Peak nasal inspiratory and expiratory flow measurements - practical tools in primary care?*

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SUMMARY

General practitioners diagnose and treat numerous patients with nasal problems but have no objective equipment to aid diagnosis. We studied the characteristics of peak nasal inspiratory (PNIF) and expiratory (PNEF) flows to explore their utility for primary care use. One hundred healthy volunteers, 50 men, 50 women, performed PNIF and PNEF measurements in standardised laboratory circumstances. Repeatability was tested for a subgroup of 20 women who performed two consecutive series of PNIF and PNEF at a 2-minute interval. Diurnal variability was tested with a subgroup of 10 men and 10 women who recorded PNIF and PNEF values at home every morning and evening for 7 days. Distribution of individual values for both PNIF and PNEF was wide and independent of subject's age, height, or gender. Repeatability was poor and diurnal variation substantial.
PNIF and PNEF lack the properties of good clinical tests and thus cannot be recommended for primary care use.

Key words: peak nasal inspiratory flow, peak nasal expiratory flow, repeatability, primary care

INTRODUCTION

General practitioners diagnose and treat most of the patients with upper respiratory tract infections, and with seasonal and perennial rhinitis. Nasal obstruction is a common symptom and complaint at primary care clinics. A thorough patient history and clinical examination are the first steps in evaluation of nasal breathing problems, but stuffiness does not always mean that the nose is obstructed (Sipilä et al., 1995). In the case of dry, atrophic nasal mucosa, sinus diseases, or poor pulmonary function, the patient can experience a sensation of nasal obstruction without significant airway restriction (Cummings, 1998). Despite the number of patients with nasal problems, general practitioners have no objective methods for evaluation of nasal obstruction and follow-up treatment. Rhinomanometry, acoustic rhinometry, and rhinostereometry are used in rhinology clinics but are too expensive and complex for primary care (Jones and Lancer, 1987; Lender and Pirsig, 1992; Hallén and Graf, 1999). In order to make correct diagnoses and to choose the right treatment, an objective method to measure nasal breathing function is essential.

Despite their variability (Bland et al., 1974) peak flow measurements are the cornerstone in diagnostics and especially follow-up of asthma and other obstructive pulmonary diseases (Quanjer et al., 1997). Allergologists and rhinologists have used nasal modifications of peak flow measurement, i.e., peak nasal inspiratory flow (PNIF) and peak nasal expiratory flow (PNEF), in nasal provocation (Munch et al., 1982), in follow-up after septoplasty (Larsen and Kristensen, 1990), for discerning the effect of medications (Benson, 1971), assessing the nasal patency (Phagoo et al., 1997) and for diagnosing acute maxillary sinusitis (Blomgren et al., 2002). Being quick, inexpensive, easy to use, non-invasive, painless, and portable, either PNIF or PNEF would be ideal for primary care use. The purpose of this study was to discover whether PNIF and PNEF could prove suitable methods for diagnostics and follow-up of nasal diseases in primary care.

MATERIALS AND METHODS

Subjects

We recruited 100 nonsmoking volunteers, 50 women and 50 men, ranging in age from 21 to 60 years, mean 39, excluding those with any upper respiratory tract infection during one month prior to the study or with seasonal or perennial rhinitis. The volunteers came from among the staff and students of the Helsinki University Otorhinolaryngology Department.

Methods

Three experienced laboratory technologists performed all measurements in the research laboratory under standardized circumstances, i.e., at normal room temperature and humidity, and with a 15 minute-waiting period before each measure-

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ment. The laboratory technologists gave a thorough presentation individually to every volunteer who practiced the technique before study measurements were performed. PNEF was measured first by each subject in a sitting position. The device was a combination of a basic PEF-meter (Wright Peak Flow Mini-meter, Clement Clarke Int. Ltd, UK) and rubbery anaesthesia face masks of variable sizes. The mask had to be large enough not to press the nose or mouth, and small enough to prevent air leakage under the chin. Each participant was asked to take a deep breath, put the mask on to cover the nose and mouth, and to exhale sharply through the nose. The best of three results was recorded. Participants who had problems with the technique were permitted to make more attempts. After cleaning of the mask, each participant measured the PNIF with an In-check peak flow meter (In-check, Clement Clarke Int. Ltd, Essex, UK), recording the best result of three forced inspirations.

