

Effects of stressful life events on bowel symptoms: subjects with irritable bowel syndrome compared with subjects without bowel dysfunction

W E Whitehead, M D Crowell, J C Robinson, B R Heller, M M Schuster

Abstract

A standardised inventory of stressful life events and a bowel symptom questionnaire were administered at three month intervals for one year to 383 women who were unselected with respect to bowel symptoms. A NEO Personality Inventory was given initially to assess neuroticism. Subjects who satisfied restrictive diagnostic criteria for irritable bowel syndrome were compared with those who complained of abdominal pain plus altered bowel habits but who did not meet restrictive diagnostic criteria (functional bowel disorder) and with controls without bowel dysfunction. The irritable bowel group showed significantly higher levels of stress than the other two groups even when the confounding effects of neuroticism were statistically controlled for. Time lagged correlations showed that stress in one three month interval was significantly correlated with bowel symptoms in the subsequent three month interval for all groups. The slope of the regression line relating stress to bowel symptoms was significantly steeper for the irritable bowel group than for the other two groups at three and six months, suggesting that subjects with irritable bowel syndrome show a greater reactivity to stress. Stress scores were also significantly correlated with the number of disability days and the number of medical clinic visits for bowel symptoms.

Psychological stress is widely believed to play a major role in the irritable bowel syndrome by precipitating exacerbations of symptoms. Two types of observations support this as follows:

(a) When directly asked, more than half of irritable bowel syndrome patients^{1,2} and non-patients with symptoms compatible with irritable bowel syndrome³ report that psychologically stressful events exacerbate their bowel symptoms, and 51% report that a stressful event preceded the onset of their irritable bowel syndrome.² (b) In laboratory studies, the acute induction of pain⁴ and emotional arousal⁵ elicit increased motility in the distal colon, and the magnitude of the response is greater in irritable bowel syndrome patients than in asymptomatic controls.

Standardised scales have been developed to compare people with respect to the frequency and severity of stressful life events,⁶⁻⁸ and early studies^{9,10} which used this method supported the stress hypothesis by showing that irritable bowel syndrome patients recalled more stressful events

than asymptomatic controls or patients with inflammatory bowel disease. However, a recent study¹¹ using an improved stress inventory, reported data inconsistent with this hypothesis; irritable bowel syndrome patients reported significantly fewer stressful life events, and their life events were significantly less stressful than asymptomatic controls. Another recent study¹² found no relation between stressful life events and a diagnosis of irritable bowel syndrome. Thus, the role of stressful life events in irritable bowel syndrome remains controversial.

Four criticisms have been levelled against previous studies of stressful life events as follows:

(a) Inaccurate recall. The reliability of recall has been shown to decrease dramatically after approximately three months.¹³ (b) Confounding of stress measures with outcome measures.¹⁴ Some stressors – for example, financial difficulty – may be consequences of illness rather than causes of illness. (c) Halo effect. Subjects who have been ill may look for causes and distort the significance of recalled events, especially if they believe stress influences their illness. (d) Individual differences in reactions to the same events. If stress is measured solely in terms of how many stressful events have occurred, differences between people in how stressful these events were felt to be are lost. However, the other extreme of measuring stress solely on the basis of how distressed the individual felt confounds personality differences (for example, neuroticism) with differences in exposure to adverse events.

This prospective study was designed to determine (a) whether subjects with irritable bowel syndrome recall more stressful life events when corrections are made for the confounding influence of neuroticism; (b) whether stressful life events are correlated with subsequent bowel symptoms, disability days, or visits to the doctor in a community sample; (c) whether subjects who meet symptom criteria for a diagnosis of irritable bowel syndrome show greater reactivity to life event stress than asymptomatic controls; and (d) which bowel symptoms are most responsive to life event stress. We attempted to improve on previous studies by (a) measuring and controlling for the personality trait of neuroticism, (b) eliminating stressful life events which subjects identified as consequences of illness, and (c) asking subjects to identify stressful life events and symptoms during each of four sequential three month intervals so that the relation between previous stress and subsequent bowel symptoms could be determined and the reliability of this relation assessed.

The Johns Hopkins University School of Medicine, and Francis Scott Key Medical Center, Baltimore, Maryland
W E Whitehead
M D Crowell
J C Robinson
B R Heller
M M Schuster

Correspondence to:
Dr W E Whitehead, Division of Digestive Disease, Francis Scott Key Medical Center, Baltimore, Maryland 21224.

