ORIGINAL RESEARCH

Patient-reported respiratory symptoms and pre-bronchodilator airflow limitation among smokers in Switzerland

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Abstract

Aims: To evaluate the prevalence and predictors of airflow limitation among smokers aged ≥40 years visiting primary care practices in Switzerland, and the correlation between airflow limitation and patient-reported symptoms.

Methods: General practitioners (GPs) were invited to participate in the study via letter. Airflow limitation was measured using an EasyOne™ spirometer without administration of a bronchodilator, and patient-reported symptoms were evaluated using an interviewer-administered questionnaire.

Results: 15,084 subjects recruited by 440 GPs had acceptable quality spirometry traces; 8,031 of these (53%) had symptom data available and were included in this analysis. Only 18.5% of the GP consultations were for respiratory reasons. In total, 29% of individuals had pre-bronchodilator airflow limitation suggesting chronic obstructive pulmonary disease according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD)/Hardie interpretation. The interviewer-administered questionnaire indicated that 58% of individuals had at least one current symptom – cough, sputum production, or dyspnoea. There were no differences in lung function for patients answering yes or no to symptom questions.

Conclusions: Pre-bronchodilator airflow limitation and patient-reported respiratory symptoms are frequent among smokers, but short dichotomous questions about symptoms are not useful for identifying patients with airflow limitation. Spirometry can identify patients with early airflow limitation in general practice. However, poor quality of spirometry, even with an automated feedback and quality control spirometer, remains an issue.

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Introduction

Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity and mortality worldwide.[1] Its progressive nature makes early diagnosis and management particularly desirable.

However, in many cases the disease is not diagnosed until it is clinically apparent and moderately advanced.[1,2] Early symptoms of COPD, such as breathlessness, are often dismissed and/or considered normal. As a consequence, identification of patients in the early stages of COPD is challenging.

Smoking remains the most important risk factor for COPD,

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and smoking cessation is widely accepted as the single most effective – and cost-effective – intervention to reduce the risk of developing COPD and prevent its progression.[1] Unfortunately, many patients find smoking cessation difficult. In the USA, for example, almost 41% of smokers try to quit smoking each year, but relapse is common, and only about 10% achieve and maintain abstinence.[1] Spirometry has for a long time been proposed as a motivational tool to encourage smokers at risk of developing COPD to quit the habit, but data on its value as a supporting technique for smoking cessation are inconclusive.[3,4]

Screening at-risk patients in primary care represents a useful option for identifying individuals with early symptoms of COPD, thereby providing the opportunity to implement aggressive smoking cessation strategies.[4,5] Spirometry has been shown to be an effective means of screening patients, thus increasing the probability of earlier diagnosis. A recent study of smokers aged ≥40 years with no formal diagnosis of COPD in the UK and USA found that 18.9% fulfilled the criteria of COPD after performing spirometry by using the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria; of these, 57% were classified as having mild, 37% moderate and 6% severe obstruction.[6] The authors concluded that screening smokers over 40 years old using spirometry in general practice may yield 10–20% undiagnosed COPD cases, with a substantial proportion of these having moderate to severe disease.[6] However, the quality of spirometry in primary care is a debated concern, and it is underused as a method for early detection.[7]

Alternatively, the use of symptom-based questionnaires has been proposed as a means of identifying persons likely to have COPD in the general population.[8] Whether such questionnaires may also be used to pre-screen smokers to find those who should be tested with spirometry is questionable.[9]

We conducted a study to determine the quality of spirometry tracings made by general practitioners (GPs) who were provided with a spirometer, and to evaluate patient-reported symptoms and the prevalence of airflow limitation in participating smoking patients aged ≥40 years making a visit for any reason to primary care in Switzerland. For this study, participating GPs were instructed in an introductory lesson how to use the spirometer and how to perform spirometry. GPs performed the spirometries in the context of automatic quality grading by the spirometers according to the National Lung Health Education Program (NLHEP) but without ongoing external quality control by the study team. The spirometry quality results were published recently.[10] We found that about 60% of the spirometry measurements were shown to have at least two reproducible measurements according to the NLHEP quality criteria and that airway obstruction was found in 27% of smokers aged ≥40 years.

