GSC Advanced Research and Reviews

eISSN: 2582-4597 CODEN (USA): GARRC2

Cross Ref DOI: 10.30574/gscarr

Journal homepage: https://gsconlinepress.com/journals/gscarr/

(RESEARCH ARTICLE)

The Comparison of Wearing *Boreh* and Socks with Oxymetazoline HCl 0.05% Spray for Nasal Congestion Among State High School 1 Students in Pupuan, Tabanan

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GSC Advanced Research and Reviews, 2025, 25(03), 344-355

Publication history: Received 11 November 2025; revised on 16 December 2025; accepted on 18 December 2025

Article DOI: https://doi.org/10.30574/gscarr.2025.25.3.0386

Abstract

Introduction: Nasal congestion is one of the most common ear, nose, and throat problems. It is mediated by various mechanisms, including vasodilatation. Indonesia is a country with abundant knowledge of traditional medicine, with increasing applications because its safety has been proven. *Boreh* is one of the traditional medicines that has been used by the Balinese for generations, with various benefits. Wearing socks also helps with distal vasodilatation and increases blood flow to extremities. We would like to compare the effect of wearing *boreh* and socks with oxymetazoline HCl 0,05% spray for nasal congestion.

Method: This crossover study was conducted in 70 students. The participants were divided into two groups: group A (*boreh* with socks) and group B (oxymetazoline HCl 0.05% spray), followed by a washout period for 48 hours and crossover. The nasal patency was measured using a stainless plate at 6 different time points for each intervention. The data were analyzed, and a p-value of < 0.05 was considered statistically significant.

Results: Most participants were girls (58.6%). Group B had statistically significantly better nasal patency but only at the 35th minute before crossover (39.35 ± 15.34 versus 32.01 ± 13.33; $p = 0.029$). Before crossover, *Boreh* with socks increased nasal patency significantly in the first 5 minutes and decreased gradually starting from the 15th minute (+7.34 mm2; $p = 0.015$), but oxymetazoline HCl 0.05% spray did not increase nasal patency significantly ($p > 0.05$). After crossover, the nasal patency in both groups did not differ significantly ($p > 0.05$).

Conclusion: *Boreh* and socks were more effective in decreasing nasal resistance than oxymetazoline HCl 0.05% spray, but further studies are required.

Keywords: *Boreh*; Nasal Congestion; Nasal Patency; Oxymetazoline; Traditional Medicine

1. Introduction

Ear, nose, and throat (ENT) problems account for 10% of primary health center visits. Nasal obstruction or congestion is one of the common problems, characterized by fullness sensation and reduced air flow in the nasal cavity.[1] Nasal obstruction were mediated by various mechanisms, including vasodilatation. Furthermore, sensory modulation also contributes to nasal congestion symptoms with or without physical congestion. Decreased sympathetic tone leads to sinusoid vein dilatation and contributes to nasal obstruction symptoms.[2]

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Indonesia is a country with abundant biodiversities and knowledge of traditional medicine. Indonesia has 30,000 plant species and it is known that at least 9,600 plant species have medicinal properties also approximately 300 species have been used as traditional medicine. It is known that traditional medicine is applied to maintain health also diagnose and treat physical or mental illnesses. Traditional medicine application is increasing because its safety has been proven with the advancement of science.[3]

Boreh is one of traditional medicine that used by Balinese for generations for health reason and it is also one of traditional products that have benefits on the skin surface area. It was made of grinded spices and rubbed on the cold or sore body parts therefore it was claimed that *boreh* can treat various illness depending on the *boreh* types.[4,5] *Boreh* has various benefits, but the utilization of various plants as *boreh* ingredients is not well-known because the plant names that were mentioned *in lontar usada* have various names.[6,7]

Wearing socks may aid in local vasodilatation and also increase the blood flow to upper and lower extremities; therefore, the body's core temperature decreases faster.[8] Oxymetazoline is a sympathomimetic medication that has vasoconstriction action that will help to relieve nasal congestion.[9] Pupuan, Tabanan was selected as the location of study because nasal congestion are commonly found because it is a high-altitude and damp area.

2. Materials and method

The crossover study was conducted in students from State High School 1 (SMAN1) Pupuan in July 2023. The participants were picked based on the inclusion and exclusion criteria. The inclusion criteria were: (1) Students aged 17 years or older, and (2) did not consume any medication in the last 24 hours. The exclusion criteria were: (1) Having hypertension or other cardiac diseases; (2) there were signs of acute infection in ENT area based on the physical examination; and (3) There was structural disorders based on physical examination that led to nasal obstruction and amenable with medications (sinonasal tumor, nasal polyps, choanal atresia, and nasal valve collapse).

