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# Prevalence and pattern of hearing loss associated with using earphones among medical students in Al-Madinah region, kingdom of Saudi Arabia: A cross sectional study

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## ABSTRACT

**Background:** Hearing is a complex process of detecting and processing sound, and it is one of the five senses. Hearing can be impaired for many causes like exposure to external noises such as headphones, loud television sounds, and construction sites which eventually can lead to noise-induced hearing loss. **Methodology:** The participants were randomly selected using a proportional cluster sampling method in March 2022. The target population is medical students who use headphones in Al-Madinah region. The students completed a questionnaire distributed through online platforms. The estimated sample size was 222 students after applying inclusion and exclusion criteria. **Results:** A total of 222 respondents were included in this study. Almost half of them are aged between 22- 24 years. Females were 51.4%, which showed higher hearing loss scores. The prevalence of hearing problems among the study participants was found to be 34.2%. Moreover, we found that there is a significant association between the usage of earphones and hearing loss. Turning the volume up was significantly associated with hearing loss. In terms of how many days a week they use their earphones, most of the participants (67%) use them 3 days or more. About (67%) of participants rate themselves as having no hearing problems. The rest (33%) have hearing problems. **Conclusion:** According to the results of our study, medical students in the Al-Madinah region had a relatively high prevalence of hearing loss related to earphones usage.

**Keywords:** Noise-Induced hearing loss, Earphones, Headphone, Music Player

## 1. INTRODUCTION

Hearing is one of the five senses, and it is the intricate process of detecting and processing sound. However, hearing loss can occur for a variety of reasons. For example, constant exposure to environmental noises such as headphones, loud sounds from the television, building sites, traffic, industrial equipment, and so on (Ogbe et al., 2014). In recent decades, headphone use has increased significantly as a result of greater accessibility and affordability, which allows students with hectic schedules to listen to music in their free time or for stress relief (Naik and Pai, 2014). Cell phones and headphones are used by approximately 90% of the population in industrialized countries such as the United States, and the situation is similar in the Kingdom of Saudi Arabia (Acharya et al., 2013). As a result, the radiofrequency fields emitted by mobile phones may damage people's hearing (Hedge et al., 2013). Noise induced hearing loss (NIHL) occurs when the hair cells in the inner ear are destroyed by prolonged exposure to loud noise. Hair cells (sensory cells) convert the sound energy into an electrical signal, which then travels to the auditory processing region of the brain. When these cells are damaged, they are unable to regenerate (Ogbe et al., 2014). NIHL is a major socioeconomic and public health issue.

According to the third National Health and Nutrition Examination Survey (NHANES III) in the United States, 12.5% of children between the ages of six and nineteen had hearing threshold changes in one or both ears as a result of exposure to excessively hazardous noise (Niskar et al., 2001). The prevalence of hearing loss among adolescents aged 12 to 19 years grew drastically from 14.9 percent in 1988-1994 to 19.5 percent in 2005-2006, according to a study conducted in the United States (Shargorodsky et al., 2010). Multiple studies have found that teenagers and young adults who wear headphones have lower hearing thresholds than those who do not (Kim et al., 2009; Kumar et al., 2009). Since there are only a few studies that have focused on a specific population, such as medical students who use their headphones more frequently for education and leisure, our objective from this study is to determine the frequency of hearing loss related to headphone use among all medical students in Al-Madinah region, Kingdom of Saudi Arabia.

## 2. MATERIALS AND METHODS

This is a cross sectional study conducted in Saudi Arabia's Al-Madinah region in 2022. Data was collected via an online questionnaire provided via social media that focused on the frequency of hearing loss among medical students who use headphones. Special criteria included medical students from Al-Madianh region, both sexes, and individuals aged 19 to 26 and excluded those who declined to participate in the study, had a prior history of any hearing problems, childhood meningitis, used ototoxic medicines, or had a family history of hearing loss.

The questionnaire was based on a validated questionnaire that had previously been published (Mohammadpoorasl et al., 2018). The questionnaire has three sections that allow for the evaluation of demographic data; questions about the past medical history of the participants; questions about using the headphones; and questions about hearing assessment conditions.

