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Ventilatory parameters in healthy nonsmoking adults of Adriatic islands (Yugoslavia)

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Ventilatory parameters in healthy nonsmoking adults of Adriatic islands (Yugoslavia). N. Smolej-Narančić, M. Pavlović, P. Rudan.
ABSTRACT: Forced expiratory volumes and flows (forced vital capacity (FVC), forced expiratory volume in one second (FEV_1) peak expiratory flow (PEF), maximal expiratory flow at 25% ($MEF_{25\%}$), 50% ($MEF_{50\%}$) and 75% ($MEF_{75\%}$) of the FVC) have been measured in 909 healthy nonsmoking men and women, ranging in age from 18–86 yrs, who live on Eastern Adriatic islands (Yugoslavia). This area is essentially free from air pollution. The results have been analysed in terms of age and height and regression equations for each sex were derived. The equations for FVC and FEV_1 were reliable and those for forced expiratory flows were not. Comparisons were made with prediction equations derived for other populations, especially with those which are commonly used in daily medical practice.
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Reference values for lung function parameters in healthy nonsmoking adults have been developed in several populations [1–19]. There is great variability in the predicted values due to the selection of subjects, methodological and technical differences in making the assessment, ethnic background, *etc.* As we have no reference values for any adult Yugoslav population so far, the results of spirometric testing have mostly been evaluated using reference values developed in other populations of Europe [2], and North America [4]. It has been noticed in practice that they are inadequate for some lung function parameters or in certain age categories [20–26]. The purpose of this study, therefore, is to analyse some lung function parameters amongst the healthy nonsmoking adults inhabiting the area of Adriatic islands (SR Croatia, Yugoslavia) and to provide reference values in the form of prediction equations. Besides their biomedical application the results of this study may also be of interest for the study of human physiological variation, since relatively little information is available regarding lung function of Yugoslav populations.

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Subjects and methods

Three hundred and twenty seven men and 582 women between the ages of 18–86 yrs were examined. The subjects were selected from a large, randomly chosen, sample of about 5,000 persons investigated from 1981 to 1987 during a multidisciplinary anthropological study of rural populations of the Eastern Adriatic islands Korčula, Brač, Silba, Olib and Pag and the Pelješac peninsula. Anthropological investigations in this area of Yugoslavia have been conducted over the last 15 yrs by the investigation team of the Department of Anthropology of the Institute for Medical Research and Occupational Health of the University of Zagreb, Yugoslavia. The main characteristics of the biotope and of the populations living in it (demography, migration, linguistics, haemogenetics, anthropometry, dermatoglyphics, cardiorespiratory physiology) have already been published [27, 28]. This area is considered to be free of urban air pollution, and the evaluation is less than 300 m above sea level. The subjects underwent a clinical interview and examination and completed the modified version of the Medical Research Council [29] standardized questionnaire on respiratory symptoms. They were all considered to be in good health at the time of the study. None had ever had symptoms of asthma or chronic bronchitis, or suffered from pneumonia, tuberculosis or pleuritis as defined. None had ever had any chest injury or operation or had been treated recently for any respiratory condition. None had ever worked in a polluted atmosphere for any extended period, and all were lifetime nonsmokers. Among the subjects investigated, more than 80% were involved in agricultural and fishing activities. The remaining subjects were mostly employed in tourism, while at the same time they performed agricultural activities as a secondary occupation.

The ventilatory tests consisted of the forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), peak expiratory flow (PEF) and maximal expiratory flows at 25% ($MEF_{25\%}$), 50% ($MEF_{50\%}$) and 75% ($MEF_{75\%}$) of the FVC. The testing was performed in a sitting position without a noseclip by means of a pneumotachographical open system with the body temperature, atmospheric pressure and saturation (BTPS) conditions. Jaeger's "Pneumoscreen" (Wuertzburg, West Germany) was used. The instrument was heated to 37°C automatically. A forced vital capacity (FVC) manoeuvre was repeated until three FVC values were obtained which varied no more than 100 ml or 5%, whichever was larger. For FVC, FEV_1 and PEF the largest values were taken regardless of the tracing from which they were obtained. To calculate FEV_1 the computer-determined back extrapolation technique was used. By evaluation of the flow-volume loop the "envelope" curve was taken to determine the maximum flow values at a specified percentage. To ensure stability of results, the equipment was calibrated using a 3 *l* syringe, after every 20 subjects, with ambient air. All tests were conducted by three members of the research team (medical doctors, specialists). The tests were performed either in June or September between 7 am and 12 pm. Height was measured according to the International Biological Programme protocol [30], feet against a wall with the head in the Frankfort plane.

