ORIGINAL ARTICLE

Predictors of abdominal pain in schoolchildren: a 4-year population-based prospective study

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Background: Chronic abdominal pain (CAP) is common among schoolchildren, but risk factors for its onset are still largely unknown.
Aims: To determine the frequency of onset of CAP in schoolchildren and investigate risk factors for its development.
Methods: 1411 schoolchildren aged 11–14 years were recruited from schools in North West England. Information was collected on recent pain symptoms and potential risk factors for developing CAP. Participants were followed up 1 and 4 years later and new episodes of CAP were identified.
Results: 22% reported new-onset abdominal pain at 1-year follow-up which persisted at 4-year follow-up (CAP). CAP was almost three times higher in girls than boys (34% vs 13%; χ^2: 26.0; p<0.001). In girls, reporting headache at baseline was the only predictive factor for CAP onset: those reporting headaches experienced a doubling in the risk of symptom onset (relative risk: 2.1; 95% confidence interval: 0.95 to 4.7). In contrast, in boys, development of CAP was independently predicted by daytime tiredness (3.0; 1.2 to 7.6), lack of school enjoyment (2.0; 0.95 to 4.2), adverse psychosocial exposures (2.3; 1.2 to 4.5) and taller stature (1.9; 0.8 to 4.5).
Conclusion: Our results suggest that over 20% of adolescent schoolchildren experience new-onset non-self-limiting abdominal pain over a 1-year period. Future abdominal pain is predicted by previous somatic symptom reporting in girls and both somatic symptom reporting and psychosocial factors in boys. These risk factors indicate a possible mechanism for understanding the development of CAP, and might have important implications for both primary and secondary preventive strategies.

Abdominal pain is common in children, with 12-month prevalence ranging from 20% in population samples[1] to 44% in primary care attendees.[2] On physical examination, most children display no abnormalities and this has led to the long-held belief that most abdominal pain is "functional" in origin.[3] In the long term, some researchers have demonstrated an increased risk of irritable bowel syndrome among adults with a history of childhood abdominal pain,[4] while others have not detected such an association but found that persistent abdominal pain in childhood is associated with adult psychiatric disorders.[1] Such findings have raised speculation that childhood abdominal pain might be a precursor of gastrointestinal and/or psychiatric disorders in adults. Thus, studying its determinants is important in understanding the origin of common and disabling adult illnesses.

Previous studies have focused on children with "recurrent abdominal pain" defined as at least three bouts of pain over a period of not less than 3 months. This term, first introduced by Apley and Naish in 1958,[5] has received criticism for being too general and unclear. Recently, the Subcommittee on Chronic Abdominal Pain of the American Academy of Pediatrics recommended that this term should be retired. Instead, they proposed that "chronic abdominal pain" (CAP) should be used to describe long-lasting intermittent or constant abdominal pain.[6]

Abdominal pain in children often coexists with other somatic pain conditions. A recent study demonstrated that one quarter of children reported pain within the previous 3 months in more than one site, the most common combination being headache and abdominal pain.[7] Behavioural symptoms are also commonly linked with abdominal pain. Children with such pain have been described as compulsive, highly strung and perfectionist.[5] In addition, these children experience sleep disturbances and are more prone to suffer from depression.[2]

A major limitation of previous studies is that they have been cross-sectional or retrospective in design and, therefore, have been unable to establish the temporal nature of any associations. It is clear, therefore, that longitudinal studies are required. Thus, the aims of the current study were to determine the frequency of onset of CAP and to identify risk factors for its development.

METHODS

Baseline survey

Children from 39 schools, both state-funded and fee-paying, in North West England were invited to take part in the study. Each school was asked to select between one and three classes of children aged 11–14 years. Parental and child consent was obtained before participation in the study, and permission to approach schools was obtained from the regional Directors of Education. Ethical approval for the study was granted by the University of Manchester Committee of the Ethics of Research on Human Beings.