The analysis was conducted using SPSS statistics version 23.0 and was based on the types of variables and differential statistics in the form of the independent samples T test and one way ANOVA test. The significance of the data was determined using the p-value. The null hypothesis is rejected when the p-value is 0.05 and not rejected when  $p \geq 0.05$ , which is indicated by using the conventional 0.05 cutoff.

## 3. RESULTS

A total of 222 respondents were involved in this study. Our results found that almost half of the respondents were aged between 22 and 24 years, and 42.3% were aged between 19 and 21 years. Moreover, our findings revealed that there is a significant association between the gender and hearing loss score. Females were (51.4%) and their score was 22.0 4.4 (P value =.0022). On the other hand, males were 48.6% and their score was 20.7 3.3. Regarding the marital status of our participants, we found that the majority of them were single (98.2%) and lived in their parents' homes. As demonstrated in Table 1, the average GPA of our participants was  $4.4 \pm 0.5$  (range 2.3–5).

The prevalence of hearing problems among the study participants: 76 (34.2%) mild: 62 (27.9%), moderate: 10 (4.5%), and severe: 4 (1.8%). Additionally, we found that the majority of our participants were using earphones (92.8%). When we checked the association between using earphones and hearing loss, we found that there was a significant association between the usage of earphones and hearing loss with a p-value < 0.001. About 85% of earphones were dual, and 76.7% of them were connected to a mobile device (Table 2). When we assessed the duration of usage of earphones, we found that half of the participants (50%) were using earphones for more than 4 years, 14.6% for 3 years, and only 4.9% reported usage for a year, and this found to be significantly

associated with hearing loss score (P value= 0.046). More than half of the participants (62%) preferred to use their earphones while they were at home.

**Table 1** Characteristics of the participants and their association with the hearing loss questionnaire (n=222).

Variable	N (%)	Hearing Loss score	P value
		Mean $\pm$ SD	
Age (years)			
19-21	94 (42.3%)	21.3 $\pm$ 3.7	0.985
22-24	108 (48.6%)	21.4 $\pm$ 4.3	
25-26	20 (9%)	21.3 $\pm$ 3.6	
Gender			
Male	108 (48.6%)	20.7 $\pm$ 3.3	0.022
Female	114 (51.4%)	22.0 $\pm$ 4.4	
Marital status			
Single	218 (98.2%)	21.3 $\pm$ 4.0	0.175
Married	2 (0.9%)	19 $\pm$ 0	
Divorced	2 (0.9%)	26 $\pm$ 0	
Where do you live?			
Parental home	208 (93.7%)	21.4 $\pm$ 3.9	0.398
Private student dormitory	2 (0.9%)	18 $\pm$ 0	
Single house	10 (4.5%)	21.6 $\pm$ 5.1	
Other	2 (0.9%)	18 $\pm$ 0	

When looking at the volume they often use to listen, we found that 28.2% used high volume (75% and above), and this was significantly associated with a higher score of hearing loss (P value 0.015) (Table 2). There is a significant association between turning down the volume after using earphones and affection for hearing loss, with a p-value (0.001). There was also a significant association between turning the volume up and hearing loss with a p-value equal to 0.001. Our results showed that about 67% of participants had already been told by someone that listening to loud music for a long period is dangerous to their hearing, and this resulted in about 59% of them changing their behavior after this warning (Table 2). Regarding the frequency of participant use of their headphones per week, most of the participants (67%) use those 3 days or more, and 39.8% of respondents use headphones more than 4 days per week. Moreover, we found that 30.1% used headphones two times per day, 19.4% used headphones three times per day, and the same percentage used headphones four times or more, and this was found to be significantly associated with hearing loss (P value 0.015).

In order to investigate the experience of tinnitus among participants, we found that about one-third of participants experienced tinnitus, and this showed a significant association with hearing loss (P value= <0.001). Concerning the rate of hearing in participants, (67%) rate themselves as having no hearing problems. The rest (33%) had problems (P value= <0.001). About 79.4% of them never see a doctor because of this problem (Table 2).