Accepted for publication
18 June 1991

Methods

SUBJECTS

Three hundred and eighty three 20–40 year old women were recruited through announcements posted in two planned parenthood clinics (Baltimore and Annapolis, Maryland). Pregnant women and those with pelvic disease were excluded, leaving women who came to the clinic primarily for help with contraception. They were recruited into the study via notices that invited them to participate in a study of menstrual symptoms, so there was no apparent bias in favour of women with bowel symptoms. However, after 363 women had been recruited in this way, the notices were changed to indicate that only women with chronic bowel symptoms were sought, and an additional 20 subjects were recruited, including 14 who met the criteria for irritable bowel syndrome and six who met the criteria for a functional bowel disorder given below. The purpose of this change in recruitment procedures was to increase the number of irritable bowel syndrome subjects. Study of these subjects was approved by the Institutional Review Board on April 20, 1985.

On the basis of a 'gastrointestinal history questionnaire' completed on their first visit, subjects were classified as irritable bowel syndrome, functional bowel disease, or normal, based on the following criteria:

(1) Irritable bowel syndrome was defined by 'self report' of relief of abdominal pain after a bowel movement plus at least two of the following five symptoms: (a) loose stools at the onset of pain, (b) more frequent bowel movements with the onset of pain, (c) distension of the abdomen, (d) mucus passed by rectum, and (e) frequent feeling of incomplete evacuation.

(2) Functional bowel disease was defined by 'self report' of abdominal pain plus constipation or diarrhoea, or both, in people who failed to satisfy inclusion criteria for irritable bowel syndrome above.

(3) Normal (non-irritable bowel syndrome, non-functional bowel disease) was defined as all other subjects in the sample, except for three subjects who met criteria for a diagnosis of irritable bowel syndrome who were found to have lactose malabsorption. These subjects were excluded.

All subjects who met the symptom criteria for irritable bowel syndrome were referred to a gastroenterologist at a local hospital for a physical examination and detailed history to rule out an organic basis for bowel symptoms.

Twenty three of the 42 scheduled and kept an appointment with this gastroenterologist. Three of these subjects (13%) were found to have lactose malabsorption and were excluded from further analysis. The remaining 20 were felt to have irritable bowel syndrome. Nineteen subjects not examined by a gastroenterologist were retained in the irritable bowel syndrome group; by inference from those tested it is estimated that two of these may have been lactose malabsorbers. The demographic characteristics of the study groups are given in Table I.

PROCEDURES

This was a prospective study of the effects of stressful life events on the subsequent frequency of bowel symptoms, disability days, and visits to the doctor. Life Event scales⁸ were given five times at three month intervals, and the outcome variables were measured on each of the last four visits. The correlation between stressful life events in each three month interval with symptom reports, disability days, and clinic visits in the subsequent three month interval (time lagged correlation) was used to test the hypothesis that stress exacerbates bowel symptoms.

At each visit the subject was given a Life Events scale⁸ and instructed to check those events which had occurred during the previous three months. When this checklist was returned to the research assistant, she asked the subject, for each item checked, to rate how distressing the event was (none, mild, moderate, or severe ratings were assigned scores of 0–3) and to indicate whether the stressor was a consequence of an illness. A stress score was computed as the sum of the severity ratings for all stressors which occurred, excluding those events which were reported to be a consequence of illness.

At the initial visit the subject also completed a NEO Personality Inventory,¹⁵ and a gastrointestinal symptom questionnaire.¹⁶ The NEO personality Inventory was used to assess and control for the effects of neuroticism and other personality traits on perceived stress and on bowel symptom reports. The bowel symptom questionnaire given at the initial visit was used to classify subjects into diagnostic groups by criteria given above.

The outcome measure used to assess the frequency of bowel symptoms during each three month interval of follow up contained the items found by Manning *et al*¹⁷ to discriminate between functional and organic causes of abdominal pain in a gastroenterology clinic population plus additional items based on the authors' experience. For each symptom, subjects were asked, 'During the past three months, how often were you bothered by each of the following symptoms?' Response possibilities were: never, rarely (defined as one a month or less), one to three times per month, often (defined as at least once a week), and constant or almost daily. These five response possibilities were assigned values of 0–4.

