Respiratory symptoms and lung function in young adults with severe α₁-antitrypsin deficiency (PiZZ)

E Piitulainen, T Sveger

Background: Neonatal screening for α₁-antitrypsin (AAT) deficiency was undertaken in Sweden between 1972 and 1974 when 129 infants with severe AAT deficiency (phenotype PiZZ) were identified. The cohort has been followed up prospectively.

Methods: 124 PiZ subjects, still alive and still living in Sweden, were invited to a follow up examination at about 22 years of age. The check up included a clinical examination, spirometric tests, and a questionnaire on smoking habits and respiratory symptoms.

Results: Ninety eight subjects (97 PiZZ and 1 PiZ–) subjects attended the follow up. The mean age of the subjects was 22.5 years (range 19.8–24.8). The mean (SD) forced expiratory volume in 1 second (FEV₁) was 98 (14)% predicted, vital capacity (VC) was 103 (14)% predicted, and the mean FEV₁/VC ratio was 83 (7)%. Eighty six subjects had previously undergone spirometric tests. The median follow up time was 4.3 years (range 0.9–7.3). The mean annual change in FEV₁ (% predicted) was –1.2% (95% CI –2.1 to –0.3), in VC (% predicted) was –1.5% (95% CI –2.0 to –0.9), and in the FEV₁/VC ratio (%) was –0.3% (95% CI –0.7 to 0.2). Twenty eight individuals (29%) reported recurrent wheezing. Fifteen subjects (15%) had been diagnosed by a physician as having asthma. Eighteen subjects reported that they had smoked at some time; 10 were current smokers. The mean number of pack years among the ever smokers was 3.4 (range 0.6–10.5). Ten of 18 ever-smokers and 18 of 80 non-smokers reported recurrent wheezing (p<0.01), while exertional dyspnoea was reported by six ever smokers and 11 non-smokers (p<0.05). Lung function test results did not differ significantly between ever smokers and non-smokers.

Conclusions: Young PiZ adults have essentially normal lung function, but have a high prevalence of asthma symptoms. Smoking in these individuals is associated with an increased frequency of respiratory symptoms.

METHODS
Study population
AAT-deficient individuals identified in the neonatal screening study are invited to follow up studies every fourth year. 122 PiZZ and two PiZ– subjects who were still alive and living in Sweden were invited to the follow up study at about 22 years of age. The check up was performed by a chest physician at the local hospital. Data on the subjects’ clinical history were drawn from the earlier check ups.³⁷

Questionnaire
In connection with the clinical check up the physician filled in a questionnaire regarding diagnoses and results of spirometric tests and lung function tests. The lung function tests included serum aspartate amino transferase (s-ASAT), serum alanine amino transferase (s-ALAT), serum alkaline phosphatase (s-ALP), and gamma glutamyl transferase (s-GT), and were analysed at the local hospitals. The results of the following questions were analysed: (1) smoking habits (whether the patient has ever smoked regularly; age at starting, age at stopping, and mean daily consumption of cigarettes); (2) current phlegm (whether the patient usually coughs up phlegm); (3) recurrent wheezing (brought on by damp weather, strong odours, cold (upper respiratory tract infection), or any other circumstances); and (4) exertional dyspnoea (shortness of breath when walking 100 metres on the level).

Lung function tests
Standard spirometric tests were performed at either the respiratory department or the physiological laboratory of the local hospital. Forced expiratory flow in 1 second (FEV₁) and vital capacity (VC) were expressed as a percentage of predicted values according to reference values published by Knudson and coworkers.²¹ The FEV₁/VC ratio was expressed as a percentage. Prebronchodilator values for FEV₁ and VC were

Original Article
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Individuals with homozygous PiZZ α₁-antitrypsin (AAT) deficiency have a considerably increased risk of developing emphysema, especially if they smoke.¹² AAT deficiency is also a genetic cause of liver disease in childhood and late adulthood.¹³–¹⁵ The development of emphysema is mainly due to the decreased amount of AAT in the lung tissue, giving an inadequate inhibition of neutrophil elastase.¹⁶ There is a large variability in the development of lung disease among individuals with severe AAT deficiency which is not fully explained by known environmental and genetic factors.¹⁷

Neonatal screening for AAT deficiency was undertaken in Sweden between 1972 and 1974 to study the pathophysiology and natural history of lung and liver disease in AAT deficiency. Of 200 000 newborn infants, 127 PiZZ, two PiZ–, 54 PiSZ, and 21 PiS– subjects who were still alive and living in Sweden were invited to a follow up examina-

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performed in 71 subjects, six of whom (8%) had an increase of (range 74–142), and the mean FEV1/VC ratio was 83 (7)% predicted (range 52–131), mean VC was 103 (14)% predicted. Eight subjects reported both current phlegm and dyspnoea. (16%) and exertional dyspnoea by 17 (17%). Eight subjects strong odours, and six suffered from wheezing in other.

The Student’s t test was used to compare continuous variables between the groups. Two tailed paired t tests were used in the analysis of dependent variables. The χ² test was used to compare categorical variables. p values of <0.05 were considered significant.

RESULTS
Lung function, respiratory symptoms, and diagnoses
Of 124 AAT-deficient individuals (122 PiZZ and two PiZ–), 52 men and 46 women participated in the study (97 PiZZ and one PiZ–). The mean age of the study participants was 22.5 years (range 19.8–24.8). The median follow up time was 4.3 years (range 0.9–7.3). The results of the lung function tests at both check ups are shown in table 3. The changes in FEV₁ and VC, expressed as % predicted values, showed a significant annual decline. Fifteen of the 86 subjects reported having smoked at some time, and nine were current smokers at the present check up. The mean annual change in FEV₁, VC, and FEV₁/VC ratio did not differ significantly between ever smokers and non-smokers.

