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Free Running Asthma Screening Test

J N TSANAKAS, R D G MILNER, O M BANNISTER, AND A W BOON

Department of Paediatrics, Sheffield University, and Children's Hospital, Sheffield

SUMMARY The free running asthma screening test (FRAST) was evaluated in 503 Sheffield schoolchildren aged 6 to 12 years and compared with responses to an asthma questionnaire. The FRAST measured peak expiratory flow rate (PEFR) before and at 1, 5, and 10 minutes after maximum voluntary running for at least 5 minutes in a standardised environment. A fall in PEFR of >15% in at least two postexercise readings was defined as abnormal. Six (1%) children did not do the test and 69 (14%) failed to complete it. Of these, 14 were known asthmatics, 18 were not testable, and 37 were normal when retested. There were 14 abnormal FRAST results among 412 'normal' children who completed the test and 10 of these were subsequently diagnosed asthmatic. None of 14 children with an abnormal FRAST result had been identified as wheezy, chesty, or asthmatic in the questionnaire. In this sample there was, on average, one child in every school class with unrecognised exercise induced bronchospasm. The FRAST is an acceptable, feasible, and cost effective way of identifying such potential asthmatics at school.

Screening tests for childhood asthma could improve the management of a condition that is currently underdiagnosed and undertreated.[1 2] Relatively few 'campaigns against asthma' have been undertaken in children, however,[3 4] mainly because no simple objective method for assessing wheezing illness in the community has been available.[5] Screening for asthma by questionnaire may be informative but is inevitably subjective. Provocation tests using bronchoconstrictor drugs or formal exercise protocols are objective, but they are not feasible in a community setting. The free running test is generally considered to be the most bronchoconstrictive of the various exercise challenges and is appropriate for field use.[6 7] In the present study we have applied the free running test to a large sample of schoolchildren to determine its value as a screening test for wheezing illness in childhood and have compared the results with response to an asthma questionnaire.

Subjects and methods

A standardised exercise test called the Free Running Asthma Screening Test (FRAST) was applied to a sample of schoolchildren aged 6 to 12 years over a six week period during the pollen season (April-May 1985). The children and their parents were informed in advance about the nature, purpose, and date of the test. At the same time written parental consent was requested and a questionnaire seeking details of general health and with special reference to asthma and any other past or recent chest illness was completed. Roughly one week before the test the height of most of the children was measured by JNT at school using a Microtoise tape.[8] On the day of the test the children were taken, one class at a time, by bus to a hospital gymnasium where the ambient temperature was 16–20°C and the relative humidity was 37–44%.[9] The children were instructed not to exercise on the day of the test and to take their medications, if any, as usual. Children who did not have parental consent or who where unwilling to participate were excluded.

In the FRAST the children were instructed to run as quickly as possible for six minutes.[10] Peak flow (PEFR, best of three efforts) was recorded for each child by OMB using a Wright peak flow meter immediately before the test and at 1, 5, and 10 minutes after the run. Heart rate during running was monitored in alternate children with a telemetric device whose characteristics have been described previously.[11] All children monitored exceeded a rate of 170/minute. The children ran in groups of nine to 12 at a time and were observed and encouraged by a school teacher who recorded their running time. Children had to complete at least five minutes' intense running to be acceptable.[12] Those showing evidence of bronchoconstriction at the end of the run were closely observed by a doctor (JNT).

Bronchospasm causing distress, which was severe or persisted for more than 10 minutes, was treated with bronchodilators. An abnormal response to the FRAST was defined as a reduction in the postexercise peak flow of more than 15% of the pre-exercise value on at least two occasions. Children who failed to complete the FRAST and who were not asthmatic nor had an obvious reason (for example, incoordination) were asked to repeat the test on another day.

Results

ANALYSIS OF QUESTIONNAIRE

Questionnaires were completed satisfactorily on all 509 children who made up the original sample. The question 'Does your child ever wheeze?' produced 52 positive answers. Of these, 36 (7%) children were deemed to be asthmatic because they also answered 'yes' to the question 'Has your child wheezed during the last 12 months?,' and reported that they had 'wheezy bronchitis,' 'asthma,' or 'chestiness.'

