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The Effect of Nasal Irrigation on The Severity of Nasal Obstruction among Toll Gate Officers: A Randomized Controlled Trial

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ABSTRACT

Background: Traffic-related air pollution can trigger inflammation of the nasal tissues, potentially leading to nasal obstruction. Toll gate officers are at risk of exposure to this pollution. Nasal irrigation with isotonic saline solution can lessen the symptoms of nasal obstruction.
Objective: To evaluate the effect of nasal irrigation on the severity of nasal obstruction on toll gate officers.
Methods: : This true experimental study employed a randomized controlled trial (RCT) with a pre-and posttest design. A total of 42 toll gate officers from Jasamarga Company, Semarang, participated in the study. Two groups were formed from the participants: one received the treatment, the other served as a control. Participants in the treatment group received nasal irrigation with isotonic saline solution once daily for 14 days. Nasal obstruction was evaluated using the NOSE Scale and PNIF. Statistical analyses were accomplished using the T-test, Wilcoxon test, and Mann-Whitney U test.
Results: A clear difference was detected in the degree of nasal obstruction, both as measured by NOSE Scale (p=0,018) or PNIF (p=0,014 ; 95% CI, 4.19 to 34.86). The degree of nasal obstruction using NOSE Scale within the treatment group decreased significantly (p = 0.035) in comparison to control group (p = 0.341). The degree of nasal obstruction using PNIF measurement in the treatment group decreased significantly (p = 0.002 ; 95% CI, -34.16 to -9.17) compared with the control group (p = 0.651 ; 95% CI, -5.89 to 9.23).
Conclusion: Nasal irrigation with isotonic saline solution significantly reduces the severity of nasal obstruction.

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1. Introduction

As a critical environmental hazard, air pollution endangered global health. The World Health Organization (WHO) reported that by 2025, approximately 7 million lives were lost as a result of air pollution exposure, both from outdoor and indoor sources (such as solid fuel combustion). Traffic-related air pollution is a risk factor that contributes to morbidity and mortality from non-accidental deaths, respiratory and cardiovascular diseases[1,2]. Additionally, air pollution has been linked to the increased prevalence of allergic diseases such as *rhinitis*, one of the symptoms of which is nasal obstruction. This symptom can lead to sleep disturbances and mood disorders, affecting the quality of life and productivity of those affected. Among the various sources of air pollution, motor vehicle emissions are the primary cause of rhinitis exacerbations[2,3,4]. Harmful vehicle emissions include carbon monoxide (CO), particulate matter (PM10, PM2.5), sulfur dioxide (SO2), ozone (O3), and nitrogen oxides (NO), all of which can cause inflammation of the nasal mucosa[5,6,7].

Semarang, as the capital city of Central Java, is one of the metropolitan cities in Indonesia with a dense population. The population in Central Java increased by approximately 238 thousand people between 2016 and 2017[8]. This rapid population growth leading to a rise in the number of motor vehicles on the road. From 2009-2012, the number of motor vehicles increased across all vehicle types, with an average annual increase of 12.30%[9].

The rapid growth of road infrastructure that does not keep pace with the increased number of vehicles can lead to traffic congestion. One solution to address this issue is the implementation of toll road construction. Toll fees are collected at toll gates, where toll gate officers work according to their designated shifts over a specific period in a routine and continuous manner. This situation exposes toll gate officers to vehicle emissions, increasing their risk of developing nasal obstruction[10,11].

Cina Research in various countries, including Italy and China, has reported that air pollution increases the prevalence of nasal obstruction complaints in individuals exposed to pollution compared to those not exposed. A study conducted on traffic police officers working at least 7 hours per day, 5 days a week, without wearing masks in Italy found the commonality of nasal obstruction complaints was 60%. An increase in cumulative exposure to PM10, SO2, and NO by 10 μg/m3 led to a 2.1% rise in the occurrence of nasal obstruction complaints among children in Changsha, China[12]. In Indonesia, a study conducted on traffic police officers in Denpasar, Bali, found that the prevalence of nasal obstruction complaints was 28.6%, with 16 out of 56 officers examined reporting such symptoms[13].