In the classroom, with the investigators present, children were asked to complete a health questionnaire on abdominal pain and a number of potential risk factors for such symptoms. Children were asked: "Thinking back over the past month, on how many days have you had a troublesome stomach ache?". Of several possible responses, children indicating "None" were defined as being free of abdominal pain.

Information was collected regarding the type and duration of physical activity in the week prior to the survey, and the amount of time spent watching TV and playing computer games was recorded to assess sedentary activity. Psychosocial

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factors were assessed using the Strengths and Difficulties Questionnaire (SDQ),[8] an instrument designed to assess pro-social behaviour (strength) and hyperactivity and emotional, peer and conduct problems (difficulties). For assessing the prevalence of other common somatic complaints (headache, low back pain, sore throats and daytime tiredness), information was collected regarding how many days in the past month the child had had each of these symptoms. In addition, the study investigators measured height and weight, and calculated BMI (kg/m^2).

Follow-up

Children who were free of abdominal pain at baseline were eligible for follow-up. These children were followed up by questionnaire 1 year and 4 years after baseline. At each time point, abdominal pain was assessed in the same manner as previously. In addition, because of the potential link between abdominal pain and menstruation, information was gathered on whether girls had started menstruating. Children who were absent from school at follow-up were left questionnaires for completion later. Children from schools that declined to participate at follow-up were sent questionnaires by mail (with reminders to non-responders). Children were defined as having CAP if they reported symptoms of abdominal pain for at least 1 day in the month prior to both follow-up questionnaires.

Analysis

Potential risk factors for CAP were examined using χ^2 tests. Thereafter, the influence of each potential risk factor on CAP, adjusted for age, was analysed using Poisson regression with robust estimates of standard error.[9] Thus, results are expressed as risk ratios (RR) with 95% confidence intervals (95% CI). All analyses were conducted in Stata 9.2 (StataCorp, College Station, TX). First, individual exposures were examined with respect to their (age-adjusted) univariable association with CAP. Thereafter, a multivariable model was constructed to determine the relative contributions of the factors previously identified as potential important predictors of onset. Variables that predicted CAP with a significance of $p \leqslant 0.2$ (as assessed using a Wald test) were entered into a forward stepwise regression model. Variables were included in the final model at $p \leqslant 0.10$ and excluded at $p \geqslant 0.15$.

RESULTS

Study population and follow-up

From 1496 children invited to participate, 1411 (94%) completed the baseline questionnaire, of whom 675 reported no abdominal pain during the previous month and were, therefore, eligible for follow-up. Altogether 570 children (84%) were followed up at 1 year, of whom 414 (73%) were followed up at 4 years. In total, 392 children were followed up at both time points, giving an adjusted follow-up rate of 58%. Children lost to follow-up were similar to those who remained in the study with respect to all baseline variables except for age: participants were slightly older (mean difference: 3.5 months; $t = 4.66$; $p < 0.001$).

Development of CAP

Of the 392 children with data at each time point, 167 children (43%) reported new-onset abdominal pain at 1-year follow-up and 87 children (22%) reported abdominal pain at both 1-year and 4-year follow-up assessments (CAP). There was no difference in the onset of CAP with age (χ^2_{trend}: 0.01; $p = 0.93$), although onset was higher in girls than boys (34% vs 13%; χ^2: 26.0; $p < 0.001$). In girls, the occurrence of new-onset CAP was similar in those who had and had not passed menarche (35% and 32%, respectively; χ^2: 0.17; $p = 0.68$).

Because of the difference in the occurrence of new-onset CAP between boys and girls, all subsequent analyses were stratified by gender.

Risk factors for developing CAP

In boys, those above the median height experienced a doubling in the risk of CAP (RR: 2.3; 95% CI: 1.03 to 5.3). No such relationship was found in girls (table 1). No association was found with weight or BMI in either gender. A high (greater than median) level of both physical and sedentary activity was associated with a modest increase risk of CAP in boys, although these increases were not statistically significant (1.6; 0.7 to 3.5 and 1.5; 0.7 to 3.4, respectively). No such association was found in girls.

