UPPER AND LOWER RESPIRATORY TRACT DISORDERS IN EIGHT-YEAR-OLD SINGAPORE CHILDREN : AN INVESTIGATION OF SURVEY TECHNIQUES

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SYNOPSIS

A study of respiratory tract disease among 351 children at three selected Singapore schools was conducted to assess the value of two simple survey techniques in detecting chronic respiratory tract disease.

These techniques involved, firstly, the use of questionnaires designed to elicit the school teachers' assessments of their pupils' respiratory tract status, and secondly, a single medical examination for the presence of nasal discharge, loose or "wet" (productive) cough, and auscultatory evidence of lower respiratory tract disease. Measurements of ventilatory capacity were also made.

Considerable inter-observer variation was found amongst school teachers, and no correlation was found between the school teachers' assessments and the clinical findings, the physicians' assessments or the spirometric measurements of forced expiratory volume (0·75 sec.).

The presence of upper respiratory tract disease as determined by the physicians did not influence forced expiratory volume, but there was detectable impairment of ventilatory function in the 20 children assessed by the physicians as having lower respiratory disease. Of the 20 children with lower respiratory tract disease, 15 were identified by the "loose cough" test alone.

Respiratory disease in childhood is not well defined, either nosologically or in terms of its natural history. Prior to more extensive investigations in Singapore, we have carried out a study intended primarily to assess the value of certain survey techniques for detecting upper and lower respiratory tract abnormality, without attempting any more specific diagnostic categorisation.

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The diversity of racial, cultural, linguistic, socio-economic and educational backgrounds in the complex Singapore community suggested that accurate histories from parents would be difficult and time-consuming to obtain without accepting a considerable lapse rate. Even if the cost of employing specially trained interviewers could be justified, grave difficulties might be anticipated in codifying the questions and answers to serve as comparable and valid epidemiological indices amongst such diverse groups. We therefore decided to see whether the opinions of school teachers, based on knowledge of each child over most of a school year, could usefully be used to assess respiratory status.

In this paper, the schoolteachers' assessments are related to the findings of single medical examinations and both are examined in relation to an objective measurement of ventilatory capacity.

PROCEDURE

Three primary schools ((A) Farrer, (B) Permaisura and (C) Umar Pulavar) were chosen to provide a reasonably wide and representative section of the three major raeial groups in Singapore (Chinese, Malay and Indian). The schoolteachers of nine classes, comprised entirely of children born in 1960, were given a questionnaire relating to each child in the language with which the teacher was

most familiar (English, Malay, or Tamil). In addition to name, birth date and age, the following questions were asked:

(i) Is this child prone to have (a) colds (b) running nose (c) stuffy (blocked) nose?
(ii) Is this child prone to have a "wet" cough (that is, a loose or rattling cough due to phlegm in the chest)?
(iii) Does this child get asthma?
(iv) Is this child's play or physical activity limited by difficulty in breathing?

All questions, including the subsections of question (i) required a yes/no answer in an appropriate square. Subsidiary questions relating to frequency of symptoms (ranging from "occasionally" to "constantly" or on most days) were asked but are not discussed in this report. A question on school absences due to respiratory illnesses proved unhelpful due to lack of reliable information. For the purpose of analysis, a positive answer to any section of question (i) was taken to indicate upper respiratory tract disease (URTD), and a positive answer to one or more of questions (ii), (iii) and (iv) was taken to indicate lower respiratory tract disease (LRTD).

Forms were circulated and completed for a total of 351 children. Without knowledge of these results, two experienced chest physicians examined the children independently a fortnight later. One physician asked each child to take a deep breath and cough hard; the cough was recorded as "loose" (productive) or "dry", as judged by ear. The second physician conducted a conventional examination of the nose, pharynx and chest, in addition to asking each child to blow his or her nose on a paper handkerchief. In the analysis of the findings on examination, a child is considered to have URTD if nasal discharge, obstruction or mucosal inflammation was recorded. A loose cough upon request and/or adventitious sounds on auscultation of the chest were taken to indicate the presence of LRTD.

At the same time as the medical examination, the forced expiratory volume at three-quarters of a second ($FEV_{0.75}$) was estimated using a McDermott spirometer and with the subject standing. The highest of three consistent efforts was recorded, "consistent" being defined as agreement within a range of 5%. No temperature correction was applied, beyond that automatically introduced into the spirometer recording system; the range of room temperature encountered during the several days of the study was from 28·9°C to 30·0°C. Thirteen children (3·7%) could not be encouraged to cooperate adequately in the spirometry; they showed no remarkable prevalence of respiratory disorder, and they are excluded from the analysis.

