

Bullying involvement in primary school and common health problems

D Wolke, S Woods, L Bloomfield, L Karstadt

Abstract

Aims—To examine the association of direct (e.g. hitting) and relational (e.g. hurtful manipulation of peer relationships) bullying experience with common health problems.

Methods—A total of 1639 children (aged 6–9 years) in 31 primary schools were studied in a cross sectional study that assessed bullying with a structured child interview and common health problems using parent reports. Main outcome measures were common physical (e.g. colds/coughs) and psychosomatic (e.g. night waking) health problems and school absenteeism.

Results—Of the children studied, 4.3% were found to be direct bullies, 10.2% bully/victims (i.e. both bully and become victims), and 39.8% victims. Direct bully/victims, victims, and girls were most likely to have physical health symptoms (e.g. repeated sore throats, colds, and coughs). Direct bully/victims, direct victims, and year 2 children were most likely to have high psychosomatic health problems (e.g. poor appetite, worries about going to school). Pure bullies (who never got victimised) had the least physical or psychosomatic health problems. No association between relational bullying and health problems was found.

Conclusions—Direct bullying (e.g. hitting) has only low to moderate associations with common health problems in primary school children. Nevertheless, health professionals seeing children with repeated sore throat, colds, breathing problems, nausea, poor appetite, or school worries should consider bullying as contributory factor.

(Arch Dis Child 2001;85:197–201)

Department of
Psychology, University
of Hertfordshire,
DWRU, College Lane,
Hatfield, Herts
AL10 9AB, UK
D Wolke
S Woods
L Bloomfield

Department of
Midwifery and Child
Nursing, University of
Hertfordshire
L Karstadt

Correspondence to:
Prof. Wolke
D.F.H.Wolke@herts.ac.uk

Accepted 14 May 2001

Keywords: bullying; health problem; primary school

Approximately 8–46% of children^{1–4} experience being bullied in primary school. Adverse effects of peer victimisation on psychological maladjustment such as anxiety, depressive feelings, low self esteem, or loneliness have been found in studies of predominantly secondary school children.^{5–7} In contrast, there is a dearth of research on the relation of bullying experiences and common health complaints⁸ and school absenteeism. Williams *et al* found that 9–10 year olds who reported common health problems such as tummy aches or sleeping problems also reported being victims of bullying two to four times more frequently.⁸ However, as

the informants on bullying and health problems were the children, often in the presence of their parents, the effects may have been inflated.⁵ There may be a tendency for victims to exaggerate adverse effects.⁷ Recent research indicates that a proportion of victims are also bullies at other times (bully/victims^{2 4 9}) and have been reported to differ significantly from “pure” bullies in their behaviour.^{10–12} They should be considered separately from pure victims or pure bullies. Finally, little is known about the adverse effects of more subtle forms of victimisation on common health complaints involving the hurtful manipulation of peer relationships and friendships, often called relational bullying^{4 13 14} compared to direct bullying comprising physical (hitting) or direct verbal (threats) aggression.

We investigated the association of bullying involvement among 6–9 year old primary school children, assessed with a structured private interview by postgraduate psychologists, to parent reports of common health complaints and school records of school absenteeism.

Participants and methods

PARTICIPANTS

All 2201 children and their parents in 78 classes in 31 primary schools were approached for consent. For 107 children (5.4%) parents declined permission and a further 112 (5.7%) were not present on the days of interviewing. Total participation rate for the interviews was thus 88.9% (n = 1982). The age ranged from 6 to 9 years with an average age of 7.6 (SD 1.0) years (year 2: 6.7 (SD 0.6) years; year 4: 8.3 (SD 0.6) years). A total of 51.4% were male and 49.6% female; 8.9% of children were from ethnic minorities.

Ethical approval for the study was granted by the University of Hertfordshire Ethical Committee.

METHODS

Bullying interview

Children were individually interviewed between 1996 and 1998 using a standard bullying interview complying with the criteria stipulated by Olweus.¹⁵ It consisted of six questions about direct bullying experiences at school, four questions relating to relational bullying at school, and two questions about whether the children had directly or relationally bullied other children in the last six months.¹⁰ Frequency of bullying experience was rated in three categories: not at all/seldom (one to three times during half a year), frequently (more than four times during half a year), and very frequently (at least once a week).

