Impaired lung function and mortality risk in men and women: findings from the Renfrew and Paisley prospective population study

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Abstract

***Objective*—To assess the relation between forced expiratory volume in one second (FEV_1) and subsequent mortality.**

***Design*—Prospective general population study.**

***Setting*—Renfrew and Paisley, Scotland.**

***Subjects*—7058 men and 8353 women aged 45-64 years at baseline screening in 1972-6.**

***Main outcome measure*—Mortality from all causes, ischaemic heart disease, cancer, lung and other cancers, stroke, respiratory disease, and other causes of death after 15 years of follow up.**

***Results*—2545 men and 1894 women died during the follow up period. Significant trends of increasing risk with diminishing FEV_1 are apparent for both sexes for all the causes of death examined after adjustment for age, cigarette smoking, diastolic blood pressure, cholesterol concentration, body mass index, and social class. The relative hazard ratios for all cause mortality for subjects in the lowest fifth of the FEV_1 distribution were 1.92 (95% confidence interval 1.68 to 2.20) for men and 1.89 (1.63 to 2.20) for women. Corresponding relative hazard ratios were 1.56 (1.26 to 1.92) and 1.88 (1.44 to 2.47) for ischaemic heart disease, 2.53 (1.69 to 3.79) and 4.37 (1.84 to 10.42) for lung cancer, and 1.66 (1.07 to 2.59) and 1.65 (1.09 to 2.49) for stroke. Reduced FEV_1 was also associated with an increased risk for each cause of death examined except cancer for lifelong non-smokers.**

***Conclusions*—Impaired lung function is a major clinical indicator of mortality risk in men and women for a wide range of diseases. The use of FEV_1 as part of any health assessment of middle aged patients should be considered. Smokers with reduced FEV_1 should form a priority group for targeted advice to stop smoking.**

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Introduction

It has been recognised for over 10 years that poor respiratory function is associated with a greatly increased mortality from chronic lung disease.[1,2] More recently evidence has suggested that forced expiratory volume in one second (FEV_1) is a risk factor in cardiovascular disease,[3-7] stroke,[8,9] and lung cancer.[10-12] The strong inverse relations found between mortality and FEV_1 in each of these diseases suggest that poor respiratory function has a predictive or even causal role in a wide range of conditions, not only respiratory disease.

We present an analysis of the relation between FEV_1 and mortality in the Renfrew and Paisley survey. This study has the advantage of a large number of deaths (2545 men, 1894 women) over a prolonged period of follow up (minimum 15 years) for a defined general population. The cohort has high mortality from coronary heart disease[13-15] and lung cancer[16] and a high prevalence of impaired respiratory function.[17] Thus, it provides an opportunity to assess accurately the steepness of the risk gradients with FEV_1 for several causes of death, while controlling for possible confounding variables, particularly cigarette smoking. The study is large enough to investigate the relations in subjects who were free of respiratory and cardiac symptoms at the outset of the study and in lifelong non-smokers. It also provides for the first time data relating to women in Britain.

Subjects and methods

The Renfrew and Paisley survey is a longitudinal study of 15 411 adults (7058 men, 8353 women) aged 45 to 64 years when first examined between 1972 and 1976. The survey was preceded by a special census to identify everyone aged 45-64 years resident in Renfrew or Paisley, in the west of Scotland. Of the eligible subjects, 79% in Renfrew and 78% in Paisley accepted a postal invitation to take part in the study. The subjects are representative of the general population in this industrial conurbation.

The measurements taken and the techniques used have been described previously.[18] Specifically, FEV_1 was measured with a vitalograph spirometer with the subject standing. The higher of two expirations was recorded after an initial practice blow. In all, 7048/7058 (99.9%) men and 8337/8353 (99.8%) women had measures of FEV_1 available for analysis. FEV_1 relative to the predicted value was used to estimate impairment. Predicted values of FEV_1 were obtained from linear regressions on age and height:

Predicted FEV_1 for men = $-1.9302 - (0.0290 \times \text{age (years)}) + (0.0373 \times \text{height (cm)})$

Predicted FEV_1 for women = $-0.2662 - (0.0289 \times \text{age (years)}) + 0.0238 \times \text{height (cm)})$

Coefficients were derived from a regression for the 878 men and 2796 women who had never smoked and who responded "no" to questions about wheeze, breathing, and asthma. The distribution of the percentages of predicted FEV_1 was divided into fifths on the basis of the whole population. The quintile points were 73%, 87%, 97%, and 108% for men and 75%, 90%, 101%, and 113% for women.