Nasal obstruction can be treated with various medications, including oral or nasal decongestants, intranasal corticosteroids, and sometimes antibiotics. For individuals with allergic rhinitis, leukotriene receptor inhibitors or antihistamines are often added to the treatment regimen. However, the intake of these medications might bring about several side effects. Therefore, nasal irrigation with isotonic saline solution has emerged as an auxiliary treatment [14,15].

Nasal irrigation is a procedure that can reduce the symptoms of nasal obstruction. Additionally, nasal irrigation can improve quality of life, reduce the consumption of medications, and thus lower costs associated with respiratory disorders while also helping to reduce the prevalence of antibiotic resistance. A solution like isotonic saline is used to rinse the nasal cavities during the procedure [15,16,17].

Nasal irrigation has been employed as a therapeutic intervention for nasal and sinus diseases due to its simplicity, safety, ease of use, and cost-effectiveness. A study involving 40 patients with chronic sinusitis concluded that nasal irrigation effectively alleviated nasal symptoms, like nasal obstruction, in individuals with chronic sinusitis. This symptom reduction is attributed to the mechanisms of nasal irrigation, which enhance the clearance of excess mucus, improve mucociliary clearance, and eliminate infectious agents within the sinuses[18]. A study conducted on employees in a wood factory before and after two weeks of nasal irrigation found a significant reduction in sinus symptoms and enhanced nasal expiratory airflow[19].

The prevalence of respiratory disorders, including nasal obstruction, among toll gate officers is not well documented, and data on this issue is unavailable. Additionally, research on the influence of nasal irrigation on toll gate officers has not yet been conducted.

2. Methods

This experimental study utilized a pre- and posttest randomized controlled trial (RCT) design. The research was conducted at the toll gates of PT. Jasamarga Semarang, including the Tembalang, Manyaran, Gayamsari, and Muktiharjo toll gates, from August to September 2017. The inclusion criteria for this study were toll gate officers working ≥ 8 hours per day, at least 5 days a week, and willing to participate until the study's completion. The exclusion criteria were individuals with acute or chronic rhinitis and rhinosinusitis, nasal tumors, severe nasal septum deviation, those receiving treatment with Nonsteroidal Anti-inflammatory Drugs (NSAIDs), or hormonal contraception, Angiotensin-Converting Enzyme Inhibitors (ACEIs), pregnant individuals, and those who have undergone nasal or paranasal sinus surgery in the past.

Sampling was performed using simple random sampling, with randomization based on the block technique corresponding to the toll gate officers' shift schedules on the study's first day. A sample size calculation formula determined a minimum of 21 subjects per group. A total of 119 subjects were screened through medical history and physical examination by a doctor, resulting in 61 participants who conformed to the criteria for inclusion. Eligible participants were split into two groups: a control group and a treatment group. The control group did not receive nasal irrigation for 14 days, while the treatment group received nasal irrigation for 14 days.

During the study, some subjects were lost to follow-up or did not continue the nasal irrigation treatment, and therefore, 42 subjects completed the 14-day study. Data collection involved measuring the degree of nasal obstruction using the NOSE Scale and PNIF on Day 1 and Day 14.

The independent variable in this study was nasal irrigation, while the dependent variable was the degree of nasal obstruction. The confounding variables included the number of vehicles passing through the toll gate, smoking, hypertrophied turbinates, allergic rhinitis, mild-to-moderate nasal septum deviation, and the use of masks.

Both groups underwent normality testing using the Shapiro-Wilk test. The degree of nasal obstruction before and after nasal irrigation, measured with PNIF, showed a normal distribution in both the control and treatment groups, so hypothesis testing was performed using a paired T-test. For the degree of nasal obstruction before and after nasal irrigation, measured with the NOSE Scale, the data distribution was not normal in both groups, so hypothesis testing was conducted using the Wilcoxon test. The difference in nasal obstruction between the two groups, measured with PNIF, showed a normal distribution and hypothesis testing was performed using an unpaired T-test. The degree of nasal obstruction between the two groups was calculated using the NOSE Scale, but the data distribution was not normal, and the Mann-Whitney test was applied.