In this paper, we report the respiratory symptoms and pre-bronchodilator airway obstruction in a subgroup of study participants where GPs administered a short questionnaire regarding respiratory symptoms on the day of the examination prior to performing spirometry. Following helpful suggestions by the editor and reviewers of the *Primary Care Respiratory Journal* (*PCRJ*) we further analysed the data *post-hoc* to determine predictors for airway obstruction in smokers aged ≥40 years by logistic regression analysis.

Methods

To recruit physicians we contacted 1,800 GPs at the address taken from a Swiss physician register (maintained by the Swiss Medical Association) using a one-off, bulk mailing of invitation letters. Four-hundred-and-forty GPs agreed to participate in this study. We did not contact non-respondents a second time. The EasyOne™ spirometer (ndd Medizintechnik AG, Zurich, Switzerland) with disposable mouthpieces was offered without charge to participating physicians even if they had already performed spirometries in their office before. Physicians were allowed to keep the spirometer at the end of the study without charge. Those who agreed to participate responded by mail, and were contacted by the spirometry sales company to schedule the installation of the spirometer and instruction section. Before commencing the study, participating GPs and their practice nurses were instructed how to perform spirometry according to American Thoracic Society (ATS) guidelines by representatives of the spirometry sales company.[11] This instruction took place at the GP's office and took approximately 1–2 hours. Physicians were asked to recruit at least 60 current smokers aged ≥40 years, independent of the reason for consultation. No data were collected on previous spirometries or confirmed diagnoses.

The spirometer employed in the study had ultrasonic transit-time flow measurement technology with built-in software for quality control and feedback for the examiner, and was factory-calibrated without the need for further calibration. All spirometry measurements were performed in a seated position and required the use of a nose clip. The quality of spirometry was assessed automatically by the spirometer, as recommended in the consensus statement from the NLHEP and using the grading recommended from that report. Spirometry data were classified into quality control grades A to D or F using the criteria of Ferguson *et al.*[12] In this study, we did not physically validate if the quality grades assigned to the spirometry by the spirometer were accurate. For the predicted values, the reference values by Brandli *et al.* (Swiss study on Air Pollution and Lung Diseases in Adults [SAPALDIA]) were used.[13] Interpretation of the spirometry data was performed by the authors according to the criteria of the GOLD committee and Hardie *et al.*,[1,14,15] with the exception that pre-bronchodilator data was used in the interest of simplicity. Accordingly, airflow limitation was defined as a pre-bronchodilator forced expiratory volume in one second (FEV_1)/forced vital capacity (FVC) ratio < 0.7 in patients younger than 70 years of age, FEV_1/FVC ratio < 0.65 in patients between

70–80 years of age, and FEV_1/FVC ratio < 0.6 in patients older than 80 years of age. Possible restriction was assigned if FEV_1/FVC was above the age-adjusted threshold values but the measured FVC was less than the lower limit of normal (LLN) and FEV_1 less than the LLN of predicted values.

Questionnaire

For collection of symptom data, GPs administered a brief unvalidated questionnaire regarding current respiratory symptoms. The questions were 'Do you cough?' (yes/no) and 'Do you have sputum production?' (yes/no), and patients were asked about the severity of dyspnoea according to the ATS modified Medical Research Council (MRC) dyspnoea score.[16,17] The severity was rated on a 5-point scale: 0. 'Not troubled by breathlessness except on strenuous exercise'; 1. 'Short of breath when hurrying or walking up a slight hill'; 2. 'Walks slower than contemporaries on the level because of breathlessness, or has to stop for breath when walking at own pace'; 3. 'Stops for breath after about 100m or after a few minutes on the level'; and 4. 'Too breathless to leave the house, or breathless when dressing or undressing'. GPs were given instructions to ask patients about their current symptoms, but no instructions on asking how long the symptoms had been present. We distributed the questionnaire pre-printed on a separate, otherwise blank, print-out sheet. GPs were asked to fill out the questionnaire during the consultation and prior to performing spirometry. The spirometry results were then printed on this sheet, and collected by the study investigators for data collection and entry. In addition, the participating physician was asked to categorise the main reason for the patient's visit. The categories included musculoskeletal system, cardiovascular system, respiratory system, gastrointestinal tract and others.

