Exercise-induced asthma in a group of South African schoolchildren during physical education classes

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Objectives. The study was conducted to ascertain whether physical education teachers, using a peak flow meter, could reliably screen for exercise-induced asthma (EIA) in children during free running.

Design, setting and subjects. The study was conducted using a convenience sample of male pupils between the ages of 12 and 18 years. They were tested with a peak flow meter for peak expiratory flow rate (PEFR) and with a flow-volume curve for forced expiratory flow in 1 second (FEV_1) before and 10 minutes after a self-paced free running test during physical education classes. Testing was undertaken by teachers using the peak flow meter and by a medical doctor using a flow-volume curve.

Results. Using a 10% decrease in flow parameters (PEFR and FEV_1), teachers detected EIA in 14.9% of pupils and the doctor detected EIA in 21.7% of pupils.

Conclusion. We conclude that EIA is common and that teachers using a peak flow meter can detect EIA and thus screen for it; they do, however, underestimate the true magnitude of the problem.

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Exercise-induced asthma (EIA) occurs commonly and is one of many non-pharmacological and non-immunological stimuli that can produce acute episodes of airway obstruction in patients with asthma. In this way EIA may affect athletic ability.[1-3] Among known asthmatics, approximately 75% may have exercise-induced symptoms.[4] EIA may be a particular problem for children and young adults because of their inherent increased level of physical activity.[5,6] Mahler asserts that 12 - 15% of a particular population can be shown to have exercise-induced bronchospasm if appropriately challenged.[7] Few studies on the prevalence of EIA exist, especially in South Africa. Screening tests for asthma could improve management and in this regard free running tests are recognised as effective, reproducible challenges in demonstrating EIA.[8,9] Most schools in South Africa have physical education classes conducted by physical education teachers as part of the set curriculum.

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We thought that if physical education teachers could reliably screen for the presence of EIA during such classes, this information could have wider implications for all communities. This study was therefore conducted to ascertain whether physical education teachers, using a peak flow meter, could detect EIA in pupils during a physical education class and in this way assist in screening for asthma. The number of pupils with EIA detected in this way was compared to the number of pupils with EIA detected by standard lung function testing undertaken simultaneously.

Subjects and methods

The study was conducted at two schools in Pietermaritzburg, KwaZulu-Natal, that admit only male pupils. The study population was drawn from Standard 6 and 7 pupils on 6 consecutive Tuesdays as this was the only time that both the medical doctor and teachers could simultaneously test the pupils. These pupils were all fit and healthy enough to participate in physical education classes and complete the prescribed running test. The study was therefore conducted using a convenience sample of 114 male pupils from the physical education classes, but only 101 pupils produced results satisfactory for analysis. The median age of these pupils was 13.9 years (range 12 - 18 years).

Equipment

A Ferraris peak flow meter was used by two physical education teachers. Both these teachers were instructed in the proper use thereof. A Microspiro HI-298 Spirometric Diagnostic system (Chest Corporation, Tokyo, Japan) was used to record flow-volume measurements by a medical doctor who also received prior instructions in the proper use of this lung function equipment. Testing followed published guidelines for the measurement of pulmonary function tests and the highest value of three manoeuvres for both the Ferraris peak flow meter and the flow-volume measurement were used.[10]

Protocol

The teachers measured 3 peak flows and the doctor 3 flow-volume curves for each pupil before exercise. The flow curves yielded the following: forced expiratory volume in 1 second (FEV_1), peak expiratory flow rate (PEFR), forced expiratory flow at 50% of vital capacity (FEF_{50}), and forced expiratory flow during the middle half of forced vital capacity, the maximum mid-expiratory flow (FEF 25 - 75%). After these measurements the pupils ran as fast as they were able to around the sportsfield for 6 minutes in groups of 3 - 5, under the supervision of the teachers. All pupils were re-measured by the teacher and then the doctor within 10 minutes of completing running. The highest value recorded of the three measurements before and all three recorded after exercise were used. None of the pupils used any bronchodilator medication before or during running or during testing.