Mortality data were obtained by flagging the cohort with the registrar general in Scotland, which ensures notification of a death provided that it took place within the United Kingdom and also provides information on the cause of death according to the ICD-9 (international classification of diseases, 9th revision). Mortality for all causes of death, coronary heart disease (ICD-9 codes 410-414), cerebrovascular disease (430-438), cancer (140-208), respiratory disease (460-519), and other causes of death are reported here.

Cox's proportional hazards regression model was used to assess the association between "relative FEV_1" (percentage of predicted FEV_1) and mortality with adjustment for known risk factors.[19] These were age (in

Table 1—*Association between relative FEV_1 (percentage of predicted value) and other cardiorespiratory risk factors*

	Quintile of relative FEV_1				
	First	Second	Third	Fourth	Fifth
Men*					
% (No) never smoked (n = 1188)	14.6 (174)	13.0 (154)	16.5 (196)	23.7 (282)	32.3 (382)
% (No) smoking ≥15 cigarettes daily (n = 3151)	25.2 (793)	23.6 (744)	20.9 (658)	18.3 (576)	12.1 (380)
Mean diastolic blood pressure (mm Hg)	86.4	85.3	85.7	86.3	86.2
Mean cholesterol (mmo/l)	5.74	5.81	5.89	5.89	5.92
Mean body mass index (kg/m^2)	25.3	25.8	26.0	26.2	26.3
% (No) in social class IV or V (n = 1999)	27.1 (542)	20.8 (416)	20.2 (403)	17.1 (341)	14.9 (297)
Mean height (m)	1.69	1.70	1.70	1.70	1.69
Women†					
% (No) never smoked (n = 3816)	16.1 (613)	18.4 (703)	18.8 (718)	22.0 (839)	24.7 (943)
% (No) smoking ≥15 cigarettes daily (n = 2330)	26.2 (611)	26.5 (618)	20.9 (486)	15.8 (367)	10.6 (248)
Mean diastolic blood pressure (mm Hg)	85.8	85.2	85.5	84.7	84.4
Mean cholesterol (mmo/l)	6.28	6.41	6.41	6.46	6.54
Mean body mass index (kg/m^2)	25.6	25.9	25.8	25.7	25.8
% (No) in social class IV or V (n = 3072)	25.5 (783)	22.8 (699)	19.2 (591)	17.6 (541)	14.9 (458)
Mean height (m)	1.57	1.58	1.58	1.58	1.58

*Quintile points for relative FEV_1 for men: <73, 73-86, 87-96, 97-107, >107.
†Quintile points for relative FEV_1 for women: <75, 75-89, 90-100, 101-112, >112.

single years), smoking habit (never smoked, former smoker, current smoker 1-14 cigarettes daily, current smoker 15-24 cigarettes daily, current smoker ≥25 cigarettes daily, smoker only of pipe or cigars), diastolic blood pressure, serum cholesterol concentration, body mass index, and social class (coded according to the registrar general's classification of occupations). The hazard ratios quoted are relative to the value pertaining in the highest fifth of the distribution of relative FEV_1 values.

Results

Mean unadjusted FEV_1 levels for men were 2.83 litres (ages 45-49 years), 2.62 litres (50-54 years), 2.38 litres (55-59 years), and 2.14 litres (60-64 years). The corresponding levels for women were 1.99 litres, 1.84 litres, 1.69 litres, and 1.54 litres.

Table 1 shows the associations between relative FEV_1 and other risk factors. Subjects with higher relative FEV_1 levels were more likely to be lifelong non-smokers, less likely to be social class IV or V, and to have a higher mean cholesterol concentration and a greater mean body mass index. No relation was apparent with diastolic blood pressure or with height.