Boreh used in this study consisting of sliced ginger, sand ginger, and galangal, which were then dried and ground into a powder for longer storage. The powdered *boreh* was dissolved in ethanol, in the form of Balinese liquor, which is 100% made from palm wine and is a Balinese ancestral heritage. It was then applied to the plantar foot, followed by socks.

We would give a brief explanation to the candidates and ask them to sign informed consent voluntarily as proof of approval. The participants were divided into two groups: the socks and the *boreh* group, and the oxymetazoline HCl 0.05% group. After the first phase of intervention, we crossed over with a washout period of 48 hours. Next, we gave an intervention based on the groups and assessed nasal patency as outcomes. Nasal patency will be assessed using a stainless plate. Participants sat on a chair, and we placed the stainless plate with a lower temperature than body temperature under the anterior nares, just below the columella. The position of the stainless plate was horizontal with the position of participants sitting with their heads upright, and they were asked to close their mouths and exhale quietly. The dew will be generated on a stainless plate from both left and right nares.

The generated dew on the stainless plate will be circled immediately using markers on the edge of the dew to avoid the loss of the dew edge. The drawn edges of the dew borders will be copied or redrawn immediately on thin paper, and the drawings of the dew borders will be measured using millimeter paper by positioning the millimeter paper under a thin paper on which the dew edge pattern has been drawn. After that, we count the squares that were marked by the edge margin markers. One small square equals 1 mm2, with the condition that if an included small square was more than half, it was counted as one, but if it was less than half, it was not counted. If there were 320 squares, it means the generated dew area was 320 mm2. The amount of generated dew means the amount of resistance in the nasal cavity, in which the nasal cavity resistance was measured using a formula that was analogous to the following Ohm formula:

$$R = \frac{P \times T}{V}$$

Notes:

R = Nasal Resistance

P = Air pressure that passes the nose

T = Time

V = Volume per second

From the above-mentioned formula, we could conclude that more exhaled air volume resulted in a wider dew area, which means that the nasal cavity resistance was small. The more air flows in the nose, the smaller the nasal cavity resistance becomes.

In a crossover study, each group will receive two interventions, *boreh* and oxymetazoline. In this study, group A will receive *boreh* first while group B will receive oxymetazoline first. The groups would be switched in the next phase; group A will receive oxymetazoline, while group B will receive *boreh*. A crossover was conducted to ensure that the interventions were valid and to compare the two groups equally.

In the *boreh* group, the nasal patency was measured prior to intervention, and then we applied a teaspoon of *boreh* on the foot soles, in hollow areas of the foot soles. The participants were asked to wear the provided socks. Next, we measure the nasal cavity resistance using a stainless plate and mark it as the 0th minute. After that, each nasal cavity resistance will be measured in the 5th, 15th, 25th, and 35th minute. On the other hand, the oxymetazoline group will receive two sprays of oxymetazoline HCl 0.05% in both nostrils, and the nasal patency will be measured on the 0th, 5th, 15th, 25th, and 35th minute. Both groups rested for 48 hours, then a crossover would be conducted with similar measurements of nasal cavity resistance.