Statistical analyses

Continuous variables are expressed as means with standard deviation [SD] or 95% confidence intervals (CI), and categorical variables are expressed as relative frequencies and percentages. Proportions were compared by using chi-square analysis. As suggested by one of the *PCRJ* reviewers, we performed *post-hoc* logistic regression analysis in the sub-dataset of patients with quality grade A–C in whom reproducible spirometries were available. Clinically important airway obstruction (FEV_1/FVC < 0.7) and FEV_1 <65% predicted were used as dependent variables. We included age (continuous variable), sex (male vs. female), obesity ($\geq$30 kg/m^2 vs. <30 kg/m^2), GP having collected symptom data (yes vs. no), consultation reason (respiratory vs. musculoskeletal vs. cardiovascular gastrointestinal vs. other), number of spirometries performed by the GP prior to this spirometry test (continuous variable), MRC dyspnoea level (level 0–2 vs. level 3–4), having cough (yes vs. no), and having sputum (yes vs. no), as independent variables. The values of the continuous variables, age and number of tests performed by the GP were divided by 10 prior to analysis. The independent variable 'GP having collected symptom data' was excluded *post-hoc* due to co-linearity with other variables in the model. We considered a p-value of <0.05 as statistically significant. Analysis was performed with SPSS® version 14 and Microsoft® Office Excel 2008 software.

Results

Four-hundred-and-forty GPs agreed to participate in the study and 30,991 tests were downloaded from the participating GPs' spirometry devices. After excluding repeated tests in the same subjects (where the lower quality grades were deleted), 29,817 tests were available for the analysis of spirometry quality that has been published previously.[10] Tests of subjects aged <40 years and of those who were not smoking were then excluded, leaving 24,995 tests. We then further excluded tests in individuals with low quality spirometry tracings (D, F). Spirometric measurements of 15,084 subjects (60%) were at an acceptable quality grade (55% grade A, 13% grade B and 32% grade C). Additional data on symptoms and the reason for the consultation were obtained for 8,301 (55%) subjects who had an acceptable spirometry quality grade – who were then included into this analysis. Age and body mass index (BMI) data are presented in Table 1. The mean age of patients was 54 years (range 40–90 years) and the mean BMI was 25.6 kg/m^2. Of the consultations, 18.5% were for reasons pertaining to the respiratory system. Other reasons for the consultation included cardiovascular system (16.7%), musculoskeletal system (15.8%), gastrointestinal system (4.1%) and other reasons (44.9%).

While approximately two-thirds of subjects showed no airflow limitation on their spirometry recording, 29% had airflow limitation as measured according to the GOLD/Hardie interpretation,[1,14,15] and 4% had spirometry values indicating possible restrictive disease (see Table 2).

The interviewer-administered questionnaire indicated that

Table 1. Baseline patient information.	
	n (%)
Age distribution (years)	8301 (100)
40–49	3181 (38.3)
50–59	2655 (32.0)
60–69	1619 (19.5)
>70	846 (10.2)
BMI (kg/m^2)	
Normal (BMI 18.5–24.9)	3578 (45.1)
Pre-obese (BMI 25.0–29.9)	2784 (35.1)
Obese (BMI $\geq$30.0)	1307 (16.5)
Underweight (BMI <18.5)	257 (3.2)
Missing data	375 (4.5)
Gender	
Male	4716 (57)
Female	3585 (43)

BMI: body mass index.

