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Araştırma Makalesi / Original Research

The Effect of Noise-Attenuating Headphones On Stress, Sleep Quality and Mental Well-being Among Sterilisation Unit Staff

Sterilizasyon Ünitesi Çalışanlarında Gürültü Önleyici Kulaklığın Stres, Uyku Kalitesi ve Mental İyi Oluşluk Üzerine Etkisi

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Abstract:
Aim: This study aimed to evaluate the effects of passive noise-attenuating headphones on sleep quality, mental well-being, and work stress among staff working in a hospital sterilisation unit.
Methods: A single-group quasi-experimental pre-test–post-test design was used. The study included 13 employees working in the sterilisation unit of a university hospital. Data were collected at three time points: baseline (T1), day 14 (T2), and day 30 (T3). The Sociodemographic Data Form, General Work Stress Scale, Richard Campbell Sleep Scale, and Warwick-Edinburgh Mental Well-being Scale were used. Participants were provided with passive noise-attenuating headphones and instructed to use them in noisy work areas for 30 days.
Results: Repeated-measures ANOVA showed no statistically significant changes in work stress or mental well-being scores across the three measurement points ($p > 0.05$). However, sleep quality scores increased significantly over time ($p = 0.008$; $\eta p^2 = 0.402$). Pairwise comparisons indicated that this improvement was particularly significant between baseline and day 14 ($p = 0.004$).
Conclusion: Passive noise-attenuating headphones significantly improved sleep quality among sterilisation unit workers, although their short-term effects on work stress and mental well-being were limited. These findings suggest that low-cost and feasible noise-reduction interventions may support healthcare worker health.

Key Words: Noise; occupational exposure; sleep quality; mental health; work stress; healthcare workers.

Özet:
Amaç: Bu çalışma, hastane sterilizasyon ünitesinde çalışan personelde pasif gürültü azaltıcı kulaklıkların uyku kalitesi, ruhsal iyi oluş ve iş stresi üzerindeki etkilerini değerlendirmeyi amaçlamıştır.
Yöntem: Çalışmada tek gruplu, yarı deneysel ön test–son test tasarımı kullanılmıştır. Araştırmaya bir üniversite hastanesinin sterilizasyon ünitesinde çalışan 13 personel dahil edilmiştir. Veriler başlangıçta (T1), 14. günde (T2) ve 30. günde (T3) olmak üzere üç zaman noktasında toplanmıştır. Veri toplama aracı olarak Sosyodemografik Veri Formu, Genel İş Stresi Ölçeği, Richard Campbell Uyku Ölçeği ve Warwick-Edinburgh Ruhsal İyi Oluş Ölçeği kullanılmıştır. Katılımcılara pasif gürültü azaltıcı kulaklıklar verilmiş ve bu kulaklıkları 30 gün boyunca gürültülü çalışma alanlarında kullanmaları istenmiştir.
Bulgular: Tekrarlı ölçümler ANOVA sonuçları, üç ölçüm zamanı boyunca iş stresi ve ruhsal iyi oluş puanlarında istatistiksel olarak anlamlı bir değişiklik olmadığını göstermiştir ($p > 0,05$). Ancak uyku kalitesi puanlarının zaman içinde anlamlı düzeyde arttığı belirlenmiştir ($p = 0,008$; $\eta p^2 = 0,402$). İkili karşılaştırmalar, bu iyileşmenin özellikle başlangıç ile 14. gün arasında anlamlı olduğunu göstermiştir ($p = 0,004$).
Sonuç: Pasif gürültü azaltıcı kulaklıklar, sterilizasyon ünitesi çalışanlarında uyku kalitesini anlamlı düzeyde iyileştirmiştir; ancak iş stresi ve ruhsal iyi oluş üzerindeki kısa dönemli etkileri sınırlı kalmıştır. Bu bulgular, düşük maliyetli ve uygulanabilir gürültü azaltıcı girişimlerin sağlık çalışanlarının sağlığını destekleyebileceğini göstermektedir.

Anahtar Kelimeler: Gürültü; mesleki maruziyet; uyku kalitesi; ruh sağlığı; iş stresi; sağlık çalışanları.