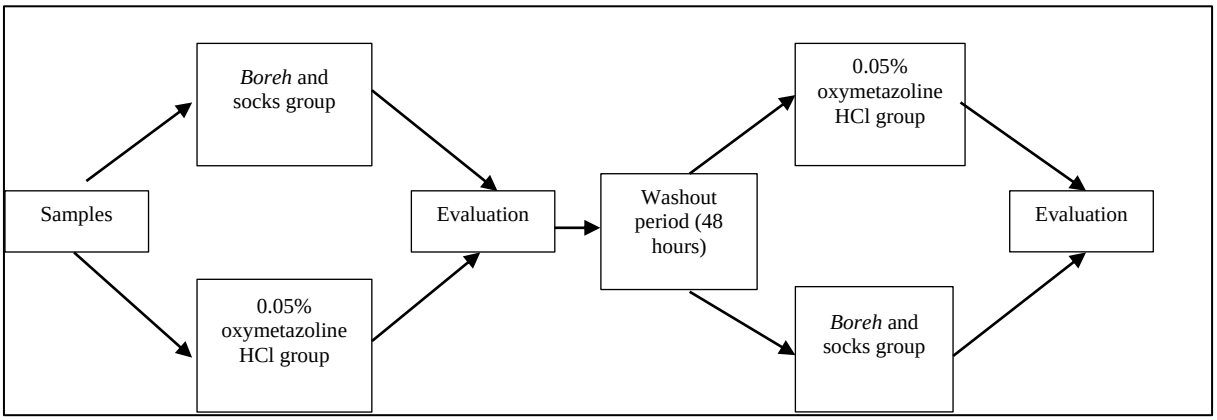

Figure 1 The Research Flowchart

The data were analyzed using the Statistical Package for Social Sciences (SPSS) software. Univariate analysis was conducted for each variable in order to assess the research characteristics. Nasal patency would be compared between groups using the Mann-Whitney U test, followed by Analysis of variance (ANOVA) for each data set. A p-value < 0.05 was statistically significant.

3. Results

3.1. Demographic Characteristics

We included 70 people in this study. Based on sex, there were 29 boys (41.4%) and 41 girls (58.6%), and most of them did not have any history of ENT complaints. Both groups have similar baseline dew areas without any significant difference (Table 1)

Table 1 The Demographic Characteristics

Variables	n (%) / mean ± SD	Normality Test (K-S)
Sex		-
Boy	29 (41.4%)	
Girl	41 (58.6%)	
ENT Complaints		
Yes	14 (20%)	
No	56 (80%)	
Age	17.3 ± 0.64	0.0005
Group A (dew area, mm^2)		
Pre *Boreh*	29.34 ± 6.39	0.217
Pre Oxymetazoline	33.12 ± 14.30	0.0005
Group B (dew area, mm^2)		
Pre *Boreh*	30.52 ± 11.40	0.016
Pre Oxymetazoline	34.30 ± 11.38	0.105

3.2. The Mean Difference of Nasal Patency of Both Groups in The First Phase (Before Crossover)

The first phase analysis, group A (*boreh* and socks), consisted of 32 people, while group B (oxymetazoline) consisted of 38 people. Initially, group B had better nasal patency, characterized by a wider dew area, but this difference was not statistically significant (34.30 ± 11.38 cm2 versus 229.340 ± 6.39 cm2, p = 0.068). We did a follow-up for both groups and compared the dew area in every measurement time point. The nasal patency did not differ significantly except in the 35th minute, which showed that group B had a better nasal patency compared to group A (39.95 ± 15.34 cm2 versus 32.01 ± 13.33 cm2; p-value = 0,029) (Table 2).

3.3. The Mean Difference of Nasal Patency of Both Groups in The Second Phase (After Crossover)

The bivariate analysis between groups in the second phase showed no significant difference in nasal patency at every follow-up time point. It means that after crossover, both groups did not have different nasal patency as in the first phase (before crossover). The oxymetazoline group had a greater nasal patency in the 35th minute, but it was not statistically significant (38.81 ± 14.85 cm2 versus 34.64 ± 11.59 cm2; p-value = 0.265) (Table 2).

Table 2 The Results of *Mann Whitney-U* Test of Both Groups

Dew Area	Pre	0th Minute	5th Minute	15th Minute	25th Minute	35th Minute
First Phase (Before Crossover)						
A (*Boreh*) n = 32	29.34 ± 6.39	36.17 ± 9.16	36.69 ± 11.39	33.80 ± 10.88	33.03 ± 9.34	32.01 ± 13.33
B (Oxymetazoline) n = 38	34.30± 11.38	36.12 ± 14.44	35.44 ± 18.69	38.67 ± 19.29	37.78 ± 13.81	39.95 ± 15.34
P value	0.068	0.679	0.180	0.667	0.232	**0.029***
Second Phase (After Crossover)						

A (Oxymetazoline) n = 32	33.12± 14.30	32.15 ± 11.37	32.00 ± 10.21	35.75 ± 12.85	34.77 ± 15.24	38.81 ± 14.85
B (*Boreh*) n = 38	30.52± 11.40	34.38 ± 11.30	34.09 ± 10.72	35.44 ± 11.92	35.21 ± 12.60	34.64 ± 11.59
P value	0.419	0.505	0.330	0.836	0.675	0.265

3.4. The Mean Difference of Group A Nasal Patency The First Phase (Before Crossover)

The RM ANOVA test compared every nasal patency value in the same group but at the different time points. The RM ANOVA test generated a value (Greenhouse-Geisser) of 0.004. It means that there was a statistically significant difference in one of the assessed relations in each measured nasal patency at different times. There was a statistically significant difference in nasal patency between pre with 0th minute and pre with 5th minute. The analysis result showed that the *boreh* and socks intervention in group A prior to crossover had a greater effectiveness in the first 5 minutes, but it was not effective starting from the 15th minute (Table 3).