Table 1. 95% reference intervals of peak nasal flows in 50 women and 50 men.

		Mean (l/min)	Upper limit (l/min)	Lower limit (l/min)
PNEF[a]	Men	368	156	581
	Women	268	98	438
PNIF[b]	Men	145	58	233
	Women	128	44	211

[a] Peak nasal expiratory flow [b] Peak nasal inspiratory flow

To test diurnal variation, a subgroup of 20 volunteers, 10 women and 10 men, was drawn. They performed PNIF and PNEF measurements every morning and evening at home for 7 days. Repeatability was assessed in an additional subgroup of 20 women. Two series of three consecutive PNEF measurements were performed with a 2-minute interval between the series. After a 1-minute interval, a similar procedure was repeated for PNIF measurement.

The study protocol was approved by the Ethics Committee of Helsinki University Central Hospital.

Statistics

Statistical analysis was conducted with SPSS 9.0 for Windows. The 95% reference intervals for PNIF and PNEF were estimated as mean +/- 1.96 standard deviations (SD). Coefficient of repeatability was calculated by the method described by Bland and Altman. Differences between the first and second measurements were calculated, and then the mean and SD of the differences were computed and the differences plotted against the average of the two measurements. Association of age and height with PNIF and PNEF measurements was calculated by stepwise multiple linear regression analysis separately for both genders.

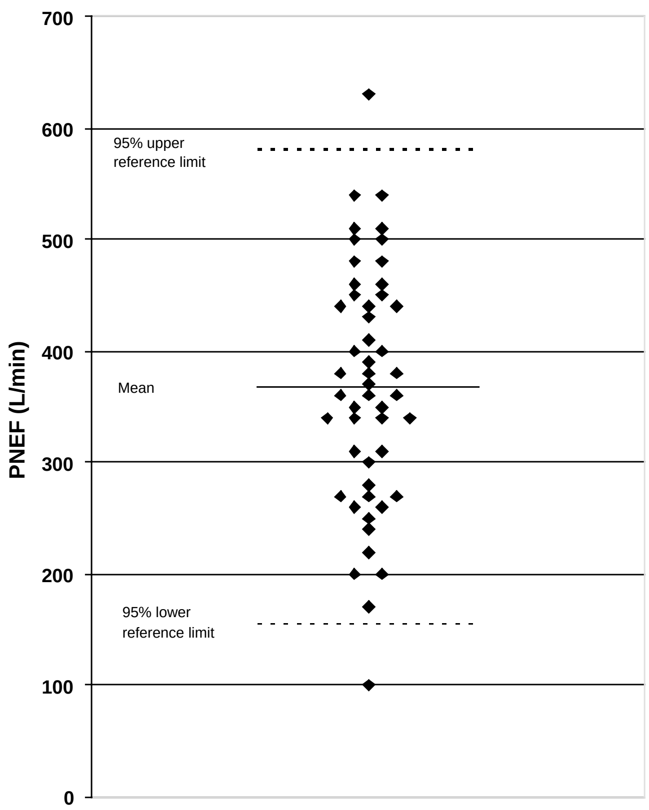

Figure 1. Distribution of individual peak nasal expiratory flow (PNEF) values in 50 male volunteers. Each point represents a measurement from one volunteer.