Criteria for a positive test

A 10% decrease in the PEFR,[2,8] a decrease of more than 10% in FEV_1[11] and a fall of more than 25% in FEF_{50}[12] post-exercise were considered positive for EIA.

Statistical analysis

Simple, descriptive analyses were used to examine the results. A scatter histogram was used to compare PEFR with FEV_1 using a 10%, 15% and 20% decline as cut-off points for a positive test for EIA. A scatter diagram of all test results was constructed, depicting the percentage change in FEV_1 and the percentage change in PEFR.

Results

Table I provides the age distribution of the 101 pupils. The majority of the pupils were 13 and 14 years old. Out of 101 pupils, physical education teachers detected 15 (14.9%) with a 10% or greater fall in PEFR as measured on a Ferraris peak flow meter. In Table II the results of the lung functions as measured with the Microspiro HI 298 system are depicted and these results are compared with the PEFR as measured by the teachers using a 10%, 15% and 20% decline in air flow as cut-off points for a positive test. A total of 22 pupils (10%) had a positive test for exercise-induced bronchoconstriction using the FEV_1 with a 10% decline. In Fig. 1, a scatter histogram compares PEFR with FEV_1 using different values (10%, 15%, 20%) of decline in air flow in those pupils with a positive test either by teacher (PEFR) or doctor (FEV_1). Eight of the 15 pupils with a reduction in PEFR of 10% or more, as detected by the teachers, did not demonstrate a reduction of 10% in FEV_1. They were considered to be false positive on testing with a Ferraris peak flow meter. When a reduction of 15% in PEFR was used as a cut-off point, 5 of the pupils had a false-positive test. There were 6 known asthmatics among the pupils and the teachers could detect 4 of these pupils with the Ferraris peak flow meter.

Table I. Age distribution of 101 pupils

Age (yrs)	No.	%
12	2	2.0
13	39	38.6
14	40	39.6
15	8	7.7
16	6	5.9
17	5	5.0
18	1	1.0

Table II. PEFR (teacher) and FEV_1 (doctor) at different percentages of lung function decline (10%, 15%, 20%) used as a positive test for EIA

Teacher (PEFR)	No. of pupils	%	Doctor (flow volume curve)	No. of pupils	%
PEFR > 10%	15	14.9	FEV_1 > 10%	22	21.7
PEFR > 15%	9	8.9	FEV_1 > 15%	16	15.8
PEFR > 20%	4	3.9	FEV_1 > 20%	12	11.8
			FEF_{50} > 25%	13	12.9
			FEF_{25-75} > 25%	15	14.9

