Nasal patency in Poles in the light of research as part of the project on Epidemiology of Allergic Diseases in Poland

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### Objective
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### Materials and method
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**INTRODUCTION**

Measuring the peak nasal inspiratory flow (PNIF) is a commonly used technique for assessing nasal patency in rhinological allergy practice, in addition to rhinomanometry, acoustic rhinometry and computed tomography. Numerous scientific studies have shown the special importance of such measurements in home monitoring, for example, in the case of nasal conditions (nasal obstruction) co-existing with allergic rhinitis [1, 2, 3]. There are a number of factors that significantly affect the reliability of PNIF measurements, which causes problems with standardization of this technique. These factors include ongoing inflammatory conditions of the nasal mucosa, such as rhinitis, polyps, and anatomical or physiological changes in the nasal cycle. Factors such as gender, age, height, weight, or measuring technique may also need to be considered while attempting to determine reference values for a given population.

**OBJECTIVE**

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**MATERIALS AND METHOD**

The ECAP study is the first to be undertaken on the epidemiology of allergic diseases in Poland conducted on such a large scale, with nearly 23,000 randomly selected survey respondents (children and adults), 30% of whom
underwent medical diagnostic tests for allergic diseases. The project was divided into two main phases: Phase 1: a questionnaire-based survey (22,500 respondents) carried out using the CAPI (Computer Assisted Personal Interviewing) technique and PDA (Personal Digital Assistant) devices. Phase 2: supplementary medical examinations of 7,000 subjects in three age groups: 6–7-year-olds, 13–14-year-olds, and 20–44-year-olds. The group of respondents in the ECAP study was randomly selected in such a manner as to ensure that it could be considered a representative sample of the studied population. The random selection was based on PESEL (Polish national identification) numbers. The respondents were selected by the Department of Development and Registration at the Ministry of the Interior and Administration. Each survey-taker involved in the project received a list of the individuals to be surveyed. From all the respondents, 30% were randomly selected to undergo an outpatient medical examination and, if qualified, to receive a nasal patency test with the PNIF method. Nasal patency was measured using the PNIF test by means of a simple device equipped with a flow (L/min) meter and a ventilation mark (In-Check, Clement-Clark).

The criteria for participating in the survey included medical history data, skin prick test results and an endoscopic inspection of the nasal cavity. The PNIF test was performed twice: before and after the administration of Xylometazolinum (0.1%), with a 20-minute interval, by qualified personnel in an outpatient setting. For the purposes of statistical analysis, the Student’s t-test for paired samples, Welch Two Sample t-test (a large sample, approximation with normal distribution), and the Kruskal-Wallis test were used to show differences in nasal patency measurements before and after mucosal vasoconstriction (P<0.05). The correlation between PNIF values and weight as well as height was assessed with linear regression and Pearson's correlation coefficient. The average PNIF levels were analyzed based on the following criteria: clinical diagnosis (seasonal and perennial allergic rhinitis – SAR/PAR), good health, age, gender, height, weight and place of residence.

RESULTS

Analysis of PNIF measured in a Polish population revealed significant age differences in the study sample, with the lowest values observed in the subgroup of 6–7-year-old children (75.95 L/min), intermediate values in 13–14-year-old adolescents (91.44 L/min), and the highest values in adults (97.12 L/min) (Tab. 1). The PNIF values also varied considerably, based on the place of residence (P<0.05, Kruskal-Wallis test), with values over 100 L/min reported in Katowice, Białystok, and Wrocław (106.36, 105.36, and 114.68 L/min, respectively) versus much lower values in Warsaw, Poznań, and Kraków (73.66, 65.14, and 60.43 L/min, respectively) (Fig. 2).

A moderate correlation was observed between patient height (r=0.51; P<0.05), body weight (r=0.49; P<0.05), and age (r=0.38; P<0.05) in comparison to PNIF values (Fig. 1). Other study criteria, such as gender (94.44 L/min in males vs. 92.64 L/min in females; P=0.36, Kruskal-Wallis test) or...
clinical diagnosis (95.25 L/min in seasonal allergic rhinitis [SAR] and 86.12 L/min in perennial allergic rhinitis [PAR]) vs. 93.60 L/min in healthy controls [HC]), showed no significant differences in PNIF values (P=0.11, Kruskal-Wallis test). The differences in values measured prior to and after mucosal vasoconstriction were statistically significant between:
- age groups, with 21.5% in 6–7-year-old children, 24.9% in 13–14-year-old adolescents, and 21.9% in adults (P<0.05; t-test for paired samples);
- groups based on the place of residence, with the highest in group 1 (VAS ≥8), the mean PNIF value in males was 69.2

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in group 2 (VAS <8), the mean PNIF values in males and females showed significant differences between both genders in the study population (PNIF 145 L/min and 128 L/min, respectively) [8]. Their in-house research demonstrated no significant differences in PNIF between the genders, with moderate differences observed between study groups stratified by height or weight. A study by Bouzgarou et al. in 212 north African subjects (100 females and 112 males) aged 13–27 showed considerable differences in PNIF in groups stratified by age and height but only in the male group (r=0.21, P<0.05; r=0.48, P<0.05) with no differences in the female group (r=0.18, P>0.05; r=0.18, P>0.05). Moreover, male subjects achieved higher PNIF values than females in all age subgroups (age 13–15: 154 L/min vs. 119 L/min; age 16–20: 184 L/min vs. 120 L/min; age 21–23: 191 L/min vs. 134 L/min; and age 24–27: 181 L/min vs. 140 L/min, respectively) [9].