Table 2 presents mortality from all causes, coronary heart disease, all cancers, respiratory disease, stroke, and other causes, by relative FEV_1 after adjustment for age, cigarette smoking, blood pressure, cholesterol concentration, body mass index, and social class. For all cause mortality, the relative hazard ratio for those in the bottom fifth was 1.9 for men and women. Increased risks were also seen for subjects with FEV_1 moderately lower than their predicted FEV_1. Trends across the categories of relative FEV_1 were highly significant for men ($P<0.001$) and for women ($P<0.001$).

Significant trends existed among both men and women for ischaemic heart disease, all cancers, lung cancer, stroke, respiratory disease, and other causes of death, the only exception being for cancers other than lung. Again, increased risks were apparent for most of the causes of death examined among subjects with FEV_1 moderately lower than their predicted FEV_1.

When deaths that occurred within five years of screening were excluded, all the associations described above remained significant, with only slight diminution in the steepness of the associations between relative FEV_1 and mortality. Analysis of the deaths that occurred 10 years after screening also made little difference to the steepness of the risk gradients.

Table 3 presents relative hazard ratios for subjects who were free of ischaemic heart disease or respiratory symptoms at baseline screening. Significant trends were apparent for mortality from ischaemic heart disease among those who had been free of the disease, for respiratory mortality among those with no respiratory symptoms, and for both all cause mortality and mortality from ischaemic heart disease in subjects with neither cardiovascular nor respiratory symptoms.

Table 4 shows the importance of the relative FEV_1 as a risk factor for major causes of death in lifelong non-smokers. There were significant trends for all cause mortality ($P<0.001$), ischaemic heart disease ($P<0.001$), stroke ($P<0.001$), respiratory disease ($P<0.001$), and other causes of death ($P<0.001$), with increased risks seen not only in the lowest fifth but also in the second lowest group. No relation was apparent among the subjects dying of cancer. Figure 1 presents relative hazard ratios for all cause mortality for lifelong non-smokers and for smokers of 15 or more cigarettes a day. The gradients of risk are approximately parallel (interaction term, P = 0.19) and the risk of dying for a non-smoker with a low relative FEV_1 is similar to that for a heavy smoker with a high value.

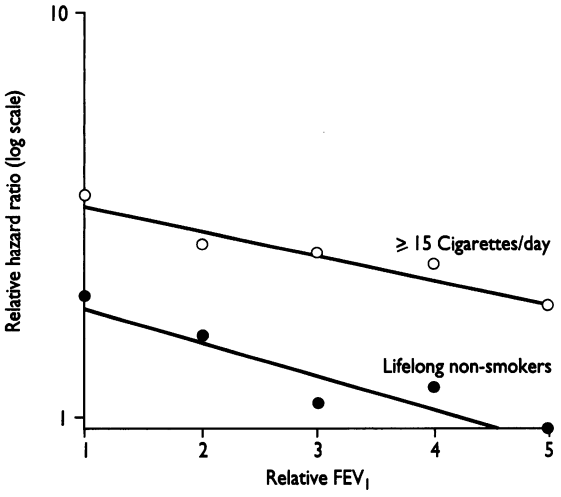

Fig 1—*All cause mortality risk by relative FEV_1 for lifelong non-smokers and heavy current smokers. Sex stratified relative hazard ratios are adjusted for diastolic blood pressure, cholesterol concentration, body mass index, and social class. Baseline category is that of a lifelong non-smoker with a relative FEV_1 in highest fifth*

Table 2—*Relative hazard ratios (95% confidence interval)† for mortality from all causes and specific causes of death by quintile of relative FEV_1 after adjustment for other risk factors*