To assess the impact of stressful life events on health care utilisation, subjects were asked to indicate the number of disability days, visits to the doctor, and admissions to hospital during

TABLE I Demographic characteristics of study population

	Normal subjects	IBS	FBD
Sample size	232	39	108
Age (mean (SD)) (yrs)	25.66 (4.63)	28.10 (6.21)*	26.27 (4.88)
Race (% black)	29.61	17.95	26.85
Married (%)	10.30	20.51†	21.30†
Education (%) who graduated college	34.07	48.15	49.28
Occupation (% blue collar)	27.47	30.77	24.07

IBS=irritable bowel syndrome; FBD=functional bowel disease.

*Scheffe test significant for IBS *v* normals, $p < 0.05$.

†Groups significantly different by $\chi^2 (2) = 9.05$, $p < 0.05$.

each three month interval for all causes (except psychiatric) and for bowel, gynaecological, and cold/flu symptoms specifically.

DATA ANALYSIS

(1) Difference between diagnostic groups in demographic characteristics were tested by χ^2 except for age, which was tested by F test.

(2) Diagnostic groups were compared on the five scales of the NEO Personality Inventory by multivariate analysis of variance, followed by univariate analysis of variance (ANCOVA) when Hotelling's T was significant.

(3) Diagnostic groups were compared with respect to stress scores by analysis of covariance (ACOVA). Neuroticism scores on the NEO Personality Inventory were used as the covariate. Only subjects who completed at least six months (three visits) were included.

(4) Time lagged correlations were computed between stress scores for each three month interval and bowel symptom reports for the subsequent three month interval.

(5) Correlations were computed between stress scores summed across all visits and individual bowel symptoms summed across all visits to determine which bowel symptoms were more highly correlated with stress.

(6) Regression equations were computed for the relation between stress and bowel symptoms for each diagnostic group at each visit. An ANCOVA was used to compare the slopes of the regression lines to determine which groups showed the greatest reactivity to psychological stress. Regression equations were also computed for each diagnostic group based on the average stress score across all visits and the average bowel symptom score for all visits. Only subjects who completed at least six months (three visits) were included in this analysis.

(7) The relation of stress to disability days and health care utilisation could not be tested by correlational analysis because most subjects reported no clinic visits or disability days. Consequently, the sample was divided into two groups at approximately the median score for average number of disability days or visits to the doctor per three months, and the two groups so formed were compared by F test with respect to average stress per three month interval.

(8) A discriminant analysis was performed to determine which if any of the stressful life events discriminated between the diagnostic groups.

Results

DEMOGRAPHY

Table I shows that the irritable bowel syndrome

group was older and more likely to be married than the normal subjects. There were also statistically non-significant trends for the irritable bowel syndrome group to be better educated and more probably white. The 14 irritable bowel syndrome subjects who were selectively recruited at the end of the study were similar to the 25 subjects recruited before this time with respect to all demographic variables except age; the age of selectively recruited subjects averaged 30.9 (7.0) years compared to 26.5 (4.9) years for irritable bowel syndrome subjects recruited earlier ($t(37)=2.23$, $p<0.05$). Selectively recruited irritable bowel syndrome subjects were also similar to (that is, not significantly different from) the irritable bowel syndrome subjects recruited earlier in terms of number of bowel symptoms, life event stress, and all NEO Personality Inventory scales. Consequently, the selectively recruited subjects were pooled with the other irritable bowel syndrome subjects in subsequent statistical analyses.

RELIABILITY OF DIAGNOSTIC CLASSIFICATION

Subjects were classified into diagnostic groups at the initial visit based on bowel symptoms checked as having occurred in the past six months. The questions used to diagnose irritable bowel syndrome were repeated at each three month follow up visit, and these data were used to assess the reliability of the diagnosis. Sixty per cent of the irritable bowel syndrome group reported symptoms appropriate for the diagnosis on at least two of four follow up visits compared with 22% of the functional bowel disease group and 8% of the normal group.