The observed lung function values for each sex were analysed as functions of height and age using full model multiple linear regression analysis [31]. The independent variables were considered to contribute significantly to the description of the dependent variable if corresponding regression coefficients departed significantly from zero according to the t-test analysis. In addition to the rectilinear model, we have tested models involving logarithmic (ln) transformations of the dependent variables (lung function measurements) as well as logarithmic (ln), quadratic and cubic transformations of the independent variables (height (H) and age (A)). The choice of the best model was based on assessment of model simplicity, analysis of residuals (they were checked for normality and also analysed for fits separately to height, age and the predicted values; these were required to be nonsignificant), comparison of the residual standard deviation, *i.e.* standard error of estimate (SEE) and comparison of the proportion of total variance in a lung function measurement explained by the model (r^2).

Results

A total of 909 healthy nonsmoking men and women were included in the study. Their age distributions by half decades and height distributions by 5 cm are shown in table 1. The numbers of subjects were approximately constant across half decades until the age of 65 yrs. The older age categories are less well represented, as are the extreme height categories. The means, standard deviations and ranges for the age and height of the subjects and for their lung function parameters are listed in table 2. Figure 1 demonstrates the distribution of all of the data points by age for FVC and FEV_1. An age-related decline is evident for both sexes through the entire age range. Variability of values appears higher until the age of 40 yrs. Regressions of lung function parameters on height and age, where these contribute significantly to the description of the findings, are given in table 3. These simple rectilinear equations proved satisfactory according to the previously mentioned criteria. No improvement in r^2 or SEE was obtained in regression analyses performed on transformed variables (ln, quadratic and cubic transformations). r^2 given in table 3 shows that the proportion of explained variance is highest

Table 1. – Distribution of subjects by age and height

Age	No. of subjects		Height	No. of subjects	
yrs	Men	Women	cm	Men	Women
18–19	3	5	140–144	–	2
20–24	17	30	145–149	–	14
25–29	29	48	150–154	–	65
30–34	33	62	155–159	3	126
35–39	54	77	160–164	16	198
40–44	42	72	165–169	47	140
45–49	47	79	170–174	96	32
50–54	30	81	175–179	73	4
55–59	37	57	180–184	64	1
60–64	18	32	185–189	22	–
65–69	4	17	190–194	5	–
70–74	8	7	195–200	1	–
75–79	5	11			
80–84	–	3			
85–90	–	1			

Table 2. – Mean values, standard deviations and ranges for age, height and lung function parameters

	Men n=327			Women n=582		
	Mean	SD	Range	Mean	SD	Range
Age yr	44	12.8	18–77	44	13.2	18–86
Height cm	176	7.0	156–196	161	6.0	141–181
FVC l	4.7	0.9	2.1–7.6	3.3	0.7	1.3–6.0
FEV_1 l	3.9	0.8	1.9–6.5	2.7	0.6	1.2–5.1
PEF $l \cdot s^{-1}$	9.2	2.3	2.4–15.8	6.1	1.5	2.3–14.4
$MEF_{25\%}$ $l \cdot s^{-1}$	2.7	1.0	0.8–6.6	2.2	0.8	0.8–5.7
$MEF_{50\%}$ $l \cdot s^{-1}$	5.9	1.6	2.2–11.2	4.3	1.1	1.7–9.3
$MEF_{75\%}$ $l \cdot s^{-1}$	8.3	2.2	4.2–19.3	5.7	1.4	2.4–12.4

FVC: forced vital capacity; FEV_1: forced expiratory volume in one second; PEF: peak expiratory flow; $MEF_{25\%}$, $MEF_{50\%}$ and $MEF_{75\%}$: maximal expiratory flow at 25, 50 and 75% of FVC, respectively.

