ORIGINAL ARTICLE

The Influence of Physical Exercise on Peak Nasal Inspiratory Flow Results in Young Adults Population

Asti Widuri[1], Rangga Putra Nugraha[2], Rizka Fakhriani[1]

[1] Otorhinolaryngology Department, Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, 55183 Kasihan, Bantul, Yogyakarta, Indonesia
[2] Department of Otorhinolaryngology Head and Neck Surgery, Faculty of Medicine, Tanjungpura University, 78124 West Kalimantan, Pontianak, Indonesia

ABSTRACT

Introduction: Exercise has a significant impact on health, and there is increasing evidence suggesting that exercise affects immunological function, contributing to its positive benefits on well-being. Physical exercise can help decrease nasal mucosal congestion through sympathetic reflex and strengthen respiratory muscle. Exercise also helps enhance the respiratory function and nasal patency, allowing individual to optimize their performance and overall health. Peak Nasal Inspiratory Flow (PNIF) examination is the objective method used to determine nasal patency. This study aims to analyze the influence of physical exercise on nasal patency using peak nasal inspiratory flow. **Materials and Methods:** A cross-sectional study was conducted at the Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, involving 82 healthy adult volunteers selected through consecutive sampling from January to March 2024. Data were collected using exercise questionnaires, NOSE questionnaire to assess nasal obstruction symptom, and the PNIF examination. Data was collected and analyzed using Spearman bivariate correlation and ANOVA. **Results:** The mean total nasal inspiratory flow (PNIF) in this study was 99.55 ± 27.11 and not correlated with the NOSE score (r= -0.081, p=0.469). Variance analysis factors showed a significant influence of the frequency of exercise (p=0.030) and gender (p=0.001) on PNIF score measurement. Post hoc test showed exercise frequency impact to PNIF score particularly for groups 3 times compared to groups none and one time a week. **Conclusion:** The frequency of physical exercise (three times a week) was the stronger influenced for nasal patency using PNIF examination in young adults.
Malaysian Journal of Medicine and Health Sciences (2026) 22(3): 1-6.doi:10.47836/mjmhs.v22i3.1584

Keywords: Exercise, Respiration, Nasal Obstruction, Adult, Habits

Corresponding Author:
Asti Widuri, ORL-HNS
Email: astiwiduri@gmail.com
Tel: +62-81392591972

INTRODUCTION

Exercise is defined as systematic, planned, and repetitive physical activity. Exercise improves athletic performance by improving fitness, motor skills, and body composition (1). Physical exercise is undeniably essential for promoting health and preventing disease. Substantial evidence demonstrates that consistent physical exercise enhances both physical and mental well-being (2). Exercise has a significant impact on health, and there is increasing evidence suggesting that exercise affects immunological function, contributing to its positive benefits on overall well-being (3).

Exercise also helps enhance the respiratory function, allowing individuals to optimize their performance and overall health. During exercise, the respiratory system adapts by increasing both the breathing rate and depth, resulting in heightened ventilation to meet the elevated oxygen demands of the working muscles (4). Furthermore, engaging in physical exercise reduces nasal mucosal congestion through the activation of sympathetic reflexes (5). The peak of this response occurs at 5–10 minutes and can last for up to 30 minutes. Exercise can serve as an alternative to medical decongestants for reducing the thickness of the mucosal lining and assessing any structural blockages in the nasal passage (6).

Nasal patency refers to the ease with which air can flow through the nasal passages, which is essential for proper respiratory function and overall quality of life. The perception of nasal patency is influenced by various physiological and anatomical factors and can be assessed using both subjective and objective methods (4). Physiologically, the act of exercising leads to an increase in nasal airflow and a reduction in nasal resistance due to multiple factors. The enhancement in nasal patency can be attributed to increased activity of the alar nasal muscle, which effectively reduces nasal resistance during physical exertion (5).