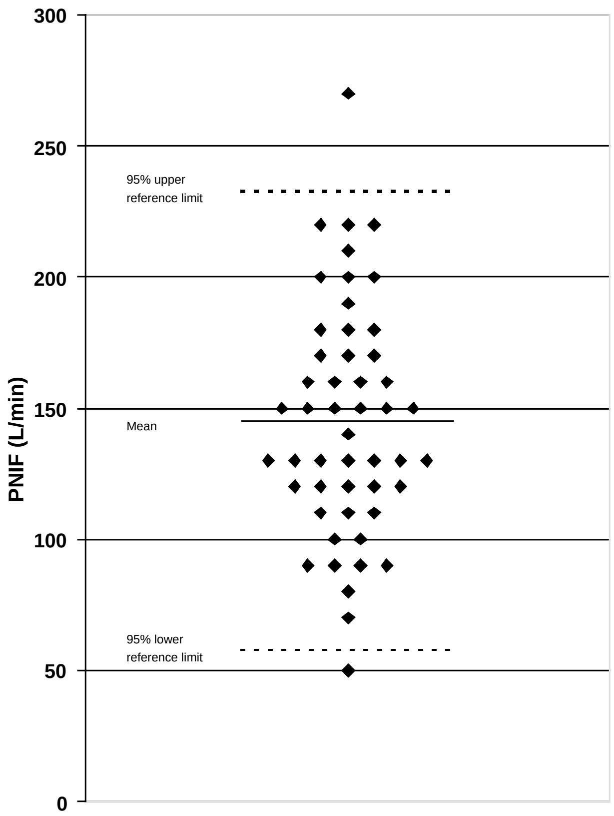

Figure 2. Distribution of individual peak nasal inspiratory flow (PNIF) values in 50 male volunteers. Each point represents a measurement from one volunteer.

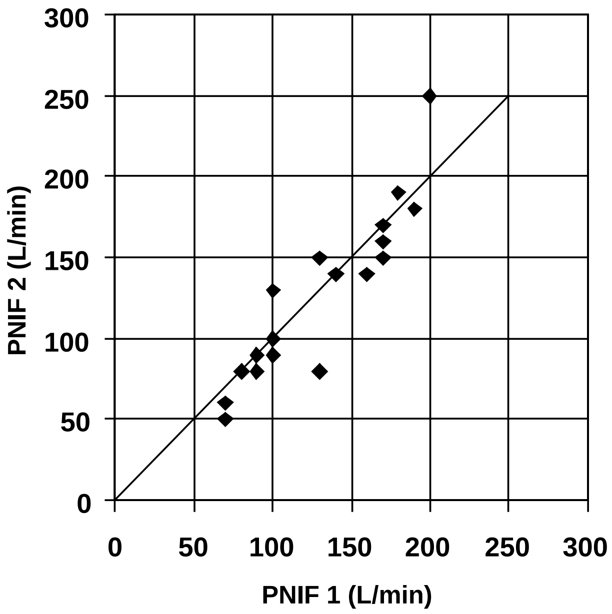

Figure 3. PNIF measurements in two consecutive series in 20 female volunteers.

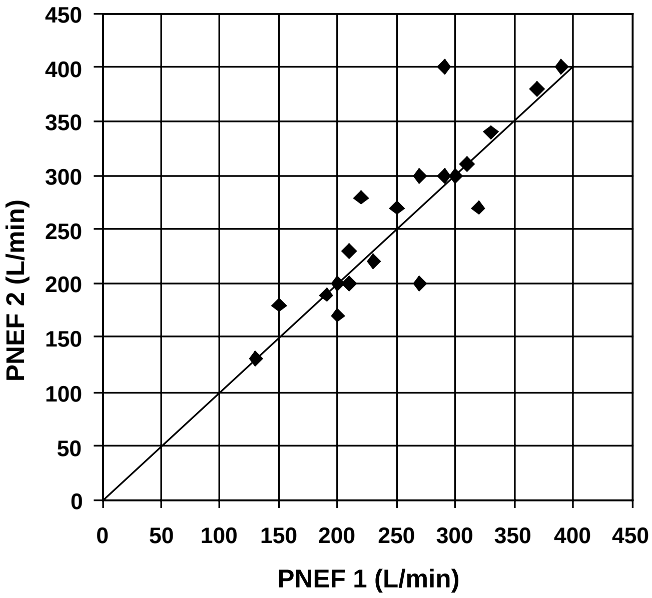

Figure 4. PNEF measurements in two consecutive series in 20 female volunteers.

RESULTS

The 95% reference intervals of PNIF and PNEF of the 100 volunteers are shown in Table 1. Distribution of individual values was highly variable (Figure 1, Figure 2). A similar pattern was evident in PNIF and PNEF and in men and women.