D Miedinger *et al.*

Table 2. Presence of airflow limitation according to GOLD/Hardie interpretation.[1,14,15]

Class of diagnosis	Pre-bronchodilator FEV$_1$ % predicted	Diagnosis	Absolute number of patients	Relative percentage	Mean age (years)	Mean BMI (kg/m²)
0		Normal	5539	67	52	25.7
I	≥80%	Mild obstruction	893	11	55	24.7
IIa	>65–79%	Moderate obstruction	387	5	56	24.8
IIb	≥50–65%		663	8	60	26.0
III	≥30–<50%	Severe obstruction	360	4	64	25.5
IV	<30%	Very severe obstruction	86	1	63	25.1
R		Possible restriction	373	4	58	27.5

FEV$_1$: forced expiratory volume in 1 second, BMI: body mass index; GOLD: Global Initiative for Chronic Obstructive Lung Disease criteria.

Note: GOLD/Hardie interpretation categories are normally based on post-bronchodilator spirometry.
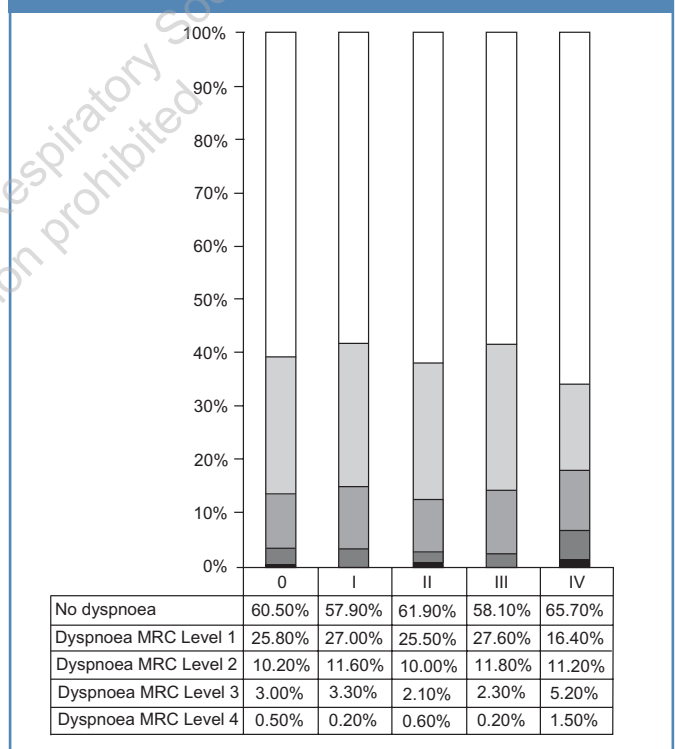
Table 3. Distribution of patient-reported respiratory symptoms among the population of individuals reporting one or more symptoms.

Symptoms	n (%)
Total reporting ≥1 symptom	4781 (58)
Cough	3432 (41)
Sputum	2284 (27)
Dyspnoea (MRC) ≥level 1	3288 (40)
Level 1	2155 (26)
Level 2	859 (10)
Level 3	235 (3)
Level 4	39 (0.5)

MRC: Medical Research Council.

58% of individuals had at least one symptom (cough, sputum) or an MRC dyspnoea level of ≥1. A similar proportion of patients reported cough and/or dyspnoea (41% and 40% of patients, respectively), while 27% reported sputum production (Table 3). Lung function did not differ significantly in individuals with or without cough: FEV$_1$% predicted in those with cough was 80.9% [95% CI: 80.3–81.4%] and in those without cough was 81.8% [95% CI: 81.4–82.3%]; FEV$_1$/FVC % in those without cough was 95.9% [95% CI: 95.6–96.3%] and in those with cough 96.1% [95% CI: 95.8–96.4%]. The same was true for sputum production: FEV$_1$% predicted in those with sputum production was 81.0% [95% CI: 80.4–81.7%] and in those with no sputum 81.7% [95% CI: 81.3–82.0%]; FEV$_1$/FVC % predicted in those with sputum was 95.9% [95% CI: 95.5–96.3%) and in those with no sputum 96.1% (95% CI: 95.8–96.3%]). Lung function did not differ significantly in individuals with different levels of dyspnoea (FEV$_1$% predicted: Level 0: 81.5% [95 % CI: 81.1–81.9%]; Level 1 81.6% [95 % CI: 81.0–82.3%]; Level 2 81.0% [95 % CI: 79.9–82.0%]; Level 3 81.3% [95 % CI: 79.2–83.3%]; and Level 4 82.4% [95% CI: 77.1–87.7%]).