Additionally, exercise induces hyperventilation, enhancing airflow, while sympathetic nervous system activation promotes vasoconstriction of the nasal mucosa, further facilitating improved nasal patency (7). This finding similar with research result conducted by Lukkarinen et al., which found that physical exercise acutely increased nasal patency in both asthmatic and non-asthmatic populations regardless of their underlying conditions (8). This indicates a direct relationship between the mechanical effects of exercise and nasal airflow characteristics.

Nevertheless, discrepancies between subjective sensations and objective measurements remain a point of contention. Studies have shown that significant portions of patients report a sensation of obstruction even when measured airflow falls within normal parameters (9). This interplay between sensory perception and objective measurements continues to spur research, bringing to light the complexities of nasal patency evaluations. PNIF is a cost-effective, portable, fast, and simple tool that does not require computer data analysis. Historically, PNIF has been successfully used to evaluate the treatment of allergic rhinitis in adults, adolescents, and pediatric patients (10). Other studies have also shown that PNIF increases with the improvement of nasal obstruction symptoms. This research aim was designed to analyze the correlation of physical exercise and nasal patency using peak nasal inspiratory flow.

MATERIALS AND METHODS

This research is an analytic observational study with a quantitative approach, utilizing a cross-sectional design. A cross-sectional study is a type of observational research that examines data from a population at a specific point in time. The research was conducted at the Faculty of Medicine and Health Science, Universitas Muhammadiyah Yogyakarta.

In this study, consecutive sampling was used to select 82 healthy adult volunteers from the Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, between January and March 2024. This study used a consecutive sampling technique, a non-probability sampling method in which participants were selected sequentially until the required sample size was achieved (11).

Sample Size Formula (11):

To determine the sample size, the following parameters are used:

Type I error (α): Set at 5% for a one-tailed hypothesis test. Therefore, the value of Z_0 is 1.64.

Type II error (β): Set at 10%, so the value of Z_s is 1.28.

Minimal correlation (r): Set at 0.4, which is considered statistically significant (12).

$$n = \left[\frac{Z_a + Z_\beta}{0.5 \ln\left(\frac{1+r}{1-r}\right)} \right]$$

The calculated sample size was 50.51, which was rounded up to 51 participants to ensure adequate representation and statistical reliability. However, in this study, a total of 82 participants were included.

Data collection in this study involved the Exercise Habits Questionnaire (13), Nasal Obstruction Symptom Evaluation (NOSE) questionnaires (14), and the Peak Nasal Inspiratory Flow (PNIF) tool. Exercise Habits Questionnaire, validated in prior research, assessed physical exercise through frequency, intensity, duration, and type of exercise The Exercise Habits Questionnaire was in Bahasa, which has been used by previous researchers to evaluate the influence of exercise habits on the incidence of dysmenorrhea (13). The NOSE questionnaire evaluated nasal obstruction severity through five items rated on a 0–4 Likert scale: not a problem (0), very mild problem (1), moderate problem (2), fairly bad problem (3), severe problem (4). Additionally, the NOSE questionnaire was tested, showing adequate test-retest reliability at 0.702 and internal consistency reliability at 0.785 (14). The PNIF tool provided objective nasal obstruction measurements by recording the maximum nasal inspiratory flow from three attempts, with the highest value recorded as the final score, a method validated in previous studies.

The subjective assessment was conducted to gauge the participants' perception of nasal obstruction. Data collection was carried out in two stages. In the first stage, participants completed demographic, exercise habits, and NOSE questionnaires via Google Forms. After completing the questionnaires, the second stage involved measuring the degree of nasal obstruction using the PNIF tool (Fig. 1).

Figure 1: Measurement of nasal patency using PNIF meter.

Data analysis was performed using SPSS 22.0. Univariate analysis assessed the outlier using boxplots, distribution and percentage of each variable and a normality test using the Kolmogorov-Smirnov test. Bivariate correlation using Spearman correlation test for NOSE Score and PNIF results as numeric data type, and variance analysis was conducted using ANOVA. Statistical significance was set at a p-value of < 0.05.