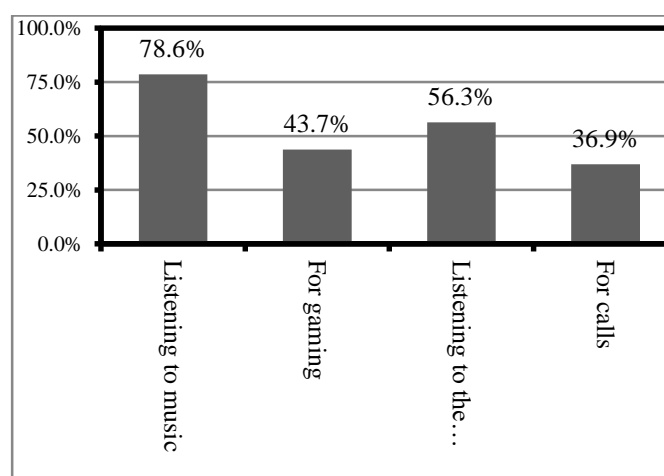
**Table 2** Earphones and their usage patterns and the relationship between the use of earphone and hearing loss

Variable	Categories	N (%)	Hearing Loss score	P value
			Mean (SD)	
Do you use headphones	Yes	206 (92.8)	21.6 (4.0)	< 0.001
	No	16 (7.2)	18 (0)	

If Yes (n=206)				
Are your headphones dual or single	Dual	176 (85.4)	21.4 (3.8)	0.078
	Single	30 (14.6)	23 (4.6)	
If single which ear do you use most often (n=30)	Right ear	14 (46.7)	22.4 (3.6)	0.292
	Left ear	6 (20)	21.3 (4.4)	
	Not sure	10 (33.3)	24.8 (5.7)	
What are the most devices that your headphones are connected to	Computer	38 (18.4)	21.9 (4.3)	0.119
	Mobile	158 (76.7)	21.4 (3.9)	
	MP3 player	2 (1)	28.0 (0)	
	Other	8 (3.9)	22.3 (4.1)	
How long have you been using headphones	< a year	10 (4.9)	24.0 (5.5)	0.046
	1 year	18 (8.7)	23.0 (5.7)	
	2 years	26 (12.6)	22.4 (4.7)	
	3 years	30 (14.6)	22.1 (3.8)	
	4 years	18 (8.7)	21.4 (3.2)	
	> 4 years	104 (50.5)	20.9 (3.3)	
What is your favorite place to wear headphones	Gym	44 (21.4)	21.2 (3.9)	0.498
	Dormitory	6 (2.9)	24.0 (4.6)	
	Home	128 (62.1)	21.8 (4.2)	
	Street	26 (12.6)	21.0 (2.8)	
	Other	2 (1)	22.0 (0)	
When you use headphones, what volume do you use most often	Very low (< 25%)	0 (0)	-	0.015
	Below the middle range (25% to 50%)	10 (4.9)	21.0 (2.7)	
	In the middle range (50%)	36 (17.5)	21.6 (3.6)	
	Above the middle (50% to 75%)	102 (49.5)	20.9 (3.4)	
	High volume (75% and above)	58 (28.2)	23.0 (5.0)	
When you use headphones, do you hear the people around you	Yes	100 (48.5)	21.5 (3.8)	0.573
	No	106 (51.5)	21.8 (4.2)	
When using headphones, do you turn up the volume after a while	Always	38 (18.4)	24.1 (5.1)	0.001
	Most of the times	50 (24.3)	21.5 (3.9)	
	Sometimes	82 (39.8)	20.9 (3.1)	
	Very little	24 (11.7)	20.9 (3.7)	
	Never	12 (5.8)	20.8 (3.5)	