NEO PERSONALITY INVENTORY

As shown in Table II, the diagnostic groups were similar in all personality dimensions except neuroticism. Consistent with an earlier study of a different community sample,¹⁵ the irritable bowel syndrome group did not show raised scores on neuroticism, but the functional bowel disease group did. The multivariate ANOVA, which included all five NEO scales, was significant (Hotelling's $T^2=23.24$, $p<0.01$) and the univariate ANOVA for the neuroticism scale was significant ($F(2,377)=9.06$, $p<0.0001$).

LEVEL OF STRESS

Figure 1 shows, for each diagnostic group, the sum of the severity ratings for all stressful life events checked (averaged across sessions) as having occurred in the previous three months. The ANCOVA showed that stress was significantly different between diagnostic groups even when the effects of neuroticism were statistically controlled for by covariance analysis ($F(2,376)=5.42$, $p<0.01$). The irritable bowel syndrome group reported significantly more stress than controls, and the functional bowel disease group was intermediate and not significantly different from either. The same analysis was repeated with number of stressful events unweighted by severity to control for possible differences in the tendency to exaggerate or minimise the impact of

TABLE II NEO Personality Inventory Scores (values mean (SD))

Scale	Normals	IBS	FBD
Sample size	233	39	108
Neuroticism	87.21 (21.94)	88.87 (22.41)	97.83 (20.38)*
Extraversion	115.24 (16.79)	116.41 (17.48)	114.23 (8.96)
Openness	121.37 (18.86)	123.77 (16.52)	125.69 (18.72)
Agreeableness	46.82 (6.75)	47.72 (8.15)	46.39 (7.25)
Conscientiousness	47.95 (8.57)	47.10 (8.22)	45.93 (8.95)

*Univariate F test for neuroticism, $F(2,377)=9.06$, $p<0.0001$.

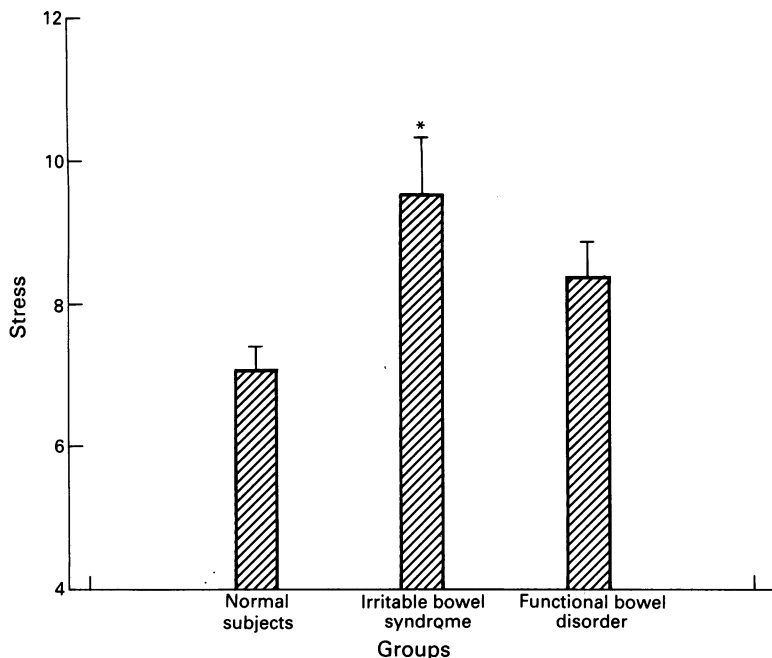


Figure 1: Stress scores averaged for the full year in normal subjects, subjects with irritable bowel syndrome, and subjects with functional bowel disease. The means have been adjusted to correct for the correlation between stress and neuroticism. The asterisk indicates that the irritable bowel syndrome group shows significantly ($p < 0.01$) greater stress even after correcting for group differences in neuroticism.

stressful events. Paired comparisons showed that the irritable bowel syndrome group reported more stressful events than the normal group (5.37 v 4.31 events, $F(1,229) = 5.14$, $p < 0.05$), and the functional bowel disease group was intermediate (4.83 events).