Table 1 *Age, sex, and asthma state of the 509 children asked to participate in the Free Running Asthma Screening Test*

	Age (years)						
	6	*7*	*8*	*9*	*10*	*11*	*12*
				Boys			
Total	12	53	46	49	37	64	9
With asthma	1	4	6	5	2	4	0
				Girls			
Total	7	27	44	31	27	57	10
With asthma	0	4	2	3	1	3	1

ANALYSIS OF FRAST

The age and sex of the 509 children are shown in table 1. Parental consent was refused in three cases and three children were absent on the test day (fig 1). In the 503 tests performed, 69 children failed to complete the test of whom 14 were said to be asthmatic. In the remaining 55 failure to complete the test was explicable in 18 cases. Explanations included incoordination, ingrowing toe nails, arm in plaster, and wilful non-cooperation. When the remaining 37 children were retested their FRAST was normal.

There were 22 children said to be asthmatic among the 434 who completed the FRAST. Of these half had an abnormal response. Among the remaining 412 supposedly healthy children there were 14 abnormal FRAST tests. None of the 14 children with positive tests had had a recent upper respiratory tract infection. They had no symptoms but had abnormal signs when screened. Retrospective examination of the questionnaires of these 14 children

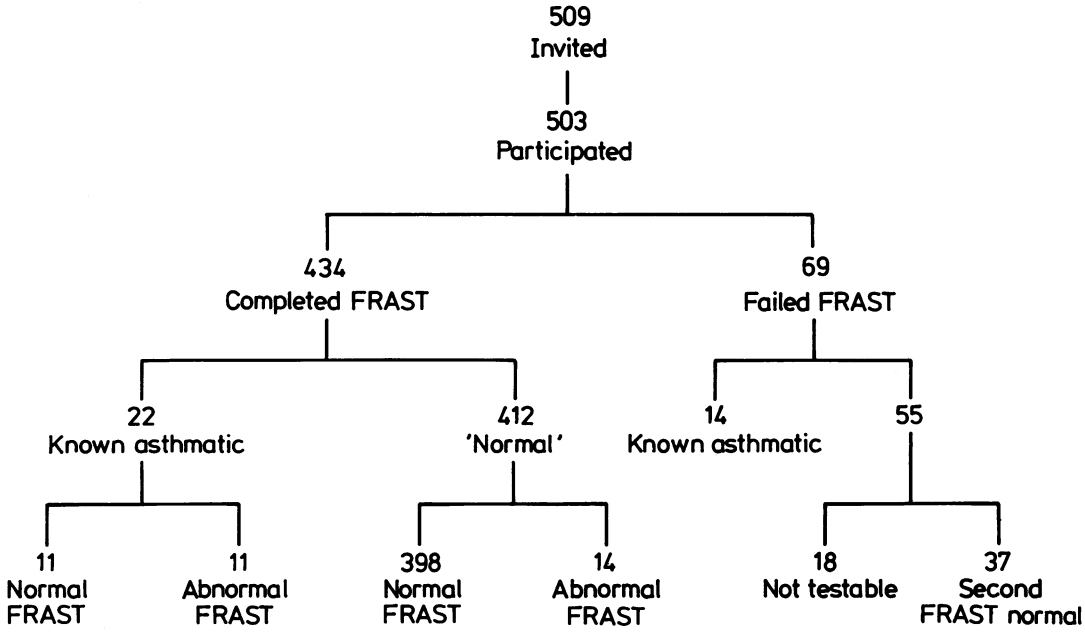

Fig 1 *Response of the 509 schoolchildren who were invited to perform the Free Running Asthma Screening Test (FRAST).*

confirmed that none had responded positively to asthma related questions, but three were reported as having had an allergy and two had relatives with asthma. The results of the 412 subjects were then analysed to determine how many tests would have been abnormal had a cut off point of 10% or 20% peak flow reduction been applied and the answers were 37 and 10, respectively.

ANALYSIS OF PEAK FLOW BEFORE FRAST

In table 2 the mean PEFR of all 471 children whose height had also been measured is shown subdivided by sex and age. The linear regression equations relating PEFR to height (H) for (a) all children, (b) all children excluding asthmatics, and (c) all children excluding asthmatics and those with abnormal FRAST results were:

(a) PEFR=4·1H−286 (n=471, r=0·73)
(b) PEFR=4·1H−291 (n=435, r=0·73)
(c) PEFR=4·1H−296 (n=421, r=0·73).