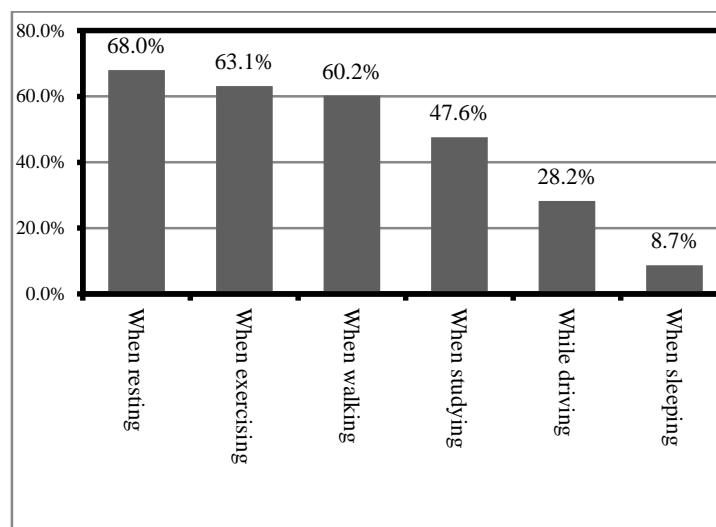
When using headphones, do you turn the volume down after a while	Always	18 (8.7)	26.8 (5.5)	< 0.001
	Most of the times	38 (18.4)	21.8 (3.9)	
	Sometimes	82 (39.8)	20.8 (3.6)	
	Very little	60 (29.1)	21.2 (2.8)	
	Never	8 (3.9)	21.0 (4.4)	
When using headphones, do you pause to rest your ears	Always	34 (16.5)	23.7 (5.4)	0.008
	Most of the times	42 (20.4)	22.0 (3.7)	
	Sometimes	42 (20.4)	21.3 (4.1)	
	Very little	56 (27.2)	20.6 (2.9)	
	Never	32 (15.5)	21.3 (3.4)	
Has anyone ever warned you that listening to loud music for long periods is dangerous for your hearing	Yes	138 (67)	21.0 (3.7)	0.002
	No	68 (33)	22.9 (4.2)	
Has such a warning (meaning the previous question) affected your behavior (for example, reducing the volume of music or reducing the duration of use) (n=138)	Yes	82 (59.4)	21.4 (4.3)	0.061
	No	50 (36.2)	20.3 (2.3)	
How many days per week do you use headphones on average	< 1 day	26 (12.6)	22.5 (5.5)	0.567
	1 day	12 (5.8)	22.3 (4.0)	
	2 days	30 (14.6)	21.9 (4.0)	
	3 days	36 (17.5)	21.9 (4.2)	
	4 days	20 (9.7)	20.8 (2.6)	
	> 4 days	82 (39.8)	21.2 (3.6)	
How many times per day do you use headphones on average	Once	64 (31.1)	21.0 (3.4)	0.017
	Twice	62 (30.1)	22.3 (4.3)	
	3 times	40 (19.4)	22.7 (5.1)	
	4 times or more	40 (19.4)	20.4 (2.2)	
How many hours per day do you use headphones on average	< an hour	26 (12.6)	21.7 (4.2)	0.150
	1 hour	46 (22.3)	22.1 (4.0)	
	2 hours	48 (23.3)	21.8 (4.8)	
	3 hours	40 (19.4)	22.4 (4.2)	
	> 3 hours	46 (22.3)	20.4 (2.0)	
What kind of headphones do you	In-ear headphones	60 (29.1)	21.1 (4.1)	0.327

usually use	Ear buds (Ordinary headphones)	104 (50.5)	21.6 (4.2)	
	Overhead headphones	42 (20.4)	22.3 (3.3)	
Have you ever had tinnitus (a sound sensation in your head) after using headphones	Yes	62 (30.1)	23.6 (4.7)	< 0.001
	No	144 (69.9)	20.8 (3.3)	
If your answer is yes, how much do you suffer from this situation (n=62)	Always	8 (12.9)	26.0 (6.0)	0.111
	Sometimes	20 (32.3)	24.3 (3.8)	
	Rarely	34 (54.8)	22.5 (4.6)	
How do you rate your hearing	No hearing problem	138 (67)	20.6 (3.6)	< 0.001
	Mild hearing problem	60 (29.1)	23.6 (3.7)	
	Moderate hearing problem	8 (3.9)	25.3 (5.3)	
	Severe hearing problem	0 (0)	-	
If you have hearing problems, have you ever seen a doctor because of your problem (n=68)	Yes	14 (20.6)	24.1 (4.3)	0.766
	No	54 (79.4)	23.7 (3.8)	

