

Cigarette Smoking and the Disadvantages of Using a Fixed Ratio of FEV₁/FVC to Diagnose Airway Obstruction

Sigara İçimi ve Havayolu Obstrüksiyonu Tanısında FEV₁/FVC<%70 Sabit Değerinin Kullanımının Dezavantajları

James E. Hansen

UCLA, Los Angeles Biomedical Research Institute, California, United States of America

ABSTRACT

Cigarette smoking is the primary cause of world-wide premature death. Therefore, thoracic physicians should try to inform patients of the harm smoking causes to airways and blood vessels. Unfortunately, in pursuing the goal of reducing the impact of chronic obstructive pulmonary disease, simple "global" guidelines were established to identify airway obstruction, but only when the ratio of the one-second to forced vital capacity (FEV₁/FVC) was less than 70%. The FEV₁/FVC is the key identifier of airway obstruction and normally declines with age, approximately 1% every 4 years. At age 30, the mean FEV₁/FVC for non-smokers is about 84%, minimally dependent on ethnicity, gender, or height. When a smoker's FEV₁/FVC is a few percentage points below the mean predicted for their age, airway obstruction is likely. At age 30, FEV₁/FVC values of 75% (9% below mean predicted) are statistically abnormal. Calling such a smoker "normal" could be considered deceptive. I recommend that we: 1) identify airway obstruction early, especially in younger smokers; 2) counsel smokers and non-smokers regarding the damage smoking causes to airways and blood vessels; and 3) help our smokers with pharmacologic tools and single or group counseling to help them overcome their addiction. These practices should help reduce premature deaths.

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Key words: Spirometry, airway obstruction, smoking

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INTRODUCTION: CIGARETTE SMOKING, COPD, AND INTRODUCTION OF GOLD GUIDELINES:

Cigarette smoking is a calamity, killing thousands of people every day and prematurely disabling many more [1]. Worldwide, smoking is believed to be the primary preventable cause of premature deaths [2]. Air pollution not only affects airflow, which we can easily measure; it also affects vascular flow to vital organs, which may be more complicated to measure [3-6]. It seems self-evident that we as health care providers

ÖZET

Sigara içimi tüm dünyada erken ölümlerin birinci sıradaki nedenidir. Bu nedenle göğüs hastalıkları uzmanları olarak sigaranın havayolları ve kan damarları üzerine zararlı etkileri konusunda hastalarımızı bilgilendirmeliyiz. Havayolu obstrüksiyonu spirometri ile saptamak kolaydır ancak, vasküler obstrüksiyona kötü olaylar gelişene kadar tanı konulamaz. Maalesef, kronik obstrüktif akciğer hastalıklarının etkilerinin azaltılmasında, havayolu obstrüksiyonunu tanımak için basit "dünya çapında" kılavuzlar hazırlandı ancak sadece 1. saniye volümünün zorlu vital kapasiteye oranının (FEV₁/FVC) %70'den az olması tanımlandı. FEV₁/FVC havayolu obstrüksiyonunu tanımlamada anahtar rol oynar ve yaş ile yaklaşık her 4 yılda %1 azalır. 30 yaşta sigara içmemişlerde, ırk, cinsiyet ve boya minimal bağlı olarak ortalama FEV₁/FVC %84 civarındadır. Sigara içen bir kişinin FEV₁/FVC oranı yaşının ortalama değerinden bir kaç değer düşükse, havayolu obstrüksiyonu varolabilir. 30 yaşta, %75 FEV₁/FVC değeri (ortalama beklenenin %9 altı) istatistiksel olarak anormaldir. Böyle bir sigara içicisine "normal" demek aldatıcıdır. Önerim; 1) Özellikle genç sigara içicilerinde havayolu obstrüksiyonunu erken saptamak, 2) Sigara içen ve içmeyenlere sigaranın havayolları ve damarlar üzerine zararlı etkilerini anlatmak, 3) Sigara içenlere bağımlılıklarını bırakmaları için farmakolojik yöntemlerle ve bireysel ya da grup danışmalıklarıyla yardım etmek. Bu uygulamalar, erken ölümlerin azaltılmasına yardım edecektir. (Tur Toraks Der 2009;10:82-5)