Introduction

According to the World Health Organization, the preservation and improvement of health and working capacity are only possible through the creation of safe and health-friendly working environments.[1] Sterilisation units, which are critical units providing uninterrupted service in hospitals, are work areas where employees are exposed to various physical factors. One of the most common physical risks encountered in these units is noise.[2] Air guns, washer-disinfectors, and high-speed devices are significant sources of noise in sterilisation units; personnel working with these devices are directly exposed to noise, putting them at risk in terms of occupational health.[3]

Noise exposure leads not only to hearing loss but also to a wide range of adverse health outcomes, such as stress and sleep disorders.[4,5] Sleep disorders have been associated with cardiovascular diseases, mental illnesses, and metabolic disorders such as diabetes, and regular and adequate sleep is a critical component of maintaining health.[6-8] On the other hand, stress can cause mental health problems such as depression and anxiety; prolonged exposure to stress can lead to fatigue, decreased cognitive function, and suppression of the immune system due to increased glucocorticoid release.[9,10]

The World Health Organization (WHO) defines mental well-being as a state in which an individual realizes their potential, copes with the normal stresses of life, works productively and fruitfully, and is able to contribute to their community.[11] The literature shows that individuals with high levels of mental well-being have better psychological and physical health indicators, a higher quality of life, and stronger social relationships.[11-13] Furthermore, mental well-being has been shown to be associated with increased creativity, stronger immunity, and higher work performance.[14]

The current literature indicates that noise exposure negatively affects sleep quality, mental well-being, and work-related stress; however, intervention-based studies focusing on healthcare professionals who are continuously exposed to high noise levels, such as sterilization unit workers, are extremely limited. In particular, no research has examined the effects of low-cost, feasible, ergonomic solutions that do not disrupt workflow, such as passive noise-attenuating headphones, on workers' health indicators. Therefore, this study aimed to evaluate the effects of headphone use on sleep quality, mental well-being, and work-related stress among sterilization unit workers. This study is significant because it fills an important gap in the literature and provides an evidence base for practical interventions to improve worker health.

Materials and Methods

Research design

Our study was designed as a single-group quasi-experimental pre-test-post-test study.

Sample size

In this study, the sample size was calculated using G*Power version 3.1.9.7 for a single-group, three-time repeated-measures design.[15] It was assumed that the use of headphones would yield a clinically meaningful and large effect on outcome variables such as sleep quality, mental well-being, and work stress. Accordingly, an effect size of f = 0.40, corresponding to a large effect according to Cohen's classification, was adopted.[16] Based on these parameters (f = 0.40, $\alpha = 0.05$, $1-\beta = 0.80$), the minimum required sample size was calculated as 12 participants.

The total population of the sterilisation unit in which the study was conducted consisted of 15 staff members (N = 15). Therefore, a census approach was employed, and all eligible individuals were invited to participate in order to maximise statistical power and minimise selection bias. One individual declined to participate, and one participant was excluded due to non-adherence to the intervention (failure to use the headphones regularly during the study period). Consequently, the study was completed with a final sample of 13 participants.

A post hoc power analysis was conducted for the sleep quality outcome using G*Power version 3.1.9.7. [15] The analysis was based on a within-subjects repeated-measures ANOVA model with three measurement points and a final sample of 13 participants. The observed partial eta-squared value of 0.402 corresponded to an effect size of f=0.82. An alpha level of 0.05, a correlation of 0.60 among repeated measurements, and a Greenhouse–Geisser nonsphericity correction of 0.645 were entered into the analysis. Based on these parameters, the achieved statistical power was 0.99.