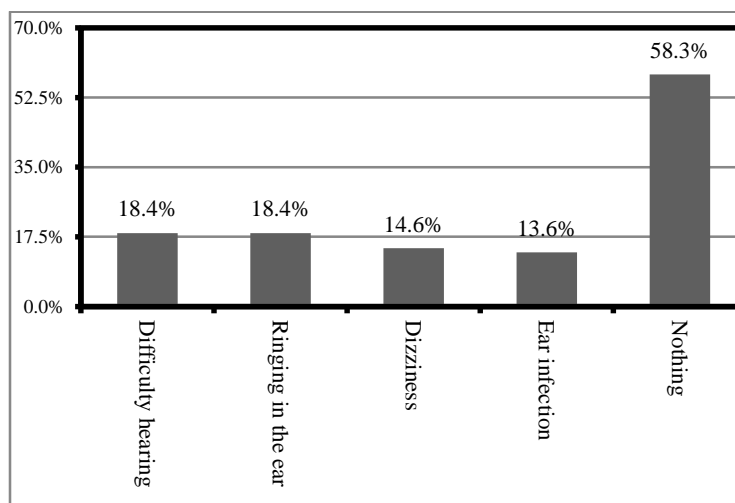


**Figure 1** The reasons for using headphones (n=206)

When looking for reasons why participants use their headphones, most of them (78.6%) use them to listen to music, and about (56.3%) use them to listen to lecture records (figure 1). Regarding the time of usage of headphones, most use them when resting (68%) and exercising (63%) (figure 2). In general, more than half of the participants (58%) experienced nothing regarding hearing problems (figure 3), analyzed in detail in table 3.



**Figure 2** Times of wearing headphones (n=206)



**Figure 3** Hearing problems caused by headphones usage (n=206)

When we look at the hearing assessment, the majority of participants (88.3%) do not suffer from any hearing problems during a phone conversation. When two or more persons were talking, approximately one third of the participants had difficulty following the conversation, whereas (67%) did not. More than 15% of them experienced someone who told them that they turned the TV volume too high. Regarding straining to understand a conversation, 20 percent of participants needed to strain. Most of the participants do not need people to repeat their words and do not think that people are not speaking clearly. Most of them do not think that the hearing problem is getting worse and is not causing problems with listening to the radio or the TV. Concerning hearing from behind, 11.7 percent reported a problem, and the same percentage of participants experienced trouble hearing the alarm clock. Regarding hearing soft sounds, 90.31% experienced no problems. When looking for family or friends who told participants that they were concerned about their hearing, (17.5%) of participants have been through this observation. When assessing the hearing of men's voices better than women's, more than 2.40% of participants have experienced this type of hearing problem (Table 3).

**Table 3** Hearing assessment questions

Question	Yes	No
Do you suffer from hearing problems when talking on the phone	24 (11.7)	182 (88.3)



When two or more individuals are speaking at once, do you find it difficult to keep up with the conversation	68 (33)	138 (67)
Do people frequently complain that your TV is too loud	32 (15.5)	174 (84.5)
Do you struggle to follow conversations	40 (19.4)	166 (80.6)
Do you have problems hearing when the background is noisy	88 (42.7)	118 (57.3)
Do you need people to repeat their words until you hear and understand them	56 (27.2)	150 (72.8)
Do you think that many people do not speak clearly (in a clear voice)	60 (29.1)	146 (70.9)
Do you frequently misinterpret what people are saying and have improper responses	60 (29.1)	146 (70.9)
Do you feel you have a hearing problem that is getting worse over time	38 (18.4)	168 (81.6)
Is it difficult for you to hear the TV or radio because of a hearing problem	28 (13.6)	178 (86.4)
If someone is speaking to you behind you, do you miss it	24 (11.7)	182 (88.3)
Do you having difficulty hearing your alarm	24 (11.7)	182 (88.3)
Are the doorbells or phone not audible to you	20 (9.7)	186 (90.3)
Are gentle noises, like birds singing, no longer audible for you	20 (9.7)	186 (90.3)
Do you believe that people (on TV, friends, doctors) speak too quickly	28 (13.6)	178 (86.4)
Has any of your family or friends told you that they are concerned about your hearing	36 (17.5)	170 (82.5)
Do you comprehend male voices more easily than female voices	44 (21.4)	162 (78.6)
To understand what is being said, do you need to cut your ear or turn toward the speaker	56 (27.2)	150 (72.8)