Figure 2 demonstrated that *boreh* and socks had direct effects and increased nasal patency significantly in the first five minutes. However, the mean of nasal patency decreased significantly starting from the 15th minute, and so did the dew area. These mean values ended in a dew area of 32 cm^2. The effect of *boreh* and socks was temporary, although in the 35th minute, the nasal patency was still better than the baseline condition.

Table 3 Group A RM ANOVA Test (*Boreh* dan Socks) Before *Crossover*

Time Group (I)	Comparison (J)	Mean difference (I – J)	P value
Pre	0th minute	-6.83	0.009
	5th minute	-7.34	0.015
	15th Minute	-4.46	0.214
	25th Minute	-3.68	0.323
	35th minute	-2.67	1.000
0th minute	Pre	6.83	0.009
	0th minute	-0.52	1.000
	5th minute	2.37	1.000
	15th Minute	3.14	0.742
	35th minute	4.15	0.873
5th minute	Pre	7.34	0.015
	0th minute	0.52	1.000
	5th minute	2.88	1.000
	15th Minute	3.66	0.215
	35th minute	4.67	0.934
15th Minute	Pre	4.46	0.214
	0th minute	-2.37	1.000
	5th minute	-2.88	1.000
	15th Minute	0.77	1.000
	35th minute	1.78	1.000
25th Minute	Pre	3.68	0.323
	0th minute	-3.14	0.742

	5th minute	-3.66	0.215
	15th Minute	-0.77	1.000
	35th minute	1.01	1.000
35th minute	Pre	2.67	1.000
	0th minute	-4.15	0.873
	5th minute	-4.67	0.934
	15th Minute	-1.78	1.000
	35th minute	-1.01	1.000

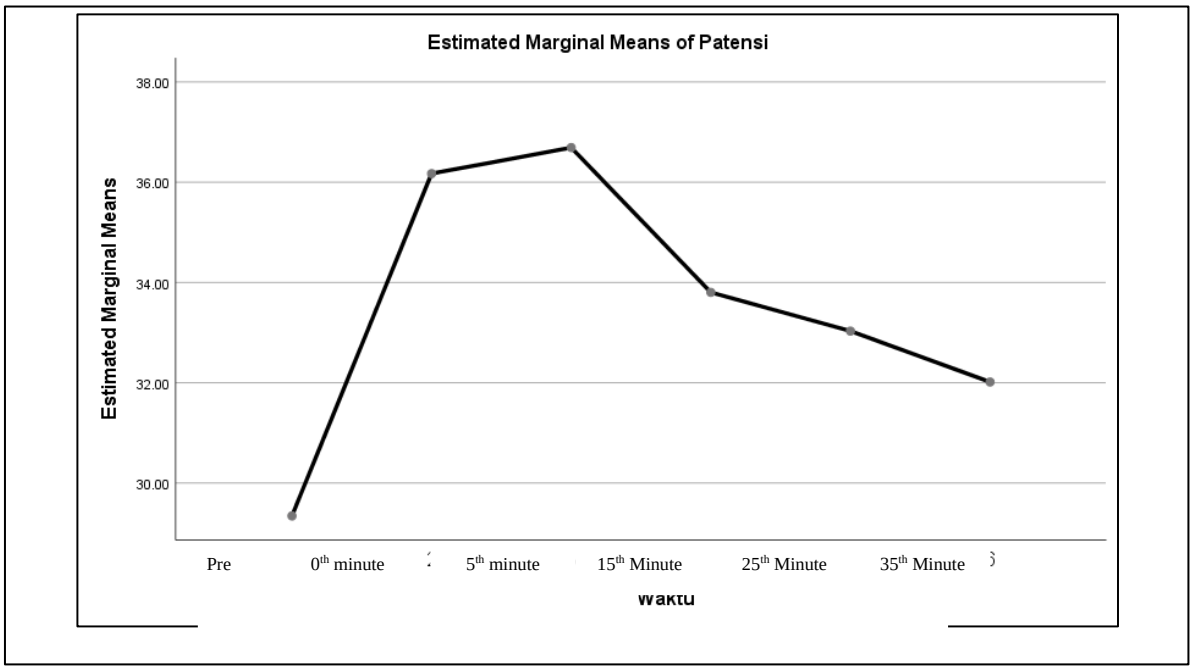

Figure 2 The Mean Value of Group A Nasal Patency During Follow Up Period (Before Crossover)