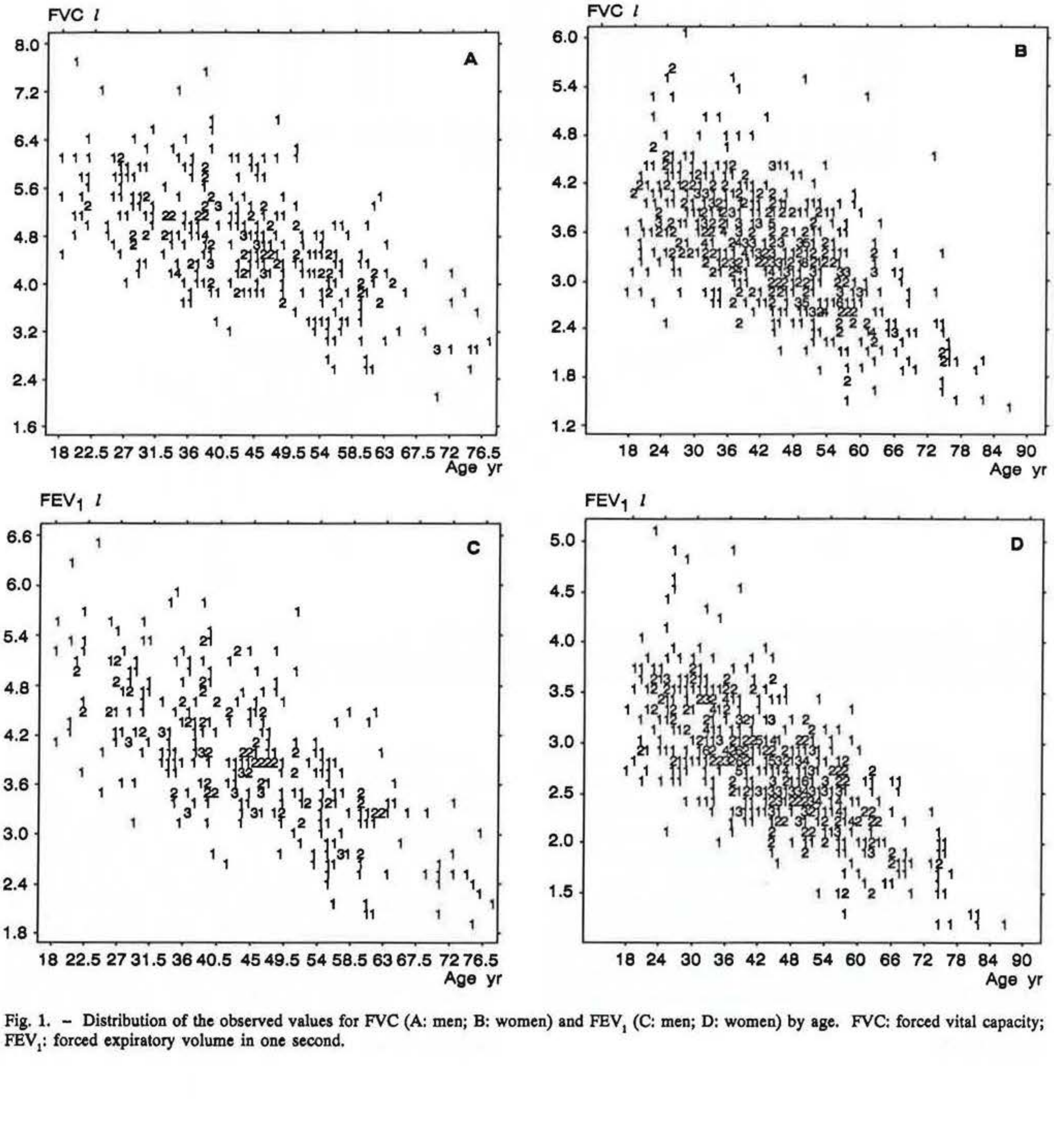

Fig. 1. – Distribution of the observed values for FVC (A: men; B: women) and FEV_1 (C: men; D: women) by age. FVC: forced vital capacity; FEV_1: forced expiratory volume in one second.

Table 3. – Regression equations of lung function parameters on height and age where these terms are significant

Parameter	Regression equation	r	r^2 %	SEE
Men				
FVC	0.0526 H – 0.0349 A - 3.0481	0.724	52.5	0.649
FEV_1	0.0437 H – 0.0347 A - 2.2732	0.765	58.5	0.532
PEF	0.0772 H – 0.0523 A - 2.0888	0.434	18.8	2.104
$MEF_{25\%}$	0.0297 H – 0.0319 A - 1.1336	0.532	28.3	0.840
$MEF_{50\%}$	0.0607 H – 0.0442 A - 2.8558	0.520	27.0	1.366
$MEF_{75\%}$	0.0723 H – 0.0414 A - 2.5416	0.400	16.0	1.980
Women				
FVC	0.0353 H – 0.0304 A - 1.0930	0.713	50.8	0.497
FEV_1	0.0251 H – 0.0294 A - 0.0074	0.756	57.2	0.395
PEF	0.0313 H – 0.0401 A +2.7861	0.404	16.3	1.385
$MEF_{25\%}$	– 0.0289 A +3.4648	0.493	24.3	0.677
$MEF_{50\%}$	0.0147 H – 0.0343 A +3.4897	0.441	19.5	0.992
$MEF_{75\%}$	0.0213 H – 0.0376 A - 3.9311	0.387	15.0	1.308

H: height in cm; A: age in years; r: multiple correlation coefficient; SEE: standard error of estimate. For further abbreviations see legend to table 2.

