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Reference Value of Nasal Peak Inspiratory Flow Rate in Indian Children: A Cross-sectional Study

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ABSTRACT

Introduction: Peak Nasal Inspiratory Flow (PNIF) measurement is a basic, convenient, easy to use and low cost method of determining the nasal airway patency. However, normative data for paediatric population is scarce and not available for Indian children aged 6 to 12 years.

Aim: To establish reference value of PNIF in Indian children aged 6 to 12 years of age.

Materials and Methods: A descriptive cross-sectional study was conducted between July 2012 and June 2013 in the Himalayan range of east Sikkim district and Sub-Himalayan Terai region of Darjeeling district of West Bengal. Total 1001 children aged 6 to 12 years were selected from 16 schools by simple random sampling. Of these 1001 children, 784 children were enrolled in the study after taking into account inclusion and exclusion criteria. Repeated PNIF measurements were taken from these 784 children. Mean PNIF value was calculated. The effect of age and height on PNIF was studied. The mean and standard deviation of Peak Inhalation Flow Rate (PIFR) are calculated and compared across groups using a one-way ANOVA test. Regression analysis was done to establish an equation of predicting PNIF level based on height for normal children. The analysis was carried out using Statistical Package for Social Sciences (SPSS) version 16 statistical software. An alpha level of 5% was chosen, which means that any p-value less than 0.05 was considered significant.

Results: Mean value of PNIF age group; 6-7 years-53.36 L/min, >7-8 years-56.79 L/min, >8-9 years-63.91 L/min, >9-10 years-69.45 L/min, >10-11years- 80.71 L/min, >11-12 years-85.69 L/min. PNIF increases with age and height. A simple formula has also been established to calculate mean PNIF at a given height. PNIF or PIFR (L/min)=-52.716+0.945×height in cm.

Conclusion: PNIF measurements are possible in children aged six years and older. Age and height also affect PNIF.

Keywords: Nasal airflow, Nasal obstruction, Normal value, Peak nasal inspiratory flow, Reference range

INTRODUCTION

Nasal obstruction may be related to age, body position, rhinic cycle or may be due to the presence of infection (tonsillitis, adenoiditis), tonsil or adenoid hypertrophy, nasal polyps and allergies. Rhinitis is a very common disease worldwide. Nasal obstruction is a common manifestation of rhinitis. Because it is difficult to evaluate nasal obstruction from a clinical examination, objective tests like rhinomanometry and acoustic rhinometry are frequently utilised [1,2]. These methods, however, needs complex, expensive equipment and highly skilled operators. Questionnaires are used to assess patient symptoms subjectively for diagnostic and research reasons. However, subjective and objective measurements of nasal obstruction do not always correlate properly [2]. As a result, a simple objective measurement of nasal airflow could be highly helpful in determining nasal patency [3]. A basic and inexpensive tool for this is the PNIF metre [3-5]. PNIF has been proved to be a reliable measurement for assessing nasal airway obstruction by several authors [6,7]. The patient sniffs air via the nose and the peak flow is measured with PNIF. PNIF has been utilised as a screening tool for detecting rhinitis severity and evaluating nasal obstruction [8].

Ottaviano G et al., conducted a study using PNIF to estimate normal values for peak nasal inspiration in adult Caucasians [9]. Normal values have also been discovered for paediatric and adolescent Greek and African populations [10,11]. Brazilian study established a simple formula to obtain reference values of PNIF for subjects aged from eight to 15 years [12].

The comparison of measured values with expected values obtained from published reference equations or normal value tables is used to interpret PNIF data.

However, to the best of our knowledge, there is no such reference value or equation for PNIF particular to the Indian paediatric population.

The American Thoracic Society and the European Respiratory Society have also advised researchers to disclose reference equations and reference values for healthy populations of various racial origins so that individual subject results can be compared to data from a racially similar group [13,14]. It is also recommended that the same assessment equipment and technique be used. As a result, this work was conducted to establish a PNIF reference equation for an Indian paediatric population, allowing for the quick, reliable, and low-cost assessment of nasal airway patency in individuals of similar racial backgrounds. The goal of this study was to find a PNIF reference value and a PNIF reference equation in the paediatric population.

