Gac Méd Caracas 2022;130(Supl 1):S257-S264
DOI: 10.47307/GMC.2022.130.s1.42

Combination of Egg Tray Silencer and Progressive Relaxation to Overcome Community Auditory Disorders in Indonesian Noise Train Environments

Combinación de silenciador de bandeja de huevos y relajación progresiva para superar los trastornos auditivos comunitarios en ambientes de ruido de tren en Indonesia

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SUMMARY

Introduction: *People who live near the edge of the railroad tracks cannot avoid environmental noise. Various efforts have been made to build a barrier between railroad crossings and residential areas and install silencers on locomotives. However. the environmental noise intensity is still above the normal threshold value (NAV 55dB). Therefore, the combination of egg tray damper and progressive relaxation (KODAMSI) is expected to be an alternative solution. This study aimed to prove the effect of KODAMSI on temporary hearing loss in respondents who are exposed to train noise intensity.*

Methods: *This study used a randomized control trial (RCT). Research subjects were screened and determined by two-stage cluster random sampling. Three hundred people (35 %) from 3 villages living on the edge of the railway were screened using the KODAMSI, and 30 research subjects were obtained according to inclusion and exclusion criteria. An amount of 30 respondents were randomly assigned to cluster stage II. The statistical analysis used Mann-Whitney and Willcoxon test.*

Results: *The mean difference in reduction (delta) of noise intensity before and after the intervention of the egg tray silencer in the treatment group was 33.87dB. KODAMSI proved effective in improving hearing loss (p=0.0001) from moderate (41.33dB) to mild (32.15dB) with an average delta threshold of 9.2dB.*

Conclusion: *KODAMSI has effectively reduced the intensity of environmental noise in noise pollution from train tracks and can significantly improve temporary hearing loss. KODAMSI might become an alternative to diminish hearing loss and prevent noise in the community.*

Keywords: *Auditory, environment, progressive relaxation, silencer.*

DOI: https://doi.org/10.47307/GMC.2022.130.s1.42

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Recibido: 1 de mayo 2022
Aceptado: 9 de mayo 2022

RESUMEN

Introducción: *Las personas que viven cerca del borde de las vías del tren no pueden evitar el ruido ambiental. Se han hecho varios esfuerzos para construir una barrera entre los cruces de ferrocarril y las áreas residenciales e instalar silenciadores en las locomotoras. Sin embargo, la intensidad del ruido ambiental sigue estando por encima del valor umbral normal (NAV 55dB). Por lo tanto, se espera que la combinación de amortiguador de bandeja de huevos y relajación progresiva (KODAMSI) sea una solución alternativa. Este estudio tuvo como objetivo probar el efecto de KODAMSI en la pérdida auditiva temporal en los encuestados que están expuestos a la intensidad del ruido del tren.*

Métodos: *Este estudio utilizó un ensayo de control aleatorio (ECA). Los sujetos de investigación fueron examinados y determinados mediante un muestreo aleatorio por conglomerados en dos etapas. Trescientas personas (35 %) de 3 aldeas que viven al borde de la vía férrea fueron examinadas utilizando el KODAMSI y 30 sujetos de investigación se obtuvieron de acuerdo con los criterios de inclusión y exclusión. Una cantidad de 30 encuestados fueron asignados aleatoriamente a la etapa II del conglomerado. El análisis estadístico utilizó la prueba de Mann-Whitney y Willcoxon.*

Resultados: *La diferencia media en la reducción (delta) de la intensidad del ruido antes y después de la intervención del silenciador de la bandeja de huevos en el grupo de tratamiento fue de 33,87 dB. KODAMSI demostró ser eficaz para mejorar la pérdida auditiva (p=0,0001). de moderada (41,33 dB) a leve (32,15 dB) con un umbral delta medio de 9,2 dB.*

Conclusión: *KODAMSI ha reducido efectivamente la intensidad del ruido ambiental en la contaminación acústica de las vías del tren y puede mejorar significativamente la pérdida auditiva temporal. KODAMSI podría convertirse en una alternativa para disminuir la pérdida auditiva y evitar el ruido en la comunidad.*