3.5. The Mean Difference of Group B Nasal Patency The First Phase (Before Crossover)

Group B RM ANOVA analysis before crossover showed insignificant results (p-value > 0.05) with p value (Greenhouse-Geisser) of 0.087 (sphericity not assumed). Although the dew area increased until 35th minute but these differences were not statistically significant (Table 4 and Figure 3).

Table 4 Group B RM ANOVA Test (Oxymetazoline) Before Crossover

Time Group (I)	Comparison (J)	Mean difference (I – J)	P value
Pre	0th minute	-1.82	1.000
	5th minute	-1.14	1.000
	15th Minute	-4.37	1.000
	25th Minute	-3.48	1.000
	35th minute	-5.64	0.176
0th minute	Pre	1.82	1.000
	0th minute	0.68	1.000

	5th minute	-2.54	1.000
	15th Minute	-1.65	1.000
	35th minute	-3.82	0.569
5th minute	Pre	1.14	1.000
	0th minute	-0.68	1.000
	5th minute	-3.22	1.000
	15th Minute	-2.33	1.000
	35th minute	-4.50	0.522
15th Minute	Pre	4.37	1.000
	0th minute	2.54	1.000
	5th minute	3.22	1.000
	15th Minute	0.89	1.000
	35th minute	-1.27	1.000
25th Minute	Pre	3.48	1.000
	0th minute	1.65	1.000
	5th minute	2.33	1.000
	15th Minute	-0.89	1.000
	35th minute	-2.16	1.000
35th minute	Pre	5.64	0.176
	0th minute	3.82	0.569
	5th minute	4.50	0.522
	15th Minute	1.27	1.000
	35th minute	2.16	1.000

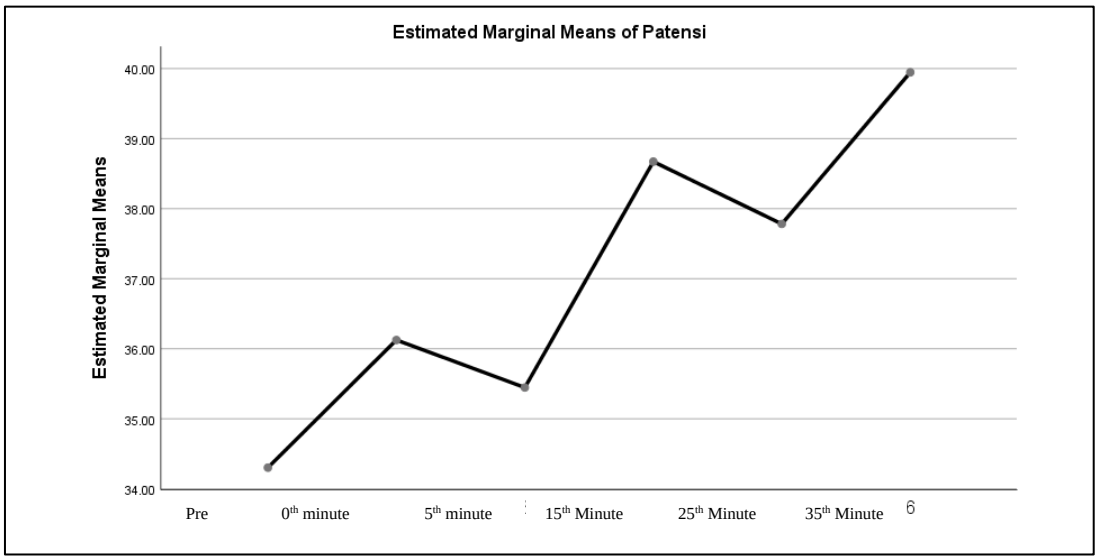

Figure 3 The Mean Value of Group B Nasal Patency During Follow Up Period (Before Crossover)

3.6. The Mean Difference of Group A Nasal Patency The Second Phase (After Crossover)

Group A RM ANOVA test result had a p-value (Greenhouse-Geisser) of 0.014. It was shown at the difference between the 5th minute and the 35th minute, as well as the 25th minute and the 35th minute. Although there was a difference in nasal patency between pre-intervention and 35th minute but this difference was not statistically significant (p value = 0.094). However, a significant difference in the 35th minute means that oxymetazoline was effective for nasal patency (Table 5 and Figure 4).