Cause of death	No of deaths	Relative FEV_1					Significance	
		First	Second	Third	Fourth	Fifth	Trend (t)	P value
All causes:								
Men	2545	1.92 (1.68 to 2.20)***	1.51 (1.31 to 1.74)***	1.45 (1.26 to 1.68)***	1.28 (1.11 to 1.48)***	1	−9.97	<0.001
Women	1894	1.89 (1.63 to 2.20)***	1.52 (1.30 to 1.77)***	1.21 (1.03 to 1.42)*	1.17 (0.99 to 1.38)	1	−9.32	<0.001
Ischaemic heart disease:								
Men	1001	1.56 (1.26 to 1.92)***	1.48 (1.19 to 1.83)***	1.55 (1.25 to 1.91)***	1.15 (0.92 to 1.43)	1	−4.64	<0.001
Women	565	1.88 (1.44 to 2.47)***	1.50 (1.13 to 1.97)**	1.22 (0.91 to 1.63)	1.01 (0.75 to 1.38)	1	−5.49	<0.001
All cancer:								
Men	771	1.57 (1.23 to 2.01)***	1.39 (1.09 to 1.79)**	1.29 (1.00 to 1.67)*	1.38 (1.08 to 1.78)*	1	−3.21	<0.01
Women	630	1.40 (1.08 to 1.83)*	1.31 (1.01 to 1.70)*	1.17 (0.90 to 1.53)	1.21 (0.93 to 1.59)	1	−2.51	<0.05
Lung cancer:								
Men	343	2.53 (1.69 to 3.79)***	1.93 (1.27 to 2.94)**	1.81 (1.18 to 2.78)**	1.36 (0.86 to 2.13)	1	−5.10	<0.001
Women	140	4.37 (1.84 to 10.42)***	4.12 (1.73 to 9.81)**	4.03 (1.68 to 9.67)**	3.63 (1.49 to 8.84)**	1	−2.93	<0.01
Other cancers:								
Men	428	1.10 (0.80 to 1.51)	1.17 (0.85 to 1.60)	1.08 (0.78 to 1.50)	1.43 (1.06 to 1.94)*	1	0.35	NS
Women	490	1.22 (0.92 to 1.62)	1.13 (0.85 to 1.50)	0.98 (0.73 to 1.32)	1.04 (0.78 to 1.39)	1	−1.51	NS
Stroke:								
Men	215	1.66 (1.07 to 2.59)*	1.65 (1.05 to 2.60)*	1.16 (0.71 to 1.90)	1.16 (0.72 to 1.88)	1	−2.75	<0.01
Women	260	1.65 (1.09 to 2.49)*	1.54 (1.02 to 2.32)*	1.31 (0.85 to 2.00)	1.40 (0.92 to 2.15)	1	−2.32	<0.05
Respiratory disease:								
Men	198	9.35 (4.87 to 17.97)***	2.02 (0.96 to 4.25)	1.45 (0.65 to 3.32)	1.12 (0.48 to 2.60)	1	−9.90	<0.001
Women	115	6.47 (3.17 to 13.19)***	2.95 (1.38 to 6.29)**	1.00 (0.40 to 2.54)	1.04 (0.41 to 2.61)	1	−7.10	<0.001
Other causes:								
Men	360	2.12 (1.46 to 3.07)***	1.73 (1.18 to 2.55)**	1.81 (1.23 to 2.67)**	1.62 (1.10 to 2.39)*	1	−3.64	<0.001
Women	324	2.30 (1.60 to 3.31)***	1.75 (1.20 to 2.54)**	1.20 (0.80 to 1.80)	1.20 (0.80 to 1.80)	1	−5.19	<0.001

*P<0.05, **P<0.01, ***P<0.001.
†Adjusted for age, cigarette smoking, diastolic blood pressure, serum cholesterol concentration, body mass index, and social class.

Discussion

This study, based on 4439 deaths from all causes, highlights the relation between a low FEV_1 value and increased mortality risks from all causes, ischaemic heart disease, lung cancer, stroke, respiratory disease, and other causes of death. The increased risks are apparent not only for the subjects with values in the lowest fifth of FEV_1 value (<73% of predicted value) but also for those with a moderately reduced value.