The analysis method used in this study was the On Treatment (OTT) approach. This method only included subjects who completed the survey until the end (14 days). Interim analysis was also employed, and if there were a suspicion that a larger syringe had more effectiveness, the study would be halted.

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3. Result

Data collection for this study was conducted from August to September 2017.

Characteristics of Research Subjects

Table 1. Characteristics of Research Subjects

Characteristics		Group		p
		Control	Treatment	
Hypertrophied turbinates	Hypertrophy	10 (47,6%)	9 (42,9%)	0,500 *
	Eutrophy	11 (52,4%)	12 (57,1%)	
Mild to moderate septal deviation	Positive	9 (42,9%)	10 (47,6%)	0,500 *
	Negative	12 (57,1%)	11 (52,4%)	
Allergic rhinitis	Positive	12 (52,9%)	13 (61,9%)	0,500 *
	Negative	9 (42,9%)	8 (38,1%)	
Smoking	Yes	13 (61,9%)	8 (38,1%)	0,483 *
	No	8 (38,1%)	13 (61,9%)	
Use of mask	Yes	17 (81,0%	14 (66,7%)	0,217 *
	No	4 (19,0%)	7 (33,3%)	

*Chi-Square test, homogeneous if p > 0.05.

The sample size for each group was 21 individuals. In the control group, there were 17 males (81.0%) and 4 females (19.0%), while in the treatment group, there were 20 males (95.2%) and 1 female (4.8%).

The mean age of participants in the control group was 30 years, with an average age of 36 years, the treatment group included participants as young as 21 and as old as 53. The average number of vehicles passing through the toll gate in the control group was 29,595 vehicles, with the lowest being 14,082 vehicles and the highest being 57,017 vehicles. In contrast, the average number of vehicles in the treatment group was 31,292, with the lowest being 14,243 vehicles and the highest being 50,895 vehicles. All study characteristic variables, including age, gender, the number of vehicles passing through the toll gate, hypertrophied turbinates, mild-to-moderate septal deviation, allergic rhinitis, smoking, and use of masks, were homogeneously distributed (p > 0.05).

Measurement Results of Nasal Obstruction Degree

Table 2. Pre-tests and Posttest Results of Nasal Obstruction Degree Using the NOSE Scale

Group		Degree of nasal obstruction			P
		N	Average± SD	Min-Max	
Treatment	*Pre-tests*	21	3.24±3,79	0-10	0,035 *
	Post-test	21	1,76±2,35	0-8	
Control	*Pretest*	21	1,33±2,08	0-8	0,341 *
	Post-test	21	1,52±1,57	0-5	

*Wilcoxon test, significant if p < 0.05.

Table 2 implies an increase in the average degree of nasal obstruction using the NOSE Scale in the control group. This indicates that there was an increase in the degree of nasal obstruction in the control group. The p-value of 0.341 indicates that the increase was not statistically meaningful. On the other hand, in the treatment group, there was a decrease in the average degree of nasal obstruction using the NOSE Scale. The statistical test results show that this decrease was significant from a statistical standpoint, with p = 0.035.

Table 3. Pre-tests and Posttest Results of Nasal Obstruction Degree Using PNIF

Group		Degree of nasal obstruction.			IK 95%	p
		N	Average±SD	Min-Max		
Treatment	*Pre-tests*	21	106,43± 37,69	50-190	(-34,16) – (-9,17	0,002 *
	Post-test	21	128,10± 42,35	60-240		
Control	*Pre-test*	21	102,62± 30,56	45-150	(-5,89) – 9,23	0,651 *
	Post-test	21	100,95± 28,13	55-160		

*Paired T-test, significant if p < 0.05.

Table 3 shows a decrease in the average PNIF value. This indicates that there was an increase in the degree of nasal obstruction in the control group. The statistical test results show that this increase was insignificant, with a p-value of 0.651. On the other hand, in the treatment group, there was an increase in the average PNIF value. This indicates a decrease in the degree of nasal obstruction. The statistical test results show that this decrease was statistically significant, with a p-value of 0.002.