Boys who, at baseline, reported the occurrence of other somatic symptoms were significantly more likely to report new-onset CAP than their peers (table 2). In particular, those who reported high levels of daytime tiredness (highest tertile of a 100 mm visual analogue scale) were at the highest risk (4.6; 1.9 to 11.2). In girls, the association between somatic symptom reporting and CAP onset was less strong. However, those who reported headaches on >7 days in the month prior to the baseline survey experienced a doubling in risk (2.1; 0.95 to 4.7).

There was no consistent evidence to suggest that psychosocial factors were important predictors of CAP in girls (table 3). In contrast, boys who reported a high level of psychosocial difficulties experienced nearly a three-fold increase in the risk of new-onset CAP (2.9; 1.5 to 5.9). In particular, conduct problems were associated with an increase in risk. Also, boys who reported that they did not enjoy school experienced nearly a three-fold increase in risk of CAP (2.7; 1.3 to 5.5). No such relationship was observed in girls (1.2; 0.7 to 1.9).

Two multivariable models were created, for boys and girls separately (table 4). In boys, four factors were found to be independent predictors of CAP onset: daytime tiredness, lack of school enjoyment, psychosocial difficulties and taller stature. Each variable was associated, independently, with between a two-fold and a three-fold increase in risk. In contrast, in girls, only baseline somatic symptoms independently predicted the onset of CAP: those who reported headaches on >7 days in the month prior to the baseline survey experienced more than a doubling in CAP risk.

DISCUSSION

We report the results of the first prospective population-based study to examine the onset of CAP in schoolchildren. Onset of CAP in girls was common (34%) and was predicted only by previous somatic symptom reporting (headache). In contrast, onset amongst boys was less common (13%), but was predicted by psychosocial factors (conduct problems and lack of school enjoyment) in addition to previous somatic symptom reporting (daytime tiredness). Taller boys also experienced an increase in risk.

There are a number of methodological issues to be addressed. Firstly, our case definition of abdominal pain was different from those used in previous reports, the majority of which used the Apley and Naish definition,[5] or the Rome II criteria for paediatric functional gastrointestinal disorders.[10] We have identified schoolchildren who developed new-onset abdominal pain that persisted/recurred 3 years subsequently. Thus, we were focusing on chronicity of symptoms rather than frequency. However, as with other potentially functional disorders (eg, fibromyalgia),[11] these symptoms are likely to be part of a continuum and, therefore, any definition is to some extent an arbitrary cut-off.

Secondly, we relied on self-report of symptoms. Therefore, the study will detect symptoms that are, on average, milder

Table 1 Univariable analysis: baseline anthropometric characteristics and lifestyle factors

	Boys			Girls		
	Yes	No	RR (95% CI)*	Yes	No	RR (95% CI)*
Height (split at median)						
≤157 cm	10 (9%)	103 (91%)	1.0	35 (34%)	68 (66%)	1.0
>157 cm	18 (17%)	85 (83%)	2.3 (1.03 to 5.3)	24 (36%)	42 (64%)	0.9 (0.6 to 1.4)
Weight (split at median)						
≤47 kg	13 (12%)	99 (88%)	1.0	34 (39%)	53 (61%)	1.0
>47 kg	15 (14%)	89 (86%)	1.2 (0.6 to 2.5)	25 (30%)	57 (70%)	0.7 (0.5 to 1.1)
BMI (split at median)						
≤19	14 (12%)	107 (88%)	1.0	28 (39%)	43 (61%)	1.0
>19	14 (15%)	81 (85%)	1.2 (0.6 to 2.5)	31 (32%)	67 (68%)	0.8 (0.5 to 1.2)
Hours spent in playing sports in the week prior to the survey (split at median)						
≤14 h	8 (9%)	78 (91%)	1.0	43 (35%)	81 (65%)	1.0
>14 h	20 (15%)	114 (85%)	1.6 (0.7 to 3.5)	16 (33%)	32 (67%)	1.0 (0.6 to 1.5)
Hours spent watching TV or playing computer games in the day prior to baseline survey (split at median)						
≤2 h	10 (9%)	97 (91%)	1.0	41 (37%)	71 (63%)	1.0
>2 h	13 (14%)	79 (86%)	1.5 (0.7 to 3.4)	14 (32%)	30 (68%)	0.9 (0.5 to 1.4)