Earlier studies did not examine the role of FEV_1 in individuals without respiratory or cardiovascular symptoms at baseline.[5 17 20] We found that the relations between a low FEV_1 and increased mortality from all causes, ischaemic heart disease, or respiratory disease also existed in this group which is free of symptoms. We also observed that among lifelong non-smokers there were inverse relations between FEV_1 and mortality from all causes, ischaemic heart disease, stroke, respiratory disease, and other causes of death, though not from cancer mortality. The number of deaths from lung cancer among lifelong non-smokers was, however, small. The gradients of the associations between the various causes of deaths and relative FEV_1 (percentage of predicted FEV_1) for lifelong non-smokers closely parallel those found among the cohort as a whole.

POTENTIAL CONFOUNDERS

Our observed associations with FEV_1 are unlikely to be due to confounding by other risk factors, as adjustment was made for the major known risk factors, particularly cigarette smoking, for which account was taken not only of the smoking habit but also of the number of cigarettes smoked a day. We also estimated relative hazard ratios within strata based on categories of cigarette smoking and found similar values for the risk gradients. The observed impairments in lung function are unlikely to have been secondary to established

Table 3—*Comparison of relative hazard ratios† for mortality from all causes and from ischaemic heart disease in relation to relative FEV_1 for subjects free of symptoms at baseline screening*

Cause of death	No of deaths	Quintile of relative FEV_1					Significance	
		First	Second	Third	Fourth	Fifth	Trend (t)	P value
No evidence of ischaemic heart disease‡								
Ischaemic heart disease:								
Men	594	1.82***	1.54**	1.46**	1.39*	1	−4.01	<0.001
Women	334	1.81***	1.41	1.13	1.03	1	−4.36	<0.001
No evidence of respiratory symptoms								
Respiratory:								
Men	54	2.70*	1.90	1.74	1.47	1	−2.21	<0.05
Women	46	3.50**	2.48	1.11	1.20	1	−3.08	<0.01
No evidence of ischaemic heart disease or respiratory symptoms								
All causes:								
Men	984	1.55***	1.43***	1.39***	1.30**	1	−4.15	<0.001
Women	873	1.61***	1.52***	1.09	1.22	1	−4.67	<0.001
Ischaemic heart disease								
Men	393	1.40	1.39	1.46*	1.29	1	−2.18	<0.05
Women	229	1.45	1.42	0.93	1.05	1	−2.14	<0.05

*P<0.05, **P<0.01, ***P<0.001.
†Adjusted for age, diastolic blood pressure, serum cholesterol concentration, cigarette smoking status, body mass index, and social class.
‡Or electrocardiographic ischaemia or angina (measured with the Rose questionnaire).

Table 4—*Relative hazard ratios (95% confidence interval)† for the major causes of death between quintile of FEV_1 among 5013 male and female lifelong non-smokers*

Cause of death	No of deaths	Relative FEV_1					Significance	
		First	Second	Third	Fourth	Fifth	Trend (t)	P value
All causes	1040	1.95 (1.62 to 2.35)***	1.60 (1.32 to 1.94)***	1.15 (0.93 to 1.14)	1.27 (1.05 to 1.54)*	1	−7.26	<0.001
Ischaemic heart disease	337	1.79 (1.29 to 2.50)***	1.53 (1.08 to 2.16)*	1.45 (1.04 to 2.04)*	1.26 (0.90 to 1.75)	1	−3.5	<0.001
Cancer	306	1.35 (0.95 to 1.92)	1.37 (0.97 to 1.94)	0.78 (0.53 to 1.16)	1.36 (0.99 to 1.87)	1	−1.50	NS
Lung cancer	31	2.45 (0.84 to 7.18)	1.18 (0.33 to 4.21)	0.81 (0.20 to 3.25)	2.19 (0.79 to 6.03)	1	−0.92	NS
Other cancers	275	1.25 (0.86 to 1.82)	1.38 (0.97 to 1.98)	0.78 (0.52 to 1.17)	1.29 (0.92 to 1.81)	1	−1.26	NS
Stroke	140	2.37 (1.43 to 3.92)***	1.89 (1.11 to 3.20)*	1.13 (0.63 to 2.04)	1.42 (0.83 to 2.43)	1	−3.38	<0.001
Respiratory	55	7.07 (3.04 to 16.47)***	3.15 (1.23 to 8.06)*	1.03 (0.30 to 3.53)	1.03 (0.33 to 3.27)	1	−5.68	<0.001
Other causes	202	2.14 (1.40 to 3.25)***	1.69 (1.09 to 2.62)*	1.32 (0.84 to 2.08)	1.08 (0.68 to 1.70)	1	−3.88	<0.001