A study by van Sprossed et al. in a group of 212 children aged 6–11 demonstrated no significant differences in PNIF with respect to either age, height, weight, or ethnicity. The authors emphasized that the high risk of technical errors allows PNIF to be measured in children not younger than 6 years old [10]. The differences in PNIF observed between the studied cities in the presented study may be due to measurement errors or to variations in the rates of allergic rhinitis (AR) between regions. The lowest PNIF values were reported in Kraków, with a 36% AR rate in the general population, followed by values from Poznań (AR 40%), and Warsaw (AR 43%). [11] This is why PNIF measurements are commonly used in differential diagnostics of rhinitis. Ottaviano et al. demonstrated the particular usefulness of PNIF in differentiating between conditions involving nasal congestion by unilateral measurements conducted in a group of healthy volunteers, and subjects with nasal congestion [6]. A study by Fernandes et al. demonstrated variability in PNIF values in a group of 40 subjects receiving either nasal corticosteroids or placebo. The study showed considerably higher PNIF values in the corticosteroid group vs. placebo group, which establishes PNIF as a good tool for nasal congestion monitoring [12]. Another study, conducted in 303 volunteers stratified into three subgroups with various degrees of nasal congestion, yielded PNIF of 82–227 L/min (no nasal congestion), 91–180 L/min (partial congestion), and 86–105 L/min (complete congestion) [13]. A study by Starling-Schwanz et al. in a population of 283 adults aged 28–30 showed a correlation between signs of congestion measured by PNIF and by anterior rhinoscopy (r=−0.38; P<0.0001); with no correlation between PNIF and questionnaire results. The group with mild to moderate asthma and concomitant rhinitis showed a greater variability in PNIF values than symptomatic rhinitis group (P=0.04) [14]. Moreover, PNIF values obtained prior to and after nasal mucosal vasoconstriction, and more specifically, the percentage difference between these two measurements, provide valuable information on the degree of nasal congestion (Tab. 2). The presented analysis demonstrated a mean PNIF difference of 25–28%, with practically no differentiation between the study groups: AR vs. HC. Another study reported a 35%
Table 2. Difference in PNIF values before and after vasoconstriction of nasal mucosa; HC vs. SAR, PAR (P<0.05)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>SAR n= 562</th>
<th>PAR n= 640</th>
<th>HC n= 2,063</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>I L/min</td>
<td>II L/min</td>
<td>%</td>
</tr>
<tr>
<td>6–7 y.o.</td>
<td>53.66</td>
<td>67.34</td>
<td>25.48</td>
</tr>
<tr>
<td>13–14 y.o.</td>
<td>94.79</td>
<td>122.34</td>
<td>29.06</td>
</tr>
<tr>
<td>Adults (20–44 y.o.)</td>
<td>104.64</td>
<td>128.96</td>
<td>23.24</td>
</tr>
</tbody>
</table>

Sex

Females | 89.80 | 112.37 | 25.13 | 96.74 | 119.84 | 23.88 | 94.94 | 115.07 | 21.20 |

Males | 91.70 | 115.04 | 25.46 | 98.19 | 124.53 | 26.82 | 97.00 | 117.86 | 21.51 |

Place of residence

Białystok | 101.14 | 121.67 | 20.29 | 111.91 | 132.52 | 18.41 | 109.46 | 128.09 | 17.03 |

Gdańsk | 93.59 | 110.32 | 17.88 | 101.95 | 123.73 | 21.36 | 98.39 | 115.91 | 17.81 |

Katowice | 118.04 | 148.95 | 26.19 | 109.88 | 147.44 | 34.18 | 105.28 | 132.59 | 25.94 |

Kraków | 80.0 | 90.0 | 12.3 | p=0.226 | 90.62 | 111.25 | 22.76 | 95.17 | 106.78 | 12.20 |

Lublin | 92.56 | 119.26 | 28.69 | 95.09 | 120.66 | 26.88 | 90.89 | 115.40 | 26.97 |

Poznań | 63.88 | 84.94 | 32.97 | 65.00 | 88.33 | 35.90 | 68.96 | 90.31 | 30.97 |

Warsaw | 82.75 | 104.79 | 26.63 | 79.10 | 104.36 | 31.93 | 73.13 | 92.01 | 25.81 |

Wrocław | 114.56 | 138.53 | 20.92 | 111.16 | 130.90 | 17.76 | 115.18 | 135.94 | 18.03 |

SAR = seasonal allergic rhinitis; PAR = perennial allergic rhinitis; HC = healthy controls; I = mean PNIF level (L/min) before mucosal vasoconstriction; II = mean PNIF level (L/min) after 0.1% Xylometazolinum administration; % = percentage difference in the mean PNIF level

difference in PNIF values obtained prior to, and after, nasal mucosa vasoconstriction [15,16]. A PNIF study by Teixeira et al. in a group of 60 healthy volunteers (physicians, nurses, administrative staff) demonstrated a mean difference of 20% (from 151 L/min to 178 L/min). The values measured prior to and after mucosal vasoconstriction with a 0.05% Oxymetazoline chloride solution (r=−0.046; P=0.080) showed a moderate correlation with the patient assessment of nasal symptoms measured with VAS [17].

CONCLUSIONS

The PNIF method is undoubtedly the most frequently used nasal patency measurement method, for example, in nasal provocation testing. However, this method requires further attempts at standardization as there are a number of factors which are mutually contradictory when it comes to establishing PNIF reference levels.

REFERENCES