish taken separately.

The correlation with sugar ($r=0.30$; $p=0.02$) was statistically significant in the 59 areas but not when the 20 exactly matched areas were considered alone (table I). In the National Food Survey sugar is packet sugar and does not include sugar already incorporated in bought foods. The correlation between appendicitis rates and sugar from all sources listed in the National Food Survey was not significant ($r=-0.03$; $p=0.8$).

Consumption of vegetables other than potatoes and hospital discharge rates for acute appendicitis in 59 areas in England and Wales.

statistically significant correlations with discharge rates. Of these, eight were vegetables and two were the fruits mentioned above. Among the others the highest correlation coefficient was -0.35 ; and none was significant in the 20 exactly matched areas.

Discussion

We have examined the dietary correlates of acute appendicitis by comparing hospital discharge rates after emergency appendectomy with household food purchases in 59 areas within England and Wales. A proportion of removed appendices are histologically normal, and in some of these cases the diagnosis of appendicitis still appears on hospital records. Hospital discharge rates therefore

socioeconomic influences associated with latitude. The negative correlation with non-potato vegetables, however, was seen both among the 17 areas within the three northern and western regions of England and Wales ($r = -0.48$) and the 16 areas within the three southern and eastern regions ($r = -0.34$). When the correlation for the 59 areas was recalculated to allow for the non-independence of appendicitis rates in nearby areas it remained significant ($r = -0.39$).⁷

If the association with non-potato vegetables is causal and they protect against appendicitis this effect seems largely confined to green vegetables and possibly tomatoes. It is shown by all the commonly used types of green vegetables (table II). Root and other vegetables do not share the effect, though their consumption varies similarly across the country.

TABLE III—Correlation between consumption of dietary fibre and hospital discharge rates for acute appendicitis in 59 areas in England and Wales

Food group	Consumption (g/person/day)			Correlation coefficients	
	Mean	Range	SD	59 Areas	20 Exactly matched areas†
All vegetables	8.8	6.7-10.8	0.8	-0.03	0.13
Vegetables other than potatoes	5.5	4.3-7.0	0.6	-0.34**	-0.37
Potatoes	3.3	1.4-4.5	0.6	0.31*	0.52*
Cereals‡	8.3	7.3-10.7	0.6	0.07	0.26
Bread	4.2	3.6-5.1	0.4	0.04	0.38
Other cereal foods	4.1	3.3-6.9	0.5	0.05	0.11
Total	19.2	16.9-22.3	1.3	-0.02	0.28

* $p < 0.05$. ** $p < 0.01$.

†See text.

‡Calculated according to Paul and Southgate.¹⁴

overestimate the incidence of acute appendicitis, and variations among areas may reflect different recording practices and surgical policies as well as true variations in incidence. In a recent survey, however, the rates in nine British towns were corrected for normal, removed appendices by detailed examination of all clinical and pathological records.⁴ The ranking of towns by corrected rates was similar to that by uncorrected ones.

Average food consumption per person was calculated from household purchases by dividing the total weight of each food bought by the number of people in the households. Most patients with appendicitis are children and young adults, however, whose consumption will usually differ from the average for all household members. We have recorded the diets of random samples of 200 children aged 13-15 in two towns in the north and south of England, Wakefield and Plymouth. Their average consumption of the main food groups per person as a percentage of the National Food Survey figure was similar in the towns (unpublished data).

Appendicitis rates correlated positively with consumption of potatoes and negatively with consumption of non-potato vegetables (table I). The negative correlation depended mainly on green vegetables and tomatoes (table II). The correlations with potatoes and non-potato vegetables were statistically significant both in the 59 areas and in the 20 areas matched exactly. In these latter areas the sampling frame for recording food purchases was the entire population for whom appendicitis rates were calculated rather than a part of it. Despite the limitations of the dietary data we conclude that the associations between vegetable consumption and appendicitis were real and not the result of bias.

Other than vegetables the only statistically significant correlations with a main food group were with fruit and sugar (table I). Consumption of both foods varies considerably across the country. Neither correlation was significant in the 20 exactly matched areas. The correlation with sugar was significant only for packet sugar. We conclude that our findings provide only weak evidence for an association between fruit or sugar and appendicitis.

Rates of appendicitis are generally higher in the north and west of Britain and geographical correlations with diet may be secondary to

Green vegetables may protect against appendicitis through mechanisms associated with fibre. No similar effect, however, was shown by fibre from other non-potato vegetables, or from potatoes, or by cereal fibre from the main cereal foods. Since the variation in cereal fibre intake was less than in vegetable fibre the findings are limited evidence against an association with appendicitis. Nevertheless, such an association might be expected to show in negative correlations with consumption of bread, which varies widely. Vegetable and cereal fibre differ in chemical composition.⁶ The findings may suggest that they have different effects on disease mechanisms.