Using equation (a) the predicted PEFR for each child was calculated and then the actual PEFR was converted to a standard deviation score using the relevant PEFR standard deviation for age and sex. The mean standard deviation scores for all 471 children did not differ significantly from 0 (fig 2) and more importantly neither did the mean (SD) standard deviation score of the asthmatic children: −0·25 (0·96) nor that of the children with abnormal FRAST: +0·12 (1·04).

ANALYSIS OF PEAK FLOW AFTER FRAST

Detailed analysis of the postexercise PEFR in the 14 children with abnormal FRAST results showed that all had an abnormally low PEFR at 5 and 10 minutes but only five were abnormal 1 minute after exercise. Three required nebulised bronchodilator treatment between 5 and 10 minutes and eight more were given bronchodilators by inhaler after 10 minutes. Therefore all these children would have been identified on either a 5 or a 10 minute PEFR alone. Ten of the 412 normal children, however, had an abnormal PEFR at 5 minutes and three others were abnormal at 10 minutes.

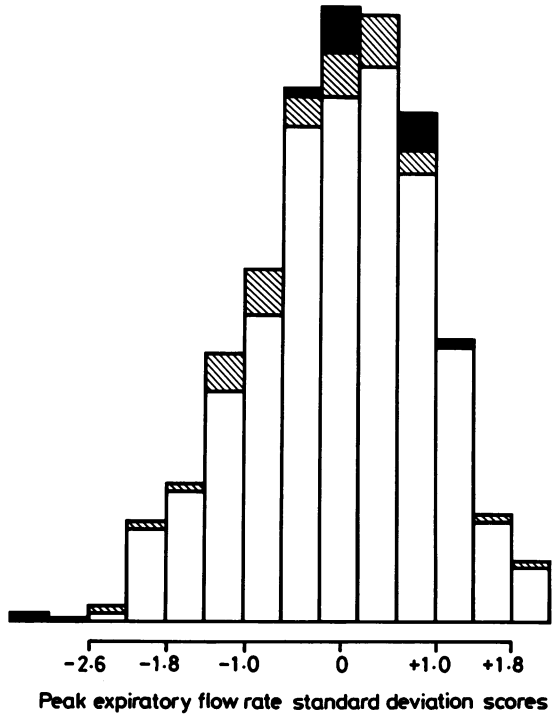

Fig 2 *Distribution of peak expiratory flow rate results of 471 Sheffield children aged 6 to 12 years expressed as standard deviation scores. Children with an abnormal Free Running Asthma Screening Test response are indicated by black areas and known asthmatics by hatched areas.*

Table 2 *Mean (SD) height and peak expiratory flow rate (PEFR) of 471 of the children who completed the Free Running Asthma Screening Test subdivided by age and sex*

	Age (years)						
	6	*7*	*8*	*9*	*10*	*11*	*12*
				Boys			
	(n=12)	(n=54)	(n=44)	(n=47)	(n=37)	(n=66)	(n=8)
Height (cm)	121·1 (6·0)	124·5 (6·0)	128·3 (5·8)	134·4 (6·1)	142·1 (5·4)	144·8 (7·1)	152·3 (9·4)
PEFR (1 minute)	207·5 (37·0)	221·3 (44·0)	224·5 (42·0)	271·1 (49·7)	299·3 (45·9)	307·9 (55·3)	338·7 (67·8)
				Girls			
	(n=7)	(n=26)	(n=44)	(n=30)	(n=27)	(n=59)	(n=10)
Height (cm)	120·0 (5·4)	123·6 (7·4)	128·3 (6·0)	132·5 (4·8)	141·9 (5·6)	144·7 (6·3)	153·2 (6·4)
PEFR (1 minute)	199·2 (32·3)	218·2 (36·0)	231·1 (38·3)	240·0 (43·0)	311·8 (47·7)	308·8 (47·7)	355·0 (52·7)

Discussion

There is a need to identify children who may suffer from asthma but not know it. Most known asthmatic children have exercise induced bronchospasm[13] and for this reason we studied the feasibility of screening children at school for exercise induced bronchospasm as a marker of childhood asthma and compared this with response to a parental questionnaire that has been shown previously to have good diagnostic precision.[2] The FRAST was created as a standardised test that can be performed in a normal school environment and which as a good chance of detecting unrecognised asthma.