Anahtar sözcükler: Spirometri, havayolu obstrüksiyonu, sigara içimi

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should do all we can to persuade the general public and our patients to reduce cigarette smoking. Therefore it may be disturbing to you, the reader, for this pulmonologist to disagree with the published guidelines of a distinguished group of experts in an organization with the goal of improving the health of those who may become or are afflicted with Chronic Obstructive Pulmonary Disease (COPD).

In 1998, encouraged by the US National Heart, Lung, and Blood Institute and the World Health Organization,

the Global Initiative for Chronic Obstructive Lung Disease (GOLD) was formed to attempt to help individuals suffering from Chronic Obstructive Pulmonary Disease. Unfortunately, in the attempt to promote simplicity and ease of use, GOLD adopted and used a spirometric classification of COPD which stated that the ratio of a forced expiratory volume in one-second (FEV₁) to forced vital capacity (FVC) or FEV₁/FVC should be 70% or less to consider the diagnosis of COPD [7]. GOLD added that the FEV₁ should be less than 80% of the predicted mean. Later, they modified these criteria by stipulating that these cut-off values were valid only when taken after the administration of an aerosolized bronchodilator [8]. Recent GOLD guidelines add the statements that “the use of this fixed ratio may result in over diagnosis of COPD in the elderly,” “using the lower limit of normal (LLN) values is one way to minimize the potential misclassification and “reference equations using post-bronchodilator FEV₁ and longitudinal studies to validate the use of the LLN are urgently needed” [8]. Because of GOLD guidelines, many physicians and public health professionals continue to consider all FEV₁/FVC values above 70% as normal, not recognizing that many individuals under age 50 have FEV₁/FVC values which are above 70% and concurrently well below the statistically determined LLN. Simply put, use of the GOLD guidelines misses airway obstruction in many adults under age 50.

Most pulmonologists agree that the FEV₁/FVC is the key measurement and the best currently available for detecting airway obstruction [9]. However the GOLD criteria are opposed by some pulmonologists singly and as committees; recent articles reinforce the reasons why the 70% criterion should not be used [9-11].

WHY GOLD GUIDELINES TO DETECT COPD ARE NOT OPTIMAL:

1) Using GOLD guidelines minimizes or misses the detection of airway obstruction in younger adults. The spirometry data in Figures 1 and 2 are from the Third National Health and Nutrition Evaluation Survey (NHANES-3) in the United States from nearly 10,000

studies deemed to be of high quality. In Figure 1, it is clear that many men below the age of 50 have FEV₁/FVC below the LLN but yet still above the GOLD cut-off of 70%. In Figure 2 it is clear that many women below the age of 55 or 60 may have FEV₁/FVC below the LLN but yet still above the GOLD cut-off of 70%. Thus many younger adults have airway obstruction with FEV₁/FVC values well above 70%, but are undetected using GOLD criteria. By middle age, the average smoker has FEV₁/FVC values close to those of non-smokers 10 to 20 years older. Because of the high inherent variability of spirometric volumes in a given population, current-smokers who have values of FEV₁/FVC approximately half-way between mean predicted and the LLN are likely to have already manifested reduced airflow and evidence of airway damage. Although counseling patients with established COPD to stop smoking is worthwhile, it is also imperative to educate individual younger smokers about the effects of smoking on their airways and blood vessels before they develop overt COPD or heart disease. From a preventive medicine viewpoint, it is important to detect airway obstruction in younger adults so that appropriate diagnosis, counseling, and therapy can be considered, regardless of whether it is due to asthma, COPD or another disorder. Because mean values of FEV₁/FVC in non-smoking and currently-smoking men and women gradually decline as adult age increases (Figures 1 and 2), there is no clear single cut-off value valid for all adults to differentiate between those with or without significant airway obstruction.

