CC/NUMBER 30
JULY 25, 1983

This Week's Citation Classic

Morris J F, Koski A & Johnson L C. Spirometric standards for healthy nonsmoking adults. *Amer. Rev. Resp. Dis.* **103**:57-67, 1971.
[Depts. Medicine, Univ. Oregon Med. Sch. and Veterans Admin. Hosp., Portland, and Dept. Health Education, Oregon State Univ., Corvallis, OR]

A sample of 988 healthy nonsmoking men and women were tested for routine spirometric function. Ventilatory function correlated positively with height but, despite the absence of known cardiopulmonary disease, correlated negatively with age. Linear regression equations and nomograms were obtained from the data to provide predicted normal standards. [The *SCI*® indicates that this paper has been cited in over 435 publications since 1971.]

James F. Morris
Veterans Administration Medical Center
P.O. Box 1034
Portland, OR 97207

May 31, 1983

"During the 1840s, the Reverend John Hutchinson in London was intrigued by breathing function. He had a spirometer devised, constructed, and titled the vital capacity procedure, and tested about 2,000 assorted Londoners. He studied their physical measurements to determine which correlated best with the vital capacity. Very little happened in this field until 100 years later when normal values were obtained at Bellevue Hospital, and two decades later by the VA-Armed Forces Cooperative Study. All these and other studies suffered from including cigarette smokers or patients with nonpulmonary diseases. It was obvious when testing a healthy nonsmoker, especially those middle-aged or older, that the available predicted normal standards were too low.

"In conjunction with Arthur Koski of Oregon State University, we decided to test approximately 1,000 healthy nonsmoking adults living in a relatively pollution-free region of western Oregon. We thought that the greatest yield would come from studying religious groups whose tenets forbade tobacco smoking. Lavon Johnson arranged the testing sessions with officials of the Mormon and Seventh-Day Adventist churches. All testing was performed in conjunction with regular church meetings. Unfortunate aspects of these ecclesiastical locations were limitation of the complexity of the testing and skewing the age distribution. It also eliminated the ability to perform physical examinations and chest roentgenograms. Linear regression equations were easily derived but construction of a nomogram proved to be an arcane, laborious process. The present level of electronics and data processing were not available to us in 1969 which made our data gathering and analysis and nomogram construction more tedious than it would be today. We are currently retesting the original population after 14 to 15 years and will take advantage of the electronic advances. This retesting will convert the original cross-sectional study to a longitudinal one.

"Publication of the original article proved to be difficult. It was initially reviewed by a Nobel laureate, who took umbrage at an unintended slur and rejected the manuscript. After my personal entreaty to the editor, the manuscript was sent to two reviewers who accepted it. The original data were supplied to five medical centers where other investigators validated the regression equations and derived additional information and tests. We reexamined the forced vital capacity volume-time curves and derived a new measurement, the forced end-expiratory flow or FEF75-85 percent.[1]

"A more recent review was published in the *Western Journal of Medicine*.[2] It added two measurements to the original nomograms for men and women. The original article is frequently cited because it represents the first study of ventilatory function in a large number of normal American nonsmokers. It was recently cited by the Section on Respiratory Pathophysiology of the American College of Chest Physicians for providing predicted normal standards which are the most widely used in general pulmonary function laboratories."[3]

1. **Morris J F, Koski A & Breese J D.** Normal values and evaluation of forced end-expiratory flow. *Amer. Rev. Resp. Dis.* **111**:755-62, 1975.
2. **Morris J F.** Spirometry in the evaluation of pulmonary function. *West. J. Med.* **125**:110-18, 1976.
3. **Zamel N, Altose M D & Speir W A, Jr.** Statement on spirometry: a report of the Section on Respiratory Pathophysiology (ACCP). *Chest* **83**:547-50, 1983.