SPIROMETRIC VALUES IN 540 HEALTHY SCHOOLBOYS

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Recently physical educationists have become interested in indices of lung function. This is very fortunate because tests of lung function are now widely used by the medical profession in assessing the severity of respiratory diseases, two of which are increasingly prevalent:- asthma and chronic bronchitis. It is very valuable indeed both from the point of view of the individual patient and from the wider point of view of the epidemiologist to have results of this kind which go as far back as possible in the history of the patient. From an entirely different standpoint these data are an important index of health.

There is a great need for a reliable body of normal values for these tests in the age range covered by school life. There is some evidence from the reliable tables which have already been published (Berlund, et al. (1963), Cherniack (1962) Godfrey, Kamburoff, and Nairn (1970) and Pistana (1969)) that regional and national variations in normal values occur.

For these reasons the following tables are published for the use of those interested for comparison with their own observations.

Techniques and population.

We have investigated 540 schoolboys who attend the Abingdon School, who ranged in age from 11 to 18 years, the actual distribution with age is shown in Table 1. This is the same group of boys who were the subjects of a previous study on a relation between academic achievement and physical fitness (Brodie and Kamburoff, 1970). None had any overt evidence of respiratory or other disease. They are seen by the school doctor from time to time.

The instrument which was used to measure the indices with which we are concerned is a dry spirometer of approved design (Vitalograph) which provides permanent records of the test data.

Each subject was given a printed sheet of instructions describing the method of delivering a single maximal expiration satisfactorily into the Vitalograph. Briefly, each subject inhales as deeply as he can and blows through a mouthpiece into the spirometer as fast and as far as he can. The volume exhaled is called

the 'forced vital capacity' (F.V.C.). It is recorded by the spirometer on a chart, which moves at a constant speed; this record gives the time course of the forced expiration from which measurements of the volume delivered in the first second (F.E.V.₁) may be measured, as well as the flow rate F.M.F. over the middle two quarters of the F.V.Cs.

Each individual was allowed a trial blow to get the feel of the machine, and then three spirograms were recorded the best of which was used for evaluation of F.V.C., F.E.V.₁ and F.M.F.

Finally each subject was weighed on a platform weighing machine. The dial was adjusted to give a zero reading unloaded before each weighing. A standard dress of gymnastic shirt and shorts was worn and the weight measured to the nearest $\frac{1}{2}$ kilo.

Height was measured, using a wall mounted stadiometer checked for accuracy with an anthropometer. The subject stood with his heels on the floor, his spine fully extended by pressure on the jaw and occiput. Height was measured to the nearest $\frac{1}{2}$ cm.

The data were analysed and their relationships investigated by application of standard methods of calculating multiple linear regressions, correlations and probability levels.

Results.

These are summarised in Table I and the statistical data derived from them are shown in Table II. The latter give all the coefficients required for the construction of regression formulae relating F.E.V.₁, F.V.C. and F.M.F. to the parameters of age, weight and height.

The important point to notice about this table is the small contribution made by the addition of weight to the value of the multiple correlation coefficient. This is so small that it is warranted to omit this parameter from the regression equation. Table III shows these equations and indicates in the last column the effect of omitting weight on the multiple correlation coefficient.

Figure 1 shows the graphs nomogram derived from these equations for ready reference.

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NORMAL SPIROMETRIC VALUES IN 540 SCHOOLBOYS FROM ABINGDON SCHOOL

TABLE I Distribution with age of weight, height, F.E.V.₁, F.V.C. and F.M.F.

AGE GROUP (years)	11	12	13	14	15	16	17	18
No of cases	20	56	78	89	85	82	92	74
Weight (Kg)	37.4	39.7	42.9	49.7	54.0	62.7	63.8	67.6
S.D.	5.72	7.18	6.77	9.01	8.42	8.88	8.14	9.25
Height (cm)	145.1	149.0	154.5	161.7	166.9	173.7	175.6	177.9
S.D.	5.44	9.10	8.86	8.25	8.77	6.73	7.17	6.12
FEV ₁ (l)	2.15	2.14	2.42	2.78	3.27	3.86	3.95	4.30
S.D.	0.294	0.342	0.474	0.630	0.629	0.729	0.722	0.732
FVC (l)	2.53	2.52	2.79	3.27	3.80	4.44	4.59	5.05
S.D.	0.323	0.368	0.566	0.669	0.710	0.744	0.714	0.709
FMF (l/min)	135.6	139.0	163.0	186.3	221.6	261.3	268.6	289.5
S.D.	34.87	37.17	37.13	59.41	66.37	73.92	82.13	68.56

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TABLE II. Normal predictions of the spirometric indices F.E.V.₁, F.V.C. and F.M.F. from age, weight and height.