Health questionnaire

Parents completed a health questionnaire with two sections: (a) seven items about physical health problems (PHP) over the previous six months rated on a seven point scale (none to six or more times) (headache, tummy ache, sore throat/ear ache, cold/cough, feeling sick, breathing problems, skin problems); and (b) seven items about psychosomatic health problems¹⁶ (PsHP) rated according to a five point scale (never to most days) (bed wetting, problems going to sleep, nightmares, woken in the night, poor appetite, excessive appetite, worried about going to school). Furthermore, parents were asked whether they ever felt that the child made up illnesses (never versus sometimes to often). School absenteeism data were obtained from parent reports and the school register for the previous six months.

STATISTICAL ANALYSIS

According to the interview, children were classified into the following groups^{1, 4} for direct bullying and relational bullying, separately: bullies (B) (children who were involved in bullying others frequently or every week but are never or only seldom victimised); victims (V) (children who experienced victimisation frequently or every week but bully others seldom or never); bully/victims (B/V) (children who both bully others and become victims frequently or every week); and neutrals (N) who neither bully others or become victims (never or seldom only). Analysis was carried out using SPSS/PC (version 10). Dropouts were compared to participants using cross tabulations.¹⁷ Item distributions of the PHP and PsHP were skewed. To gain a more symmetrically distributed total PHP and PsHP score, each rating of two or more times occurrence on each item in the previous six months was assigned a value of 1. PHP and PsHP item scores were then totalled separately. Differences in total physical (PHP) and psychosomatic health problems

(PsHP), and bullying classification (independent factor levels: B, B/V, V, N) were analysed using one way analysis of variance for direct and relational groups separately. Contrasts were computed using a posteriori Tukey–HSD test. Logistic regression analysis (all independent factors entered at the same time) were carried out to determine best prediction of highly increased total PHP and PsHP scores defined as the number of health problems above the 90th percentile (PHP: more than four symptoms; PsHP: more than three symptoms) and school absenteeism above the 90th percentile (parental: more than nine days; school register: more than 11 days). Predictor variables were: (a) relational bullying status (reference category: neutrals); (b) direct bullying status (reference category: neutrals); (c) gender: girls versus boys; (d) age: year 2 versus year 4; and (e) ethnic minority: ethnic minority versus white English.

Results

FINAL SAMPLE AND THE PREVALENCE OF BULLYING

Of the 1982 children who had interviews, 1639 parents returned the health questionnaire (82.7% return rate). No differences between participants ($n = 1639$) and dropouts ($n = 343$) were found according to school year or ethnicity of the children (table 1). However, slightly more parents of girls than boys returned questionnaires (<2% difference) ($\chi^2(1, n = 1982) = 11.59, p < 0.001$; table 1). Table 2 shows the prevalence of children who were involved in bullying.

DIRECT AND RELATIONAL BULLYING AND TOTAL HEALTH PROBLEMS

Significant differences between direct bullies, victims, bully/victims, and neutral children and total physical health symptoms were revealed ($F(3, 1561) = 4.18, p < 0.01$; fig 1). A posteriori contrasts (Tukey–HSD test) indicated that victims had significantly more physical health problems than bullies ($p < 0.05$) and neutral children ($p < 0.05$) but were not different from bully/victims (victims: mean 3.70, 95% CI 3.58 to 3.83; bullies: mean 3.08, 95% CI 2.63 to 3.53; neutral: mean 3.47, 95% CI 3.35 to 3.59).

Significant differences for direct bullying groups on total psychosomatic health symptoms was found: ($F(3, 1628) = 5.03, p < 0.01$; fig 1). A posteriori contrasts (Tukey–HSD test) indicated that direct victims ($p < 0.05$) had significantly more psychosomatic health symptoms than neutral children (victims: mean 2.34, 95% CI 2.22 to 2.46; neutral: mean 2.10, 95% CI 1.99 to 2.21). No differences between involvement in relational bullying and total PHP and PsHP scores were found.

CHILDREN INVOLVED IN BOTH DIRECT AND RELATIONAL BULLYING

Children who were involved in both types of bullying behaviour—that is, direct bullies, bully/victims, or victims, and also relational bullies, bully/victims, or victims ($n = 499$ –517, some missing scores for PHP) were compared

Table 1 Sample data

	Total group ($n = 1982$)	Returned questionnaires ($n = 1639$)	% returned (82.7)
Year group			
Year 2	886 (44.7%)	722 (44.1%)	81.5
Year 4	1096 (55.3%)	917 (55.9%)	83.7
Gender*			
Male	1019 (51.4%)	814 (49.7%)	79.9
Female	963 (48.6%)	825 (50.3%)	85.7
Ethnicity			
White	1805 (91.1%)	1500 (91.5%)	83.1
Other	177 (8.9%)	139 (8.5%)	78.5

* $\chi^2 = 11.59, df(1), p < 0.001$.