Palabras clave: *Auditivo, ambiente, relajación progresiva, silenciador.*

INTRODUCTION

Loud is one of the most prominent forms of noise pollution in industrial areas. heavy in road and rail traffic. The World Health Organization (WHO) stated that 250 million (4.2 %) of the world's population suffer from hearing loss due to various noises. and 75-140 million are found in Southeast Asia (1,2). The impact of noise on the Indonesian people ranks 4th in Southeast Asian countries with a relatively high prevalence of hearing loss which is 4.6 % after Sri Lanka at 8.8 %. Myanmar at 8.4 %, and India at 6.3 % (3,4). The prevalence of hearing loss is 4.6 % which can cause social problems in Indonesian society. The South-East Asia Regional Office (WHO-SEARO) consultation meeting stated that noise-induced hearing loss is the third most common cause of hearing loss in Indonesia (5-9).

People who live in noisy areas experience hearing loss in the right ear. Based on the survey. Exposure to noise causes changes in the hearing threshold. depending on sound frequency. intensity and duration of exposure (10-14). There are two effects of train noise on the auditory: Noise-Induced Temporary Threshold Shift (NITTS) and Noise-Induced Permanent Threshold Shift (NIPTS). Individuals exposed to train noise have a higher hearing threshold at high frequencies. The results of the audiometric examination showed a steep "notch" at a frequency of 4000 Hz, called an acoustic notch (15,16). Efforts have been made to overcome train noise by building a barrier between the railroad tracks and residential areas. The action of installing a barrier that is 100 m long is 4 m high, and 23.88-28.9 cm thick, can reduce the noise intensity received by residents in settlements around the railroad track to 79.96 dBA (17,18).

The silencer can reduce or eliminate noise by keeping the transmission or transmission distance from the source of the noise receiver. Protecting noise receivers with earplugs is one of the efforts made by people affected by noise (19,20). The damping material he had researched consisted of; play wood Foam egg tray and coir (21). It is concluded that the egg tray has the highest muffle capability or Sound Transmission Loss (STL), which is 41.96 dB at a frequency of 4000 Hz (22). Furthermore. progressive relaxation techniques for 20-30 minutes once a day regularly for one week can significantly reduce complaints of sleep disturbances (23). The researcher offers a solution to overcome the impact of train noise by using a combination method of dampening and progressive relaxation or KODAMSI. This study aimed to explain the effect of KODAMSI on hearing loss while respondents were exposed to the intensity of train noise intensity.

METHODS AND MATERIALS

Design and Study Sample

This research method used an experimental design with the type of randomized pre-test post-test control group design. Recruitment of research subjects began with screening a population of 85 766 people in the district of Kediri City. Then, based on survey data and interviews with district officials. people who lived on the edge of the railroad were tracked. The inclusion criteria for noise intensity are 85dB. Phase I was conducted to randomly select areas. and three research sites were selected. Based on surveys and interviews. it was determined that 35 % (300 people) live on the edge of the railroad tracks. Phase II cluster began with screening using the KODAMSI questionnaire tested for validity with the results of values above the r table value of 0.549, all of which consist of 13 questions and reliability with Cronbach's alpha value of 0.929. Furthermore, screening for the distance from the house to the train tracks was less than 10 meters and ear examination with a whisper test and examination of the cleanliness of the external ear canal. so that 30 respondents were expected to be homogeneous.

Intervention

The KODAMSI method is the installation of a silencer in the form of an egg tray as a noise-canceling material combined with a modification of progressive relaxation. The egg tray is made from an arrangement of paper particles that undergo a deposition process so that they can reduce (muffle) noise by absorbing and reflecting sound well. The egg tray has the shape of an outward and inward basin such as hills and valleys or a pyramid absorber (24). The shape of the egg tray is like a pyramid capable of breaking up sound waves hitting the uneven surface of the egg tray. As a result, the sound waves are split. and the sound intensity is reduced.