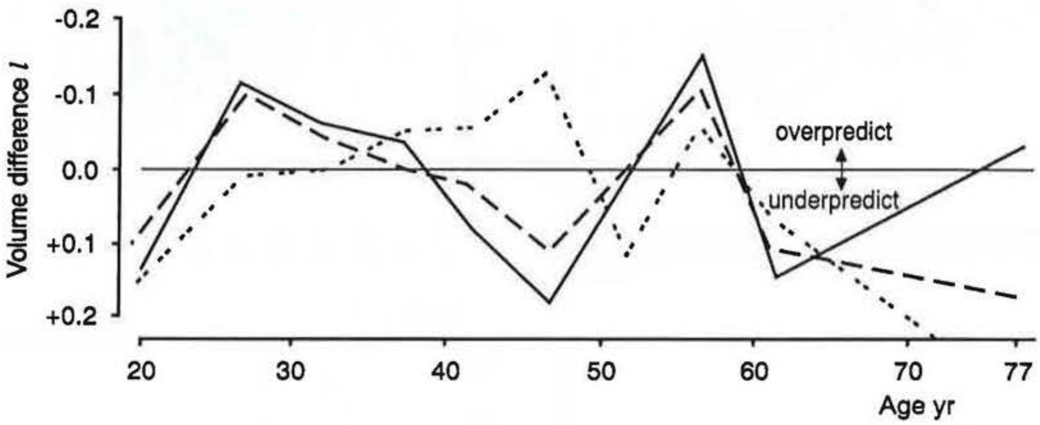

Fig. 2. – The mean residuals for 5 yr age groups of FVC (FVC res) (——), FEV_1 (FEV_1 res) (– – – –) and $MEF_{25\%}$ ($MEF_{25\%}$ res) (- - - -) calculated for men using the linear regression equations (see table 3). The zero value on the ordinate indicates the observed mean of a lung function parameter in each age group. $MEF_{25\%}$: maximal expiratory flow at 25% FVC. For further abbreviations see legend to figure 1.

for FVC and FEV_1 (51–59%) and considerably less for other studied variables (15–28%). The extent to which linear regressions fit the observed data was considered in the entire age range by plotting the mean residuals in five year age groups. Figure 2 demonstrates the examples of FVC, FEV_1 and $MEF_{25\%}$ in men. There is no consistency in the variability of the residuals around the zero value on the ordinate, which indicates the average observed mean of a lung function parameter in each age group. The deviations of the predicted from the observed values are of the same magnitude in young and elderly as those in middle age categories, that is relatively small.

A comparison of the present equations was made with other published reports obtained for healthy adult nonsmokers using the same type of regression equation. The equations of CECA from 1971 [2], CHERNIACK and RABER [4] and MORRIS *et al.* [3] were selected because they are most often used in Yugoslavia. The equations of FERRIS *et al.* [1], KNUDSON *et al.* [5, 12], CRAPO *et al.* [9] and CECA from 1983 [11] were selected because they are widely used in North America and Europe. Finally equations of SALORINNE [6], PAOLETTI *et al.* [13] and ROCA *et al.* [14] were included in the comparison because they are based on samples of subjects from the Mediterranean region. Table 4

Table 4. – Comparison of prediction equations for nonsmoking adults

Author [Ref.]	Men SEE	Men Diff.	Women SEE	Women Diff.
FVC				
Ferris *et al.* [1]	0.66	-0.55	0.47	-0.38
Morris *et al.* [3]	0.74	+0.19	0.52	+0.09
Cherniack and Raber [4]	-	-0.03	-	+0.03
Knudson *at al.* [5]	0.60	+0.02	0.52	0.00
Salorinne [6]	0.69	+0.50	0.40	+0.28
Crapo *et al.* [9]	0.64	+0.29	0.39	+0.12
CECA [11]	0.61	+0.03	0.43	-0.19
Knudson *et al.* [12]	0.61	-0.01	0.49	+0.03
Paoletti *et al.* [13]	0.58	+0.48	0.39	+0.38
Roca *et al.* [14]	0.53	+0.54	0.40	+0.31
Present result	0.65	+0.07	0.50	-0.03
FEV_1				
Ferris *et al.* [1]	0.59	-0.72	0.42	-0.33
Morris *et al.* [3]	0.55	-0.23	0.47	-0.13
Cherniack and Raber [4]	-	-0.08	-	-0.10
Knudson *at al.* [5]	0.54	-0.14	0.43	-0.11
Salorinne [6]	0.52	+0.43	0.34	+0.37
Crapo *et al.* [9]	0.49	+0.12	0.33	+0.07
CECA [11]	0.51	-0.10	0.38	+0.01
Knudson *et al.* [12]	0.52	-0.09	0.39	-0.03
Paoletti *et al.* [13]	0.48	+0.01	0.29	+0.03
Roca *et al.* [14]	0.44	+0.11	0.31	+0.04
Withers *et al.* [18, 19]	0.47	+0.11	0.34	+0.18
Present result	0.53	+0.03	0.40	0.00
PEF				
Cherniack and Raber [4]	-	-0.01	-	+0.09
Knudson *at al.* [5]	2.08	-0.21	1.61	+0.01
CECA [11]	1.21	-0.20	0.90	+0.38
Paoletti *et al.* [13]	1.24	+0.86	0.87	+0.39
Roca *et al.* [14]	1.47	+0.71	1.04	+0.18
Present results	2.10	-0.03	1.38	-0.04
$MEF_{25\%}$				
Cherniack and Raber [4]	-	-0.05	-	-0.02
Knudson *at al.* [5]	1.03	+0.36	0.94	+0.24
CECA [11]	0.78	-0.61	0.69	-0.57
Knudson *et al.* [12]	0.69	-0.74	0.65	-0.60
Paoletti *et al.* [13]	0.58	-1.05	0.46	-0.49
Present result	0.84	+0.04	0.68	0.00
$MEF_{50\%}$				
Cherniack and Raber [4]	-	-0.20	-	-0.06
Knudson *at al.* [5]	1.42	+0.20	1.22	+0.29
CECA [11]	1.32	-0.89	1.10	-0.42
Knudson *et al.* [12]	1.29	-1.08	0.97	-0.66
Paoletti *et al.* [13]	1.29	-1.04	0.81	+0.62
Roca *et al.* [14]	1.30	-0.93	0.93	-0.67
Present result	1.37	+0.07	0.99	+0.06
$MEF_{75\%}$				
Cherniack and Raber [4]	-	-0.17	-	-0.04
Knudson *at al.* [5]	2.01	-0.04	1.53	0.00
CECA [11]	1.71	-0.42	1.35	-0.05
Present result	1.98	-0.03	1.31	-0.07

