INDICES OF VENTILATORY LUNG FUNCTION
 (FVC, FEV₁, FEV%) WHICH ADJUST FOR AGE AND HEIGHT

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The results of ventilatory function tests (FVC, FEV₁, and FEV%) depend to a great extent on age and height. In epidemiological investigations, the main purpose of which is to analyse the influence of environmental factors on lung function in the population, it is therefore necessary to use multiple regression methods. This form of statistical analysis is difficult and laborious when there is no access to a computer. An alternative method is to use indices of ventilatory function that adjust for age and height.

Khosla (1971) has recently developed a series of such indices. These indices show a high correlation with ventilatory tests and are independent of age and height.

The main purpose of our work was to test the value of these new indices on material from our own epidemiological studies of chronic non-specific chest disease carried out in two small industrial enterprises in Kraków, taking into account the possible anthropological differences between the British and Polish populations.

MATERIAL AND METHODS

The epidemiological studies which have been described in detail elsewhere (Sawicki, 1971) were carried out in two occupational groups, A (drivers) and B (workers of a chemical factory), using questionnaires slightly modified and translated from the English Medical Research Council questionnaire. Chronic cough and chronic phlegm were defined as chronic bronchitis. Spirometric tests were carried out on each person and simple anthropometric features such as standing height, sitting height, and weight, were measured. The subjects were asked to blow into a Vitalograph spirometer five times, and FVC, FEV₁, and FEV%, adjusted to BTPS, were calculated from the highest spirogram.

Calculations were made of the Khosla indices and of predicted FVC, FEV₁, and FEV% values for

each person by multiple regression analysis. As we came to the conclusion that the regression was linear we used the following equations:

$$\begin{aligned} \text{FVC} &= a_1 \text{ age} + b_1 \text{ height} + c_1 \\ \text{FEV}_1 &= a_2 \text{ age} + b_2 \text{ height} + c_2 \\ \text{FEV\%} &= a_3 \text{ age} + c_3 \end{aligned}$$

All calculations were carried out on the Polish computer ODRA 1204 and the program was written in ALGOL—1204. The first step of the analysis showed that the distributions of the new indices were perfectly normal.

Table I shows basic data concerning the examined populations, and Table II the results of the ventilatory function tests transformed into Khosla indices. As is evident from Table II, the indices were lower for bronchitics than for non-bronchitics in both populations but especially in factory B, where the workers were exposed to a dusty environment.

The main part of our work was to examine the correlation between the indices and observed values

TABLE I
 MEAN VALUES AND STANDARD DEVIATIONS OF AGE, HEIGHT, FEV₁, FVC, AND FEV%

	Group A		Group B		Port Talbot Survey, Males*
	B (–)	B (+)	B (–)	B (+)	
No. of cases ..	363	40	184	60	7,701
Age $\bar{x}$..	34.21	40.57	41.66	47.33	41.93
s ..	10.18	11.16	12.66	11.15	—
Height $\bar{x}$..	173.38	173.02	169.78	169.68	171.45
(cm) s ..	5.79	6.31	6.26	6.66	—
FEV ₁ $\bar{x}$..	4.33	3.96	3.77	3.26	3.48
(litres) s ..	0.87	1.02	0.90	0.89	—
FVC $\bar{x}$..	5.30	5.05	4.86	4.42	4.46
(litres) s ..	0.85	0.91	0.93	0.96	—
FEV% $\bar{x}$..	81.42	77.33	77.17	73.25	77.71
s ..	8.26	10.95	8.40	8.89	—

*Index for FEV₁ = FEV₁ · Age^{1/2}, for FVC = FVC · Age^{1/2}, and

$$\frac{\text{FEV}_1}{\text{Ht}^2} \quad \frac{\text{FVC}}{\text{Ht}^2}$$
 for FEV% = FEV% · Age^{1/2}.

* From Khosla (1971)
 $\bar{x}$ mean value
 s standard deviation
 B(–) non-bronchitics
 B(+) bronchitics

Nomogram for the index $W_{FEV\%}$

TABLE II
MEAN VALUES AND STANDARD DEVIATIONS OF INDICES

	Group A		Group B		Port Talbot Survey Males*
	B(-)	B(+)	B(-)	B(+)	
No. of cases ..	363	40	184	60	7,701
Index FEV ₁ $\bar{x}$..	0.817	0.814	0.811	0.755	0.755
s ..	0.127	0.177	0.135	0.154	—
Index FVC $\bar{x}$..	0.562	0.570	0.571	0.544	0.522
s ..	0.074	0.090	0.082	0.090	—
Index FEV% $\bar{x}$..	163.3	160.5	160.9	157.3	163.5
s ..	13.8	20.0	15.7	17.5	—

* Recalculated indices for height in centimetres
 $\bar{x}$ mean value
s standard deviation
B(-) non-bronchitics
B(+) bronchitics

TABLE III
CORRELATION COEFFICIENTS BETWEEN DEVIATIONS OF INDEX VALUES FROM MEAN AND DEVIATIONS OF OBSERVED MEASUREMENTS FROM THOSE PREDICTED BY MULTIPLE REGRESSION

	Group A		Group B	
	B(-)	B(+)	B(-)	B(+)
FEV ₁	0.949	0.960	0.916	0.958
FVC	0.949	0.979	0.970	0.968
FEV%	0.987	0.954	0.981	0.992

B(-) non-bronchitics
B(+) bronchitics

of the individual spirometric measurements. The results of this analysis gave evidence that there was a very high correlation between the deviations of the indices from mean values and the deviations of the observed values of spirometric measurements from those predicted by regression (Table III). It is important to say that the deviations were expressed as a ratio of differences to the root of the variance. In all cases the coefficients of correlation were higher than 0.90, and the differences between the two examined populations were not substantial even when the groups of persons with and without symptoms of chronic bronchitis were considered separately.

These results suggest that the new indices give the same amount of information as the multiple regression analysis. As the new indices are already adjusted for age and height the very laborious regression analyses are unnecessary. It is also very

important that they are distributed normally, since simple statistical tests, e.g., the *t* test, can be used in comparisons between various populations. To avoid difficulties in calculating the new indices we have prepared nomograms from which it is easy to derive fairly exact values of the indices for FVC, FEV₁, and FEV%.

INSTRUCTIONS FOR USE OF THE NOMOGRAMS

FEV or FVC Join the age and height axis and put a mark at the point of crossing with axis A; then put through the mark a new line to the observed value and read the index from the W_{FVC} or W_{FEV} axis.

FEV% Join the age and FEV% axis; at the point of the crossing of W_{FEV%}, read the value of the index.

SUMMARY

The aim of our study was the assessment of the practical value of Khosla indices on the basis of data obtained during epidemiological studies of chronic non-specific chest diseases in two occupational groups, A (drivers) and B (workers in a chemical factory). Having derived multiple regression equations of spirometric measurements on age and height, we calculated the correlation coefficients between deviations of the indices from the mean value and deviations of the observed values from regression lines taken for each person. The results of the correlation analysis gave evidence that there was indeed a very high correlation ($r=0.90$) between the Khosla indices and real results of the spirometric tests. The chronic bronchitics had lower indices in both groups of workers, but in group B they were lower than in group A.

The authors have prepared special nomograms from which the values of the indices can readily be derived.

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