This study received ethical approval from the Health Research Ethics Committee of the Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, under approval number 021/EC-KEPK FKIK UMY/I/2024. The ethical approval is valid from January 9, 2024, to January 9, 2025. Prior to filling out the questionnaire, participants were asked to complete an informed consent form. The researchers provided instructions on how to properly complete the questionnaire.

RESULTS

We identified outliers in the PNIF and SNOSE score data using box plot and remove four outliers, leaving 78 data points for analysis. The normality of the data was tested using Kolmogorov-Smirnov test, which showed that the PNIF score were normally distributed, while the SNOSE score were not. Data on patient characteristics in this study can be seen in Table I. The majority of respondents in this study were aged 15-24 years (70.5%) and female (64.1%). In addition, the majority of respondents also have exercise habits (70.5%).

Table I: Respondent Characteristics

Variable	Category	n	%	Mean ± SD
PNIF score				99.55 ± 27.11
SNOSE score				5.69 ± 5.41
Age (Years)	15 – 24	55	70.5	
	25 – 34	10	12.8	
	35 – 44	7	9.0	
	45 – 54	6	7.7	
Total		78	100	
Gender	Male	28	35.9	
	Female	50	64.1	
Total		78	100	
Exercise habit	Yes (once a week)	55	70.5	
	No	23	29.5	
Total		78	100	
Type of exercise	Jogging	26	33.3	
	Run	5	6.4	
	Swimming	3	3.8	
	Cycling	5	6.4	
	Gymnastics	8	10.3	
	Basketball	1	1.3	
	Badminton	5	6.4	
	Table tennis	2	1.3	
Total	Short distance sprint	55	100	
Duration of exercise	<30 min	28	35.9	
	≥30 min	27	34.6	
Total		55	100	
Frequency of exercise (times/week)	1	22	28.2	
	2	22	28.2	
	3	7	9.0	
	4	2	2.6	
	5	2	2.6	
Total		55	100	

The results of the bivariate analysis using Spearman correlation test showed no significant correlation between the NOSE score and the PNIF score, with p-values of r= -0.007 and p=0.953. Homogeneity of the PNIF score data from respondents was tested using Levene's test, which showed p=0.077 (indicating homogeneity) and heteroskedasticity test with p=0.279 (indicating no heteroskedasticity). In the variance analysis using common ANOVA (Table II), significant influences were found between the PNIF score and both the gender (p = 0.001) and the frequency of exercise (p = 0.030). Following by post hoc analysis, three times a week frequency of exercise showed as main influence for PNIF score.

Table II: Variance analysis factor influences on PNIF score

Variable	df	p value
Age	3	0.081
Gender	1	0.001*
Type of Exercise	8	0.821
Duration of Exercise	1	0.052
Frequency of Exercise	4	0.030*

* = p-value < 0.05 indicates a statistically significant

DISCUSSION

Nasal obstruction may be assessed by patient-reported outcome measures such as SNOSE, but objective measures need to assess physiological parameter confirmation. In this study there was no significant correlation between subjective evaluation using NOSE score and objective measurement of PNIF score. This result aligns with a systematic review from 59 studies, which conclude the objective outcome measures and patient-reported outcome measures for assessing sinonasal symptoms are poorly correlated. Although the study recommended to confirming the nasal obstruction symptom depending on the setting, by PNIF in clinical practice and rhinomanometry or acoustic rhinometry in research (15).

PNIF is a cost-effective, portable, fast, and simple tool for evaluating the treatment of allergic rhinitis in adults, adolescents, and pediatric patients (10). Several factors can influence the PNIF value. For example, age is one of the significant factor; as a person ages, their PNIF value tends to decrease (16),(17). Additionally, PNIF values are generally higher in males than in females. Unlike previous studies, this study found that age did not significantly influence PNIF score, while gender did. However, it is important note that the number of respondents was not balanced across groups.

The main finding of this study is that the frequency of physical exercise (three times a week) influences the nasal patency using PNIF score measurement. Several studies in the literature have previously shown that physical exercise leads to an increase in nasal permeability. This increase is attributed to vascular changes in the lateral nasal wall caused by mucosal decongestion, which reduces nasal resistance and allows for greater nasal air volume, thereby preparing the nasal passages to meet the increased air demand (18).