Table 5 Group A RM ANOVA Test (*Oxymetazoline*) After Crossover

Time Group (I)	Comparison (J)	Mean difference (I – J)	P value
Pre	0th minute	0.97	1.000
	5th minute	1.11	1.000
	15th Minute	-2.63	1.000
	25th Minute	-1.66	1.000
	35th minute	-5.69	0.094
0th minute	Pre	-0.97	1.000
	0th minute	0.14	1.000
	5th minute	-3.59	1.000
	15th Minute	-2.62	1.000
	35th minute	-6.66	0.261
5th minute	Pre	-1.11	1.000
	0th minute	-0.14	1.000
	5th minute	-3.74	0.685
	15th Minute	-2.77	1.000
	35th minute	-6.80	0.037
15th Minute	Pre	2.63	1.000
	0th minute	3.59	1.000
	5th minute	3.74	0.685
	15th Minute	0.97	1.000
	35th minute	-3.06	0.123
25th Minute	Pre	1.66	1.000
	0th minute	2.62	1.000
	5th minute	2.77	1.000
	15th Minute	-0.97	1.000
	35th minute	-4.03	0.034
35th minute	Pre	5.69	0.094
	0th minute	6.65	0.261
	5th minute	6.80	0.037
	15th Minute	3.06	0.123
	35th minute	4.03	0.034

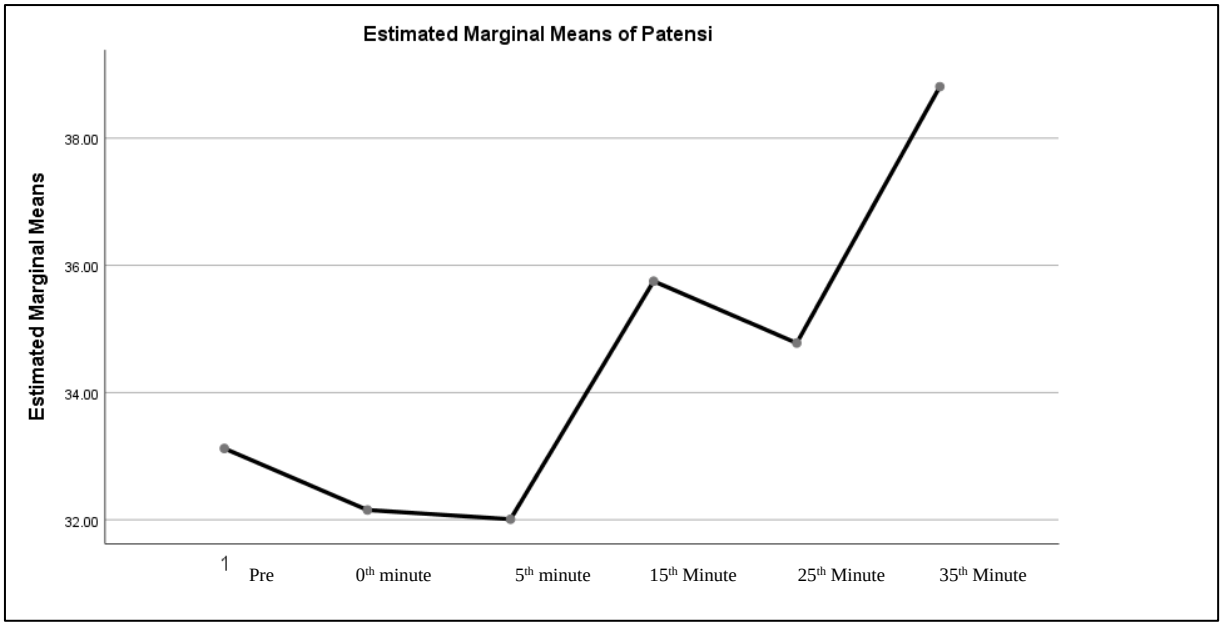

Figure 4 The Mean Value of Group A Nasal Patency During Follow Up Period (After Crossover

3.7. The Mean Difference of Group B Nasal Patency The Second Phase (After Crossover)

Similar to group A, the RM ANOVA test result after crossover, group B RM ANOVA did not show a significant p-value, with a p-value (Greenhouse-Geisser) of 0.056. Based on the mean value of nasal patency, this group had a wider dew area in the 15th minute and then decreased gradually in the following times. However, the difference of nasal patency in the 15th minute and pre-intervention was 4.92 cm^2, and it was not statistically significant (p value = 0.217). Similar to the *boreh* and socks group (group A) before crossover, the effectiveness of these interventions was temporary and did not last until the 35th minute. Nevertheless, these interventions were effective in the first 15 minutes.