*Adjusted for age.
95% CI, 95% confidence interval; RR, risk ratio.

than those seen in clinical settings. This might have led to underestimation of the strength of the risk associations. We also used a 1-month recall period for measuring abdominal pain experience, to avoid the recall problems. So, it is possible that some of our baseline study population developed abdominal pain over the intervening period and were pain-free again at follow-up. If this is the case, then we will have underestimated our onset rate and, again, the true risk associations would be greater than we present here.

Thirdly, despite a high initial participation, our follow-up rate was modest (58%). However, most children lost to follow-up came from schools which declined to participate rather than from the individual child being absent from school. Furthermore, subsequent analysis revealed that the only individual level predictor of loss to follow-up was age. Because age was not a predictor of CAP onset, it is unlikely that attrition will have introduced any major selection bias.

Fourthly, the sole use of the SDQ as a psychosocial tool limited the extent of psychological evaluation. However, the SDQ has been well-validated for behavioural and emotional assessment in large community samples of this age group. Furthermore, studies have shown that self-reported scores correlate well with parent- and teacher-reported psychological scores on this instrument.[12 13]

We have found that the incidence proportion of CAP was 22% and was significantly higher in girls than in boys but showed little variation with age. The marked female preponderance was not attributed to menstruation, as development of CAP was considerably higher in both menstruating and non-menstruating girls compared to boys.

Development of CAP in both genders was predicted by prior report of some somatic symptoms. It is well recognised, in both children and adults, that various somatic symptoms frequently co-exist.[7 14 15] In terms of predictors of abdominal pain, one

Table 2 Univariable analysis: somatic symptoms

	Boys			Girls		
	Yes	No	RR (95% CI)*	Yes	No	RR (95% CI)*
Headache in month prior to baseline survey						
None	12 (10%)	114 (90%)	1.0	20 (24%)	64 (76%)	1.0
1–7 days	15 (17%)	73 (83%)	1.7 (0.8 to 3.5)†	35 (44%)	45 (56%)	1.8 (1.1 to 2.8)
>7 days	0 (0%)	3 (100%)		4 (50%)	4 (50%)	2.1 (0.95 to 4.7)
Sore throat in month prior to baseline survey						
None	12 (10%)	111 (90%)	1.0	20 (26%)	56 (74%)	1.0
1–7 days	14 (16%)	73 (84%)	1.7 (0.8 to 3.6)	35 (41%)	51 (59%)	1.5 (0.97 to 2.4)
>7 days	2 (22%)	7 (78%)	2.2 (0.6 to 8.3)	4 (40%)	6 (60%)	1.5 (0.7 to 3.5)
Low back pain in month prior to baseline survey‡						
No	19 (11%)	158 (89%)	1.0	50 (34%)	99 (66%)	1.0
Yes	7 (22%)	25 (78%)	2.0 (0.9 to 4.4)	9 (45%)	11 (55%)	1.3 (0.8 to 2.2)
Daytime tiredness (tertiles of 100 mm visual analogue scale)						
Low	7 (6%)	113 (94%)	1.0	31 (36%)	56 (64%)	1.0
Medium	10 (18%)	46 (82%)	3.1 (1.2 to 7.7)	11 (24%)	34 (76%)	0.7 (0.4 to 1.2)
High	11 (26%)	31 (74%)	4.6 (1.9 to 11.2)	17 (45%)	21 (55%)	1.2 (0.8 to 1.9)

*Adjusted for age; †RR for 1–7 days and >7 days combined; ‡insufficient data to break down into 1–7 vs >7 days.
95% CI, 95% confidence interval; RR, risk ratio.