The optimal frequency of exercise has been a subject of considerable study across various populations and health conditions, with recommendations generally centering around achieving a balance that promotes health benefits while minimizing risks . Engaging in exercise three times a week has been widely recognized as an optimal frequency for achieving various health benefits across different populations. Regular physical activity at this frequency not only enhances physical health but also supports psychological well-being (19). Additionally, the World Health Organization recommends that adults should engage in activity providing a total of at least 150 minutes of moderate-intensity aerobic exercise per week, which aligns well with a regimen of three sessions per week, allowing for adequate recovery while reaping health benefits (Elbe et al., 2019).

Research has demonstrated that various forms of exercise can improve nasal patency. The first is aerobic exercise. Activities such as running, cycling, or swimming are known to enhance nasal patency by reducing nasal congestion. These exercises increase blood flow and oxygenation to the nasal mucosa, helping to reduce swelling and congestion (7). In this study, the majority of respondents engaged in jogging. However, according to previous research, exercises such as brisk walking, jogging, or cycling do not significantly affect nasal patency. The primary mechanism responsible for increased nasal patency during exercise is the constriction of the nasal mucosa by the sympathetic nervous system, which may not be triggered by these types of exercises (20).

The potential physiological explanation of numerous studies discuss why moderate-intensity activities like jogging might not influence the nasal patency. First, physical exercise can lead to acute changes in nasal function, such as variations in olfactory thresholds and peak nasal inspiratory flow, the overall impact on nasal patency remains limited. Their findings indicate that changes in nasal airflow can be transient and do not necessarily translate to long-term improvements in nasal patency metrics, particularly with common forms of exercise like brisk walking or jogging (5). Second, factors such as age and gender significantly influence nasal airway patency measurements, suggesting that the physiological responses to exercise may not override intrinsic demographic factors (21).

Further supporting this point, Rimmer et al. report that nasal patency is actively regulated by various physiological mechanisms, which include responses to physical activity. They underscore that exercise alone does not guarantee improvements in nasal airflow or patency, especially in healthy subjects (22). This aligns with other literature that discusses complex perceptions of nasal patency, indicating a mismatch between subjective perceptions and objective nasal resistance measurements during physical activities (23).

Moreover, numerous articles on the effects of aerobic exercises, including brisk walking, reaffirm that while these activities promote general health benefits such as improved cardiovascular fitness, they do not show a consistent, significant correlation to enhanced nasal patency (24). Studies examining the physiological responses to brisk walking indicate that while there are general health improvements, both subjective and objective assessments of nasal airflow remain relatively unchanged (25).

Additionally, research indicates a lack of evident dose-response relationships between increased physical activity and nasal patency enhancement. One study noted that higher volumes of physical activity did not correlate with better nasal function outcomes, indicating a possible saturation effect where further exercise does not yield additional benefits for nasal airflow (26). While physical exercise is undeniably beneficial for general health and various physiological parameters, the data predominantly suggest that exercises such as brisk walking, jogging, or cycling do not yield significant improvements in nasal patency. Future research could further explore the nuances and potential modifiers of this relationship, but current evidence leans toward a minimal impact of these common aerobic activities on nasal airflow.

LIMITATION

This study has several limitations, including the use of questionnaires to measure exercise habits rather than objective measures of physical activity, such as pedometers or accelerometers. Additionally, the study participants were limited to Indonesian adolescents, which may affect the generalizability of the findings to other age groups or populations from different countries and cultural backgrounds.

CONCLUSION

Based on the results of this study, frequency of physical exercise (three times a week) was influenced with nasal patency using PNIF examination. To be able to know precise results regarding the correlation of exercise with nasal patency, it is necessary to conduct intervention research in the future.

ACKNOWLEDGEMENTS

This work is supported by The Research and Innovation Institute Universitas Muhammadiyah Yogyakarta Indonesia and was never published.