Progressive relaxation is a technique to reduce muscle tension with a simple and systematic process of tensing a group of muscles and then relaxing them again (25). Edmund Jacobson introduced progressive relaxation in 1929 with the book Progressive Relaxation. Edmund Jacobson's progressive relaxation measures are combined with relaxation response techniques to cope with stress Herbert Benson (26). Progressive relaxation in this study was a combination of breathing relaxation techniques. a series of contractions and relaxation of muscle groups and techniques to divert the mind from the stimulation of train noise problems. KODAMSI was expected to be able to overcome temporary hearing loss (NITTS).

The treatment and control groups were measured using an audiometer to obtain temporary hearing loss data from the air-bone gap audiogram before and after treatment. The treatment group was given the intervention of installing an egg tray silencer and practicing progressive relaxation every day for 20-30 minutes for two weeks. Hearing loss data was in the Air Bone Gap Audiogram value (difference in value or gap between air conduction and bone conduction 10dB). Interpretation of audiometric measurement resulted in 0-25 dB (normal hearing threshold), 26-40 dB (mild hearing threshold decrease), 41-60 dB (moderate hearing threshold decrease), 61-90 dB (severe hearing loss threshold), >90 dB (decrease in hearing threshold is very severe).

Statistics

Data were tested to compare the mean of the two variables before and after interventions in two groups. Statistical analysis was conducted using a computer with Whitney and Wilcoxon tests.

Ethical Consideration

Ethical clearance of the study was obtained from the Ethics Commission on Health and Medicine Research at the Faculty of Medicine. Universitas Diponegoro. Number 528/EC/FK-RSDK/VIII/2017. All participants signed the informed consent in Bahasa.

RESULTS

Table 1 showed no difference in age. sex. educational level. type of occupation. length of stay at home in a day. and the distance from the house in meters to the rail in the treatment group and control group respondents (p>0.05). The mean age was 52.2 years in the treatment group and 51.6 years in the control group. The average length of stay at home in a day was 15.53 hours in the treatment group and 15.07 hours in the control group. The average distance from the house to the rail was 5.27 meters in the treatment group and 5.23 meters in the control group.

Table 1

Demographics of the Participants

Characteristic	Treatment (n=15)		Control (n=15)		p-value
	F	%	f	%	
Age (Years)					0.668a
Mean	52.2	51.6			
45-59 years (Middle Age)	14	93.3	14	93.3	
60-74 years (Elderly)	1	6.7	1	6.7	
Sex					
Male	10	66.7	8	53.3	0.273b
Female	5	33.3	7	46.7	
Educational Level					
Junior High School	7	46.7	8	53.3	0.745c
Senior High School	7	46.7	6	40	
College	1	6.7	1	6.7	
Occupation					
Housewife	4	26.7	4	26.7	0.552c
Trader	5	33.3	4	26.7	
Private Employees	2	13.3	1	6.7	
Enterpriser	2	13.3	2	13.3	
Handyman	2	13.3	3	20	
Driver	0	0	1	6.7	
Length of Stay (hours)					
Mean	15.07		15.53		0.766a
10-14	8	53.3	7	46.6	
15-19	3	20.1	5	33.3	
20-24	4	26.6	3	20.1	
The Distance (m)					
Mean	5.23		5.27		0.887a
4	2	13.3	1	6.7	
5	7	46.7	9	60	
6	6	40	5	33.3	

a T-Test. b Chi-Square Test. c Mann-Whitney Test

Differences in auditory disturbances were measured using an audiometer/audiometric with the Air Bone Gap Audiogram. Results before and after the KODAMSI intervention in the treatment and control groups can be seen in Table 2.