RELATION BETWEEN STRESS AND BOWEL SYMPTOMS

Table III shows for each visit the correlation between stress scores for the past three months and the frequency of bowel symptoms reported

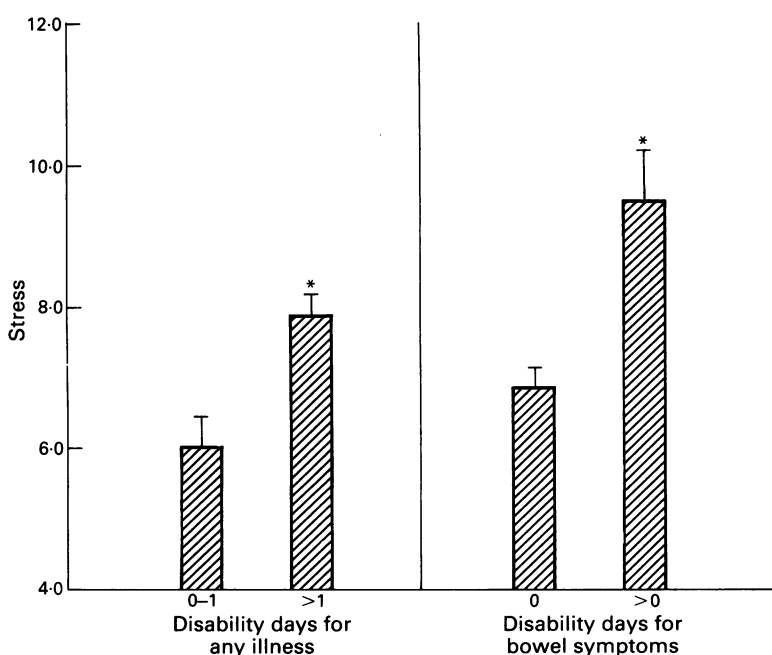


Figure 2: Relation between stress and disability days. The left panel shows that subjects reporting two or more disability days per year for any illness show significantly ($p < 0.01$) more stress than subjects reporting one or fewer disability days. The right panel shows that subjects reporting one or more disability days for bowel symptoms show significantly ($p < 0.01$) more stress than subjects reporting no disability days for bowel symptoms.

during the subsequent three months. Column 1 shows that bowel symptoms were significantly correlated with stress across all subjects in the study.

It was predicted that the irritable bowel syndrome group would show greater reactivity to stress than the asymptomatic controls. Consistent with this prediction, the slope of the regression equation relating bowel symptoms to stress was significantly steeper for the irritable bowel syndrome group at three months ($F(2,332) = 3.91$, $p < 0.05$) and six months ($F(2,319) = 3.65$, $p < 0.05$), and tended to be steeper for the whole 12 months of follow up (Table IV).

Table V shows the correlation of stress scores to individual bowel symptoms, both variables being summed across visits for each diagnostic group. The symptoms most highly correlated with stress in the irritable bowel syndrome group were loose stools with the onset of pain and a feeling of incomplete evacuation. The irritable bowel syndrome and the functional bowel disease group differed from the normal subjects in showing a lower association between stress and abdominal distension.

DISABILITY DAYS AND HEALTH CARE UTILISATION

Stress was also correlated with disability days

TABLE III Time lagged correlation of stress with sum of bowel symptoms (sample sizes are given in parentheses)

Time	All subjects	Normal	IBS	FBD
3 months	0.14* (336)	0.08 (205)	0.14 (35)	0.05 (96)
6 months	0.26 (306)	0.32 (187)	0.19 (31)	0.16 (88)
9 months	0.28 (290)	0.18 (184)	0.42 (22)	0.41 (84)
12 months	0.26 (266)	0.23 (166)	0.10 (20)	0.26 (80)
Summed across all visits	0.33 (343)	0.30 (212)	0.27 (32)	0.37 (98)

*Criterion levels for statistical significance varied greatly because of unequal sample sizes. For the pooled sample, correlations were significant at $p < 0.01$ at all time intervals.

IBS=irritable bowel syndrome; FBD=functional bowel disease.

TABLE IV Slopes of regression equations relating bowel symptoms to stress

Time	Normal	IBS	FBD
3 months	0.12	0.61*	0.21
6 months	0.21	0.63*	0.33
9 months	0.16	-0.11	0.13
12 months	0.24	0.33	0.37
Total	0.28	0.64	0.36

*ANOVAs comparing diagnostic groups with respect to slope significant at $p < 0.05$.

IBS=irritable bowel syndrome; FBD=functional bowel disease.