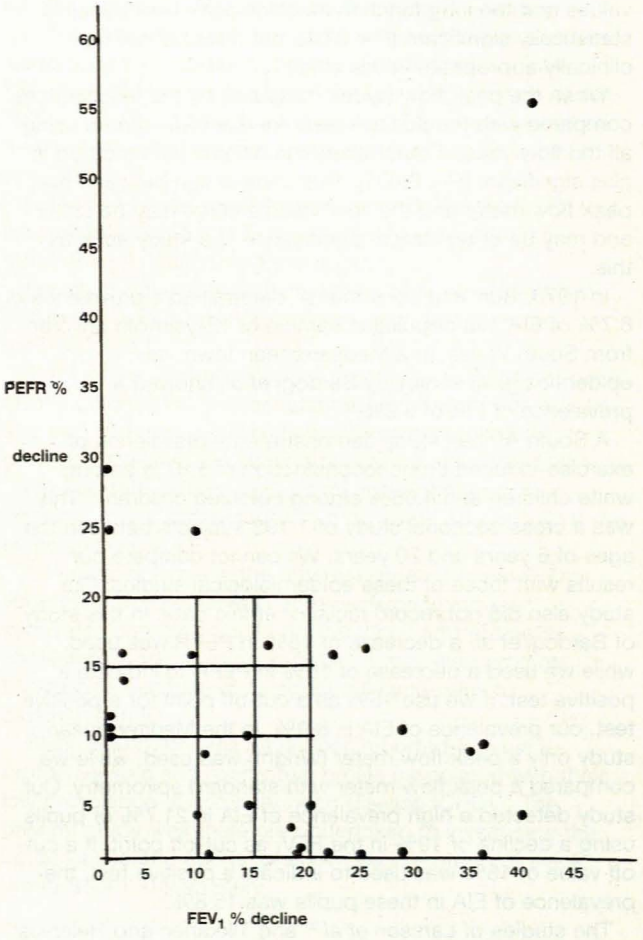

Fig. 1. Scatter histogram showing the percentage decline in PEFR (teacher) and FEV_1 (doctor) in those pupils with a positive test for EIA using 10%, 15% and 20% as cut-off points for a positive test.

Discussion

The primary purpose of this study was to determine whether a physical education teacher can screen for asthma using a peak flow meter. This study shows that the use of a Ferraris peak flow meter by physical education teachers can detect a clinically significant number of exercise-induced asthmatics in young pupils during a running test. The free running test is generally considered to be the most bronchoconstrictive of the various exercise challenges and is appropriate for field use.[13,14] We are therefore satisfied that the test we used was appropriate for the purpose intended. According to Fourie and Joubert,[15] the sensitivity of exercise as a test for asthma in individual patients may vary from 0% in very mild asthmatics to 100% in severe asthmatics. A negative result does not entirely exclude asthma, especially in the case of very mild asthmatics.[15] We have shown that the use of PEFR as the only parameter may not be reliable enough to detect all exercise-induced asthmatics under these conditions, but can serve as an inexpensive, easily available screening test. Rice *et al.*[16] demonstrated that 14 out of 19 athletes with EIA would have been missed if peak expiratory flow had been the only parameter examined. In this study the difference between the teachers' peak flow

values and the lung function machine peak flow values is statistically significant ($P < 0.01$), but this may not be clinically appropriate in this study.

When the peak flow values measured by the teachers are compared with the positive tests for exercise asthma using all the flow volume parameters the difference in method is also significant ($P < 0.001$). This comparison between the peak flow meter and the flow-volume curve may be unfair and may be of no clinical significance in a study such as this.

In 1973, Burr and co-workers[17] determined a prevalence of 6.7% of EIA in a population sample of 12-year-old children from South Wales. In a Mediterranean town, an epidemiological survey by Bardogi *et al.* showed a prevalence of EIA of 6.9%.[18]

A South African study demonstrated a prevalence of exercise-induced bronchoconstriction of 5.87% among white children and 4.05% among coloured children.[19] This was a cross-sectional study of 1 192 subjects between the ages of 6 years and 20 years. We cannot compare our results with those of these epidemiological studies. Our study also did not record racial or ethnic data. In this study of Bardogi *et al.* a decrease of 15% in PEFR was used, while we used a decrease of 10% in PEFR to indicate a positive test; if we use 15% as a cut-off point for a positive test, our prevalence of EIA is 8.9%. In the Mediterranean study only a peak flow meter (Wright) was used, while we compared a peak flow meter with standard spirometry. Our study detected a high prevalence of EIA in 21.7% of pupils using a decline of 10% in the FEV_1 as cut-off point. If a cut-off value of 15% was used to indicate a positive test, the prevalence of EIA in these pupils was 15.8%.

The studies of Larsson *et al.*[20] and Tikkanen and Helenius[21] reported an even higher prevalence of more than 50%. In a recent study to detect EIA in figure skaters, 35% of these athletes had a positive test for asthma.[22] Our results show a 21.7% prevalence of EIA and are different from published data, although it is difficult to draw direct comparisons between studies that differ vastly in respect of the patient populations examined.

In conclusion, we demonstrated a high prevalence of exercise-induced bronchoconstriction in male pupils in one region of South Africa. We also demonstrated that the detection of EIA by physical education teachers using a peak flow meter can serve a useful purpose in screening for exercise-induced asthmatics.

Understandably the use of a peak flow meter underestimates the true prevalence of exercise-induced asthmatics.

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