Table 3 Univariable analysis: psychosocial factors

	Boys			Girls		
	Yes	No	RR (95% CI)*	Yes	No	RR (95% CI)*
Pro-social behaviour (split at median)						
Low	6 (11%)	50 (89%)	1.0	32 (34%)	61 (66%)	1.0
High	22 (14%)	140 (86%)	1.3 (0.5 to 3.0)	27 (35%)	51 (65%)	1.0 (0.6 to 1.5)
Total psychosocial difficulties (split at median)						
Low	11 (8%)	131 (92%)	1.0	30 (34%)	58 (66%)	1.0
High	17 (22%)	61 (78%)	2.9 (1.5 to 5.9)	29 (35%)	55 (65%)	1.0 (0.7 to 1.5)
Conduct problems (split at median)						
Low	12 (8%)	130 (92%)	1.0	39 (32%)	83 (68%)	1.0
High	16 (21%)	62 (79%)	2.4 (1.2 to 4.9)	20 (42%)	28 (58%)	1.3 (0.9 to 2.0)
Hyperactivity (split at median)						
Low	16 (11%)	131 (89%)	1.0	33 (31%)	75 (69%)	1.0
High	12 (17%)	58 (83%)	1.6 (0.8 to 3.2)	24 (39%)	38 (61%)	1.3 (0.9 to 2.0)
Emotional symptoms (split at median)						
Low	15 (11%)	124 (89%)	1.0	31 (36%)	55 (64%)	1.0
High	13 (17%)	65 (83%)	1.6 (0.8 to 3.1)	28 (33%)	56 (67%)	0.9 (0.6 to 1.3)
Peer problems (split at median)						
Low	18 (16%)	97 (84%)	1.0	39 (38%)	64 (62%)	1.0
High	10 (10%)	92 (90%)	0.6 (0.3 to 1.3)	20 (30%)	46 (70%)	0.8 (0.5 to 1.2)
School enjoyment						
Yes	9 (8%)	107 (92%)	1.0	42 (33%)	87 (67%)	1.0
No	19 (20%)	78 (80%)	2.7 (1.3 to 5.5)	14 (41%)	20 (59%)	1.2 (0.7 to 1.9)

*Adjusted for age.
95% CI, 95% confidence interval; RR, risk ratio.

study found that 31% of children with recurrent abdominal pain had a history of migraine.[16] Similarly, studies in adults have shown that fatigue predicts abdominal pain onset.[17] It has been postulated that central processing of afferent information from different regions of the body in the form of hypervigilance or altered sensory modulation may play a central role in aggregation of somatic symptoms.[18] The strong relationship between CAP and other somatic symptoms might also be attributed to a common aetiology shared by all these symptoms.

Other studies have found that children presenting with recurrent abdominal pain do not differ in weight and height from healthy children undergoing a routine check-up at primary care clinics.[19] This finding is partially in accordance with our results, which found that weight and BMI were not associated with the onset of CAP. However, in the current study boys of taller stature experienced an increase in the risk of CAP. There are two possible explanations for this. Firstly, that height itself is the risk factor or, secondly, that height is a marker for some other risk factor – early puberty perhaps.