TABLE V Correlation of stress with individual bowel symptoms. Stress and bowel reports summed across visits

	Normal	IBS	FBD
Sample size	202	30	95
Loose stools with pain	0.22	0.42	0.19
Increased bowel movement with pain	0.34	0.27	0.21
Pain decreased with bowel movement	0.29	0.25	0.25
Visible abdominal distension	0.27	-0.01	0.16
Feeling of distension	0.31	0.05	0.21
Mucus	0.24	0.16	0.16
Incomplete evacuation	0.27	0.37	0.35
Constipation	0.15	0.32	0.26
Diarrhoea	0.12	0.18	0.23

For sample size 202, $r \geq 0.14$ is significant ($p < 0.05$).

For sample size 30, $r \geq 0.36$ is significant.

For sample size 95, $r \geq 0.20$ is significant.

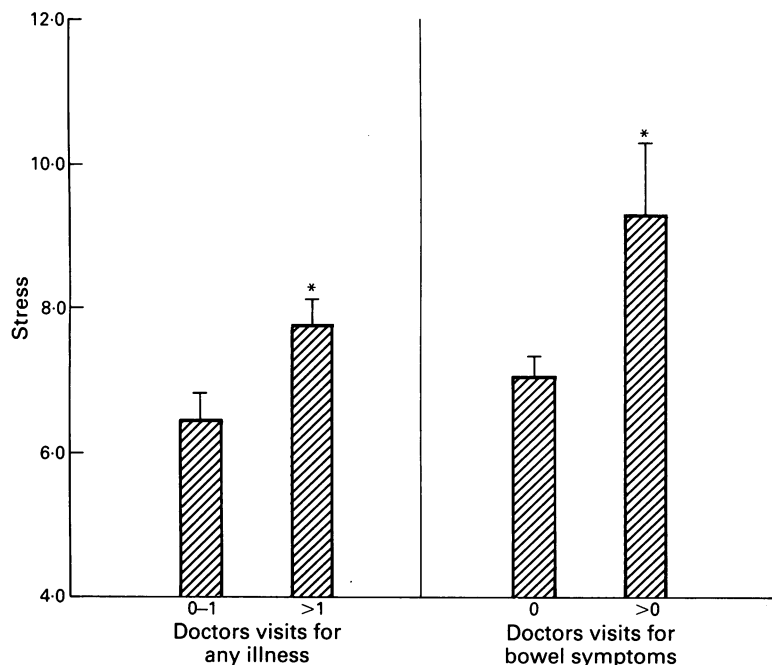


Figure 3: Relation between stress and visits to medical clinics. The left panel shows that subjects reporting two or more medical clinic visits for any illness show significantly ($p < 0.01$) more stress than subjects reporting one or fewer clinic visits. Right panel shows that subjects reporting one or more clinic visits for bowel symptoms report significantly ($p < 0.01$) more stress than subjects reporting no medical clinic visits for bowel symptoms.

(Fig 2). Subjects who reported one or more disability days for bowel symptoms had significantly ($t(301) = 3.69$, $p < 0.001$) higher stress scores (9.52 (4.64)) than subjects who did not report disability days related to bowel symptoms (6.87 (4.36)). Similarly, subjects who reported two or more disability days for any illness had higher stress scores (7.90 (4.44)) than subjects who reported fewer than two disability days (6.02 (4.34)) ($t(301) = 3.52$, $p < 0.001$). Subjects who consulted physicians about bowel symptoms during the 12 months of follow up (Fig 3) also reported significantly higher stress scores ($t(301) = 2.34$, $p < 0.05$) than subjects who did not consult physicians about bowel symptoms (9.30 (4.96) v 7.08 (4.41)). Similarly, subjects who consulted physicians two or more times about any illness had significantly ($t(301) = 2.53$, $p < 0.02$) higher stress scores (7.78 (4.65)) than subjects who consulted fewer than two times for any illness (6.45 (4.11)).

DISCRIMINANT ANALYSIS

Separate discriminant analyses were performed on the Life Events scale at each visit to identify stressors which might distinguish the diagnostic groups from each other. For the initial visit, three items discriminated the irritable bowel syndrome group from controls: arguments outside the household, unwanted employment, and minor financial problems. On subsequent visits there were no stressors which discriminated significantly between groups.