Dependent variable	Independent variables	$\bar{Y}$ S.D. (Y)	$\bar{X}_1$ S.D.(x ₁)	$\bar{X}_2$ S.D.(x ₂)	$\bar{X}_3$ S.D.(x ₃)	Multiple correl. coeff. R	Intercept a	Regression Coefficients C ₁ (x ₁) C ₂ (x ₂) C ₃ (x ₃)	't' value	Probability level.		
Y = FEV ₁ (1)	X ₁ = age	3.31	15.19	55.11	166.25	0.86	-4.50	b ₁ 0.125 (0.0177)	b ₂ 0.024 (0.0037)	b ₃ 0.028 (0.0039)	age:7.07 wgt:6.48 ht: 6.96	***
	X ₂ = weight	0.984	2.017	12.849	12.524							***
	X ₃ = height											***
Y = FVC	X ₁ = age	3.84	The same as above			0.90	-4.79	0.127 (0.0167)	0.032 (0.0035)	0.030 (0.0038)	age:7.58 wgt:9.26 ht: 7.92	***
	X ₂ = weight.	1.084										***
	X ₃ = height											***
Y = FMF	X ₁ = age	223.0	The same as above			0.68	-320.3	12.600 (2.1690)	1.040 (0.4506)	1.771 (0.4867)	age:5.80 wgt:2.30 ht: 3.63	***
	X ₂ = weight	83.33										*
	X ₃ = height											***

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TABLE III. Prediction formulae for F.E.V.₁, F.V.C., and F.M.F. on age and height.

	S.D. (1)	't' value	multiple correl. coefficient R
F.E.V. = - 6.64 + 0.1507 age + 0.04605 height.	age = 0.0179; ht. = 0.00288	age = 8.42; ht. = 15.96	0.85
F.V.C. = - 7.67 + 0.1613 age + 0.05451 height.	0.0175; 0.00282	9.20; 19.30	0.89
F.M.F. = - 413.19 + 13.7205 age + 2.5726 height.	2.1235; 0.34204	6.46; 7.52	0.68

Highly significant

* significance at 5% level of probability.

** significance at 1% level of probability.

*** significance at 0.1% level of probability.

Figure 1

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Invitation to the International Contest for the Carl Diem Plaque 1971/72

1. Every two years the German Sports Federation (Deutscher Sportbund) awards the Carl Diem Plaque for an outstanding scientific paper relating to the field of sport.
2. In special consideration of the fact that the Olympic Games of 1972 will be held in Munich entries for the contest are invited on an international scale.
3. The award of the Carl Diem Plaque in 1972 will be accompanied by a prize in money of up to DM 10,000.—. Other scientific papers relating to the field of sport submitted within the framework of the contest may be awarded a prize in money or receive commendation.
4. The papers must be submitted in the German, English or French language. They must not have been published before and may not be published either in whole or in part or made the subject of contract negotiations until the end of the contest and the grant of the awards. Habilitation theses and theses for an academic degree may be considered only if they have not yet been made available to the public.
5. The final date for submitting the papers to be addressed in six copies by registered mail to Deutscher Sportbund, 6000 Frankfurt am Main, Arndtstrasse 39, will be February 1st, 1972, the postmark serving as proof. Papers submitted at a later date will not be considered.
6. The six submitted voucher copies of the papers awarded the Carl Diem Plaque or other prizes will become the property of the German Sports Federation. Two voucher copies each of all other papers will remain with the German Sports Federation as library copies.
7. A paper awarded the Plaque or a prize in money may be published in the "Wissenschaftliche Schriftenreihe des Deutschen Sportbundes" (Series of Scientific Publications of the German Sports Federation), if the Committee so decides. Publication by another publisher or any other form of publication will not be allowed until the final selection of these papers.
8. In order to safeguard the anonymity of the writer, the papers will be submitted under a code word. Each paper must be accompanied by a closed envelope showing the code word and containing the following data:
 - a) name, address and short curriculum vitae of the writer;
 - b) a statutory declaration to the effect that the paper has been prepared by the writer without any assistance and that the entry for the contest conforms to the conditions of the invitation;
 - c) a complete listing of the aids used as well as an assurance that no other aids were used (provided such statements are not already contained in the paper itself);
 - d) a declaration stating whether, where and in what version the paper has already been the object of a contest.
 If the anonymity of the writer is not maintained during the proceedings through the writer's own fault the paper submitted by him will be excluded from the contest.
9. The result of the contest will be announced at a festive gathering arranged by the German Sports Federation.

Frankfurt am Main, March 1st, 1971

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