Table 2 Prevalence of children involved in direct or relational bullying ($n = 1639$)

	Bully	Bully/victim	Victim	Neutral
Direct bullying				
Total*	70 (4.3%)	167 (10.2%)	653 (39.8%)	748 (45.6%)
Boys	47 (5.8%)	122 (15.0%)	339 (41.6%)	306 (37.6%)
Girls	23 (2.8%)	45 (5.5%)	314 (38.1%)	442 (56.7%)
Relational bullying				
Total†	18 (1.1%)	96 (5.9%)	622 (37.9%)	901 (55.0%)
Boys	14 (1.7%)	58 (7.1%)	297 (36.5%)	444 (54.7%)
Girls	4 (0.5%)	38 (4.6%)	325 (39.4%)	457 (55.4%)

Results expressed as n (%).

*One child had missing data; †two children had missing data.

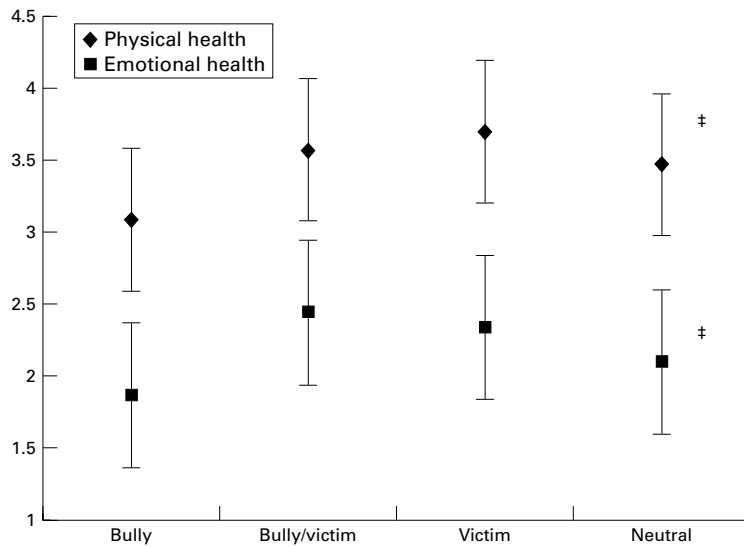


Figure 1 Average total health problems for children involved in direct bullying.

with children who were not involved in either type of bullying—that is, direct neutrals and relational neutrals (n = 510–531), children who were involved in direct bullying only (n = 349–365), and children involved in relational bullying only (n = 510–531). No significant differences between involvement in both types of bullying behaviour on total physical health symptoms (PHP) was found (F (3, 1560) = 1.29, p = 0.28) (both types of bullying involvement: mean 3.62, 95% CI 3.47 to 3.76; direct only: mean 3.65, 95% CI 3.48 to 3.83;

Table 3 Logistic regression of relational and direct bullying on total physical health problems (>90th percentile) controlling for gender, school year, and ethnic minority (n = 1560)

	Wald	df	Sig.	Adjusted odds ratio	95% CI for adjusted odds ratio	
					Lower	Upper
Relational bullying	3.62	3	0.31			
Bully (1)	0.97	1	0.33	0.52	0.15	1.90
Victim (2)	0.00	1	0.95	1.00	0.80	1.27
Bully/victim (3)	2.56	1	0.11	0.65	0.38	1.10
Direct bullying	8.30	3	0.04			
Bully (1)	0.12	1	0.73	1.11	0.63	1.95
Victim (2)	5.48	1	0.02	1.34	1.05	1.70
Bully/victim (3)	5.62	1	0.02	1.62	1.09	2.43
Gender (girl)	8.87	1	0.00	1.39	1.12	1.72
School year (year 2)	1.16	1	0.28	0.89	0.72	1.10
Ethnic minority	0.00	1	0.97	1.01	0.68	1.45
Constant	9.71	1	0.00	0.52		

Full model: χ^2 (9, n = 1560) = 19.65, p = 0.02.