Figure 1. Level of dyspnoea by airflow limitation; 0=normal, I=mild obstruction, II=moderate obstruction, III=severe obstruction, IV=very severe obstruction.

	0	I	II	III	IV
No dyspnoea	60.50%	57.90%	61.90%	58.10%	65.70%
Dyspnoea MRC Level 1	25.80%	27.00%	25.50%	27.60%	16.40%
Dyspnoea MRC Level 2	10.20%	11.60%	10.00%	11.80%	11.20%
Dyspnoea MRC Level 3	3.00%	3.30%	2.10%	2.30%	5.20%
Dyspnoea MRC Level 4	0.50%	0.20%	0.60%	0.20%	1.50%

Little difference was found in the level of dyspnoea when classifying individuals regarding the grade of airflow limitation according to the GOLD/Hardie classification. Only the subgroup with severe and very severe obstruction tended to have more severe dyspnoea (Figure 1) although due to the small number of individuals in this sub-group it did not reach statistical significance (p=0.175). There was, however, no correlation between the number of symptoms reported and lung function, and asymptomatic and symptomatic subjects were equally likely to present with any level of airflow

Table 4. Logistic regression to determine factors that contribute to clinically relevant airway obstruction (low FEV$_1$/FVC ratio and FEV$_1$% predicted below 65%).

Co-variates	Odds ratio	Lower 95% CI	Upper 95% CI
Age (per 10 year increment)	1.99	1.89	2.10
Female sex	0.78	0.69	0.88
Quality grade A+B	1.24	1.09	1.43
Spirometry experience (per increment of 10 tests)	0.97	0.96	0.99

FEV$_1$: forced expiratory volume in 1 second; FVC: forced vital capacity; CI: confidence interval. Age = age at examination; Sex (male vs. female); Spirometry experience = number of tests performed by the GP prior actual test.

The co-variates obesity, consultation reason, having dyspnoea, having cough, having sputum were included in the model but are not displayed as the 95% CI is including 1.

limitation (data not shown). Similarly, there was no relation between the reason for the consultation and lung function at the lower grades of airflow limitation, although consultations for respiratory reasons tended to increase at higher grades of airflow limitation (data not shown).

The results of multivariate logistic regression analysis in order to determine the factors that contribute to obstruction (low FEV$_1$/FVC ratio and FEV$_1$% predicted below 65%) can be seen in Table 4.

Discussion

The findings of this study indicate a prevalence of airflow limitation of approximately 29% among smokers aged ≥40 years in Switzerland, and 58% of them reported at least one current respiratory symptom. However, lung function did not differ in individuals who reported respiratory symptoms compared to those who did not. In multivariate logistic regression analysis, age, sex, obesity, spirometry quality grade and GPs' spirometry experience were associated with clinically relevant airway obstruction.

We used pre- rather than post-bronchodilator spirometry to identify patients with possible COPD, otherwise using the GOLD/Hardie classification.[1,14,15] This may have led to an overestimation of its prevalence in the study population since subjects with fully reversible airflow limitation – and therefore not meeting the GOLD criteria of COPD – may have been wrongly included.[18] As ageing affects lung volumes, over-diagnosis of COPD in elderly patients is likely when using an FEV$_1$/FVC ratio <0.7 to define obstructive lung disease. To minimise misclassification we used different FEV$_1$/FVC ratios to classify obstruction for patients ≥70 years; for the logistic regression analysis, however, we selected patients in whom the FEV$_1$/FVC ratio was <0.7 and the FEV$_1$% predicted <65%. Another possibility to avoid misclassification is the use of LLN