RESULTS

Physicians' Assessment

It is convenient first to summarise the overall situation in terms of the physicians' assessments; these are set out by race and sex in Table I. Because of the small numbers of children with abnormal respiratory conditions it was necessary to amalgamate the three abnormal categories in order to obtain reliable results in statistical tests of significance. The X^2 tests that were made failed to suggest significant race or sex differences in the prevalence of the combined abnormal respiratory tract conditions at the 5% level of probability.

Schoolteachers' Assessment

The teachers' assessments are summarised by school in Table II; the influence of race and sex is safely assumed to be irrelevant or unimportant in view of the results obtained from the physicians' assessments.

The only teacher concerned with School C misinterpreted the questionnaire. The subjects concerned have been eliminated from all the subsequent analyses, a procedure which has the effect of reducing the overall disagreement between the teachers' and the physicians' assessments.

The difference between schools A and B in terms of the frequency with which respiratory disease was reported (44·4% at School A and 11% at School B) is highly significant ($p<0·0005$), but there was a similar variation between the individual teachers at School A, the reported prevalences ranging from 8% to 69%, with an intermediate value of 33% in a third class of 43 students ($p<0·0005$). On *a priori* grounds, it seems unlikely that such differences should exist, at least within one school, and no similar differences were found in the physicians' assessments. In the absence of any correlation between the teachers' and the physicians' assessments (see below), it is concluded that the differences in prevalence are attributable to variation between teachers.

Relationship between Teachers' and Physicians' Assessments

The relationship between the teachers' and physicians' assessments is set out in Table III (after exclusion of all 38 children of one class recorded as abnormal by one teacher, and of the 13 children who did not cooperate adequately in the lung function tests).

Untabulated data indicate concurrence of opinion between teachers and physicians that URTD and LRTD are associated. However, Table III provides no evidence of statistically significant associations between the teachers' and

TABLE I

PHYSICIANS' ASSESSMENT OF RESPIRATORY TRACT ACCORDING TO RACE AND SEX

Physicians' Assessment	Chinese		Malay		Indian		Total	
	Male	Female	Male	Female	Male	Female	Male	Female
	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %
URTD	5 (10·4)	2 (4·7)	7 (7·1)	11 (13·1)	7 (17·1)	4 (10·8)	19 (10·2)	17 (10·4)
LRTD	1 (2·1)	0 (0)	3 (3·1)	0 (0)	3 (7·3)	2 (5·4)	7 (3·7)	2 (1·2)
U & LRTD	2 (4·2)	1 (2·3)	8 (8·2)	5 (6·0)	2 (4·9)	0 (0)	12 (6·4)	6 (3·7)
Normal	40 (83·3)	40 (93·0)	80 (81·6)	68 (80·9)	29 (70·7)	31 (83·8)	149 (79·7)	139 (84·7)
TOTAL	48 (100·0)	43 (100)	98 (100)	84 (100)	41 (100)	37 (100)	187 (100)	164 (100)

TABLE II

SCHOOLTEACHERS' ASSESSMENT OF RESPIRATORY TRACT, ACCORDING TO SCHOOL

School Teachers' Assessment	School A	School B	School C	Total
	No. %	No. %	No. %	No. %
URTD	40 (25·2)	10 (6·5)	0 (0)	50 (14·2)
LRTD	7 (4·4)	7 (4·5)	0 (0)	14 (4·0)
U & LRTD	23 (14·5)	0 (0)	38 (100·0)	61 (17·4)
Normal	89 (56·0)	137 (89·0)	0 (0)	226 (64·4)
TOTAL	159	154	38	351

TABLE III

TWO-WAY CLASSIFICATION OF TEACHERS' ASSESSMENTS VERSUS PHYSICIANS' ASSESSMENTS

Physicians' Assessment	Teachers' Assessment				Total
	URTD	LRTD	U & LRTD	Normal	
URTD	6 (A)	2 (B)	1 (C)	20 (D)	29
LRTD	0 (E)	0 (F)	3 (G)	1 (H)	4
U & LRTD	3 (J)	0 (K)	2 (L)	11 (M)	16
Normal	39 (N)	10 (P)	16 (Q)	186 (R)	251
TOTAL	48	12	22	218	300

Footnote: the sub-groups in the main body of the table have been given the letters A - R for identification purposes; see text, and Tables IV & V.

the physicians' assessments in respect of either the condition of the upper respiratory tract or the condition of the lower respiratory tract.