MATERIALS AND METHODS

A descriptive cross-sectional study was conducted between July 2012 and June 2013 in the Himalayan range of east Sikkim district and Sub-Himalayan Terai region of Darjeeling district of West Bengal, India. The study was approved by the Institutional Ethics Committee and written informed consent was taken from parents/caregivers of all participants included in the study. 1001 school children aged 6-12 years were recruited from 16 schools in the study area using simple random sampling method. From 15 of those schools 62 children of age 6 to 12 years were selected by simple random sampling. From one of those 16 schools 71 students of age group 6 to 12 years were selected by simple random sampling.

Sample size calculation: Sample size calculated from Cochran formula; n= $z^2(pq)/e^2$. n=sample size, z=standard error associated with the chosen level of confidence, p=standard deviation taken from previous studies [10,12], q=1-p, e=acceptable sample error. n=1.962 (0.5)(0.5)/0.052=384. In the present study, 1001 sample size was taken for more appropriate analysis. Parents of respondents were asked to complete two questionnaires on enrollment in the study and prior to testing: ATS-DLD-78C questionnaire [15] and the MiniRQLQ test [16]. These questionnaires were used to know whether they had any respiratory or nasal symptoms so that those having such problems can be excluded from the study.

Inclusion criteria: (1) no acute disease; (2) no chest malformations, congenital abnormalities or respiratory tract disease; (3) no cardiovascular or neuromuscular system disease or symptoms of allergic rhinitis for the previous 12 months; (4) no nasal blockage, or other nasal symptoms; (5) no chronic cough; (6) no previous nasal or paranasal sinus surgery; (7) no known case of asthma; and (8) somatometric parameters above the third percentile;

Exclusion criteria: Score of one or more in any column of MiniRQLQ test were excluded from the study.

Study Procedure

Peak nasal inspiratory flow was measured using an in-check peak flow metre (Clement Clarke International Ltd., Edinburgh Way, Harlow, Essex, CM20 2TT, UK). Rubber anaesthetic face masks of various sizes (Vital Signs, Totowa, New Jersey, USA) were employed; masks had to be wide enough to avoid constricting the nose yet small enough to prevent air escape under the chin.

All of the individuals were assessed while they were seated. Following the end of a full expiration, they were told to take a deep, quick, forced inspiration through the nose (and mask), keeping the mouth tight (i.e., the residual volume method). Three measurements were taken for each participant, with the highest of the three findings used to determine the PNIF. In the event that wrong technique was used, an additional recording was made. All tests were conducted (under standardised conditions) by the same, highly qualified examiner to prevent the introduction of variability due to various technicians.

STATISTICAL ANALYSIS

The mean and standard deviation of PIFR were calculated and compared across groups using a one way ANOVA test. Regression analysis was done to establish an equation of predicting PIFR level based on height for normal children. The analysis was carried out using SPSS version 16.0 statistical software. An alpha level of 5% was chosen, which means that any p-value less than 0.05 was considered significant.

RESULTS

Out of 1001 school children selected by simple random sampling, 784 children (557 males, 227 females) satisfied our inclusion criteria and were enrolled in the study. From the table, it is clearly seen that mean PIFR increases with age [Table/Fig-1]. From the table, it is clearly seen that PIFR increases with height (R^2=0.769) [Table/Fig-2].

