Large lungs in divers?

To the Editor: Crosbie, Reed, and Clarke (2) believe that commercial divers have large lungs as a result of their occupation. They do not discuss the obvious alternative: divers may be a selected group of men with large lungs to begin with. In this, divers may be similar to brass wind instrument players (see Fig. 1 in Ref. 1). The authors describe “...how years of diving experience increases the FVC up to about 30 yr of age,...” However, a similar time course of FVC changes has been observed in healthy nonsmoking men and women living in three US communities (see Fig. 1 and Table 1 in Ref. 5). Crosbie et al. (2) used simple linear prediction equations for FVC; these do not adequately correct for age in young adults (5). Hence, their conclusion that diving experience has an effect on FVC that is independent of age (p. 641, lines 4–6) is not well founded.

The relation between $FEV_{1.0}/FVC \times 100$ and FVC (as a percentage of the predicted value) shown in Crosbie et al.’s Fig. 1 is not confirmed by our data on 154 healthy lifetime nonsmoking white males aged 18–50 yr, the age group studied by Crosbie et al. (2). The men we studied are part of a larger population reported elsewhere (3, 5). After reading Crosbie et al.’s paper, we examined our data for these men, and found that $FEV_{1.0}/FVC \times 100$ correlates significantly with FVC ($\%_{\text{pred}}$) over the full range of FVC (from 67 to 138% pred), not just in those with a larger than predicted FVC. For the total group of 154 men, $Y = -0.290 X + 109.47$, where $Y = FEV_{1.0}/FVC \times 100$ and $X = FVC$ in % of predicted value ($r = -0.429; t = -5.86; P < 0.01$). For the subgroup of 82 men whose FVC was larger than 100% of predicted, the correlation between $FEV_{1.0}/FVC \times 100$ and FVC ($\%_{\text{pred}}$) was less ($r = -0.330$ though still significant ($t = -3.12; P < 0.05$). Thus, the relation between $FEV_{1.0}/FVC \times 100$ and FVC ($\%_{\text{pred}}$) is not unique to divers, since it also occurs among men in the general population. Nor is it unique to men with large lungs, since it is similar over the full range of vital capacities in our group.

There are no valid reasons to think that men with large lungs have airway obstruction, as Crosbie et al. appear to imply. Our prediction equations (5) remove the effects of age, height, and weight better than those Crosbie et al. used. For men of similar age, height, and weight, the size of the vital capacity is probably related, in part, to muscular strength. Other factors being equal, men with more powerful inspiratory muscles may be able to expand their chest and lungs more than men with less powerful inspiratory muscles. $FEV_{1.0}$, on the other hand, is influenced by muscular power only to the extent that greater effort may increase peak flow rates; but $FEV_{1.0}$ is much less effort dependent than peak flow. Thus, the relation between $FEV_{1.0}/FVC \times 100$ and FVC ($\%_{\text{pred}}$) may simply be an expression of differences in muscular power between men of similar age, height, and weight. Use of the $FEV_{1.0}/FVC$ ratio accentuates the relation by putting FVC in the denominator.

Crosbie et al. (2) also describe a subgroup of men in whom there seemed to be evidence of airway obstruction. However, their arguments used to distinguish an “abnormal” subgroup are largely spurious. These were persons selected for their relatively low $FEV_{1.0}/FVC$; the difference between them and others is a consequence of this selection. Use of statistical comparisons between the “abnormal” and “normal” groups (as on p. 643) is invalid and misleading.

If, as Crosbie et al. point out, good lung function is essential for divers, one would have thought that one’s first concern should be to examine the importance of cigarette smoking. But smoking is not even mentioned in their paper, although it is known that smoking is associated with functional and structural evidence of airway obstruction even among young adults and teenagers (4, 6).

In conclusion, the group of divers studied by Crosbie et al. appears to be a selected group of men with more than average lung size, perhaps due to greater than average muscular strength. There is no valid evidence that the time course of FVC with age among these men differs from that among men in the general population. Nor is there valid evidence for the existence of airway obstruction in men with large lungs. Hence, it is not surprising that Crosbie et al.’s subjects had an excellent physical working capacity. Their initial assumption (p. 644) that these men were free from any significant lung disease was probably correct.

REFERENCES


REPLY

To the Editor: We thank Drs. Bouhuys and Beck for making us analyze our data in another way and for stimulating our thoughts on divers’ lungs.

Their major criticism concerns our statement about diving experience increasing FVC up to about 30 yr. We used the linear prediction equation of Kory et al. (Am. J. Med. 30: 243–258, 1961), which does not include weight as a variable, whereas the prediction regression equation of Schoenberg, Beck, and Bouhuys (Respir. Physiol. 33: 367–393, 1978) does. Assuming that the predicted values based on data obtained from 194 healthy, nonsmoking male inhabitants of three towns in North American can be used to compare the results obtained from 404 healthy, highly selected, worldly individuals employed in a physically demanding occupation, where at least half smoke regularly, we reran the multiple regression analysis using the new predicted value of our critics. The results were as follows

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\begin{align*}
\text{old} & \quad \text{new} \\
< 30 \text{ yr} & \quad \% \text{pred FVC} = 5.435 \times A + 1.63 \text{ YD} \\
& \quad + 101.0 \\
& \quad -15.47 \times A + 0.99 \text{ YD} \\
& \quad +169.9 \\
\text{old} & \quad \% \text{pred FVC} = -3.15 \times A - 2.2 \text{ YD} \\
& \quad + 135.9 \\
> 30 \text{ yr} & \quad \% \text{pred FVC} = -4.12 \times A - 2.43 \text{ YD} \\
& \quad + 137.2
\end{align*}
\]

where old is the linear prediction equation, new is the Schoenberg et al. equation, A is age in years, and YD = years of diving.

It is apparent that no real difference is seen in the over 30 yr group. This contrasts with a change of sign of the age coefficient and increase in its value (<30 yr). We find it hard to believe that weight alone would cause such a large difference. Only 6% of our group of men were above 120% of their predicted weight and the mean %fat was normal. It is in the younger age range that the subjects first take up diving and then are exposed to long periods of working under the water. We agree with the concept of a “muscular effect” leading to enlargement of the thoracic muscles, chest wall, and hence lung volume. This effect and the difference in the FEV1.0/FVC x 100 results in the group of 11 individuals under 100% of the predicted FVC seem most likely to be due to the large differences in the two populations being compared.

We do feel Drs. Bouhuys and Beck are being unfair in stating that our subdivisions of the 26 divers into a “normal” and “abnormal” subgroup is invalid and misleading. They ignore the significant hyperventilation that occurs in the abnormal subgroup during exercise but not in the “normal” subgroup. They also fail to comment on the marked reduction in the absolute mean rates of expiratory airflow in the “abnormal” subgroup. If these individuals have healthy lungs with increased muscular power, then such low flows should not occur.

Large lungs can develop early pathological changes in the airways or elastic recoil properties of the parenchyma. Such is the reserve capacity of the lungs that only during severe exercise would functional abnormalities appear.


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