Table 4 Logistic regression of relational and direct bullying on total psychosomatic health problems (>90th percentile) controlling for gender, school year, and ethnic minority (n = 1627)

	Wald	df	Sig.	Adjusted odds ratio	95% CI for adjusted odds ratio	
					Lower	Upper
Relational bullying	3.30	3	0.347			
Bully (1)	0.00	1	0.958	0.97	0.31	3.03
Victim (2)	3.05	1	0.081	1.25	0.97	1.61
Bully/victim (3)	0.77	1	0.381	1.26	0.75	2.10
Direct bullying	7.66	3	0.054			
Bully (1)	0.10	1	0.752	1.10	0.60	2.03
Victim (2)	6.01	1	0.014	1.39	1.07	1.80
Bully/victim (3)	4.25	1	0.039	1.55	1.02	2.36
Gender (girl)	0.00	1	0.988	1.00	0.79	1.27
School year (year 2)	5.59	1	0.018	1.32	1.05	1.66
Ethnic minority (1)	0.54	1	0.462	1.16	0.78	1.75
Constant	40.39	1	0.000	0.24		

Full model: χ^2 (9, n = 1627) = 23.09, p = 0.006.

relational only: mean 3.47, 95% CI 3.24 to 3.70; neutral: mean 3.47, 95% CI 3.32 to 3.61).

In contrast, significant differences between involvement in both types of bullying behaviour on total psychosomatic health symptoms (PsHP) was found (F (3, 1627) = 3.44, p < 0.05). A posteriori contrasts (Tukey–HSD test) indicated that children involved in both direct and relational bullying had significantly more psychosomatic health problems than neutral children (p < 0.01) (both types: mean 2.36, 95% CI 2.22 to 2.50; direct only: mean 2.27, 95% CI 2.11 to 2.43; relational only: mean 2.20, 95% CI 1.99 to 2.41; neutral: mean 2.06, 95% CI 1.92 to 2.19).

FACTORS PREDICTING A HIGH AMOUNT OF HEALTH SYMPTOMS AND SCHOOL ABSENTEEISM

The logistic regression model for predicting high physical health problems was significant (χ^2 (9, n = 1560) = 19.65, p = 0.02; table 3). Girls (adjusted odds ratio 1.39, 95% CI 1.12 to 1.72), direct bully/victims (adjusted odds ratio 1.62, 95% CI 1.09 to 2.43), and victims (adjusted odds ratio 1.34, 95% CI 1.05 to 1.70) were most likely to have high physical health symptoms (PHP).

The full model for predicting high psychosomatic health symptoms (PsHP) was also significant (χ^2 (9, n = 1627) = 23.09, p = 0.006; table 4). Direct bully/victims (adjusted odds ratio 1.55, 95% CI 1.02 to 2.36), direct victims (adjusted odds ratio 1.39, 95% CI 1.07 to 1.80), and year 2 children (adjusted odds ratio 1.32, 95% CI 1.05 to 1.66) were more likely to have a high level of psychosomatic health symptoms.

School register and parental reports of absenteeism correlated at $r_s = 0.63$ (Spearman rank correlation; p < 0.001). Children’s absenteeism from school reported either by the parents (full model χ^2 (9, n = 1423) = 11.05, p = 0.272) or extracted from the school attendance records (full model χ^2 (9, n = 1480) = 15.50, p = 0.078) was not significantly predicted by bullying involvement

BULLYING EXPERIENCE AND CLINICALLY RELEVANT INDIVIDUAL HEALTH SYMPTOMS

To determine which individual health symptoms were more frequently reported by parents for direct victims or bully/victims, the individual physical and psychosomatic health items were dichotomised: if repeated symptoms in the last six months were experienced by less than 10% of the total sample (item score >90th percentile), the health problem was considered as clinically significant. Table 5 shows the significant cross tabulations between bullying group and clinically relevant health symptoms. Direct victims and bully/victims had significantly more often repeated sore throats, colds or coughs, breathing problems, nausea, and poor appetite. They were also more often worried about going to school and were more likely to make up illnesses to stay at home during school days.

Table 5 Association of individual health items (frequent symptoms) to direct bullying status ($n = 1560-1628$)

Health item (symptoms last 6 months)	Bully	Direct bullying status		
		Bully/victim	Victim	Neutral
Sore throat (4 times or more)***	2/65 (3.1%)	10/160 (6.3%)	70/623 (11.2%)	48/713 (6.7%)
Cold/coughs (4 times or more)*	2/65 (3.1%)	14/160 (8.8%)	58/623 (9.3%)	39/713 (5.5%)
Breathing problems (3 times or more)*	3/65 (4.6%)	15/160 (9.4%)	57/623 (9.1%)	38/713 (5.3%)
Nausea (4 times or more)**	7/65 (10.8%)	23/160 (14.4%)	79/623 (12.7%)	50/713 (7.0%)
Poor appetite (once a week or more)*	6/69 (8.7%)	14/165 (8.5%)	53/648 (8.2%)	35/746 (4.7%)
Worried about school (once a month or more)**	8/69 (11.6%)	23/165 (13.9%)	107/648 (16.5%)	74/746 (9.9%)
Made up illnesses (sometimes/often)**	18/65 (27.7%)	53/160 (33.1%)	237/623 (38.0%)	209/713 (29.3%)

