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Influence of personal and family factors on ventilatory function of children

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Leeder, S. R., Corkhill, R. T., Wysocki, M. J., Holland, W. W., and Colley, J. R. T. (1976). *British Journal of Preventive and Social Medicine,* **30,** 219-224. **Influence of personal and family factors on ventilatory function of children.** We wanted to assess the relative influence of various personal and family factors upon the development of ventilatory function in young children. The relationship of several such factors to peak expiratory flow rates measured at the age of five years was studied in 454 children. These children were members of a birth cohort born between 1963 and 1965 in Harrow, north-west London, who were examined regularly from birth through the first five years of life. Beside its expected association with height, peak expiratory flow rate at the age of five years was also related to a lesser extent with peak expiratory flow rate in parents. Children with a history of lower respiratory illness had mean peak flow rates which were lower than those of children who escaped these illnesses. The earlier the onset of the illness and the more frequent its recurrence, the more marked its effect on ventilatory function. The group of children with a history of asthma and bronchitis had the lowest mean peak expiratory flow rate, but a history of bronchitis or pneumonia alone (that is, without asthma) was also associated with reduced ventilatory function. Respiratory illness beginning in the first year of life was the most potentially modifiable determinant of peak expiratory flow rate in children in this study.

The association of poor social circumstances and urban living with increased morbidity in children from respiratory illness has been demonstrated many times (Wahdan, 1963; Lunn, Knowelden, and Handyside, 1967; Holland *et al.*, 1969; Colley and Reid, 1970; Colley, 1971; Bland, Holland, and Elliott, 1974) and children who suffered respiratory illness were found, in several of these studies, to have lower ventilatory function than those who escaped these illnesses. Recently, Higgins and Keller (1975) found small but statistically significant correlations between ventilatory function in children and their parents in a family study in Tecumseh. Cotes (1974) has also reviewed several studies of the inheritance of ventilatory function. However, little attention has been given to either the genetic or other family factors as determinants of ventilatory function in children. In this paper, we report a study of a birth cohort of children with reference to the influence and relative importance of several personal and family factors on lung function at the age of five.

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METHODS

The sampling procedures, data collection methods, and techniques of measurement of ventilatory capacity in both children and adults are described in detail in the first paper (pages 204-205) including the numbers of children available for study during the five years.

Results

Several personal and family factors influenced peak expiratory flow rate in the children at the age of five years, including a history of bronchitis or pneumonia. Children with a history of bronchitis or pneumonia had mean peak expiratory flow rates that were lower than those in children who escaped these illnesses. The earlier the onset of the illness, the more marked was its effect on ventilatory function (Table I). The group of 56 children who suffered from bronchitis or pneumonia during the first year of life had a mean peak expiratory flow rate (adjusted for differences in sitting height) at the age of five years which was 8·5% lower ($P < 0{\cdot}001$) than that found in the children without this history. Children with lower respiratory illness that had begun after the first year had a mean peak expiratory flow rate by the age of five which lay between that of the children who had had their first attack during the first year and those with no history of bronchitis or pneumonia in any year, and differed significantly from the latter group ($0{\cdot}01 < P < 0{\cdot}02$).

When children were grouped according to both the age of onset and recurrence of respiratory illness during the first five years (Table II) the peak expiratory flow rates (adjusted for differences in sitting height) followed a trend. Children who had lower respiratory illness each year (Group 2, Table II) had the lowest mean of 131·5 litres/min which differed significantly (14% lower; $P < 0{\cdot}001$) from the mean peak flow rate of children with no attacks (Group 1, Table II). Children with only two or three subsequent episodes after the first

Table I

PEAK EXPIRATORY FLOW RATES IN CHILDREN AGED FIVE YEARS BY AGE OF FIRST REPORTED ATTACK OF BRONCHITIS OR PNEUMONIA

Age at First Attack	Mean PEFR‡ for Group (litres/min)	Population*	Standard error of Means	Significance of Difference between Means of Groups With and Without Symptoms	
				t	P
No attack	151·3	335	1·4	—	—
Under 1 year	138·5	56	3·5	3·41	$P < 0{\cdot}001$
Between 1 and 5 years	142·2	63	3·3	2·55	$0{\cdot}01 < P < 0{\cdot}02$
Total	—	454	—	—	—

*Excludes 169 children who had incomplete data for the full five years or incomplete annual PEFR measurements.
‡Standardized by sex and sitting height at age five years.