Data collection

Data were collected from the staff working in the sterilisation unit of a university hospital between August 12 and September 11, 2025. Data pertaining to the participants were obtained using the Sociodemographic Data Form, General Work Stress Scale, Richard Campbell Sleep Scale, and Warwick-Edinburgh Mental Well-being Scale. At the beginning of the research process, participants were trained on the use of headphones, and after the headphones were introduced, the first measurement (baseline measurement) data were

collected. Participants were provided with 3M™ PELTOR™ Optime™ II passive noise-attenuating earmuffs and were instructed to use them regularly in noisy areas for 30 days[17]. During the follow-up period, repeat measurements were taken on day 14 (second measurement) and day 30 (third measurement) using the General Work Stress Scale, Richard Campbell Sleep Scale, and Warwick-Edinburgh Mental Well-being Scale. Headphones were given as a gift to the participants to encourage their participation in the study. The inclusion criteria for the study were defined as having worked in the sterilisation unit for at least six months, having no hearing impairment, not receiving pharmacological treatment to improve sleep quality, and having no psychopathology. Not using headphones regularly during the study period was considered an exclusion criterion.

Data collection forms

Socio-demographic data form

This form was created to obtain data such as the participants' age, gender, and length of service in the sterilisation unit.

General Work Stress Scale

Developed by De Bruin, the General Work Stress Scale is a 5-point Likert-type scale consisting of nine items. The General Work Stress Scale is short and unidimensional. High scores indicate high work stress, whereas low scores indicate low work stress. The scale has a Cronbach's alpha value of 0.91.[18] It was adapted into Turkish by Teleş.[19] In our study, the measurements were calculated as 0.91, 0.86, and 0.92, respectively.

Warwick-Edinburgh Mental Well-being Scale

The Warwick-Edinburgh Mental Well-being Scale was developed by Tennant et al.[20] to measure the mental well-being of individuals in the United Kingdom. The scale, which covers ‘psychological well-being’ and ‘subjective well-being’, consists of 14 positive items. High scores on the scale indicate good mental well-being. Keldal[21] carried out the Turkish adaptation. The Cronbach's alpha value of the scale was reported to be 0.92. In our study, Cronbach’s alpha values were 0.90, 0.88, and 0.95, respectively.

Richard Campbell Sleep Scale

It was developed by Richards to measure sleep quality in adults.[22] Özlü and Özer[23] adapted the scale for Turkish. Each item was evaluated on a scale ranging from 0 to 100 using the visual analog scale technique. A score between '0-25' on the scale indicates very poor sleep, while a score between '76-100' indicates very good sleep. The total scale score was assessed over five items; the 6th item, which assessed the noise level in the environment, was excluded from the total score assessment. The Cronbach's alpha reliability coefficient of the scale was reported to be 0.91. In our study, these values were 0.76, 0.86, and 0.93, respectively.

Ethical considerations

The study protocol was reviewed and approved by the Mersin University Clinical Research Ethics Committee (Approval No: 2025/637). Participants were provided with both verbal and written information about the study, and written informed consent was obtained from all participants before their inclusion in the research. Participant confidentiality was ensured, and no identifying information was recorded at any stage of the study. The study was conducted in accordance with the 2013 revision of the Declaration of Helsinki.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 27.0.[24] Continuous variables were summarised as mean and standard deviation, whereas categorical variables were presented as numbers and percentages. The normality of the data was assessed using the Shapiro–Wilk test, and the assumption of normal distribution was met ($p > .05$).[25] Repeated-measures ANOVA was used to examine within-group changes across time points. When Mauchly's test indicated a violation of the sphericity assumption, Greenhouse–Geisser correction was applied and corrected degrees of freedom were reported. Bonferroni correction was used for pairwise comparisons between time points to control for multiple comparison error. Effect size was evaluated using partial eta-squared (ηp^2). Statistical significance was set at $p < .05$ for all analyses.

Results

The demographic characteristics of the participants are presented in Table 1.

Table 1. Characteristics of Participants

Characteristics	Categories	n	%
Gender	Female	8	61.5
	Male	5	38.5
Marital Status	Married	9	69.2
	Single	4	30.8
Education Level	High school	1	7.7
	University	12	92.3
Previous Use of Hearing Protection	Never	10	76.9
	Rarely	3	23.1
		Mean	SD
Age (years)		34.3	10.90
CSSD working experience (years)		6.6	8.11

SD: Standard Deviation; CSSD: Central Sterile Supply Department.