Subjects not participating in the present follow up examination (“drop outs”)
Of the 124 PiZ individuals who had been invited to the present follow up, 26 did not attend the clinical examination or spirometric test. Fourteen had attended a previous check up at 16 or 18 years of age and reported that they had never smoked. No information was available on smoking habits or health status of the remaining 13 subjects who had not attended the previous check ups at 16 or 18 years of age.

DISCUSSION
This study was included in the long term follow up of the PiZ individuals identified by the Swedish neonatal AAT screening study during 1972–4. Our results indicate that lung function is still essentially normal in 20–24 year old individuals with severe AAT deficiency (PiZZ). However, all lung function test results, when expressed as a percentage of reference values, were significantly lower than at the previous check up at 16 or 18 years of age (table 3). We compared spirometric results with reference values published by Knudson and coworkers, which we also used in our previous analysis of lung function in the cohort. Using the same reference values in both studies made possible a longitudinal analysis of lung function expressed as percentage predicted values. Overall changes in lung function were small, which may indicate that lung function in these subjects had reached a plateau phase during the observation period.
In contrast to the results of our previous analysis of risk factors for lung disease in AAT-deficient adolescents,11 we did not find significant differences in lung function between smokers and non-smokers (table 2). The significantly increased prevalence of self-reported respiratory symptoms in the smoking subjects indicates, however, that harmful effects of smoking are already in progress (table 1). We found similar results at the previous check up at the age of 16–18 years when the presence of current phlegm was more common among ever smokers than non-smokers.11 All data on smoking history were self-reported by the study participants, and no objective tests were performed to verify their smoking status.

At the 16 year check up the prevalence of self-reported recurrent wheezing among 103 PiZZ individuals was 10.7%. At the present examination 29% of the individuals reported recurrent wheezing, while 15% had physician reported asthma. Previously published reports have suggested that symptoms and diagnosis of asthma are over-represented in severe AAT deficiency.16 The prevalence of asthma reported in the Swedish general population varies from 5% to 11%,15,18 taking into account the high prevalence of self-reported recurrent wheezing in our study, it may support an over-representation of asthmatic symptoms in severe AAT deficiency. It is therefore possible that respiratory symptoms are initially interpreted as “usual” asthma when young PiZZ adults seek health care, which may delay the correct diagnosis. This is especially critical for young PiZZ smokers who may develop irreversible obstructive pulmonary disease within a few years if they continue smoking. Our results may support the WHO recommendation that all adults and adolescents with asthma should be screened for AAT deficiency.19 Moreover, a postal survey of AAT-deficient individuals in the USA has shown that the mean delay between the first symptoms and the correct diagnosis of AAT deficiency was 7.2 years, indicating that the symptoms may be misunderstood by doctors.19

In contrast to other epidemiological studies on AAT deficiency, our study was not affected by selection bias because the study population represented 79% of all PiZZ individuals born in Sweden between 1972 and 1974. Although this is the largest ongoing epidemiological study of AAT deficiency, the number of subjects in subgroups such as smokers is low as a result of effective smoking prevention. The power to detect significant differences between the groups is therefore low and false negative results cannot be excluded. Our results may also have been influenced by the lack of an age and sex matched control group. The follow up of a parallel healthy cohort has not been practically possible because the participants in the study are spread throughout Sweden. We therefore compared the smoking habits of the study participants with the statistics published by Statistics Sweden. In our study three of 52 men (6%) and seven of 46 women (15%) reported that they were current smokers. According to Statistics Sweden, the proportion of daily smokers was about 12% among men and 20% among women aged 16–24 years in Sweden during the same period as the present study was being performed.20

We conclude that young PiZZ adults have essentially normal lung function. The prevalence of asthmatic symptoms seems to be high, and smoking is associated with an increased frequency of respiratory symptoms.

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**Table 3** Lung function test results at 16–18 and at 22 years of age and annual change in lung function in 86 subjects who had performed two spirometric tests.

<table>
<thead>
<tr>
<th></th>
<th>16–18 years (n=86)</th>
<th>22 years (n=86)</th>
<th>Annual change</th>
<th>p (annual change)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEV1 (l)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>4.1</td>
<td>4.2</td>
<td>0.01</td>
<td>NS</td>
</tr>
<tr>
<td>95% CI</td>
<td>3.9 to 4.3</td>
<td>4.0 to 4.4</td>
<td>-0.01 to 0.03</td>
<td></td>
</tr>
<tr>
<td>FEV1 (l %pred)</td>
<td>105</td>
<td>98†</td>
<td>-1.2</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>95% CI</td>
<td>101 to 108</td>
<td>95 to 101</td>
<td>-2.1 to -0.3</td>
<td></td>
</tr>
<tr>
<td>VC (l)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>4.8</td>
<td>5.0†</td>
<td>0.03</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>95% CI</td>
<td>4.6 to 5.1</td>
<td>4.8 to 5.3</td>
<td>0.01 to 0.06</td>
<td></td>
</tr>
<tr>
<td>VC (l %pred)</td>
<td>109</td>
<td>103†</td>
<td>-1.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>95% CI</td>
<td>106 to 112</td>
<td>100 to 106</td>
<td>-2.0 to -0.9</td>
<td></td>
</tr>
<tr>
<td>FEV1/VC (%)</td>
<td>85</td>
<td>84*</td>
<td>-0.3</td>
<td>NS</td>
</tr>
<tr>
<td>95% CI</td>
<td>84 to 87</td>
<td>82 to 85</td>
<td>-0.7 to 0.2</td>
<td></td>
</tr>
</tbody>
</table>

FEV1=forced expiratory volume in 1 second, VC=vital capacity.

*p<0.05, †p<0.01, ‡p<0.001 v 16–18 years (two tailed t test).
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