To test repeatability, 20 pairs of measurements were performed. Means of the first and second PNIF measurements were 126 (SD 43.2) and 123 (SD 51.3) L/min, respectively, and the mean of all measurements 124.5 L/min (SD 46.3). The average difference between PNIF measurements was 3 L/min. Coefficient of repeatability was 40.3 L/min (32% of the mean of the whole series), and the 95% limits of agreement, –37.3 to 43.3 L/min (Figure 3). For PNEF means of the first and second measurements were 257 and 264 L/min, and the mean of all measurements was 260 L/min (SD 71.9) and the average difference between the measurements, –7 L/min (Figure 4). The coefficient of repeatability was 72.8 L/min (28.0% of the mean) and the 95% limits of agreement –79.8 to 65.8 L/min. Diurnal variation of both PNEF and PNIF was notable (Figure 5, Figure 6). In several volunteers, the results varied over 50% in measurements performed on consecutive days, at the same hour. Age and height showed no reasonable association with either PNIF or PNEF (data not shown).

DISCUSSION

In our previous study, low values of PNEF correlated with acute maxillary sinusitis (Blomgren et al., 2002). This inspired us to explore the properties and clinical utility of PNIF and PNEF. An ideal nasal airway test is comfortable for the patient, reproducible, standardisable, clinically useful, inexpensive, and quick and uses already available equipment (Maran et al., 1971). PNIF and PNEF did not, unfortunately, fulfill these criteria. As long as the variability is large and repeatability poor, other advantages of the tests are useless. Learning the proper technique for PNIF and especially for PNEF was also harder than we had assumed for our well-educated volunteers. It was sometimes difficult to fit a mask tightly enough but not too tightly because of the various face sizes. Air leakage through the mouth was a general problem with PNEF and partly explains the large variation. For some participants, breathing effort for PNEF was obviously not maximal because they felt embarrassed about the secretions flying out of their noses into the masks.

Since PEF results depend on patients' age and height (Nunn and Greg, 1989), we calculated the relationship of these to PNIF and PNEF. Neither the volunteers' age nor height was associated with either PNIF or PNEF, although unlike us, Jones and Prescott demonstrated a correlation between PNIF and height; their study was, however, conducted among children (Jones et al., 1991; Prescott and Prescott, 1995).

Several authors have, based on calculating intraclass correlation coefficients, found PNIF and PNEF reproducible and clinically useful. PNIF has been used and recommended for domiciliary measurement in allergic rhinitis (Holmström et al., 1990; Wilson et al., 2000), in epidemiologic studies of air pollutant exposure (Cho et al., 1997), and in assessment of nasal airway patency during challenge, and PNEF recommended for the evaluation of the efficacy of immunotherapy (Frostad, 1980). Our large diurnal variability of PNIF and PNEF does not support their use in follow-up of any treatment or symptom, even though domestic measurement may explain a part of the variability. Moreover, the values for the 95% limits of agreement between two consecutive measurements indicate that in every new pair of measurements we expect to get values that differ less than approximately 30% in either direction.