Table II

PEAK EXPIRATORY FLOW RATES IN CHILDREN AGED FIVE YEARS BY HISTORY OF ANNUALLY REPORTED ATTACKS OF RESPIRATORY ILLNESS†

Age at First Report of Attack of Respiratory Illness	Group	No. of Years in which Respiratory Illness Occurred	Mean PEFR* for Group (litres/min)	Population‡	Standard Error of Mean
No attack	1	Nil	152·3	121	2·3
One year	2	Four or five	131·5	26	5·1
	3	Two or three	137·6	48	3·7
	4	One	148·5	15	6·6
Two years	5	Three or four	140·5	27	5·0
	6	Two	148·1	10	8·2
Three years	7	Three	149·7	50	3·6
	8	Two	157·0	40	4·1
Four years	9	Two	153·7	27	5·0
Between two and five years	10	One	150·2	90	2·7
Total	—		—	454	—

*Standardized by sex and sitting height at age five years.
‡Excludes 169 children for whom lung function data or respiratory illness data for the first five years of life were incomplete.
†Consists of a history of any of the following: bronchitis, pneumonia, bronchiolitis, chest, chest cold, wheeze, asthma, persistent cough.

year also had significant, although smaller, reductions in mean peak flow rate. Illness which was recurrent in consecutive years was not consistently associated with a more marked reduction in peak expiratory flow rate. However, the earlier illnesses began, the larger the deficits in ventilatory function especially when those illnesses began in the first and second years of life (Groups 2 to 6), but the small numbers in some of these groups (for example, Groups 4 and 6) prevent firm conclusions being drawn. Children with illnesses beginning in the third, fourth, and fifth years (Groups 8, 9, and 10) had peak flow rates within the normal range.

Lower respiratory illnesses of different types (for example, wheezing, asthma, bronchitis or pneumonia) were associated with different effects on peak expiratory flow rates at the age of five as shown in Table III. Wheezing appeared to have no influence on ventilatory function on its own and the presence of wheezing in a child with bronchitis or pneumonia had no added effect on mean peak expiratory flow rate. While there were too few children with asthma alone for any worthwhile conclusions concerning its effects on lung function, those who suffered from both asthma and bronchitis or pneumonia had the lowest mean peak expiratory flow rate (119·7 litres/min) of any group.

Height and peak expiratory flow rate in children at the age of five were correlated with their parents' measurements taken the same year, as shown in Tables IV and V. The correlations between peak expiratory flow rates in parents and children (Table V) were not as strong as those seen between height in parents and children.

TABLE IV

CORRELATION OF HEIGHT BETWEEN CHILDREN AT AGE FIVE YEARS AND THEIR PARENTS

	Mother	Father
Son	0·27*** (231)†	0·29*** (214)
Daughter	0·18** (222)	0·30*** (204)

†Number of parent-child pairs with complete fifth year data.
Significance of correlation coefficient:
** $0{\cdot}001 < P < 0{\cdot}01$; *** $P < 0{\cdot}001$.

TABLE V

CORRELATION OF PEAK EXPIRATORY FLOW RATE BETWEEN CHILDREN AT AGE FIVE YEARS AND THEIR PARENTS

	Mother	Father
Son	0·18* (231)†	0·27*** (214)
Daughter	0·16* (222)	0·13 (204)

†Number of parent-child pairs with complete fifth year data.
Significance of correlation coefficient:
* $0{\cdot}01 < P < 0{\cdot}05$; *** $P < 0{\cdot}001$.

No association was found between parental social class (Table VI) and children's peak expiratory flow rates at the age of five years. Area of residence did not affect peak flow rate. Parental smoking habits and respiratory morbidity also had no obvious influence.

Events during pregnancy and in the immediate postnatal period have been examined previously

TABLE III

PEAK EXPIRATORY FLOW RATES IN CHILDREN AGED FIVE YEARS BY HISTORY OF BRONCHITIS OR PNEUMONIA, ASTHMA AND/OR WHEEZING†

Symptom or Illness Group	Mean PEFR* for Group (litres/min)	Population‡	Standard Error of Mean	Significance of Difference Between Means of Groups With and Without Symptoms	
				t	P
Nil	151·5	292	1·5	—	—
Bronchitis or pneumonia only	143·3	76	3·0	2·48	$0{\cdot}01 < P < 0{\cdot}02$
Bronchitis or pneumonia with wheeze	140·3	33	4·5	2·37	$0{\cdot}01 < P < 0{\cdot}02$
Wheezing without bronchitis or pneumonia	149·4	40	4·1	0·48	$0{\cdot}6 < P < 0{\cdot}7$
Bronchitis or pneumonia with asthma	119·7	10	8·2	3·83	$P < 0{\cdot}001$
Asthma without bronchitis or pneumonia		3			
Total		454			

*Standardized by sex and sitting height at age five years.
‡Excludes 169 children for whom lung function data or respiratory illness data for the first five years of life were incomplete.
†Asthma includes children who may have had wheezing as well; wheezing excludes children who had asthma.

TABLE VI

PEAK EXPIRATORY FLOW RATE AND SITTING HEIGHT OF CHILDREN AGED FIVE YEARS BY PATERNAL SOCIAL CLASS

Paternal Social Class	Sex	Population†	Mean PEFR* for Group (litres/min)	Standard Error of Mean	Mean Sitting Height (cm)	Standard Error of Mean
I and II	Boys	83	153·0	3·0	59·3	0·3
	Girls	73	145·6	3·0	58·9	0·3
III	Boys	121	151·2	2·5	59·6	0·3
	Girls	110	143·8	2·4	58·8	0·3
IV and V	Boys	18	159·2	6·4	58·8	0·6
	Girls	29	141·3	4·8	58·8	0·6
Total		434				

*Standardized by sitting height at age five years.
†Excludes 189 children for whom either lung function data at age five or paternal social class data at age five were unavailable.

for effects upon ventilatory function of the infants in this sample during the first three months of life but none was found to be important (Colley 1969).