The data for Work Stress, Mental Well-being, and Sleep Quality were normally distributed ($p > 0.05$).

Descriptive statistics for work stress, mental well-being, and sleep quality scores across the three measurement points are presented in Table 2.

Table 2. Descriptive Statistics of Scale Scores by Time Period, Internal Consistency and Normality Results

Scales	Time	Mean ± SD	Min-Max	CA (α)	Shapiro-Wilk
Work Stress	T1	19.23±7.16	9-31	0.91	0.56
	T2	17.38±6.03	9-29	0.86	0.20
	T3	17.00±6.67	9-28	0.92	0.15
Mental Well-being	T1	54.23±8.48	41-69	0.90	0.89
	T2	55.92±7.08	44-70	0.88	0.93
	T3	56.07±10.05	34-70	0.95	0.61
Sleep Quality	T1	59.15±16.13	34-95	0.76	0.57
	T2	74.23±15.98	48-94	0.86	0.24
	T3	71.84±19.31	39-97	0.93	0.40

SD: Standard Deviation. CA (α)=Cronbach's Alpha

The repeated measures ANOVA results indicated that work stress scores did not show a statistically significant change across the three time points ($F(2,24) = 2.27$; $p = 0.125$; $\eta p^2 = 0.159$). Similarly, the mental well-being variable did not show a significant difference according to the measurement time ($F(2,24) = 0.69$; $p = 0.510$; $\eta p^2 = 0.054$). In contrast, a statistically significant change was found in sleep quality scores over time ($F(1.29, 15.54) =$

8.21; p = 0.008; partial η ² = 0.402). The mean sleep quality scores increased from 59.15 ± 16.14 at T1 to 74.23 ± 15.99 at T2. At T3, the mean score was 71.85 ± 19.31.

Binary comparisons of sleep quality measurement times showed a statistically significant difference between T1 and T2 (F(1.12) = 14.55; p = 0.004; ηp^2 = 0.55). The difference between T2 and T3 was not significant (F(1.12) = 0.95; p = 0.696; ηp^2 = 0.07) (Table 3)(Fig. 1).

Table 3. Changes in Work Stress, Mental Well-being, and Sleep Quality Over Time: Descriptive Statistics and Repeated Measures ANOVA Results

Scales	Sphericity (Mauchly p)	df	F	p	Partial η^2
Work Stress	0.789	(2. 24)	2.27	0.125	0.159
Mental Well-being	0.898	(2. 24)	0.69	0.510	0.054
Sleep Quality	0.013	(1.29. 15.54)	8.21	**0.008***	0.402
Sleep Quality	T1-T2		14.55	0.**004***	0.55
	T2-T3		0.953	0.696	0.07

SD: Standard Deviation. η^2: effect size. T: Measurement times. *p < .05

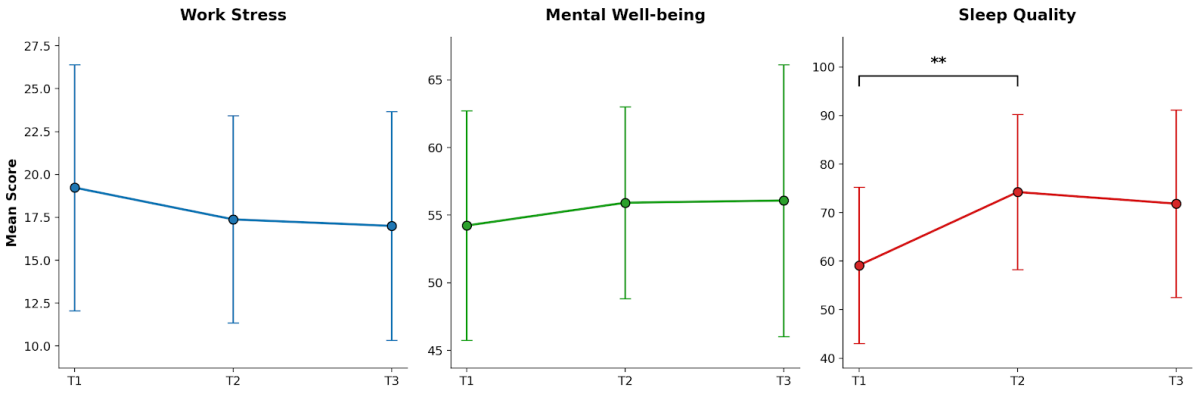

Figure 1. Changes in Work Stress, Mental Well-being, and Sleep Quality Scores Across Timepoints