Results of most,[2 6 20] but not all,[21] previous studies suggest that children with abdominal pain have more internalising emotional symptoms (anxiety and depression) than their peers. Similar studies investigating the relationship with other

Table 4 Multivariable analysis

	Age adjusted RR (95% CI)	
	Boys	Girls
Daytime tiredness (tertiles of 100 mm visual analogue scale)		
Low	1.0.	–
Medium	2.9 (1.2 to 7.1)	–
High	3.0 (1.2 to 7.6)	–
School enjoyment		
Yes	1.0.	–
No	2.0 (0.95 to 4.2)	–
Total psychosocial difficulties (split at median)		
Low	1.0.	–
High	2.3 (1.2 to 4.5)	–
Height (split at median)		
≤157 cm	1.0.	–
>157 cm	1.9 (0.8 to 4.5)	–
Headache in month prior to baseline survey		
None	–	1.0
1–7 days	–	1.8 (1.1 to 2.8)
>7 days	–	2.1 (0.95 to 4.7)

95% CI, 95% confidence interval; RR, risk ratio.

What is already known on this topic

- Chronic abdominal pain is common among schoolchildren and is a major cause of school absenteeism and medical care visits.
- Although a number of cross-sectional and case-control studies have identified some potential risk markers, there have been no longitudinal studies of the onset of chronic abdominal pain in children.

What this study adds

- The onset of chronic abdominal pain is more common in girls than in boys.
- In girls, future abdominal pain is predicted by prior report of headaches, whereas, in boys, adverse psychosocial factors, daytime tiredness and taller stature predict pain onset.

psychosocial problems are scarce and have been conducted in adults.[22][23] In the current study, psychosocial factors were predictive of CAP development in boys but not in girls. Lack of school enjoyment, which may be indicative of psychosocial problems, was an independent risk factor for CAP in boys but, again, showed no predictive role in girls. These results are inconsistent with the findings of Ghandour et al who found a higher prevalence of abdominal pain in adolescent girls who reported low psychosocial support.[24] However, girls' psychosocial wellbeing was not directly assessed in the current study. In addition, both studies differed in terms of design and pain measurement. It is acknowledged that psychosocial dysfunction plays an important, but poorly understood, role in the pathophysiology of functional abdominal pain in adults, either directly through interaction between the central and enteric nervous systems or indirectly though influencing pain experience and medical care consultation.[25][26] The potential gender-related differences found in the current study highlight the complexity that surrounds this relationship and needs further investigation.

In conclusion, our results suggest that new-onset CAP is common in adolescents, particularly among girls. Further, we have shown that although there are similarities, there are also differences in the predictors of CAP between boys and girls. Sex differences in pain mechanisms, perception, reporting and coping are well documented[27] and these differences might be stronger in adolescence, when biological, cognitive, psychological and social changes take place in boys and girls at different rates. Our results suggest that the two genders are also different with respect to risk factors for pain development, and these factors might indicate a possible mechanism for understanding the development of CAP, and might have important implications for both primary and secondary preventive strategies.