Table 2

Distribution of the Effect of KODAMSI on Auditory Disorders

Temporary Hearing Loss (dB)	Group: Treatment (n=15)				Control (n=15)				p
	Mean±SB	Median	Min	Max	Mean±SB	Median	Min	Maks	
Before	41.33±5.164	40	30	50	42.0 ± 4.14	40.0	40	50	0.735*
After	32.15±7.909	32.15	20	45	42.0 ± 4.14	40	40	50	0.002*
p		0.000**				1.00**			
	Mean±SB	Median	Min	Max	Mean±SB	Median	Min	Max	
Delta Air	9.2±4.5857	10	0.00	20	0.00±3.7796	0.00	-10	10	
Bone Gap	95%CI for Mean			p		95%CI		p	
Audiogram									
(dB)	Lower	Upper		Shapiro-Wilk	Lower		Upper	Shapiro-Wilk	
	6.6605	11.7395		0.042	-2.0931		2.0931	0.0001	

*Man-Whitney test.**Wilcoxon Test

Table 2 showed the hearing threshold value of the treatment group before the intervention was categorized as moderate hearing loss, decreased to mild and normal. The results of the Wilcoxon test analysis in the treatment group showed an effect of KODAMSI intervention on temporary hearing loss (NITTS) p=0.0001. The average difference in the decrease in temporary hearing loss before and after the KODAMSI intervention in the treatment group was 9.2dB. The control group had no average decrease. but there was an increase in the minimum value of temporary hearing loss of 10dB.

Before the KODAMSI intervention, the average Air Bone Gap Audiogram in the treatment group was 41.33dB (medium hearing loss criteria), with a minimum Air Bone Gap Audiogram of 30dB (mild hearing loss criteria) and a maximum Air Bone Gap Audiogram of 50dB (moderate hearing loss criteria). However. the group control obtained an average of 42.0dB (criteria for moderate hearing loss) with an Air Bone Gap Audiogram of at least 40dB and a maximum of 50dB. the same as the treatment group. The results of the Mann-Whitney analysis of the treatment group and the control group before the intervention were homogeneous (no difference, p= 0.735), i.e., both experienced temporary hearing loss. After the KODAMSI intervention. the average Air Bone Gap Audiogram in the treatment group decreased to 32.15dB (criteria for mild hearing loss) with Air Bone Gap Audiogram at least 20dB (criteria for normal hearing threshold) and Air Bone Gap Audiogram a maximum of 45dB (criteria for moderate hearing loss). While in the control group. the average Air Bone Gap Audiogram was fixed. which was 42.0dB (moderate hearing loss criteria), with the Air Bone Gap Audiogram minimum constant at 40dB (mild hearing loss criteria and the maximum remained at 50dB (moderate hearing loss criteria). Based on the Wilcoxon test, it was obtained. After the KODAMSI intervention treatment. the treatment group was different or there was an effect of p<0.05, namely p=0.001; while the control group had no difference p>0.05, namely p=1.00. KODAMSI in the treatment group was 9.2dB. However, the control group had no mean decrease, but an increase in the value Minimum Air Bone Gap Audiogram was 10dB.

The results of this study indicate the value of the Air Bone Gap Audiogram as an indicator of temporary hearing loss, namely the average value or value that occurs in a gap >10dB at a frequency of 250-8 000Hz between air conduction and bone conduction on the audiogram. Thus, numerical data can be presented. The average temporary hearing loss as a parameter of auditory impairment before the KODAMSI intervention in the treatment group was 41.33dB (moderate hearing loss) with a minimum value of 30dB (mild hearing loss) and a maximum value of 50dB (moderate hearing loss). The mean temporary hearing loss in the control group was 42.0dB (moderate hearing loss) with a minimum value of 40dB (mild hearing loss) and a maximum value of 50dB (moderate hearing loss). The treatment and control groups' data before the intervention were homogeneous. i.e., both experienced temporary hearing loss. However, data after the intervention showed differences between the treatment and control groups. The results of the study on the treatment and control groups were obtained from the audiogram gap between air conduction and bone conduction in the standard range of 0-25dB (the normal hearing threshold), and 26-40dB (mild hearing loss), 41-60dB (moderate hearing loss), 61-90dB (severe hearing loss), >90dB (highly severe hearing loss) (27,28). The impact of a noisy environment on the hearing sense is the emergence of an increase in the hearing threshold or adaptation. temporary hearing loss and permanent hearing loss.