The lack of a geographical correlation between appendicitis and total vegetable or cereal fibre intake in Britain is in keeping with the lack of correlation between time trends in appendicitis and fibre consumption during this century.⁸ Furthermore, case-control studies in Britain have shown no differences in intake of vegetable or cereal fibre between patients with appendicitis and controls.^{9,10} We have extended one of these studies⁹ to a dietary comparison between 53 children who had had appendicitis and 97 controls, using a seven day weighed food record. The patients had a lower intake of all the main nutrients and had lower mean heights and weights (unpublished). In Seattle a case-control study of children found no difference in total fibre intake but a rise in relative risk with decreasing intake of certain foods containing fibre.¹¹ Without information on other nutrients and body size this finding cannot be interpreted. In Sweden the mean fibre intake of 31 adult patients was lower than that of controls after allowance for their lower energy intake.¹² In Hong Kong, however, no case-control differences in fibre intake were found (Donnan and Ho, unpublished data).

At present the evidence for an association between appendicitis and dietary fibre rests on international comparisons, which show that fibre consumption is high in certain countries where appendicitis is uncommon. Geographical correlation studies carried out in one country, rather than internationally, have the potential advantage that the populations being compared are likely to be more similar in respect of confounding variables.

As an alternative to the fibre hypothesis it has been suggested that

the initiating event in acute appendicitis is an infection leading to lymphoid hyperplasia in the appendicular wall and consequent obstruction of the proximal lumen.⁸ Under this hypothesis the epidemic of appendicitis in Britain was a consequence of altered immunity in children, consequent on improved sanitation and hygiene. It is generally agreed that the ultimate event in pathogenesis is invasion of the distal appendicular wall by organisms habitually among the appendicular flora. Diet may influence this by changing the flora. After ingestion of green vegetables an undigested residue reaches the caecum, which may alter the transit time and the substrate of the bacterial flora. Cooked potatoes are digested completely, however, and do not influence the substrate of the caecal flora.¹³ Multiple regression analysis supports the conclusion that the positive correlation with potatoes reflects the inverse relation between their consumption and that of other vegetables which protect against appendicitis.

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First trimester prenatal diagnosis of congenital rubella: a laboratory investigation

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Abstract

Acute primary maternal infection with rubella virus during pregnancy often, but not invariably, leads to the congenital rubella syndrome. Diagnosis by detection of virus specific IgM in the mother is not always possible, and in those cases in which IgM is detected the fetus has not necessarily also been infected. A method for direct, prenatal detection of fetal infection would allow more accurate early diagnosis of congenital rubella syndrome.

In this study a case of suspected preconception rubella infection that was not referred until 14 weeks after the appearance of a rash was studied to determine whether a retrospective serological diagnosis of primary rubella could be made, and whether direct evidence of fetal infection could be obtained from a chorionic villus biopsy specimen by detecting virus specific antigens or ribonucleic acid (RNA) sequences. Monoclonal antibodies and a cloned complementary deoxyribonucleic acid probe were used successfully to detect antigens to rubella virus antigens and RNA sequences in the chorionic villus biopsy specimen, which was taken at 15 weeks' gestation.

This method should serve as a new approach to the diagnosis of congenital rubella syndrome in utero.

Introduction

Primary acute rubella infection in pregnancy often, but not invariably, results in congenital rubella syndrome in the fetus.^{1,2} The diagnosis usually relies on the detection of virus specific IgM in the mother. Serum fractionation followed by haemagglutination inhibition testing usually detects virus specific IgM only up to six weeks after the onset of the rash, though some laboratories report occasional persistence of IgM up to 25 weeks.^{3,4} Consequently, more sensitive immunoassays have been developed for rubella IgM detection,^{5,6} but this has generated two distinct problems. Firstly, the more frequent detection of rubella IgM has inevitably led to an increase in the number of therapeutic abortions being carried out and, therefore, an increase in fetal wastage. Secondly, the low levels of IgM that can now be detected are not necessarily indicative of recent infection and may be present in serum samples obtained from subjects during reinfection as well as months after the acute phase of a primary infection,^{7,8} when the risk to the fetus is minimal.¹

These observations clearly show that diagnosis of congenital rubella by detecting maternal virus specific IgM is not entirely satisfactory and that a method for direct fetal diagnosis is desirable. Such a method should be capable of detecting fetal infection as early in pregnancy as possible for maximum benefit to the patient. Rubella specific IgM can sometimes be shown in fetal blood after maternal rubella infection.^{9,10} This is indicative of fetal infection as maternal IgM does not normally cross the placenta,¹¹ but the usefulness of the method is limited by the late (at 19-22 weeks' gestation) and unreliable development of detectable levels of fetal IgM.¹⁰ Isolation of virus from amniotic fluid¹²⁻¹⁵ is similarly limited as amniocentesis cannot be carried out until at least 16 weeks' gestation, and to this must be added the time required to confirm isolation, which, even if successful, may be several weeks.

We describe the laboratory investigation of a case of suspected preconception rubella infection that was not referred until 14 weeks after the rash had appeared. Our objectives were to determine whether a retrospective serological diagnosis of primary rubella could be made and whether direct evidence of fetal infection could be obtained from a chorionic villus biopsy specimen by detection of

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