

# This Week's Citation Classic

**Grimby G & Söderholm B.** Spirometric studies in normal subjects. III. Static lung volumes and maximum voluntary ventilation in adults with a note on physical fitness. *Acta Med. Scand.* 173:199-206, 1963.  
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Static lung volumes and dynamic function test had been studied in normal men and women. Equations and nomograms for prediction of normal values were given. In men, exercise test was also performed on a bicycle ergometer and no correlations were found between spirometric data and working capacity. [The SCJ® indicates that this paper has been cited in more than 280 publications.]

## Early Control Values for Spirometry

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At the time of the late 1950s and early 1960s, laboratory physiological measurements were more fully introduced into clinical practice. The Bernstein spirometer<sup>1</sup> and the helium dilution technique had been in use for some time, but there was a lack of reference values. Before the time of the large epidemiological studies, laboratory personnel and friends were used as control subjects, their representativeness definitely being questionable. In seeking control subjects, we were able to recruit persons from employment groups who underwent regular health checkups and therefore might have been more representative than previous control groups. The problem of recruiting female control subjects, however, was demonstrated by the fact that most of them were house-

wives or belonged to different organizations; they volunteered for the study.

At the time of the study, the introduction of computer technology made it possible to use multiple regression analyses, which enabled calculations of the prediction equations using age, height, and weight. As can be seen in the paper, however, there is still a large variation to be accounted for. On the other hand, introducing more background factors would have made the prediction too cumbersome. One aspect, however, is that the effects of smoking on pulmonary function were not taken into account, as one was not so aware at that time of the effects of smoking on lung function in normal subjects. Nowadays, subjects would be divided into smokers and nonsmokers or smoking habits would be used in the prediction formulas.<sup>2</sup>

In Sweden exercise tests had been introduced into clinical practice by Sjöstrand and Wahlund<sup>3</sup> in the 1940s and by Åstrand<sup>4</sup> in ergonomics and medicine. There might have been a belief that physical fitness and lung volumes covaried; in nonathletic persons, however, it was demonstrated not to be the case. This paper was one of the first opportunities to present control values of the results of exercise tests performed as in clinical practice at that time in Sweden with stepwise increased work loads up to maximal "steady state" load. The form of presentation of data was somewhat crucial as all subjects did not reach the same work load. The results had therefore to be stratified in subgroups according to the highest work load achieved. This principle for presentation of data was used in later, similar studies.

The reference values have been used in a number of studies, as an example see the recent publication by Wu and Eriksson.<sup>5</sup>

1. Bernstein L, D'Silva J L & Mendel D. The effect of the rate of breathing on a maximum breathing capacity determined with a new spirometer. *Thorax* 7:255-62, 1952. (Cited 190 times.)
2. Fridriksson H V, Malmberg P, Hedenström H & Hillerdal G. Reference values for respiratory function tests in males. Prediction formulas with tobacco smoking parameters. *Clin. Physiol.* 1:349-64, 1981. (Cited 15 times.)
3. Wahlund H. Determination of the physical working capacity. *Acta Med. Scand.* 132(Supp.215):1-78, 1948. (Cited 70 times.)
4. Åstrand I. Aerobic work capacity in men and women with special reference to age. *Acta Physiol. Scand.* 49(Supp.169):1-92, 1960. (Cited 240 times.)
5. Wu M C & Eriksson S. Lung function, smoking and survival in severe alpha<sub>1</sub>-antitrypsin deficiency, PiZZ. *J. Clin. Epidemiol.* 41:1157-65, 1988.

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