SEE: standard error of the estimate in the cited study; Diff.: difference between the mean predicted from cited equation (using mean values for height and age of the present sample) and the mean observed in the present study. For further abbreviations see legend to table 2.

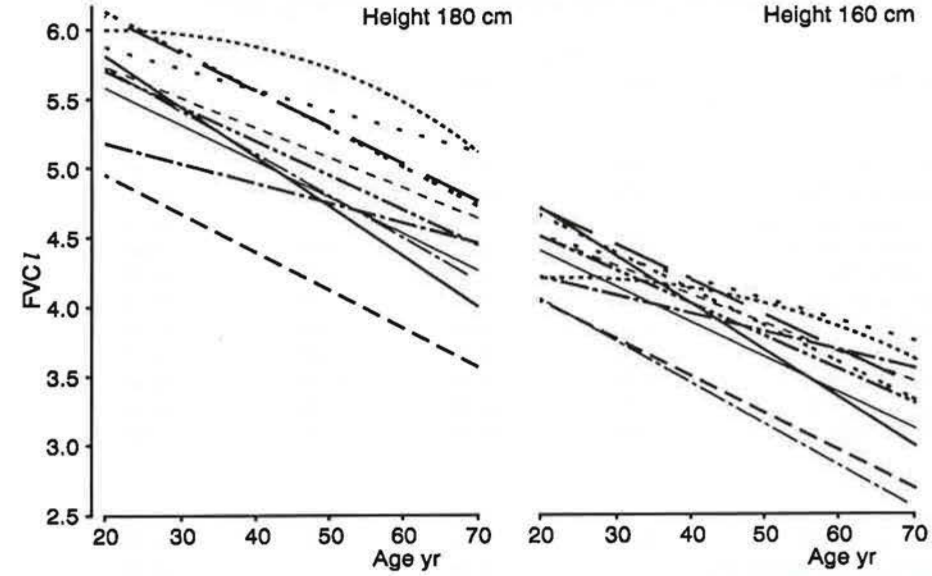

Fig. 3. – Reference values for forced vital capacity (FVC) in healthy adult nonsmoking men. For sources see references. - - - Ferris *et al.* [1]; · · · · CECA [2]; — - - — Morris *et al.* [3]; — – — Cherniack and Raber [4]; — —Salorinne [6]; · · · · Crapo *et al.* [9]; – – – Knudson *et al.* [12]; ——— CECA [11]; – – – – Poletti *et al.* [13]; - · · · - Roca *et al.* [14]; ——— Present result.