Table 4. Delta of Nasal Obstruction Degree in the Control and Treatment Groups Using the NOSE Scale

Group	Delta of nasal obstruction degree			p
	N	Average±SD	Min-Max	
Treatment	21	-1,57±3,03	(-9)-2	0,018*
Control	21	0,10±1,86	(-6)-4	

* Mann-Whitney test, significant if p < 0.05.

The delta value represents the change in the degree of nasal obstruction, calculated by subtracting the posttest NOSE Scale value from the pre-tests NOSE Scale value. Table 4 shows an increase in the average NOSE Scale value in the control group, while a reduction was observed in the treatment group. The average delta of the degree of nasal obstruction, assessed utilizing the NOSE Scale, was lower in the treatment group compared to the control group. These results indicate a significant change in the average degree of nasal obstruction, both statistically (p = 0.018) and based on clinical judgment. The minimal difference in the average degree of nasal obstruction before and after nasal irrigation is considered significant, at>0.6 (1.67) per clinical judgment.

Table 5. Delta of Nasal Obstruction Degree in the Control and Treatment Groups Using PNIF

Group	Delta of nasal obstruction degree			Difference in average (IK 95%)	p
	N	Average±SD	Min-Max		
Treatment	21	17,86± 30,19	(-40) -65	19,52 (4,19-34,86)	0,014 *
Control	21	-1,67± 16,61	(-40) -25		

*Unpaired T-test, significant if p < 0.05.

The delta value represents the change in the degree of nasal obstruction, calculated by subtracting the posttest PNIF value from the pretest PNIF value. Table 5 shows a decrease in the average PNIF value in the control group, while the treatment group experienced an increase. The average delta of the degree of nasal obstruction, assessed using PNIF, was higher in the treatment group in comparison with the control group. These results indicate a significant change in the average degree of nasal obstruction, both statistically (p = 0.014) and based on clinical judgment. The minimal difference in the average degree of nasal obstruction before and after nasal irrigation, considered significant, was >0.6 (16.19) as per clinical judgment.

Results of Analysis on Confounding Variables

Table 6. Bivariate analysis of confounding variables on the reduction of nasal obstruction severity.

Variable		NOSE Scale		PNIF	
		Average±SD	p	±SD	P
Septal deviation Mild-Moderate	Positive	2,00± 2,47	0,264 *	17,89± 17,82	0,507 *
	Negative	1,17± 1,99		21,74± 18,87	
Hyper-trophied turbi-nates	Hiper-trophy	1,26± 2,08	0,163 *	16,58± 18,34	0,142 *
	Eutro-phy	1,78± 2,37		22,83± 18,14	
Allergic rhinitis	Positive	1,64± 2,43	0,618 *	18,80± 20,07	0,283 *
	Negative	1,41± 1,97		21,76± 15,71	
Smoking	Yes	1,10± 1,87	0,186 *	21,43± 20,99	0,909 *
	No	2,00± 2,51		18,57± 15,50	
Use of mask	Yes	1,87± 2,49	0,176 *	20,97± 17,96	0,333*
	No	0,64± 0,81		17,27± 19,79	
Number of Vehicles Passing Through the Toll Gate			0,146 **		0,430**

* Mann-Whitney test, significant if p < 0.05
** Pearson test, significant if p < 0.05

Based on Table 6, this study found that the variables of mild-to-moderate septal deviation, hypertrophied turbinates, allergic rhinitis, smoking, use of masks, and the number of vehicles passing through the toll gate did not have a significant relationship with the degree of nasal obstruction, as the p-value was greater than 0.05.

4. Discussion

The degree of nasal obstruction in the control group in this study showed an increase in nasal obstruction that was not statistically significant (p > 0.05), as indicated by the increase in the average NOSE Scale value and the decrease in the average PNIF value. This occurred because the control group did not receive nasal irrigation.

Tollgate officers are at risk of exposure to motor vehicle emissions while working. The emissions produced by motor vehicles contain various pollutants such as PM 10, PM 2.5, SO2, CO, NO, and O3. These pollutants can induce the formation of Reactive Oxygen Species (ROS). The induction of ROS leads to a series of reactions that culminate in inflammation of the nasal mucosa, increasing the degree of nasal obstruction[20].