Age (years)	6-7 (n=58)	>7-8 (n=141)	>8-9 (n=156)	>9-10 (n=110)	>10-11 (n=63)	>11-12 (n=256)	p-value
PIFR (L/min)	53.36±3.02	58.79±3.32	63.91±5.86	69.45±5.84	80.71±4	85.69±4.7	<0.001*

[Table/Fig-1]: PIFR (mean±SD) in selected children age group-wise (Mean age±SD=8.95 years±1.72 years).
ANOVA was used; *p-value <0.001 was significant

Height	110-119 cm (123)	120-129 cm (272)	130-139 cm (157)	140-149 cm (167)	150-159 cm (65)	p-value
PIFR	56.46±4.09	63.38±7.06	76.62±8.46	84.82±4.83	86.71±3.56	<0.001*

[Table/Fig-2]: PIFR (mean±SD) in selected children heightwise (height grouping done in 10 cm interval).
ANOVA was used; *p-value <0.001 was significant

The regression analysis to establish the equation for predicting PIFR level based on height in normal children is shown in [Table/Fig-3 as PIFR=-52.716+0.94×Height i.e., if Height increases by one unit PIFR will rise by 0.945 unit i.e.,=-52.716+0.945×Height.

Model summary				
Model	R	R^2	Adjusted R^2	Std. error of the estimate
1	0.877[a]	0.769	0.768	6.104
a. Predictors: (Constant), Height				

Co-efficients[a]					
	Unstandardised coefficients		Standardised coefficients		
Model	B	Std. error	Beta	t	Sig.
(Constant)	-52.716	2.450		-21.521	<0.001
Height	0.945	0.019	0.877	50.890	<0.001
a. Dependent variable: Peak inspiratory flow rate					

[Table/Fig-3]: Regression analysis to establish an equation of predicting PNIF level based on height for normal children.

DISCUSSION

Peak Nasal Inspiratory Flow (PNIF) has been utilised by many researchers to assess nasal patency, demonstrating its reliability [17,18]. Rhinomanometry has also been used as an appropriate and safe method of measuring nasal airway obstruction, with only minor inaccuracy; however, it is time-consuming, expensive, and difficult to transport, and accurate use requires experience [19]. Therefore, a simple, reliable, inexpensive method of assessing nasal airway obstruction would be of value.

Evaluation at the same time and by the same examiner, and use of standardised assessment circumstances (e.g., normal room temperature and humidity) were used in the current investigation to control procedural factors affecting PNIF variability as much as possible. Not much study is available in literature regarding PNIF reference value in children.

Study done in South Africa revealed normative data of PNIF upto eight years of age [11]. With the exception of a dip at three years, PNIF rises linearly from a mean of 30 L/min in early infancy to a mean of 80 L/min at the age of eight. With growing height, there is a fairly linear gradual increase. In present study, mean value of PNIF at eight years of age is 63.91 L/min. Present study also showed increment of PNIF with age and height. The difference in the value in PNIF may be attributed to difference in geographic location of the population as well as racial variation among the population. The racial difference may be attributed to difference in nasal dimension among races. In a study by Morgan NJ et al. concluded that race has a considerable impact on acoustic rhinometry measures and that this must be considered [20]. Study done on Greek children also found continuous increase in PNIF with age [10]. The PNIF readings of the current study participants increased in proportion with their height. This is consistent with prior findings that this variable has a major impact. [12]. The authors discovered that subject age had an independent effect on PNIF. Blomgren K et al., on the other hand, found no evidence of a link between age and PNIF [21]. The greater PNIF values reported in the older patients were most likely due to the steady rise in height that happens with age, as documented by Papachristou A et al., [10]. From this study, the authors for the first time ever in literature established a simple formula for calculating normative value of PNIF in Indian children.

Limitation(s)

According to the questionnaire results, the present study subjects were not suffering from any acute or chronic cardiorespiratory disease. But investigations like spirometry, chest X-rays and electrocardiography would have provided more precise cardiorespiratory status of the participants. Moreover, lack of weight measurement parameter and effect of gender on PIFR was another limitation of the present study.

CONCLUSION(S)

As per knowledge, this is the first study in India to establish a reference range of nasal PIFR in this paediatric age group. However, more studies are required in other parts of India to correlate the reference levels and also to detect any racial variation.

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