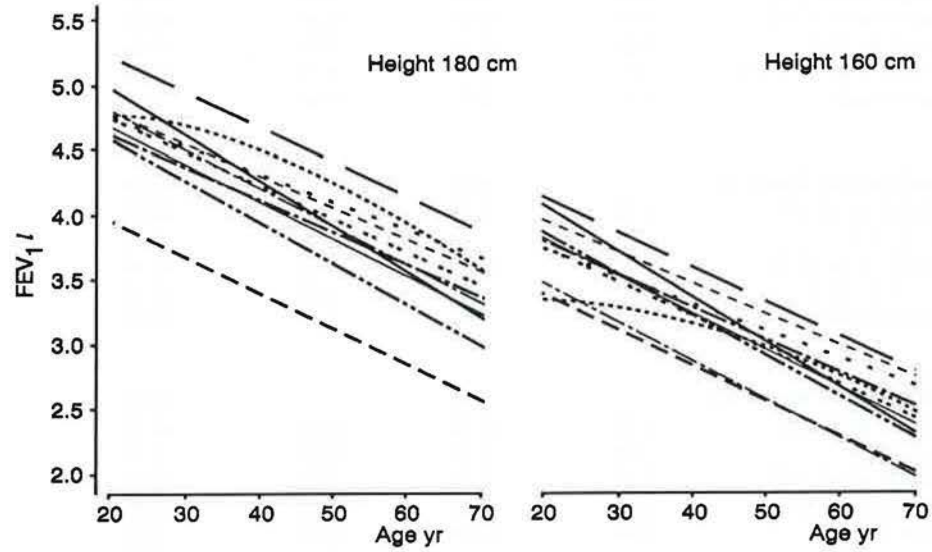

Fig. 4. – Reference values for forced expiratory volume in one second (FEV_1) in healthy adult nonsmoking men. For sources see references. - - - Ferris *et al.* [1]; · · · · CECA [2]; — · · — Morris *et al.* [3]; — · — Cherniack and Raber [4]; — —Salorinne [6]; · · · · Crapo *et al.* [9]; - - - Knudson *et al.* [12]; ——— CECA [11]; – – – – Poletti *et al.* [13]; - · · - Roca *et al.* [14]; ——— Present result.

indicates, for each lung function parameter, the differences between the mean value predicted from equations of other authors and the mean values observed in the present study. Departures from zero in the case of presently developed prediction equations result from the rounding of the regression coefficients to three decimal places. The differences between predicted and observed means permit comparison of different prediction equations. It should be emphasized that such an analysis is a sufficient basis only for discarding prediction equations which give considerable differences as unacceptable for our population. It is by no means adequate for recommending any of the other prediction equations to be accepted. The age range is approximately the same in all studies cited in table 4. It is obvious that, because of the large standard errors of the estimate, the predicted means do not differ significantly. It should be noted, however, that although within the value of standard error, the equations of Salorinne [6], Paoletti *et al.* [13] and Roca *et al.* [14] predict higher values of FVC and the equations of Ferris *et al.* [1] lower values of FVC than do our equations. Comparisons for FEV_1 also show higher values predicted by the equations of Salorinne [6], and lower values predicted by the equations of Ferris *et al.* [1]. This is graphically shown in the example of FVC and FEV_1 in men in figures 3 and 4. In figure 3 it is also quite noticeable that the age coefficients of the equations of Roca *et al.* [14] and Cherniack and Raber

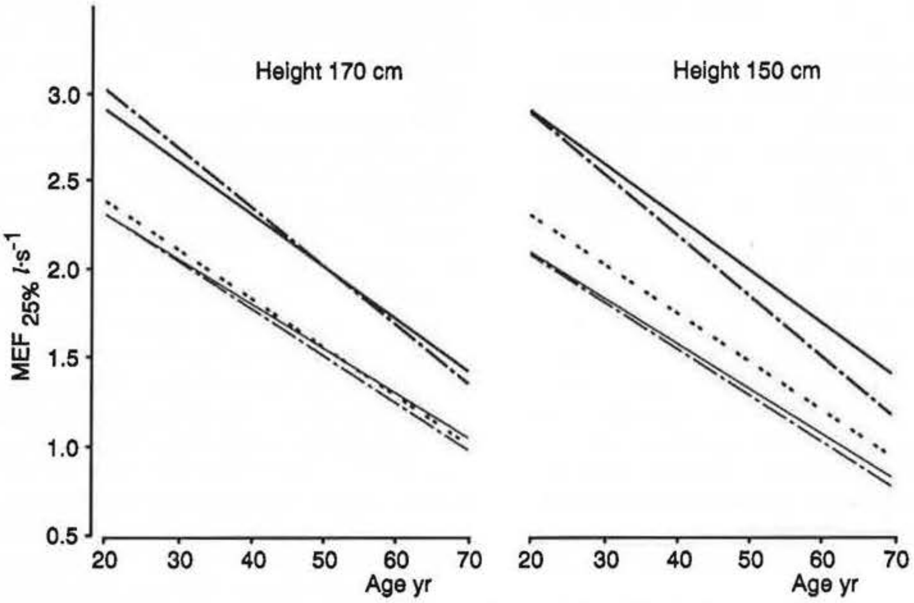

Fig. 5. – Reference values for maximal expiratory flow at 25% FVC ($MEF_{25\%}$) in healthy adult nonsmoking women. For sources see references. – -– CHERNIACK and RABER [4]; - - - KNUDSON *et al.* [12]; ——— CECA [11]; – – – – PAOLETTI *et al.* [13]; ——— Present result.