The results of the study in the treatment group showed a significant reduction in nasal obstruction severity ($p<0.05$), as evidenced by the decrease in the average NOSE Scale score and the increase in the average PNIF score. Nasal irrigation using isotonic saline solution performed on the treatment group was able to reduce nasal obstruction symptoms through mechanisms such as moisturizing thick and hard secretions, making them softer and easier to clear, reducing inflammatory mediators due to allergen exposure in the nasal mucosa, and improving mucociliary transport through direct mechanical effects, as well as increasing ciliary movement frequency, thereby enhancing mucociliary clearance[15-16,19,21].

Furthermore, it is important to note that the NOSE Scale not only measures the severity of nasal obstruction, but also includes other domains such as sleep disturbance and the impact of nasal symptoms on daily activities[22]. Therefore, the significant reduction in the NOSE Scale score observed in the treatment group may reflect improvement in multiple aspects of patients quality of life. A study in Saudi Arabia found that nasal obstruction significantly affects patients quality of life, including physical, psychological, social, and environmental aspects. Subjective evaluations using the NOSE Scale and WHOQOL-BREF showed that patients without nasal obstruction had better quality of life scores than those with nasal obstruction[23]. Nasal irrigation contributes to these improvements not only mechanically clearing nasal passages but also biologically reducing inflammation and mucosal swelling. This supports the idea that reducing nasal obstruction benefits not only physical symptoms but also patients psychological well-being. These combined effects help explain the broader improvement across all components of the NOSE Scale[24].

The results of the study on the degree of delta of nasal obstruction, both using the NOSE Scale and PNIF, in the control and treatment groups showed a significant change in the average degree of nasal obstruction, both statistically and based on clinical judgment. These results are consistent with previous studies on nasal irrigation. A study conducted on 81 children with allergic rhinitis over 14 days showed a reduction in scores on the Total Nasal Symptom Score (TNSS) questionnaire[20]. Another study involving 124 healthy student aged 8-11 years showed increased peak inspiratory nasal flow after 30 minutes of nasal irrigation with an isotonic saline solution using a syringe[25].

The observed increase in PNIF scores in the treatment group of this study can be attributed to improved nasal airway patency following irrigation, which removes obstructive secretions and reduces mucosal edema. This promotes more laminar airflow through the nasal passages, allowing for greater inspiratory volume during maximal effort. Supporting this, an experimental study on healthy volunteers practicing Jala Neti (nasal irrigation) reported a significant PNIF increase from 84.56 ± 12.56 L/min to 110.85 ± 12.56 L/min ($p = 0.001$), confirming that the removal of physical blockages and improved mucosal conditions directly enhance nasal airflow [25-26].

The variables considered as confounders in this study include the number of vehicles passing through the toll gate, hypertrophied turbinates, mild-to-moderate septal deviation, smoking, and the use of masks. This study's analysis of these confounding variables showed no significant effects ($p > 0.05$). This indicates that none of the confounders impacted the degree of reduction in nasal obstruction, as this was primarily influenced by nasal irrigation.

5. Conclusion

Nasal irrigation affects the degree of nasal obstruction in toll gate officers exposed to traffic-related air pollution. The limitations of this study include the fact that when the subjects were on break from work, they performed nasal irrigation independently without supervision from the researcher. Additionally, the measurement of nasal obstruction degree in this study was conducted using the NOSE Scale, which is subjective. In future studies, it is recommended that when the subjects are on break from work, direct supervision by the researcher should continue, and other methods of measuring the degree of nasal obstruction, such as rhinomanometry, should be used.

Ethical Approval

Ethical clearance was secured from the Ethical Committee of the Faculty of Medicine, Diponegoro University No. 400/EC/FK-RSDK/VI/2017 prior to the commencement of the study.

Conflicts of Interest

There are no conflicts of interest to disclose.

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Author Contributions

Writing-original draft preparation and editing, Faradis Karmilah; Writing-review, dr. Anna Mailasari Kusuma Dewi, Sp.THT-KL(K).

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