Discussion

These data show that subjects with symptoms compatible with irritable bowel syndrome, as compared with asymptomatic controls, report significantly more life event stress. These group differences in stress are not attributable to neuroticism since they persist when neuroticism has been statistically controlled for. Similar observations have been made by other investigators and

have been interpreted as evidence that irritable bowel syndrome is a stress disorder.

A more rigorous test of the stress hypothesis would be to show that the amount of stress is correlated with amount of subsequent bowel symptoms. This prediction was supported. However, the correlations were relatively low (0.14 to 0.28). Judging by correlations which are based on data pooled for the year, approximately 11% of the variance in bowel symptoms could be explained by stress.

The correlations between stress and bowel symptoms are surprisingly small since, when subjects in a previous study³ were asked directly whether stress affected their bowel symptoms, 47% stated that stress caused abdominal pain and 68% stated that stress caused a change in stool frequency or consistency. This discrepancy between direct inquiry and the results of formal assessment of stressful events could have been due to insensitivity in the method of measuring stress in the present study. Such insensitivity could result if stress produced only a transient change in bowel symptoms which was missed when subjects were asked to report on stress and bowel symptoms for a three month period. Alternatively, insensitivity could result if the Life Events Scale did not include some of the stressors which were responsible for changes in bowel symptoms. However, other data previously reported by our laboratory suggest that insensitivity in the method of assessment does not account for these low correlations; when the relation between stress and bowel symptoms was assessed by the highly sensitive method of asking subjects to keep a symptom log in which they rated the degree of subjective stress or tension and of bowel symptoms four times daily for one week, the median within subject correlation between stress ratings and abdominal pain was found to be 0.13 in a group of 149 community women¹⁸ and 0.19 in a group of nine irritable bowel syndrome clinic patients.¹⁹ Thus, quite different approaches to measurement agree in suggesting that the correlation between stress and bowel symptoms is relatively low. It seems that the two thirds of subjects who report that stress causes bowel symptoms when directly asked, are overgeneralising from relatively infrequent events.

Laboratory studies suggest that irritable bowel syndrome patients show a greater increase in colon motility in response to emotional arousal⁵ or balloon distension of the rectosigmoid²⁰ than healthy controls. It was therefore predicted that the irritable bowel syndrome group would show a greater increase in bowel symptoms for each increment in stress. As shown in Table IV, this was supported: the regression line relating amount of stress to amount of bowel symptoms was steeper in the irritable bowel syndrome group than in normal subjects and those with functional bowel disease. The functional bowel disease group, however, was similar to normal. This is consistent with laboratory stress data²¹ in suggesting that irritable bowel syndrome but not functional bowel disease subjects are hyper-reactive to stress.

Life event stress was significantly related to the self reported number of disability days and

medical clinic visits for bowel symptoms. These self reports were not verified by examining employer records or medical charts, but the collection of these reports close to the time that the events were said to occur (that is, at three month intervals) increases the likelihood that the reports were correct. Moreover, these data are supported by earlier reports by Mechanic,²² who studied clinic visits from all causes. These observations suggest that stress related exacerbation of bowel symptoms has a significant economic impact.

The subjects in this community study were diagnosed on the basis of a bowel symptom questionnaire at their initial visit as having (or not having) irritable bowel syndrome, and 55% of those subjects felt to have irritable bowel syndrome were further evaluated by a gastroenterologist to rule out alternative explanations for their symptoms. The reliability of this method of classifying subjects was evaluated by determining which subjects would have merited the diagnosis of irritable bowel syndrome on the basis of symptoms reported at follow up visits. By this criterion, the sensitivity of the diagnostic algorithm was 60% which is consistent with the intermittent course of this disorder, and the specificity was 88%.

This study extends previous work on the relation between stress and bowel symptoms by prospectively following a large group of women for one year, repeating the measurement of both stress and bowel symptoms at three month intervals to assess stability, and controlling for the personality trait of neuroticism. The data show that there is a statistically significant correlation between stress and bowel symptoms, illness related absenteeism, and medical clinic visits. However, the magnitude of this correlation is small, on the order of 0.33. These data suggest that approximately 11% of the variance in bowel symptom reports is attributable to life event stress.

Supported in part by grants RO1 NR01369 and KO5 MH00133. Abstract published in *Gastroenterology* 1990; 98: A341.