values for FEV$_1$/FVC and FEV$_1$ when interpreting pulmonary function tests.[19] The use of reversibility testing alone to differentiate between asthma and COPD is not appropriate.[20] Some older patients with asthma may have beta-adrenergic dysfunction and therefore will respond poorly to short-acting beta-adrenergic bronchodilators[21] whereas others need a prolonged course with oral steroids[20] in order to show improvement in lung function. Patients with a longstanding history of asthma often show limited reversibility as a result of chronic airway inflammation, or both diseases may be present in the same patient.[20] Patient history, including symptoms, development over time, exposure, atopy and family history, will therefore often contribute more to the correct diagnosis than lung function testing alone.[20,22] Furthermore, smoking is an independent risk factor for asthma as well as COPD, and patients with or without airflow limitation should benefit from smoking cessation intervention.

The quality-controlled, auto-feedback, factory-calibrated spirometer provides an easy, time-efficient and good quality tool for office spirometry, which allows screening in a large population of people at risk of COPD. However, even with use of such a spirometer, only 60% of traces in the whole sample were of satisfactory quality. Performing spirometry prior to, and after, administration of a short-acting bronchodilator, however, is much more time consuming; therefore, the screening is less likely to be performed in all patients at risk, especially if their reason for presentation is for reasons other than respiratory symptoms. The use of an agent with potential adverse effects is also debatable when asymptomatic individuals are tested, even though short-acting β$_2$-agonists (e.g. salbutamol) are sold as over-the-counter drugs in some countries. Nevertheless, as shown below, patients in this group are equally likely to present with moderate to severe airflow limitation and need to be identified. We therefore suggest pre-bronchodilator spirometry as an appropriate method to exclude COPD in a GP setting. Patients with a low FEV$_1$/FVC ratio and less than 65% FEV$_1$% predicted should undergo post-bronchodilator spirometry thereafter to diagnose asthma if the obstruction is reversible, or if not, to classify the patients correctly and to optimise therapy given the severity of the disease.[1]

Estimates of the prevalence of COPD among smokers show considerable variation, depending on the COPD definition used (British Thoracic Society [BTS], European Respiratory Society [ERS], ATS, GOLD),[23] and on factors such as age, gender, smoking habits, environmental exposure and ethnicity; therefore prevalence rates cannot easily be compared. In Europe, the prevalence of COPD ranges between 13% (UK) and 46% (Belgium, Poland).[24-28] However, recent studies show that even after elimination of the known influencing factors, considerable national differences in prevalence remain unexplained and should be the subject of further investigations.[18]

Symptoms of cough, sputum production and dyspnoea were

distributed fairly evenly across our study population, independent of the presence and severity of airflow limitation, and asymptomatic subjects were as equally likely to present with airflow limitation as symptomatic ones. Only moderate to severe dyspnoea showed a higher prevalence in patients with very severe airflow limitation. These findings contrast with those from other studies,[9] and highlight the importance of using validated symptom questionnaires in diagnostic screening. We cannot exclude a potential information bias as physicians might have recorded their patients' answers on the spirometry print out form after being aware of the spirometry results. If this is the case the correlation of symptoms with spirometry abnormalities would be even smaller in reality. Secondary selection bias is also likely to have occurred: those patients in whom data on respiratory symptoms were available were more often classified as having 'normal spirometry' or 'mild obstruction' compared to patients whose spirometries were performed but with no accompanying recorded data on respiratory symptoms.[10] Therefore, our findings need to be interpreted with care before generalising to the whole population of patients with COPD in primary care. Cough, sputum production and dyspnoea are individual factors that vary in intensity over time. Therefore, classification bias might have occurred as some patients declared to the physician symptoms they encountered during the last 24 hours whereas others referred to the symptoms they had on the day of the exam. The same might be true for the recording of the symptoms by the GPs.