*P<0.05, **P<0.01, ***P<0.001.
†Adjusted for age, sex, diastolic blood pressure, serum cholesterol concentration, body mass index, and social class.

disease, as exclusion of deaths occurring in the first five and 10 years of follow up did not alter the findings. While residual confounding cannot be totally excluded,[21] these data suggest that impaired lung function contributes to the cause or the progression of several disease processes, not only respiratory disease.

COMPARISONS WITH OTHER STUDIES

The magnitude of the risk of death from any cause among those individuals with an FEV_1 value in the lowest fifth of the distribution is nearly twice that observed for those in the highest fifth. This remains true even when those dying of respiratory disease are excluded. Comparison of our data with the Whitehall study[4] and use of its categorisation of FEV_1 <65% of predicted value versus FEV_1 ≥65% of predicted value produced a relative risk of 1.6, exactly the same risk as that study found. Similar risk gradients have been observed in other studies.[22-24] A higher risk gradient of approximately 4 was observed by Peto *et al* but no adjustment for cigarette smoking had been made.[1]

Coronary heart disease mortality in our study was based on 1001 deaths from ischaemic heart disease in men and 565 such deaths in women and gave risk ratios of 1.6 and 1.9 respectively in the lowest fifth of the distribution of relative FEV_1 values. The data in British regional heart study that were based on ischaemic heart disease events produced a risk gradient of 1.8 in middle aged men with the same quintile comparison.[5] The Whitehall study produced a risk differential of 1.3 for FEV_1 below and above 65% of predicted FEV_1 on the basis of 889 deaths from ischaemic heart disease, again identical to ours if the same cut point is used. Others have also shown risk differences of this magnitude.[23]

ATTRIBUTABLE RISK

With the regular publication of studies linking poor respiratory function with increased risk of death for a wide variety of diseases, it is surprising that a measure of respiratory function does not play a bigger part in health assessment programmes. That respiratory function is not perceived as an important risk factor for diseases other than respiratory disease may be due to a lack of appreciation of the importance of this compared with other conventional risk factors, such as cigarettesmoking, blood pressure, serum cholesterol concentration, and body mass index. A comparative measure of the impact of a risk factor is population attributable risk. This is a measure of the reduction in mortality that would occur if everyone in the population exhibited the same (optimal) level of the risk factor. For all cause mortality FEV_1 is second in importance to cigarette smoking and more important than both diastolic blood pressure and social class (table 5). Even for ischaemic heart disease its impact is of the same magnitude as cholesterol concentration and social class, though less than cigarette smoking and diastolic blood pressure.

Hence the value of FEV_1 as a marker of subsequent disease and death is quite clear. The 15 year mortality for men in the Renfrew and Paisley study increases from 15% among lifelong non-smokers to 28% among those smoking 20 cigarettes a day with a good FEV_1 and to 48% for those smoking 20 cigarettes a day with a poor FEV_1. The corresponding figures for women are 10%, 17%, and 29%. Thus the potential gain from persuading heavy smokers with a low FEV_1 to stop smoking could be substantial.

To what extent might an individual's FEV_1 be improved? The main determinant of respiratory impairment is cigarette smoking.[24] In the cohort in the multiple risk factor intervention trial a smoking cessation programme slowed the decrease in FEV_1 with age.[25] Other strategies for slowing the decrease in FEV_1 are less well established. A randomised controlled trial to determine the effects of bronchodilators in addition to the effects of smoking intervention has been carried out in the United States and Canada by the Lung Health Study Research Group.[26] A significant reduction in the age related decrease in FEV_1 in middle aged smokers associated with the smoking intervention and a small improvement in FEV_1 associated with use of an inhaled anticholinergic bronchodilator were seen, although the latter effect reversed after the bronchodilator was