- 1 Chaudhary NA, Truelove SC. The irritable colon syndrome: a study of the clinical features, predisposing causes, and prognosis in 130 cases. *Q J Med* 1962; 31: 307-23.
- 2 Hislop IG. Psychological significance of the irritable colon syndrome. *Gut* 1971; 12: 452-7.
- 3 Drossman DA, Sandler RS, McKee DC, Lovitz AJ. Bowel patterns among subjects not seeking health care. *Gastroenterology* 1982; 83: 529-34.
- 4 Almy TP, Tulin NM. Alterations in colonic function in man under stress. I. Experimental production of changes simulating the 'irritable colon'. *Gastroenterology* 1947; 8: 616-26.
- 5 Welgan P, Meshkinpour H, Beeler M. Effect of anger on colon motor and myoelectric activity in irritable bowel syndrome. *Gastroenterology* 1988; 94: 1150-6.
- 6 Holmes TH, Rahe RH. The social readjustment rating scale. *J Psychosom Res* 1967; 8: 221-9.
- 7 Sarason IG, Johnson JH, Siegel JM. Assessing the impact of life changes: development of the life experiences survey. *J Consult Clin Psychol* 1978; 46: 932-46.
- 8 Paykel ES, Prusoff BA, Uhlenhuth EH. Scaling of life events. *Arch Gen Psychiatry* 1971; 25: 340-7.
- 9 Mendeloff AI, Monk M, Seigel CI, Lilienfeld A. Illness experience and life stresses in patients with irritable colon and with ulcerative colitis. An epidemiologic study of ulcerative colitis and regional enteritis in Baltimore, 1960-1964. *N Engl J Med* 1970; 282: 14-7.
- 10 Fava GA, Pavan L. Large bowel disorders. I. Illness configuration and life events. *Psychother Psychosom* 1976/77; 27: 93-9.
- 11 Drossman DA, McKee DC, Sandler RS, Mitchell CM, Cramer EM, Lowman BC, et al. Psychosocial factors in the irritable bowel syndrome. A multivariate study of patients and nonpatients with irritable bowel syndrome. *Gastroenterology* 1988; 95: 701-8.
- 12 Ford MJ, Miller PM, Eastwood J, Eastwood MA. Life events, psychiatric illness and the irritable bowel syndrome. *Gut* 1987; 28: 160-5.
- 13 Jenkins CD, Hurst WH, Rose RM. Life changes: do people really remember? *Arch Gen Psychiatry* 1979; 36: 379-84.
- 14 Paykel ES. Methodological aspects of life events research. *J Psychosom Res* 1983; 27: 341-52.
- 15 Costa PT Jr, McCrae RR. *The NEO Personality Inventory manual*. Odessa, Florida: Psychological Assessment Resources, 1985.
- 16 Whitehead WE, Bosmajian L, Zonderman AB, Costa PT Jr, Schuster MM. Symptoms of psychologic distress associated with irritable bowel syndrome. Comparison of community and medical clinic samples. *Gastroenterology* 1988; 95: 709-14.
- 17 Manning AP, Thompson WG, Heaton KW, Morris AF. Towards positive diagnosis of the irritable bowel. *BMJ* 1978; 2: 653-4.
- 18 Whitehead WE. Gastrointestinal motility disorders - the psychologist's perspective. In: Champion MC, McCallum RW, eds. *Physiology, diagnosis & therapy in GI motility disorders*. Toronto: MES Medical Education Services, 1988: 109-22.
- 19 Haderstorfer B, Whitehead WE, Schuster MM. Intestinal gas production from bacterial fermentation of undigested carbohydrate in irritable bowel syndrome. *Am J Gastroenterol* 1989; 84: 375-8.
- 20 Whitehead WE, Engel BT, Schuster MM. Irritable bowel syndrome. Physiological and psychological differences between diarrhea-predominant and constipation-predominant patients. *Dig Dis Sci* 1980; 25: 404-13.
- 21 Whitehead WE, Holtkotter B, Enck P, Hoelzl R, Holmes KD, Anthony J, et al. Tolerance for rectosigmoid distension in irritable bowel syndrome. *Gastroenterology* 1990; 98: 1187-92.
- 22 Mechanic D. Social psychologic factors affecting the presentation of bodily complaints. *N Engl J Med* 1972; 286: 1132-9.