REFERENCES

1. Duraiswamy G, Thirthalli J, Nagendra HR, Gangadhar BN. Yoga therapy as an add-on treatment in the management of patients with schizophrenia - a randomized controlled trial. Acta Psychiatr Scand. 2007;116(3):226–32. Available from: https://doi.org/10.1111/j.1600-0447.2007.01032.x
2. Klaperski S, Koch E, Hewel D, Schempp A, Mьller J. Optimizing mental health benefits of exercise: The influence of the exercise environment on acute stress levels and wellbeing. Ment Heal Prev [Internet]. 2019;15(200173):200173. Available from: http://dx.doi.org/10.1016/j.mhp.2019.200173
3. Zietkowski Z, Skiepko R, Tomasiak-Lozowska MM, Mroczko B, Szmitkowski M, Bodzenta-Lukaszyk A. RANTES in exhaled breath condensate of allergic asthma patients with exercise-induced bronchoconstriction. Respiration 2010;80(6):463–71. Available from: http://dx.doi.org/10.1159/000264923
4. Brinkman JE, Toro F, Sharma S. Physiology, respiratory drive. In: StatPearls. Mery Fitzgerald Hospital: StatPearls Publishing; 2024. Available from: https://www.ncbi.nlm.nih.gov/books/NBK482414/
5. Marioni G, Ottaviano G, Staffieri A, Zaccaria M, Lund VJ, Tognazza E, et al. Nasal functional modifications after physical exercise: olfactory threshold and peak nasal inspiratory flow. Rhinology. 2010;48(3):277–80. Available from: http://dx.doi.org/10.4193/rhin09.141
6. Baraniuk JN, Merck SJ. Nasal reflexes: implications for exercise, breathing, and sex. Curr Allergy Asthma Rep. 2008;8(2):147–53. Available from: http://dx.doi.org/10.1007/s11882-008-0025-7
7. Haavisto LE, Lukkarinen M, Lukkarinen H, Jartti T, Papadopoulos NG, SipilΔ JI. Physical exercise increases nasal patency in asthmatic and atopic preschool children. Am J Rhinol Allergy. 2013;27(6):451–6. Available from: http://dx.doi.org/10.2500/ajra.2013.27.3956
8. Lukkarinen M, Haavisto LE, Lukkarinen H, Sipilä JI, Papadopoulos NG, Jartti T. Exercise simultaneously increases nasal patency and bronchial obstruction in asthmatic children. Respirology. 2016;21(8):1493–5. Available from: https://doi.org/10.1111/resp.12849