Table 6 Group B RM ANOVA Test (*Boreh* and Socks) After Crossover

Time Group (I)	Comparison (J)	Mean Difference (I – J)	P value
Pre	0th minute	-3.86	0.206
	5th minute	-3.57	0.343
	15th Minute	-4.92	0.217
	25th Minute	-4.69	0.231
	35th minute	-4.12	0.437
Menit 0	Pre	3.86	0.206
	0th minute	0.29	1.000
	5th minute	-1.06	1.000
	15th Minute	-0.83	1.000
	35th minute	-0.26	1.000
Menit 5	Pre	3.57	0.343
	0th minute	-0.29	1.000
	5th minute	-1.35	1.000
	15th Minute	-1.13	1.000
	35th minute	-0.55	1.000

Menit 15	Pre	4.92	0.217
	0th minute	1.06	1.000
	5th minute	1.35	1.000
	15th Minute	0.22	1.000
	35th minute	0.79	1.000
Menit 25	Pre	4.69	0.231
	0th minute	0.83	1.000
	5th minute	1.13	1.000
	15th Minute	-0.22	1.000
	35th minute	0.57	1.000
Menit 35	Pre	4.12	0.437
	0th minute	0.26	1.000
	5th minute	0.55	1.000
	15th Minute	-0.79	1.000
	35th minute	-0.57	1.000

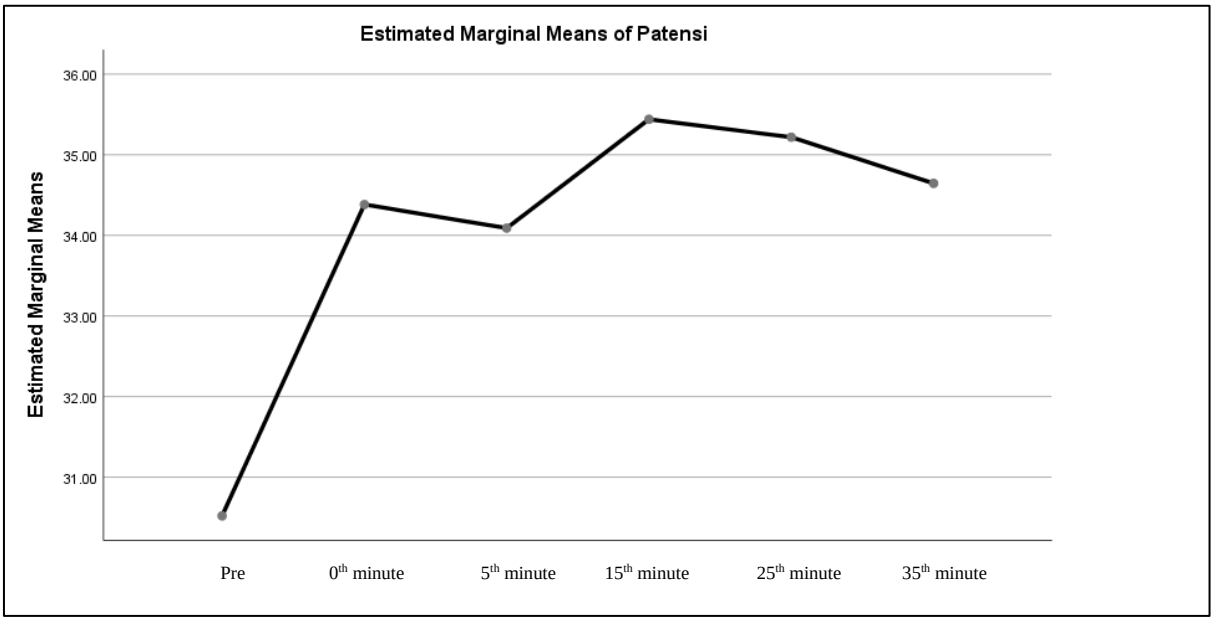

Figure 5 The Mean Value of Group B Nasal Patency During Follow Up Period (After Crossover)