Note. The line graphs display the mean scores for Work Stress, Mental Well-being, and Sleep Quality at three distinct timepoints (T1, T2, and T3). Error bars represent standard deviations (± *SD*). A repeated-measures analysis of variance (ANOVA) revealed a statistically significant increase in Sleep Quality between T1 and T2. ***p* < .05.

Discussion

This study examined the effects of using headphones on sleep quality, mental well-being, and work stress among staff working in a sterilisation unit. The findings showed that the use of headphones provided a significant and large effect size improvement in sleep quality

over time but did not produce a statistically significant change in work stress and mental well-being.

Our study observed a marked increase in sleep quality on day 14 compared to the baseline measurements (Table 3). This finding is consistent with previous studies that have demonstrated the adverse effects of noise exposure on sleep physiology. Noise exposure is known to prolong sleep onset latency, disrupt sleep integrity, and increase nighttime awakenings.4,26 Reducing environmental noise through headphones likely contributed to decreased pre-sleep physiological arousal and improved sleep quality. However, no statistically significant changes in work stress scores were detected over time (Table 3). This can be explained by the fact that work stress is related not only to physical environmental factors but also to multidimensional variables such as workload, organizational structure, shift patterns, level of responsibility, and managerial factors. De Bruin18 states that although noise is an important factor that increases work stress, it is not the main factor that determines stress levels on its own. Ganster and Rosen27 reported that physical factors such as noise are important, but factors such as workload, role conflict, control, and organizational structure can be more decisive in terms of stress. Therefore, it is believed that an environmental intervention, such as headphones, may have a limited effect on work stress in the short term.

Similarly, the lack of a significant change in mental well-being scores may be related to mental well-being being more dependent on long-term psychosocial processes than on physical activity. Mental well-being is shaped not only by environmental noise levels but also by the interaction of many factors, such as coping skills, perceived social support, job satisfaction, and living conditions.[12,13] In this context, the absence of a measurable change in mental well-being after a 30-day intervention period can be considered consistent with the literature. The findings of this study show that headphones are an effective, low-cost, and feasible intervention, particularly for improving sleep quality. Considering that active noise control systems may not be feasible in every healthcare setting owing to cost, technical infrastructure, and sustainability concerns, headphones offer a practical alternative.28,29 Particularly in work areas where noise levels are constant and unavoidable, such as sterilisation units, these types of ergonomic solutions can be considered a supportive approach to employee health.

Results and Recommendations

In conclusion, this study found that the use of headphones significantly improved sleep quality in sterilisation unit workers to a clinically important degree but had limited short-term

effects on work stress and mental well-being. The findings emphasize the importance of simple, low-cost, and feasible interventions to reduce environmental risks faced by healthcare workers and provide valuable groundwork for evidence-based practices aimed at improving worker health in the future.

Limitation

This study has several limitations. First, the small sample size (n = 13) limits the generalizability of the findings to broader populations. Second, the intervention was delivered using passive headphones only; therefore, the findings may not be generalizable to other audio delivery methods. Third, the study outcomes were assessed solely using self-report measures, which may be subject to response bias. Future studies should incorporate objective biophysiological indicators, such as cortisol levels, alongside self-report measures to provide a more comprehensive evaluation of the intervention's effects.

Conflict of Interests

The authors declare that there is no conflict of interest.

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Author contributions

Conceptualization, methodology, supervision, formal analysis, interpretation of data, writing—original draft, and writing—review and editing (UA). Data collection, investigation, and writing—review and editing (SA). Data collection, investigation, and writing—review and editing (Y.Ç.C). Data collection, investigation, and writing—review and editing (MT). All authors read and approved the final version of the manuscript.

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