Efforts to overcome hearing loss begin by reducing the noise of the respondent's living environment due to the intensity of the train noise by installing an egg tray silencer. Egg Tray as a silencer is an economical solution for music practice rooms. The results of research on silencers were conducted at the Acoustic Laboratory of the Faculty of Engineering. the University of Porto. in a 200 m^3 reverberation room using EN ISO 35, that the egg tray for 30 eggs made of paper has a better silencing function than the egg tray for 20 eggs made of plastic (29). The silencer can reduce or eliminate noise by removing the transmission or distance transmission from the source to the noise receiver. Protecting noise receivers with earplugs is one of the efforts that societies can make (19,22). The silencing material they had researched consisted of plywood. foam. egg tray. and coir. It can be concluded that the egg tray has the highest silencing ability or Sound Transmission Loss (STL). which is 41.96 dB at a frequency of 4 000 Hz (21).

The KODAMSI intervention research (Combination of Silencer and Progressive Relaxation) applied the technique of installing egg tray silencers on the respondent's living room's entire wall surface arranged tightly and neatly. The progressive relaxation technique is a relaxation technique to reduce muscle tension with a simple and systematic process of tensing muscle groups and then relaxing them again (30). Edmund Jacobson first introduced the progressive relaxation technique in 1929 in the Progressive Relaxation book. In this study. the progressive relaxation intervention procedure combines Edmund Jacobson's progressive muscle relaxation with Herbert Benson's deep breathing relaxation. Therefore. the progressive relaxation of this research is in the form of a combination of contraction-relaxation techniques of the body system muscle groups. followed by deep breathing relaxation and ending with the relaxation of the mind and positive suggestions.

Noise-Induced Hearing Loss (NIHL) is a form of change in hearing ability that occurs due to exposure to noise or the sound of passing trains. This study's way to overcome auditory disturbances is through progressive relaxation by systematically contracting the entire body's muscle system. This starts from the contraction of the muscles of the lower extremity system from the toes to the entire muscle system above it up to the muscle system of the head. followed by relaxation from the muscular system of the head down to the toes so that the respondent can feel relaxed and comfortable. then proceed by relaxing deep breaths by inhaling through the nose to make the abdominal cavity or diaphragm expand until satisfied and comfortable. repeated at least three times or repeated until the respondent can feel satisfied with deep breathing; while identifying with suggestions that train noise is not a threat. then take a deep breath by seriously suggesting that train noise does not interfere with hearing. After the condition becomes more relaxed deep breaths and positive suggestions have been obtained. relaxation of the mind is carried out so that the source of environmental problems in the form of train noise intensity can be temporarily forgotten. because respondents still need to be aware of safety when avoiding passing trains. Finally. relaxation of the mind is continued by focusing on positive suggestions about hearing health. making the mind calm and able to bring the subconscious to suggestions for healthy hearing. These procedures are performed routinely at bedtime for 20-30 minutes in 2 weeks.

The results showed that the average noise intensity decreased from 89.0dB (very loud noise criteria) to 55.13dB (moderate noise criteria). This happened after the KODAMSI intervention and when the condition was relaxed after progressive relaxation with healthy hearing suggestions. The respondent could relax the auditory organ system. especially the middle ear organ. Noise intensity >80dB can cause a shift in Temporary Threshold Shift (TTS). This intensity can cause the tensor tympani muscle to pull the manubrium malleus in an anteromedial direction, causing the tympanic membrane to move inward thus the amount of sound energy entering the inner ear is limited (31,32). Improvement of temporary hearing loss (TTS) can be undertaken by reducing the noise source (train noise intensity) with an egg tray silencer combined with progressive relaxation. This proved significant with a p-value of 0.001.

CONCLUSION

In conclusion. an egg tray mounted on house walls as a silencer can reduce the railroad tracks' noise intensity. Furthermore, KODAMSI is a combination of egg tray silencer and progressive relaxation can prevent the impact of environmental noise on the edge of the railroad tracks and is proven to reduce temporary hearing loss from moderate to mild and normal.

ACKNOWLEDGEMENT

The Ministry of Research and Technology funded the research High Education Contract Number 081 / SP2H / PKM / K7 / 2017

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