4. Discussion

Nasal congestion affects nasal patency because it interferes with the inspiration and expiration of air volume. There are various etiologies of nasal congestion, such as rhinitis, rhinosinusitis, concha hypertrophy, and so on. Cold temperature also affects nasal patency and leads to concha congestion. Nasal patency can be preserved by conservative or surgical methods, which is indicated when the conservative method does not provide any benefits. A vasoconstrictor is one of the medications that can be used to relieve nasal congestion. It can be administered systemically or topically, such as Oxymetazoline HCl. Furthermore, *boreh* and socks have been used by Balinese people and other regions for generations as a conservative method to relieve nasal congestion.[9–11]

The sex distribution of participants in the present study was female (n = 41, 58.6%) and male (n = 29, 41.4%). Most of our participants did not have any history of ear, nose, and throat symptoms, which means that of *boreh*, socks, and oxymetazoline can be applied to patients with ENT symptoms as well as healthy patients. Both groups had similar baseline dew area, and no significant statistical difference was found. Therefore, the assessment of intervention effects in this study was valid.

The first phase Mann-Whitney test results of both groups (before crossover) showed a significant difference in nasal patency only in the 35th minute. In the second phase (after crossover), there was no significant difference in nasal patency. However, the oxymetazoline group had greater nasal patency in the 35th minute, and the dew area tended to be wider than the *boreh* and sock group during assessment (35 minutes), although it was not statistically significant. It indicated that socks and *boreh* were still reliable. This was supported by the analysis result of the socks and *boreh* group that showed a wider dew area after intervention (Tables 2 and 3).

The *repeated measures* analysis of variance (RM ANOVA) test compared the nasal patency in the same group at different times. The analysis showed that the *boreh* and socks intervention in group A (before crossover) had a greater effect in the first 5 minutes, but there was no efficacy thereafter, starting from the 15th minute. The mean of nasal patency decreased significantly in the 15th minute. The mean of nasal patency also decreased significantly in the 15th minute. Starting from the 15th minute, the dew area was measured at 10-minute intervals, and it showed that the dew area decreased continuously, although the nasal patency in the 35th minute was still better than pre-intervention (Figure 1).

Socks have a distal vasodilatation effect that can increase the blood flow to the feet and other extremities, including hands. Increased blood flow to the feet and extremities may lead to slightly decreased blood flow to the brain because blood in the body core (including the brain) will shift to the distal body parts. This is one of the ways our body releases heat. Increased blood flow to the extremities leads to a slight decrease in midsection body blood flow, including the nose. The decreased blood flow to the nose will increase the nasal patency by relieving nasal congestion.[12,13] Furthermore, *boreh* also has synergistic effects in which it can warm the body and improve the local blood circulation in the applied area of *boreh*.[6] Socks and *boreh* were easy to find. The significant difference between the groups in the present study was not consistent. The side effects of topical *boreh* that was applied to the feet were not found.

This study has a limitation regarding the accuracy of nasal cavity resistance measurement because rhinomanometry was not available; therefore, we used a millimeter-scale measuring papers. Further studies about the effectiveness of available *boreh* types are required. However, this study found that *boreh* with socks was a reliable therapeutic method of nasal congestion for people who live in the mountains, the elderly, and communities because they were widely available and easy-to-apply before the patients were seeking therapy from a specialist doctor. *Boreh* needs special attention in order to preserve the traditional therapy of nasal congestion.

5. Conclusion

Boreh and socks are more effective than oxymetazoline HCl 0.05% nasal spray to decrease the nasal cavity resistance. Further studies are required to assess the thermal physical effect of various available *boreh* as well as the effective package for long-term storage.

Compliance with ethical standards

This study is a retrospective evaluation of a community-based otorhinolaryngology social service program conducted among high school students of State High School 1 Pupuan, Tabanan. The interventions applied were commonly used, non-invasive, and low-risk treatments for nasal congestion.

As the activity was conducted primarily as a social service program and not originally designed as a research project, prior ethical committee approval was not sought. Students included in the study were aged over 17 years old. Informed consent assent were obtained, and if student don't want to take part in the study is pleased to do so, and all data were anonymized before analysis.

No identifiable personal information is included in this publication, and the study was carried out in accordance with the principles of the Declaration of Helsinki.

No conflict of interest to be disclosed.

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