[4] for FVC stand out from the others. The equations of ROCA *et al.* [14] constantly predict higher values, while the equations of CHERNIACK and RABER [4] predict lower values of FVC in younger age and higher values in older age than do our equations in both sexes. This cannot be seen in table 4 where, based on substitution of average height and age, the equations of CHERNIACK and RABER [4] come out as very acceptable. Figures 3 and 4, in addition to different reference values cited in table 4, also show for us especially interesting values reported by CECA in 1971 [2]. For FVC CECA values are lower than our predicted values in young subjects of lower stature and rather high in all other subjects. For FEV_1, CECA values are lower than our predicted values in young subjects as well as in subjects of lower stature, and higher in older and in taller subjects. For maximal flows in healthy nonsmokers of varying age there are fewer published prediction equations so far. Among the predicted means shown in table 4 the equations of KNUDSON *et al.* [12], PAOLETTI *et al.* [13] and ROCA *et al.* [14] give predictions notably different from ours which are close to, or even exceed the values of standard errors of the estimate. The equations of CHERNIACK and RABER [4] give generally the closest predictions to ours, which is also shown in figure 5 in the example of $MEF_{25\%}$ in women. The figure demonstrates the similarity of predicted flow values in the entire age and height range.

Discussion

The present results relate to a healthy adult population of nonsmokers living in rural areas of Eastern Adriatic islands, the pollution-free parts of SR Croatia, Yugoslavia. The subjects for this study predominantly work in activities that entail strenuous physical labour (agriculture, fishing).

The parameters of lung function have been regressed on age and height. As the present material covers a wide range in both sexes (18–86 yrs), in addition to simple linear regressions, models which included logarithmic, quadratic and cubic transformations of height and age were tested. According to objective statistical criteria simple linear regressions were shown to be satisfactory. Historically most investigators have in cross-sectional studies treated the effect of age in adults as a constant decline starting from age 20 or 25 yrs, by using a single negative age term. There is evidence, however, that in young adults lung function does not decline linearly with age and that the transition between the growth in adolescence and the decay with age in adults occurs in a wide span of about 18–30 yrs of age [12, 13]. Furthermore, some investigators have in longitudinal, as well as in cross-sectional, studies noted that the rate of decline in lung function is initially small, gradually accelerating with advancing age which causes the linear regressions to overestimate predicted values in the very elderly [12, 32–35]. SCHOENBERG *et al.* [32] have shown on a large sample of 3,046 subjects that a simple linear model over-predicts most function values at both ends of the age scale and, at the same time, under-predicts for the middle ages. By the introduction of complex age terms in place of a single negative age term, their equations performed better. Such a tendency was not detected in the present sample. The fact that the linear model provided the satisfactory fit does not necessarily imply that the decline in lung function is truly linear in an individual. The linear relationship found in this cross-sectional analysis is at least in part due to a selection effect: subjects in whom lung function decays rapidly with age do not survive to an old age. It is also probable that the secular trend contributes to the linearity of the relationship: subjects born many decades ago did not achieve height as great as those born later. It has been shown that a secular trend is still significant in the Yugoslav populations [36, 37].

In clinical medicine and epidemiological research it is important to have reference values for lung function parameters that are appropriate to the population under study. Despite numerous attempts, we only have our own reference values in Yugoslavia, valid for children aged 7–18 yrs [38]. For adults, prediction equations developed in other populations are being used. The reference values proposed by CECA in 1971 have been considered to be the most suitable for FVC and FEV_1 in our population. For lung flows, the reference values proposed by Cherniack and Raber [4] are primarily used, despite the observation that these are too high for flows measured in the second half of the flow-volume curve, particularly for $MEF_{25\%}$ [24]. Those equations, as well as some other widely used linear equations developed for populations of healthy adult nonsmokers from Europe and North America (cited in table 4), were compared with the Eastern Adriatic regression equations from this study.

For FVC and FEV_1 the CECA equations generally give lower predictions in younger age categories and in subjects with lower stature and much higher predictions in all other categories. The main reason for high values of CECA may be their selected sample composed of highly physically active workers in the heavy coal and steel industry. Differences in predicted values reach up to 1 *l* which is physiologically highly significant and makes those reference values inappropriate for use in the Eastern Adriatic population.