According to GOLD guidelines, in COPD, mucus hypersecretion, airflow limitation, air trapping and hyperinflation, gas exchange abnormalities and cor pulmonale may occur, and moderate to severe COPD is nowadays considered to be a systemic disease with findings such as cachexia, skeletal muscle wasting, cardiovascular disease, anaemia, osteoporosis and depression.[1] Respiratory symptoms such as cough, dyspnoea and sputum production are very unspecific and may or may not be present in subjects with airflow limitation. Subjects in whom there is a predominant distortion of gas exchange may have more dyspnoea, but may complain of less cough and sputum production. Subjects can have other diseases that cause these unspecific symptoms and may over- or under-report these symptoms. Our findings suggest that respiratory symptoms, when elicited by brief unvalidated questions, are neither adequate to detect COPD nor to determine the severity of the disease, which reflects the fact that the diagnosis of COPD is, by definition, based on spirometry and does not take into account elements like chronic bronchitis and emphysema. This is not in concordance with past studies using questionnaires to screen for COPD.[8,9] Even when using the St George's Respiratory Questionnaire (a frequently used multidimensional health status questionnaire for COPD) the subscores and total scores only weakly correlate with FEV_1 and

FVC.[29] COPD patients with moderate to severe obstruction, therefore, need a tailored investigation incorporating not only simple spirometry, but eventually a referral to a specialist investigator, to determine residual volumes with body plethysmography, carbon monoxide (CO) diffusion capacity, 6-minute walking distance and sometimes pulmonary arterial pressure measurement in order to guide therapy.[1]

The observation that the primary reason for consultation generally was not due to respiratory problems supports the recommendation that spirometry should be performed routinely for all smokers aged over 40 years, irrespective of their reason for attending the GP's office. The GOLD guidelines suggest that all subjects either presenting with respiratory symptoms, or with a history of exposure to risk factors, be screened for COPD by spirometry. For assessment of COPD severity only, spirometric classification should be complemented by the severity of the patient's symptoms, the degree to which they affect the patient's daily life, the patient's exercise impairment, and the presence of complications.[1] Our findings highlight the fact that patients only see their GP for respiratory symptoms in the late stages of obstructive airway disease, and therefore physicians should actively look for airflow limitation and COPD in high risk patients.

The findings from logistic regression suggest that the risk for obstruction increases with age and is higher for males than for females, which is in concordance with other studies investigating the prevalence of COPD in primary care.[30,31] However, as discussed above, when using arbitrary cut-off points, over-diagnosis of COPD in elderly individuals is likely and these results need to be interpreted with care. Good quality spirometries (grade A–B) were associated with obstruction, probably because the end-of-test criteria were more likely to be satisfied than in those with lower spirometry quality.[32] Obstruction was negatively associated with increasing numbers of spirometries. We have already reported that the quality grade of spirometries performed by GPs can vary according to training: GPs who performed fewer than 10 tests had the lowest mean quality grade recorded, whereas the highest quality grades were achieved by GPs who had performed between 21 and 30 tests. The quality was even lower in those who performed more spirometries, suggesting that refresher training might be important to maintain a good standard.[10]

Overall, this study shows that airflow limitation is a frequent condition among smokers and that patient-reported respiratory symptoms do not correlate with spirometry findings. Good quality spirometries as well as increasing age are positively associated with obstruction, whereas female sex and increasing number of spirometries performed were negatively associated. Pre-bronchodilator spirometry is a practical method for early identification of patients with airflow limitation, allowing earlier diagnosis and intervention in patients with possible COPD. However, poor quality of spirometry in primary care, even with an

automated feedback and quality control spirometer, remains a major issue.

Conflict of interest declaration
D. Miedinger and J.D. Leuppi have received free spirometric equipment from ndd Medizintechnik AG for other research studies. C. Buess is responsible for Research and Development at ndd Medizintechnik AG.

A. Linz, C. Praehauser, P.N. Chhajed, S. Schafroth Török, H. C. Bucher and M. Tamm have no conflicts to disclose.

Participating physicians were provided with an EasyOne™ spirometer with disposable mouthpieces without charge for this study. Physicians were allowed to keep the spirometer at the end of the study without charge.

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