In the present study the parents and schoolteachers cooperated enthusiastically even though a national teaching dispute was in progress at the time. The drop out rate before the test was very low (1%). To ensure a standard environment all tests were performed in a hospital gymnasium, which meant bussing the children to and from school, but there is no reason why the test should not take place in the school gymnasium or assembly hall. The apparatus required is modest and only a clock timer, a peak flow meter, mouth pieces, and facilities for giving bronchodilator treatment are needed. Not fewer than three adults were present when the tests were performed: a school teacher, physiotherapist, and a doctor, and our experience indicates that this is the minimum needed to screen ethically and accurately.

The pattern of free running used in the FRAST ensured a high sustained submaximal workload as judged by heart rate monitoring in 240 of the 503 children tested.[11] The children with heart rate monitors could not be distinguished from the rest during exercise. The choice of 1, 5, and 10 minutes as the times for measuring PEFR after exercise was based on previous work.[14] Examination of the results retrospectively showed that the discriminating power of the postexercise PEFR increased with time. The 1 minute PEFR result was useless in identifying children with exercise induced bronchospasm whereas the 5 and 10 minute PEFR results were both subnormal in every case. If the 5 minute PEFR result had been used alone, however, there would have been a 42% false positive rate and if the 10 minute PEFR result had been used alone there would have been a 18% false positive rate. Furthermore some of the previously unrecognised asthmatic children deteriorated between 5 and 10 minutes after exercise. Three needed nebulised bronchodilator treatment before 10 minutes and eight more required bronchodilator by inhaler after 10 minutes. For these reasons it is prudent to measure PEFR 5 and 10 minutes after exercise but not at 1 minute, and it is essential that appropriate medical support is present.

The 503 children studied were subdivided on the basis of completing the test, known asthma, and response (fig 1). Asthmatics were included in the study group to avoid the potential of social stigma and to provide an indication of their quality of control. Only 11 of 36 asthmatics had a normal response, the remainder either completed the test and needed bronchodilator treatment or failed the test because of fear of bronchospasm. These results reflect the quality of medical management of known asthma and do not indicate poor discriminatory power of the FRAST. Among the 467 non-asthmatic children, 37 needed a second test before being shown to be normal and 18 (4%) were not testable. All 14 (3%) children with an abnormal FRAST result were studied further with the consent of their parents and family doctor and as a result 10 were diagnosed as asthmatic and were given appropriate treatment.

The relation between pretest PEFR and height in this sample differs from that reported for a similar cohort of Sheffield children studied recently.[14] This may be because the present study was deliberately carried out in the pollen season (April–May) whereas the earlier study took place in December. When the PEFR of the present subjects was converted to standard deviation scores using the earlier standards[15] the mean (SD) of the group was significantly less than 0: $-0{\cdot}35$ (1·00) ($p<0{\cdot}001$). The possibility that PEFR of normal children changes with seasons of the year could be tested by studying a large cohort sequentially.

Any screening test for asthma is of necessity empirical and the FRAST shares with all other screening procedures the weakness that some unrecognised asthmatic child may have had a normal FRAST response. The usefulness of the FRAST approach, however, is shown by the fact that, with the definition of abnormal chosen by us, 10 out of 14 abnormal FRAST responders were subsequently diagnosed asthmatic. This produced a total of 46 (9%) asthmatic children in the whole sample and our questionnaire identified only 78% of these, not 96% as reported by others.[2] If the more modest definition of abnormality, 10% fall in postexercise PEFR, had been used there would still only have been 37 children requiring further investigation to confirm or exclude asthma. The importance of FRAST is further shown by the fact that only one of the 14 children might have been predicted from an abnormal pretest PEFR result.

If our results are representative of schoolchildren in general, roughly one child in every class has an unrecognised exercise induced bronchospasm and

deserves medical attention. We conclude that such children can be identified by the FRAST test, which can be carried out at any school with the cooperation of the teachers, school nurse, and school doctor.

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Correspondence to Professor RDG Milner, Department of Paediatrics, Children's Hospital, Sheffield S10 2TH.

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