Teachers' and Physicians' Assessments in Relation to $FEV_{0\cdot75}$

The values for $FEV_{0\cdot75}$ are influenced by height and sex and possibly also by race (Chia, Virabhak and Gandevia, unpublished analysis). Direct comparisons of mean values for $FEV_{0\cdot75}$ in any of the groups or subgroups indicated in Table III are therefore inappropriate. Comparisons were therefore made between the various "abnormal" subgroups and appropriate random samples, matched for race and sex, drawn from the 186 normal children as agreed by both teachers and physicians (subgroup R of Table III). To eliminate the effect of height on $FEV_{0\cdot75}$, regression lines were used as the basis for comparison rather than the absolute $FEV_{0\cdot75}$ measurements.

Subgroups N, P, Q represent, respectively, 39, 10 and 16 children assessed by the teachers as having URTD, LRTD or both findings which were unconfirmed by the physicians. These subgroups were combined and ventilatory function was compared in the amalgamated subgroups and in a series of matched controls as described above. Comparison of three parameters, namely the square of the residual variance, regression coefficient (b) and mean $FEV_{0\cdot75}$ values adjusted for difference in heights, did not reveal any significant difference between the amalgamated subgroups N, P and Q, and the control sample from subgroup R. Subgroup N and subgroup P plus Q were then compared separately with control series and again no significant differences were detected in ventilatory function. Thus there was no observable impairment of ventilatory function in the group of children assessed as abnormal by the teachers but normal by the physicians.

Subgroups D, H and M represent, respectively, 20, 1 and 11 children assessed by the physicians as having URTD, LRTD or both and none of these children was assessed as abnormal by the teachers. These subgroups were combined and ventilatory function was compared in the combined subgroups and in a series of matched controls using two parameters, the square of the residual variation and the regression coefficient. Taking first residual variance, there is no significant difference in ventilatory function between the abnormal subgroup D plus H plus M and a matched normal control series (Table IV) but taking the regression coefficient, the difference in ventilatory function is significant ($p<0\cdot05$). Thus ,there was observable impairment of ventilatory function in the group of children assessed by the teachers as normal, the severity of the impairment varying with the heights of the children.

Subgroups A, B, C and D represent, respectively 6, 2, 1 and 20 children assessed by the physicians as having URTD only and these subgroups were combined and the ventilatory function in the combined group compared with a series of matched normal controls. There was no significant difference between the combined URTD group and the normal controls using either of the parameters, the square of the residual variation or mean $FEV_{0\cdot75}$ adjusted for height. Thus there is no observable impairment of ventilatory function in the group of children assessed as having URTD by the physician.

Subgroups E to M represent, in total, 20 children assessed by the physicians as having LRTD. Ventilatory function was compared in the combined subgroups and in a series of matched controls (Table V). There is no significant difference between the groups in terms of residual variance but the difference in ventilatory capacity in terms of the regression coefficient is significant ($p<0\cdot01$).

Thus, there is observable impairment in ventilatory function in the group of children assessed by the physician as having LRTD, the severity of the impairment varying with the height of the children; the difference is more marked in the shorter children and tends to diminish in taller children. The effect is shown graphically in Fig. 1.

A comparison of the mean heights of the LRTD group and its control showed no significant difference, the mean height of the LRTD group (47·2 ins.), being actually slightly greater than that of

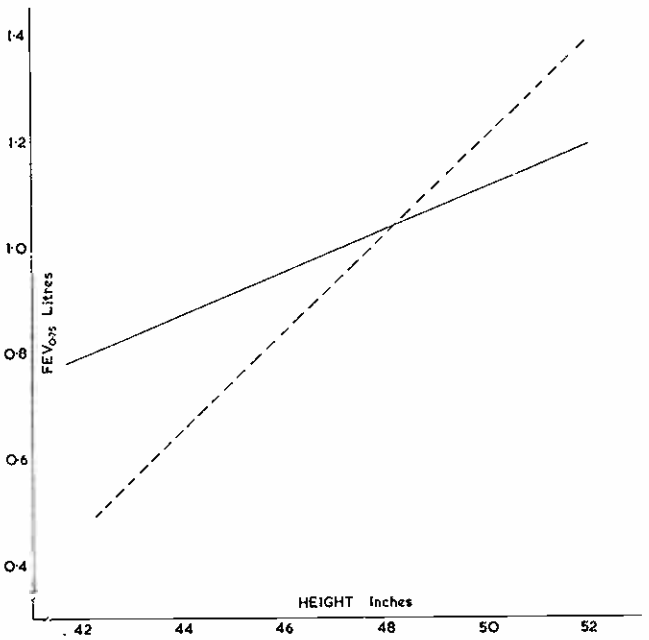

Fig. 1. Regression of $FEV_{0\cdot75}$ on height for subjects with lower respiratory tract disease (physician's assessment) (- - -) and for healthy control subjects (——).