2) Airway obstruction can be present when FEV₁ is above 80% of predicted mean. In a normal population all spirometric volume measurements, e.g. forced expiratory volumes in 1-, 3-, and 6-seconds and FVC have high variability in apparently healthy, non-smoking individuals of the same size, age, gender, and ethnicity [12]. Despite this absolute volume variability, the ratios of these volumes have much less variability for all ages, heights, and both genders. Table 1 gives an example of the differing coefficients of variation for men of the same height and age. The use of the mid-expiratory flow

Table 1: Variability about the mean of spirometric measurements of 11 NHANES-3 never-smoking white men: All are 35.6±0.8 years old and 178.5±0.9 cm tall.

Measure	Units	Mean	SD	Coefficient of variation
FEV ₁	L	4.32	0.27	6.2
FEV ₃	L	5.09	0.35	6.9
FEV ₆	L	5.32	0.40	7.5
FVC	L	5.42	0.40	7.4
FEV ₁ /FVC	%	79.9	3.3	4.1
FEV ₃ /FVC	%	93.9	2.1	2.3
FEV ₁ /FEV ₆	%	81.5	3.1	3.8
FEV ₃ /FEV ₆	%	95.8	1.4	1.4
FEF ₂₅₋₇₅ %	L/sec	4.06	0.64	15.8

Abbreviations: FEV₁, FEV₃, and FEV₆ = forced expiratory volume in 1, 3, and 6, seconds. FVC = forced vital capacity; FEF₂₅₋₇₅ = forced expiratory volume between 25% and 75% of the FVC.

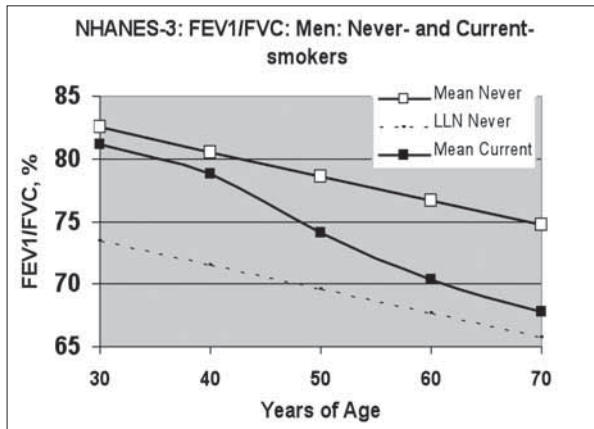


Figure 1. Changes in FEV₁/FVC in men with aging. Abbreviations: NHANES-3 = Third National Health and Nutrition Evaluation Survey (United States); FEV₁/FVC = percent ratio of forced expiratory volume in 1 second/forced vital capacity; Mean Never = mean predicted FEV₁/FVC of never-smokers; LLN Never = 95% lower limit of normal of FEV₁/FVC of never-smokers; Mean Current = actual mean FEV₁/FVC of current-smokers

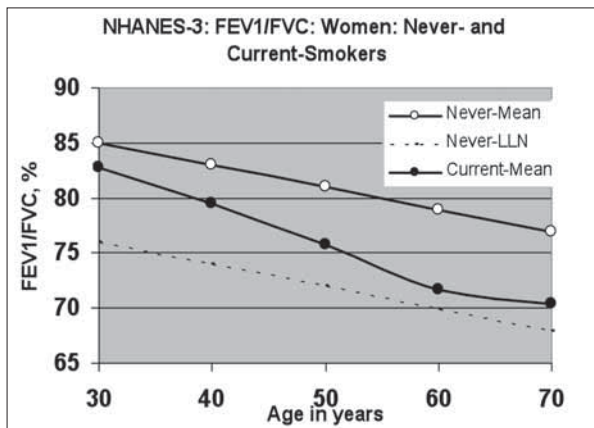


Figure 2. Changes in FEV₁/FVC in women with aging. Abbreviations: NHANES-3 = Third National Health and Nutrition Evaluation Survey (United States); FEV₁/FVC = percent ratio of forced expiratory volume in 1 second/forced vital capacity; Mean Never = mean predicted FEV₁/FVC of never-smokers; LLN Never = 95% lower limit of normal of FEV₁/FVC of never-smokers; Mean Current = actual mean FEV₁/FVC of current-smokers