Table 5—*Percentage population attributable risks (95% confidence interval) for mortality from all causes and from ischaemic heart disease*

Risk factor (baseline)	All causes		Ischaemic heart disease	
	Men	Women	Men	Women
Cigarette smoking (never smoked)	37.2 (31.9 to 42.5)*	24.4 (20.3 to 28.5)	37.7 (29.6 to 45.8)	32.2 (25.1 to 39.3)
FEV_1 (highest fifth)	30.8 (25.9 to 35.7)	26.5 (20.8 to 32.2)	26.2 (18.6 to 33.8)	23.9 (13.8 to 34.0)
Diastolic blood pressure (lowest fifth)	18.4 (12.8 to 24.0)	18.8 (13.0 to 24.6)	30.3 (22.7 to 37.9)	39.8 (30.5 to 49.1)
Cholesterol (lowest fifth)	NR	NR	20.5 (12.8 to 28.2)	24.8 (14.9 to 34.7)
Social class (I and II)	14.6 (9.1 to 20.1)	14.5 (8.1 to 20.9)	NR	24.7 (14.1 to 35.3)

NR = No significant relation between the risk factor and the disease listed.

Key messages

- Increased death rates from all causes, ischaemic heart disease, all cancers, lung cancer, stroke, respiratory disease and other causes have been found among healthy middle aged men and women with reduced (including moderately reduced) forced expiratory volume in one second (FEV_1)
- These increased risks, with the exception of the cancers, are apparent for lifelong non-smokers
- FEV_1 is second in importance to cigarette smoking as a predictor of subsequent all cause mortality and is as important as cholesterol in predicting mortality from ischaemic heart disease
- FEV_1 should be included in health assessment of middle aged men and women
- Smokers with a reduced FEV_1 should be targeted with advice to stop smoking

discontinued. Thus, smoking cessation is currently the best means of slowing the decrease in FEV_1, and smokers with reduced FEV_1 should form a priority group for targeted advice.

Forced expiratory volume is only one measure of respiratory function. It does have the advantage, however, of being an objective and quantitative measure, whereas many other measures are based on self reporting. The fact that FEV_1 is linked to mortality risk for a wide range of conditions strengthens its value as the marker of respiratory function. Adjustments for age and height for each sex can be built in to assess the relevance of an individual level.

Physical measures currently included in the cardiovascular health promotion package in primary care are height, weight, and blood pressure. The addition of FEV_1 for middle aged patients would provide an important indicator of subsequent general health as well as a means for deciding who might be most appropriate for receiving advice on risk factor modification aimed at reducing cardiorespiratory mortality.

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Commentary: Predicting and preventing premature mortality

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Established risk factors for premature mortality may be fixed or modifiable. Prevention in clinical practice naturally concentrates on identifying and attempting to correct modifiable factors such as smoking, hypertension, and hyperlipidaemia. In this context, fixed predictors such as age, sex, and family history of disease may be useful in guiding decisions about whom and when to treat.[1] Under the common (but rarely tested) assumption that the relative benefits of treatment are the same for different patient groups, greater absolute benefits may be expected for patients at higher underlying risk of disease. The balance of benefits and side effects may thus depend on the level of fixed risk factors. Pharmacological treatment for mild hypertension, for instance, may be justified at a lower level of initial blood pressure among older patients or those with a family history of cardiovascular disease.[2]

What are clinicians to make of the observation by Hole and colleagues that forced expiratory volume in one second (FEV_1) is a powerful clinical predictor of premature mortality among both men and women? FEV_1 may be regarded as a partially modifiable risk factor, in so far as its rate of decline may be slowed by stopping smoking. However, enquiry about smoking habits is quicker and cheaper than spirometry, and advice to stop smoking should form part of the preventive package offered to all patients in primary or secondary care.

Intriguingly, Hole and colleagues and others[3] have found that the association of FEV_1 with premature mortality also holds for lifelong non-smokers, independent of other cardiovascular risk factors. This suggests that FEV_1 should be considered as a "fixed" clinical indicator of underlying risk to guide treatment decisions in

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