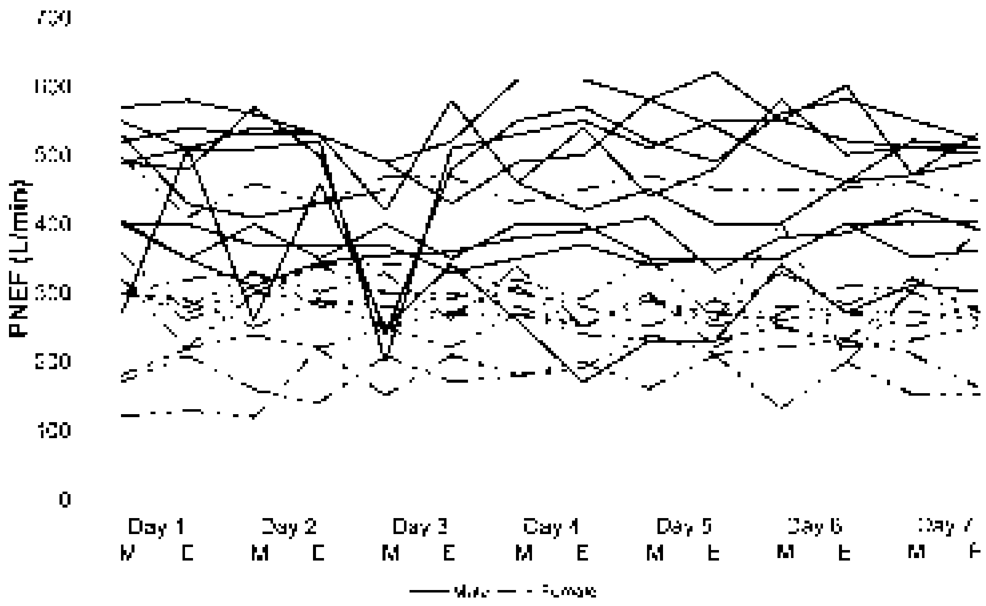

Figure 5. Diurnal variation of PNEF values in 20 volunteers during 7 days. M=morning, E=evening

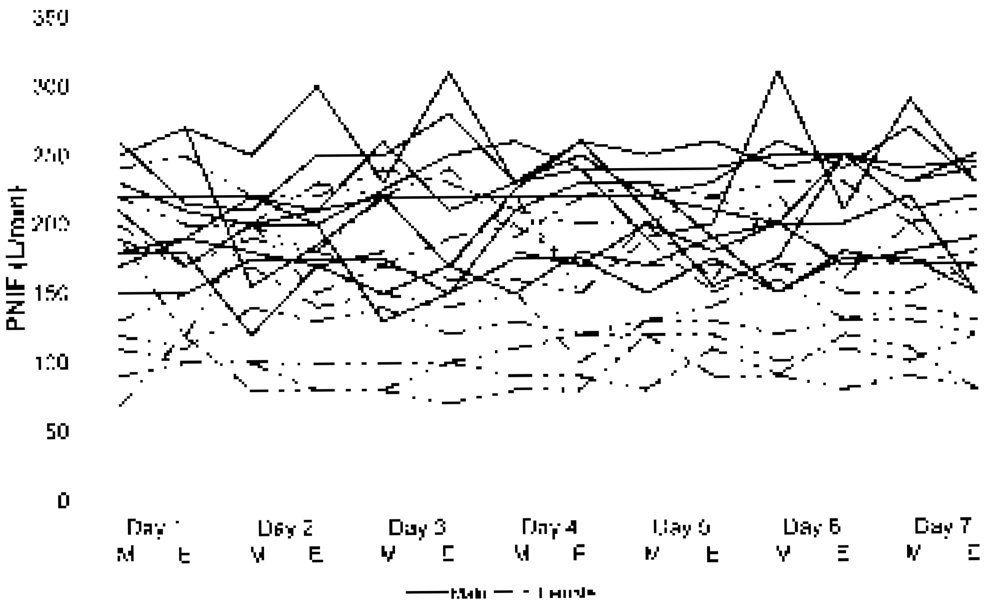

Figure 6. Diurnal variation of PNIF values in 20 volunteers during 7 days.

For many purposes, it is unwise to consider this level of precision satisfactory. Since rhinomanometry is the method of choice in most rhinology clinics, numerous authors have tested correlations between measurements of rhinomanometry, PNIF, and PNEF and found them significant (Frölund et al., 1987; Wihl and Malm, 1988; Holmström et al., 1990, Jones et al., 1991). No consensus, however, exists as to the utility of PNIF and PNEF (Druce and Schumacher, 1990; Enberg and Ownby, 1991).

The prevalence of allergic rhinitis is high and increasing (Linneberg et al., 1999; Shamssain and Shamsian, 1999). It is difficult to compare studies or to assess efficacy of treatment because diagnostic criteria are not standardised and diagnoses are often based only on a subjective sensation of nasal patency. It seems essential to find those patients who would benefit from treatment and save others from unnecessary medication (Toren et al., 2002). Continuous and objective follow-up could also motivate patients regularly to use their medication. As it is impossible to send every patient with a stuffy nose to a rhinology clinic, objective methods for evaluation of nasal function are needed in primary care. With this study we join those still searching for the ideal or at least an acceptable nasal functioning test for primary care.

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