(FEF25-75%) should be discouraged because of its high variability and high incidence of both false negatives and false positives [12]. Wisely, the ratio of one of these pairs of volumes (FEV₁/FVC) rather than absolute volumes has long been used as the key measure of airway obstruction [9]. Because of the high variability of FVC and FEV₁ in all populations, both may be above 80% of mean predicted in the presence of milder airway obstruction.

3) The use of GOLD recommendations may over-identify airway obstruction in adults over age 60. An FEV₁/FVC value within normal limits for over age 60 may be below 70% [10-11]. Such over-detection and over-diagnosis in older men and women can lead to unnecessary, costly, wasteful, and even dangerous treatment.

4) The new emphasis of GOLD guidelines to emphasize the post-bronchodilator values rather than pre-bronchodilator values also seems to be misdirected. Many patients with proven diagnoses of asthma or COPD improve their airflow considerably after using aerosolized

bronchodilators from “below normal limits” to “within normal limits.” To miss identifying the asthmatic or COPD individual who increases the FEV₁/FVC to above 70% because of good responsiveness to aerosolized bronchodilators does not seem sensible to the author.

RECOMMENDED ALTERNATE POLICY:

The author favors the use of well-performed spirometry to detect airway obstruction in mild, moderate, and severe forms. In non-smokers, mean population FEV₁/FVC declines with age at the approximate rate of 2.5% per decade [13]. The use of formulae, which are more specific for age, gender, and ethnicity, are available and encouraged [13-15]. However, even when ethnicity differs from that of the population from which the predicting equations were extracted, the relationship between age, FEV₁/FVC and FVC appears to be predictable [13]. The published 95% confidence limits for FEV₁/FVC are well established and are approximately 9% below mean predicted FEV₁/FVC values, i.e. outside the usually considered normal range [12-15]. However, according to the Bayesian theory, regardless of age, if a cigarette smoker has a FEV₁/FVC that is 4-8% below mean predicted, it is likely that that individual also has airway obstruction related to cigarette smoking. I suggest that presenting this evidence to the smoker, rather than stating, “Your spirometry is normal”, would be an action likely to help the smoker stop smoking and reduce continuing damage to his or her respiratory and circulatory systems.

1) What about the smokers who have FEV₁/FVC above mean predicted values for non-smokers? I suggest that even though their airflow is above the population average, their airways would likely be healthier if they had not smoked. At a minimum, stopping smoking will help reduce their risk of cancer, obstructive airway disease, heart disease, and strokes.

2) What about the smokers with FEV₁/FVC below mean predicted but above the 95% LLN? I suggest that they should be told that their airflow is below that of the average non-smoker, indicating that it is likely that they have sustained some airway damage from smoking. Because of the strong association of smoking and airway damage with lung cancer, heart disease and strokes, they should be strongly advised to stop smoking.

3) What about the smokers with FEV₁/FVC below the LLN.? At a minimum, that person needs a diagnostic workup including history and physical exam plus gas transfer index measurement and spirometry after aerosolized bronchodilator. Regardless of the findings, cessation of smoking should be advised.

In all cases adding medications and group sessions to reinforce your advice should be helpful.

SUMMARY:

The well-intentioned policy of using 70% of FEV₁/FVC as a cut-off value to detect airway obstruction is flawed and does not help in alerting younger individuals to the damage they incur from cigarette smoking. Using a cut-

off FEV₁/FVC value of 70% under-detects airway obstruction in younger adults and may over-detect airway obstruction in older adults. A policy based on the known normal decline of FEV₁/FVC with age should result in improved detection, counseling, and treatment in younger smoking adults.

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