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

Discussion

Our results indicate that direct and relational bullying behaviour are widespread at primary school age. Direct bullying victimisation, but not relational bullying was associated to both physical and psychosomatic health problems, although the associations were weaker than previously reported by Williams and colleagues.⁸ This is likely to be accounted for by methodological factors. Firstly, the interview carried out by school nurses was unstandardised and occurred during a routine health assessment.⁸ Secondly, children were the informants for both bullying and health problems recorded by school nurses.⁸ This is likely to have led to overestimations of the effects of victimisation on common health problems as noted in previous research on the relation between bullying experience and psychological problems.⁵ In contrast, in the present study children reported bullying in a highly structured standard interview and a different data source, the parents, reported on health problems; both parents and school records provided data on school absenteeism. However, despite the differences in strength of associations compared to Williams and colleagues,⁸ victimisation is related to health problems at primary school age.

“Pure” bullies (i.e. those children who do not become victims themselves at other times) have been reported to be either stronger^{4, 19} or to have superior social understanding and insight of how best to manipulate and dominate other children.^{20, 21} Victims are often smaller in height,²² and boys who are victims are often physically weaker¹⁹ than same aged peers. Findings here suggest that pure bullies are also healthier compared to victims or bully/victims and even neutral children. Pure bullies appear to have a constitution and characteristics that allow them to be dominant in peer relations.^{4, 5} Findings here and elsewhere also do not support the view that pure bullies are worried, depressed, or anxious individuals.^{7, 10, 11, 23} Rather bully/victims and victims are at an increased risk for health problems as shown here. Those who become victims of bullying, including those who also bully at other times (bully/victims) are also at the highest risk for behaviour and psychiatric problems.^{10, 11} In future research and clinical practice it is thus necessary to distinguish between pure bullies, versus victims and bully/victims. The physical or social cognitive²¹ advantages that “pure” bullies possess may be able to be channelled into more appropriate behaviours, for example,

Key messages

- Bullying is widespread among primary school children. Many bullies are also victims of bullying
- At primary school age, the effects of bullying on health and school absenteeism are less strong than reported for secondary school children
- “Pure” bullies are healthier children compared to victims and bully/victims, suggesting that they have a constitution that allows them to be dominant in inappropriate ways
- Health professionals seeing children with repeated sore throat, colds and coughs, breathing problems, nausea, poor appetite or worries about going to school should consider bullying as contributory factor

by providing a leadership role in peer support or sport activities rather than bullying.

No association between bullying involvement and school absenteeism was found. This is in contrast to previous reports for secondary school students where up to 20% of students stated that they would truant to avoid being bullied.²⁴ Primary school children are more likely to make up illnesses to try to stay at home rather than play truant. Health problems and staying absent from school may increase with persistent victimisation that continues into secondary school.²⁴ Breaking the cycle of victimisation during the early primary school years before some children become chronic victims or bully/victims may help prevent persistent health, behaviour, and truancy problems.

To detect bully victimisation early, health practitioners, parents, and teachers should consider bullying as a contributory factor when children present repeatedly with sore throats, colds and coughs, nausea, appetite problems, or are worried about going to school.

The research was supported by grant No. R000 222563 (<http://www.regard.ac.uk>) from the Economic and Social Research Council (ESRC) and a primer grant of the University of Hertfordshire Faculty of Health and Human Sciences. Special thanks to Katherine Stanford and Anna Marsden who contributed to the data collection and the teachers, children, and their parents for their participation.

1 Whitney I, Smith PK. A survey of the nature and extent of bullying in junior/middle and secondary schools. *Educ Res* 1993;35:3-25.