TABLE IV

COMPARISON OF VENTILATORY FUNCTION BY ANALYSIS OF COVARIANCE (FEV ON HEIGHT) IN A SERIES OF NORMAL CONTROLS (FROM SUB-GROUP R, TABLE III) AND IN THREE SUB-GROUPS (D, H AND N, TABLE III) ASSESSED BY THE PHYSICIANS AS HAVING RESPIRATORY DISEASE BUT BY THE TEACHERS AS NORMAL

Source of Variation	F	Mean Square Deviation from Regression Line	Parameter Tested	Variance Ratio	P
Abnormal group	30	172·20		1·27	n.s.
Control group	126	218·49	residual variance		
Within groups	156	209·59			
Regr. coef.	1	1192·06	regr. coef.	5·69	<0·05
Common	157	215·85			

TABLE V

COMPARISON OF VENTILATORY FUNCTION BY ANALYSIS OF COVARIANCE (FEV ON HEIGHT) IN A SERIES OF NORMAL CONTROLS (FROM SUB-GROUP R TABLE III) AND IN CHILDREN ASSESSED AS HAVING LRTD BY THE PHYSICIANS (SUB-GROUPS E TO M TABLE III)

Source of Variation	F	Mean Square Deviation from Regression Line	Parameter Tested	Variance Ratio	P
Abnormal group	18	270·36			
Control group	138	212·15	residual variance	1·27	n.s.
Within groups	156	218·87	regr. coef.	15·30	<0·01
Regr. coef.	1	3687·53			

the control group (46·9 ins.). There is, therefore, no evidence to suggest that LRTD affects height or that short children have a greater risk of contracting LRTD than taller children (Chia *et al*, 1969).

DISCUSSION

The present small study does not, of course, provide definitive information on the overall prevalence of upper and lower respiratory tract

disease in Singapore nor on racial differences, which would demand, in addition, consideration of complex social and economic factors. However, it does indicate that lower respiratory disease, as judged on isolated medical examination based upon a requested cough as well as auscultation of the chest, tends to be associated with a reduction in ventilatory capacity. This finding is of significance to any nation concerned with the physical fitness of its youth.

Periodic medical examinations are an integral part of a school health service, but they may fail to detect cases of chronic or recurrent disease in relative or absolute remission, or they may misinterpret a transient acute infection as chronic. Histories from parents or schoolteachers might be expected to counter these tendencies. Our study indicates that inter-observer variation renders teachers' assessments unreliable. As positive, objective signs were required by the physicians for a diagnosis of upper or lower respiratory tract abnormality under-diagnosis relative to the teachers is to be anticipated, but some correlation between the teachers' and physicians' diagnosis should still be apparent. Insofar as lower respiratory tract disease is concerned, the finding of a significantly lowered ventilatory capacity in those so diagnosed by the physicians supports the accuracy of their diagnosis. There was no undue incidence of acute respiratory illnesses in Singapore in the weeks before, during or after the survey.

As no reliance can be placed on teachers' assessments, it follows that when effective histories are not obtainable from parents or from the children themselves, the detection of chronic respiratory disorders must depend solely upon physical examination. In the present study, conventional auscultation of the chest revealed only five of the 20 cases diagnosed as having lower respiratory tract disease. The remaining 15 were identified because a deliberate cough upon request was considered "loose" or "productive" simply on the basis of its auditory characteristics. The validity of this sign is indicated by the lowered mean $FEV_{0\cdot75}$ by comparison with that for subjects regarded as normal, a finding consistent with those of Cullen *et al* (1969) in an epidemiological survey of adults. This simple and rapidly elicited index of lower respiratory abnormality has been shown to have low inter-observer variation and to be related to measured daily sputum volumes (Hall and Gandevia, 1971). The proportion of abnormal subjects "missed" by this technique but identified on more elaborate examination was 25% (5 out of 20). Further study might show that the "loose cough" sign detects a sufficiently high proportion of subjects in a large population to dispense with the more time-consuming physical examination. In any case, its use in this childhood population clearly increased the sensitivity of auscultation in the detection of lower respiratory tract disease.

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