9. Saliba J, Fnais N, Tomaszewski M, Carriere JS, Frenkiel S, Frasnelli J, et al. The role of trigeminal function in the sensation of nasal obstruction in chronic rhinosinusitis. Laryngoscope. 2016;126(5):E174-8. Available from: http://dx.doi.org/10.1002/lary.25952
10. Bermüller C, Kirsche H, Rettinger G, Riechelmann H. Diagnostic accuracy of peak nasal inspiratory flow and rhinomanometry in functional rhinosurgery. Laryngoscope. 2008;118(4):605–10. Available from: http://dx.doi.org/10.1097/MLG.0b013e318161e56b
11. Dupont WD, Plummer WDJ. Power and sample size calculations. A review and computer program. Control Clin Trials. 1990 Apr;11(2):116–28. Available from: https://doi.org/10.1016/0197-2456(90)90005-m
12. Pagano RR, Francis G, Neath I. Understanding Statistics in the Behavioral Sciences - Product Details - Cengage Instructor Center. 2013. 677 p.
13. Alkhoeriyah S. Hubungan Kebiasaan Berolahraga Dengan Kejadian Dysmenorrhea Pada Pegawai BPJS Kesehatan Jakarta Barat Tahun 2017. Repos Univ Esa Unggul. 2017;11(1):92–105.
14. Stewart MG, Witsell DL, Smith TL, Weaver EM, Yueh B, Hannley MT. Development and validation of the Nasal Obstruction Symptom Evaluation (NOSE) scale. Otolaryngol neck Surg Off J Am Acad Otolaryngol Neck Surg. 2004 Feb;130(2):157–63. Available from: https://doi.org/10.1016/j.otohns.2003.09.016
15. Ta NH, Gao J, Philpott C. A systematic review to examine the relationship between objective and patient-reported outcome measures in sinonasal disorders: recommendations for use in research and clinical practice. Int Forum Allergy Rhinol. 2021 May;11(5):910–23. Available from: https://doi.org/10.1002/alr.22744
16. Bouzgarou MD, Ben Saad H, Chouchane A, Cheikh I Ben, Zbidi A, Dessanges JF, et al. North African reference equation for peak nasal inspiratory flow. J Laryngol Otol. 2011;125(6):595–602. Available from: http://dx.doi.org/10.1017/S0022215111000181
17. Chaves C, Ibiapina C da C, de Andrade CR, Godinho R, Alvim CG, Cruz БА. Correlation between peak nasal inspiratory flow and peak expiratory flow in children and adolescents. Rhinology. 2012;50(4):381–5. Available from: http://dx.doi.org/10.4193/Rhino12.073
18. Fonseca MT, Machado JA van P, Pereira SA, Pinto KM, Voegels RL. Effects of physical exercise in nasal volume. Braz J Otorhinolaryngol. 2006;72(2):256–60. Available from: http://dx.doi.org/10.1016/s1808-8694(15)30065-3
19. Brown CEB, Richardson K, Halil-Pizzirani B, Hughes S, Atkins L, Pitt J, et al. PEAK Mood, Mind, and Marks: a pilot study of an intervention to support university students' mental and cognitive health through physical exercise. Front Psychiatry. 2024;15:1379396. Available from: http://dx.doi.org/10.3389/fpsyt.2024.1379396
20. Pendolino AL, Nardello E, Lund VJ, Maculan P, Scarpa B, Martini A, et al. Comparison between unilateral PNIF and rhinomanometry in the evaluation of nasal cycle. Rhinology. 2018;56(2):122–6. Available from: http://dx.doi.org/10.4193/Rhin17.168
21. Wang J-J, Chiang Y-F, Jiang R-S. Influence of age and gender on nasal airway patency as measured by active anterior rhinomanometry and acoustic rhinometry. Diagnostics (Basel). 2023;13(7):1235. Available from: http://dx.doi.org/10.3390/diagnostics13071235
22. Rimmer J, Greenwood A, Bartlett D, Hellgren J. Nasal steroids improve regulation of nasal patency in asthma and mild rhinitis: a randomised, cross-over trial. Eur Arch Otorhinolaryngol. 2012;269(4):1133–8. Available from: http://dx.doi.org/10.1007/s00405-011-1803-8
23. Tjahjono R, Singh N. Correlation between nasal mucosal temperature change and the perception of nasal patency: a literature review. J Laryngol Otol. 2021;135(2):104–9. Available from: http://dx.doi.org/10.1017/S0022215121000487
24. Bai X, Soh KG, Omar Dev RD, Talib O, Xiao W, Cai H. Effect of brisk walking on health-related physical fitness balance and life satisfaction among the elderly: A systematic review. Front Public Heal. 2021;9:829367. Available from: http://dx.doi.org/10.3389/fpubh.2021.829367
25. Chen CK, Ismail NS, Al-Safi AA. Effects of brisk walking and resistance training on cardiorespiratory fitness, body composition, and lipid profiles among overweight and obese individuals. J Phys Educ Sport. 2016;16(3):957–63. Available from: https://doi.org/10.7752/jpes.2016.03151
26. Lotsu E, Physiotherapy Department Accra, Ghana. K-BTH, Kwakye S, Mohammed T, Opoku B, Quartey J, et al. Effects of aerobic exercise on fasting blood glucose and blood pressure levels of diabetic-hypertensive clients at a diabetes clinicin Accra, Ghana. J Prev Rehabil Med [Internet]. 2021;3(2):75–84. Available from: http://dx.doi.org/10.21617/jprm2021.3213