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REFERENCES
1 **Hotopf M**, Carr S, Mayou R, et al. Why do children have chronic abdominal pain, and what happens to them when they grow up? Population based cohort study. BMJ 1998;**316**:1196–200.
2 **Huang RC**, Palmer LJ, Forbes DA. Prevalence and pattern of childhood abdominal pain in an Australian general practice. J Paediatr Child Health 2000;**36**:349–53.
3 **Apley J**. The child with abdominal pains. Oxford: Blackwell Scientific, 1975.
4 **Howell S**, Poulton R, Talley NJ. The natural history of childhood abdominal pain and its association with adult irritable bowel syndrome: birth-cohort study. Am J Gastroenterol 2005;**100**:2071–8.
5 **Apley J**, Naish N. Recurrent abdominal pains: a field study of 1000 school children. Arch Dis Child 1958;**33**:165–70.
6 **American Academy of Pediatrics Subcommittee on Chronic Abdominal Pain and NASPGHAN Committee on Abdominal Pain**. Chronic abdominal pain in children. J Pediatr Gastroenterol Nutr 2005;**40**:245–8.
7 **Perquin CW**, Hazebroek-Kampschreur AAJM, Hunfeld JAM, et al. Pain in children and adolescents: a common experience. Pain 2000;**7**:51–8.
8 **Goodman R**. The Strengths and Difficulties Questionnaire: a research note. J Child Psychol Psychiatry 1997;**38**:581–6.
9 **Greenland S**. Model-based estimation of relative risks and other epidemiologic measures in studies of common outcomes and in case-control studies. Am J Epidemiol 2004;**160**:301–5.
10 **Rasquin-Weber A**, Hyman PE, Cucchiara S, et al. Childhood functional gastrointestinal disorders. Gut 1999;**45(Suppl II)**:1160–8.
11 **Macfarlane GJ**. Generalized pain, fibromyalgia and regional pain: an epidemiological view. Baillieres Best Pract Res Clin Rheumatol 1999;**13**:403–14.
12 **Goodman R**. Psychometric properties of the Strengths and Difficulties Questionnaire (SDQ). J Am Acad Child Adolesc Psychiatry 2001;**40**:1337–45.
13 **Muris P**, Meesters C, van den Berg F. The Strengths and Difficulties Questionnaire (SDQ): further evidence for its reliability and validity in a community sample of Dutch children and adolescents. Eur Child Adolesc Psychiatry 2003;**12**:1–8.
14 **Zuckerman B**, Stevenson J, Bailey V. Stomach aches and headaches in a community sample of preschool children. Pediatrics 1987;**79**:677–82.
15 **Aggarwal VR**, McBeth J, Zakrswezka JM, et al. The epidemiology of chronic syndromes that are frequently unexplained: do they have common associated factors? Int J Epidemiol 2006;**35**:468–76.
16 **Dimson SB**. Transit time related to clinical findings in children with recurrent abdominal pain. Pediatrics 1971;**47**:666–74.
17 **Halder SLS**, McBeth J, Silman AJ, et al. Psychosocial risk factors for the onset of abdominal pain. Results from a large prospective population-based study. Int J Epidemiol 2002;**31**:1219–25.
18 **Lee OY**, Mayer EA, Schmulson M, et al. Gender-related differences in IBS symptoms. Am J Gastroenterol 2001;**96**:2184–93.
19 **Macarthur C**, Saunders N, Feldman W, et al. Helicobacter pylori and childhood recurrent abdominal pain: community based case-control study. BMJ 1999;**319**:822–3.
20 **Walker LS**, Garber J, Greene JW. Psychosocial correlates of recurrent childhood pain: a comparison of pediatric patients with recurrent abdominal pain, organic illness, and psychiatric disorders. J Abnorm Psych 1993;**102**:248–58.
21 **Hodges K**, Kline JJ, Barbero G, et al. Depressive symptoms in children with recurrent abdominal pain and in their families. J Pediatr 1985;**107**:622–6.
22 **Drossman DA**, Creed FH, Olden KW, et al. Psychosocial aspects of the functional gastrointestinal disorders. Gut 1999;**45(Suppl 2)**:II25–30.
23 **Ringel Y**, Sperber AD, Drossman DA. Irritable bowel syndrome. Annu Rev Med 2001;**52**:319–8.
24 **Ghandour RM**, Overpeck MD, Huang ZJ, et al. Headache, stomach ache, tiredness, and feeling low: associations of somatic symptoms with biological and psychosocial factors in US teenage girls. Arch Pediatr Adolesc Med 2004;**158**:797–803.
25 **Di Lorenzo C**. Abdominal pain: is it in the gut or in the head. J Pediatr Gastroenterol Nutr 2005;**41(Suppl 2)**:S44–6.
26 **Whitehead WE**, Bosmajian L, Zonderman AB, et al. Symptoms of psychologic distress associated with irritable bowel syndrome: comparison of community and medical clinic samples. Gastroenterology 1988;**95**:709–14.
27 **Berkley K**. Sex differences in pain. Behav Brain Sci 1997;**20**:371–80.