2 Austin S, Joseph S. Assessment of bully/victim problems in 8 to 11 year olds. *Brit J Educ Psychol* 1996;66:447-56.

- 3 Bentley KM, Li AKF. Bully and victim problems in elementary schools and students' beliefs about aggression. *Can J School Psychol* 1995;11:153-65.
- 4 Wolke D, Stanford K. Bullying in school children. In: Messer D, Millar S, eds. *Developmental psychology*. London: Arnold, 1999:341-60.
- 5 Hawker DJS, Boulton MJ. Twenty years' research on peer victimization and psychosocial adjustment: a meta-analytic review of cross-sectional studies. *J Child Psychol Psychiatry* 2000;41:441-56.
- 6 Stanley L, Arora T. Social exclusion amongst adolescent girls: their self-esteem and coping strategies. *Educ Psychol Pract* 1998;14:94-100.
- 7 Salmon G, James A, Smith DM. Bullying in schools: self reported anxiety, depression, and self esteem in secondary school children. *BMJ* 1998;317:924-5.
- 8 Williams K, Chambers M, Logan S, Robinson D. Association of common health symptoms with bullying in primary school children. *BMJ* 1996;313:17-19.
- 9 Boulton MJ, Smith PK. Bully/victim problems in middle-school children: stability, self-perceived competence, peer perceptions and peer acceptance. *Brit J Dev Psychol* 1994;12:315-29.
- 10 Wolke D, Woods S, Bloomfield L, Karstadt L. The association between physical and relational bullying and behaviour problems among primary school children. *J Child Psychol Psychiatry* 2000;41:989-1002.
- 11 Kumpulainen K, Räsänen E, Henttonen I, et al. Bullying and psychiatric symptoms among elementary school-age children. *Child Abuse Negl* 1998;22:705-17.
- 12 Mynard H, Joseph S. Bully/victim problems and their association with Eysenck's personality dimensions in 8 to 13 years olds. *Brit J Educ Psychol* 1997;67:51-4.
- 13 Craig WM. The relationship among bullying, victimization, depression, anxiety and aggression in elementary school children. *Personality and Individual Differences* 1998;24:123-30.
- 14 Crick NR, Grotpeter JK. Children's treatment by peers: victims of relational and overt aggression. *Dev Psychopathol* 1996;8:367-80.
- 15 Olweus D. Norway. In: Smith PK, Morita Y, Junger-Tas J, et al, eds. *The nature of school bullying: a cross-national perspective*. London: Routledge, 1999:28-48.
- 16 Ewles L, Simnett I. *Promoting health: a practical guide*. Edinburgh: Bailliere Tindall, 1999.
- 17 Wolke D, Söhne B, Ohrt B, Riegel K. Follow-up of preterm children: important to document dropouts. *Lancet* 1995;345:447.
- 18 Cohen J. *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Lawrence Erlbaum Associates, 1988.
- 19 Olweus D. *Aggression in schools: bullies and whipping boys*. New York: John Wiley and Sons, 1978.
- 20 Sutton J, Smith PK, Swettenham J. Bullying and 'theory of mind': a critique of the 'social skills deficit' view of anti-social behaviour. *Soc Dev* 1999;8:117-27.
- 21 Sutton J, Smith PK, Swettenham J. Social cognition and bullying: social inadequacy or skilled manipulation? *Br J Dev Psychol* 1999;17:435-50.
- 22 Voss LD, Mulligan J. Bullying in school: are short pupils at risk? Questionnaire study in a cohort. *BMJ* 2000;320:612-13.
- 23 Slee PT. Bullying: health concerns of Australian secondary school students. *Int J Adolesc Youth* 1995;5:215-24.
- 24 Sharp S. How much does bullying hurt? The effects of bullying on the personal wellbeing and educational progress of secondary aged students. *Educ Child Psychol* 1995;12:81-8.

Mannose binding lectin

Mannose binding lectin (MBL) is a protein present in serum that is thought to play an important part in innate, non-specific immunity. It is, therefore, likely to be particularly important in young children before they have developed specific, exposure induced immunity. The gene (*MBL2*) which encodes for this protein is on chromosome 10. Three variant alleles are known and heterozygotes have 10-20% of normal serum MBL concentrations. There are also variant polymorphisms in the promoter region of the gene which affect serum concentrations of MBL. Danish researchers (Anders Koch and colleagues. *JAMA* 2001;285:1316-21) have studied the MBL genotypes and susceptibility to acute respiratory infection of 252 children under the age of 2 years in Greenland.

Thirteen of the children (5%) had MBL insufficient genotypes and the risk of acute respiratory tract infections, diagnosed by history and clinical examination, was doubled in these 13 compared with the other 239. The increase in risk was significant only in the 6-17 month age group. The prevalence of MBL insufficient genotypes in this population (81% Eskimo) is thought to be less than in many other populations.

The innate immune system is particularly important in young children and mannose binding lectin is one component of it.

ARCHIVIST