Among other prediction equations, notable overpredictions of FVC are obtained by those of Salorinne [6], Paoletti *et al.* [13] and Roca *et al.* [14], whilst Salorinne's equation continuously overpredicts FEV_1 also. In comparison with these regressions, all based on Europeans from the Mediterranean region (Italians and Spaniards), our regression lines are steeper. Interpopulational factors do not represent a satisfactory explanation for the differences observed since there are also some sampling and technical differences between these and our study. The samples of Salorinne [6] and Roca *et al.* [14] comprise subjects from 20–70 yrs, the sample of Paoletti *et al.* [13] comprises males from 29–64 yrs and females from 21–64 yrs, while our sample also includes subjects older than 70 yrs; the values of the old age group influence the slope of our regression line. The technical differences refer to the criteria for defining end-points of the spirometric manoeuvres. Salorinnes' testing was prior to the current American Thoracic Society (ATS) standards [39], Paoletti *et al.* [13] and Roca *et al.* [14] used automated analysis of FVC (Hewlett-Packard System) in which the end-point of forced expiration was defined as the point in which flow was less than 15 mls^{-1}, while our testing followed the ATS suggestions which defines the end-point when flow reaches values less than 25 mls^{-1}. The evaluation of the influence of these criteria on spirometric measurements has shown that the criterion utilized by Hewlett-Packard (HP) Systems results in higher values of FVC than the ATS criterion [14, 40]. Consequently, the two different criteria for the end-point selection have contributed partly to the lower values of FVC in our study in comparison with those in the Italian and Spanish study.

The equations of Ferris *et al.* [1], the oldest ones in the present comparison, notably continuously underpredict both FVC and FEV_1. The underpredictions reach significant 1 *l* for FEV_1. Such low values may be explained by the inclusion of ex-smokers in the reference sample and, as noted by Paoletti *et al.* [13], probably by the low resolution of reading tracings manually, due to the low speed of the recording paper.

The other equations for FVC and FEV_1 compared to those developed for the Eastern Adriatic population give closer predictions. The differences in testing equipment (*e.g.* spirometer *vs* pneumotachograph) and procedures (*e.g.* ATS *vs* other methods) used in the studies, as always, partly handicap the comparison. Despite this criticism, the equations of Morris *et al.* [3], Knudson *et al.* [12] and Crapo *et al.* [9], that are most widely used in the United States, do not appreciably differ from ours, since the differences in prediction are within the error span assumed by the prediction equation. The equations of Cherniack and Raber [4] developed for a Canadian population, have more gradual slopes than ours. They give predictions close to ours in the middle of the adult age and height span, but (particularly for FVC) significantly different predictions towards the extremes of age span. The different slope may be the result of the inclusion of young subjects (15–20 yrs) in the reference sample from which their single regression has been derived. The summary equations of CECA derived for Caucasians and proposed in 1983 [11] give predictions of FVC and FEV_1 very similar to ours. The prediction differences at the extremes of the age span (20 and 70 yrs) are of the order 0.02–0.28 *l* which is lower than the standard error of the estimate for FVC and FEV_1 equations. This satisfactory result is a contribution to the "insufficient information available about the applicability of summary reference values in different ethnic groups within Europe" set as a problem in the CECA recommendations [11].

The measurements of maximal flows showed high variability, with standard errors of estimate being approximately 21–30% of the mean values. A similar problem with flows exists in other studies which were used for comparisons with the Eastern Adriatic data [5, 11–14]. Consequently, the differences in predictions that are large enough to be of physiological significance, come out as statistically nonsignificant and it appears as if our regression equations compare favourably with those reported in the literature. Actually, only the equations of Cherniack and Raber [4] which have been used most often for our populations, give predictions similar to ours in the entire age and height range. In the comprehensive review of CECA [11] it was concluded that, due to the methodological and sampling problems, the equations for flows were widely divergent and that no useful regressions existed for them. The more recent study of Paoletti *et al.* [13] also led to the conclusion that their predictions from "normals" for general use were questionable [13]. The sample applies to our equations characterized by the low precision of prediction. Because of the high variability of instantaneous flows between the instruments it must also be pointed out that the proposed values may not be applicable to other instruments.

In conclusion, the present results indicate the lung function to be expected for adult population of the Eastern Adriatic islands and should prove useful in clinical medicine and respiratory epidemiology. Further research is needed in order to validate the proposed reference values in comparatively selected mainland Yugoslav populations with different ecological background.

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Paramètres ventilatoires chez des adultes bien portants non fumeurs des Iles Adriatiques (Yougoslavie). N. Smolej-Narančić, M. Pavlović, P. Rudan.
RÉSUMÉ: Les volumes expiratoires forcés et les débits (CVF, VEMS, DEP, $MEF_{25\%}$, $MEF_{50\%}$, $MEF_{75\%}$), ont été mesurés chez 909 hommes et femmes bien portants et non fumeurs, âgés de 18 à 86 ans, et vivant sur les Iles Orientales de l'Adriatique (Yougoslavie). Cette zone est essentiellement libre de toute pollution de l'air. Les résultats ont été analysés en termes d'âge et de taille, et des équations de régression ont été dérivées pour chaque sexe. Les équations pour la CVF et le VEMS s'avèrent valables, alors que celles qui concernent les débits expiratoires forcés ne le sont pas. Des comparaisons avec des équations de prédiction provenant d'autres populations ont été réalisées, principalement avec celles qui sont utilisées couramment dans la pratique médicale de tous les jours.
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