To assess the independent effects of the personal and family factors in the tables presented so far upon peak expiratory flow rate at the age of five years, a multiple regression analysis was performed using the following independent variables: age of first episode of bronchitis or pneumonia; history of asthma, wheezing, bronchitis or pneumonia; birth weight; birth length; sex; sitting height at the age of five; peak expiratory flow rates of parents (measured at the initial interview); parental social class, smoking habits and symptoms of respiratory morbidity; bronchitis or pneumonia in siblings and number of siblings. Factors which did not have a statistically significant effect were removed and the model was recalculated. The significant factors from this second analysis are given in Table VII. These included a history of bronchitis or pneumonia in the child (the earlier in life the first attack occurred, the more marked the effect), sex of child (boys had higher peak flow rates than girls), sitting height at the age of five, and father's peak expiratory flow rate.

TABLE VII

OBSERVED AND ADJUSTED MEAN PEAK EXPIRATORY FLOW RATES AT AGE FIVE IN PRESENCE AND ABSENCE OF SEVERAL FACTORS

Factor	No. of Subjects	PEFR (litres/min)		Significance of Factor (t Value of Largest Difference Between Means)
		Adjusted	Observed	
Time of first attack of bronchitis or pneumonia				
First year	56	139·1	137·7	3·23
2nd–5th year	59	142·6	142·8	0·001 < P < 0·005
No attack	318	151·3	151·5	
Sex				
Boys	223	151·8	152·1	2·66
Girls	210	145·1	144·7	0·005 < P < 0·01
Sitting height in cm at age 5 years				
≤57	135	140·8	139·6	4·06
58–60	165	150·7	150·9	P < 0·001
61+	133	153·7	154·7	
Father's peak expiratory flow rate*				
≤480	86	141·6	140·5	3·67
480–	76	146·4	145·5	P < 0·001
520–	97	150·4	151·4	
560–	85	147·5	146·3	
600+	89	156·0	158·0	
Total	433		148·5	

*Measured at first interview (litres/min).
†Excludes children for whom data on respiratory illness during the first five years of life, sitting height at age five, or paternal peak expiratory flow rates at the initial interview were unavailable.

Discussion

We found that children with a history of bronchitis, pneumonia or asthma in the preceding years had lower peak flow rates by the time they were five years old than children without such a history. The earlier the onset of these illnesses, the greater their subsequent effect on ventilatory function. Recurrent illnesses had a greater influence than single episodes, and combined episodes of asthma and bronchitis had the most powerful effect of all upon peak expiratory flow rate at the age of five. Even the more substantial differences in mean peak flow rate attributable to past lower respiratory illness were small compared with the reductions in ventilatory function observed in adults with established chronic lung disease. However, these differences could be consistent with the beginning of airways obstruction. Peak expiratory flow rate is not an especially sensitive measurement of the state of the small peripheral airways where it is thought that obstruction occurs early in the course of chronic bronchitis (Macklem, 1972).

Parental cough-phlegm, asthma-wheeze, and smoking habits, number of siblings, and sibling bronchitis or pneumonia were without apparent influence on ventilatory function in the index children. However, these same factors were found to influence the incidence of bronchitis in the first year of life in the same birth cohort (pages 203-212) The association of these factors with illness incidence, however, was noted in analyses derived from the full sample (2149 children), whereas the studies of ventilatory function were based on the one-in-three systematic sample, so relationships between these factors and ventilatory function could have been overlooked in the smaller sample. Alternatively, these factors influencing the incidence of bronchitis and pneumonia in the first year may have only an indirect, once-removed effect on ventilatory function by predisposing to infections which, in turn, lead to lung damage in some, but not all, children.

The association between peak expiratory flow rates in parents and their children in this study was similar to that found by Higgins and Keller in their comparison of forced expiratory volume in one second ($FEV_{1\cdot0}$) in 1000 children of all ages and their parents in Tecumseh (Higgins and Keller, 1975). However, the correlation coefficients between peak flow rate in the children and the parents were in general smaller than those of Higgins and Keller for $FEV_{1\cdot0}$. The association between parents' and child's lung function could be due to shared experience or to common genes. Twin studies may provide further information on this point.

In conclusion, recurrent respiratory illness beginning in the first year of life influenced subsequent ventilatory function of children, as measured by peak flow rate at the age of five years. During infancy, viral infections may impair the normal development of the airways and lung. Prevention of bronchitis and pneumonia in early childhood by modifying the home environment, especially by encouraging parents not to smoke (Colley, Holland, and Corkhill, 1974), is one approach that may help to reduce the immediate and distant consequences of these illnesses.

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