#### 4. DISCUSSION

Our study aimed to determine the frequency of hearing loss associated with earphones, their usage patterns, and the association between earphone usage and hearing loss among medical students in Al-Madinah region, Kingdom of Saudi Arabia. Hearing loss is a health issue that can interfere with the quality of life (Magilvy, 1985) (Mulrow et al., 1990). Our results demonstrated that the prevalence of hearing loss was 34.2%, with mild (27.9%), moderate (4.5%), and severe (1.8%). The impact of mild hearing loss on communication is significantly greater. About 50% of the audible information in conversational speech will be missed by a person with minor hearing loss. This amount is raised for quiet or distant level speech. Even at close range, a moderate degree of hearing loss distorts conversational level speech. While severe hearing loss renders a person's close speech inaudible (Watkinson et al., 2018). These results are lower than another study that was conducted in Iran, which revealed a prevalence of 60% (Mohammadpoorasl et al., 2018). Similarly, a previous study demonstrated that portable music players can have a deleterious effect on the hearing threshold of participants (Kim et al., 2009).

Consistent with our findings, another study in Malaysia revealed a lower prevalence of 7.3% (Sulaiman et al., 2013). Moreover, an earlier study that was conducted in Nigeria showed that only 18.2% of the respondents claimed to have hearing problems that were linked to mobile phone usage (Olaitan and Osisanya, 2017). However, another study in Pakistan showed prevalence similar to



our results (Asghar et al., 2022). The current study demonstrated that there is a significant association between the usage of earphones and hearing loss with a p-value  $< 0.001$ . Furthermore, we found that hearing loss was significantly associated with gender; females had a higher hearing loss score than males. These findings were inconsistent with results from another study, which reported that significant elevations of hearing threshold were observed in males (Kim et al., 2009). Similarly, a previous study in Nigeria demonstrated that (54.55%) were males, while (45.45%) were female participants who presented with hearing loss (Olaitan and Osisanya, 2017). This is most likely due to differences in the sampled population, as in our study we had a higher number of female participants.

With regard to the duration of usage of other earphones, we end up with about half of the participants (50%) using earphones for more than 4 years. We discovered a p-value (0.001) significant relationship between them. In addition, there is also a significant association between turning the volume up and hearing loss with a p-value equal to 0.001. Another study that was conducted in Malaysia revealed that subjects who listened at higher volumes also tended to listen for longer durations ( $P = 0.012$ ) (Sulaiman et al., 2013). In order to investigate the experience of tinnitus among participants, we ended up with 69.9% of participants who did not experience tinnitus.

An earlier study showed that only 9.5% reported associated tinnitus (Asghar et al., 2022). However, another study showed that 27% had tinnitus (Zia et al., 2014). When looking at the volume they often used to listen at, we found that about half of the participants (49.5%) used above the middle volume. This is consistent with another study which revealed that about half of the participants used to listen to higher volumes (Shah et al., 2009). Regarding straining to understand a conversation, (80%) of participants do not need to strain. Most of the participants do not need people to repeat their words, and do not think that people don't speak clearly. By virtue of the study design, the current study has certain unavoidable limitations.

Based on the findings of this study, a causal relationship cannot be established, and further research is required. Because this was a single-center study using convenience sampling, the findings cannot be generalized.

## 5. CONCLUSION

Our study concluded that the prevalence of hearing loss associated with earphones was found to be relatively high among medical students in Al-Madinah region, Kingdom of Saudi Arabia. The higher hearing loss score among headphone users necessitates additional investigation to implement interventions and develop strategies to improve students' awareness and attitude toward the use of personal listening devices.

### Abbreviation

NIHL (Noise-Induced Hearing Loss)

### Consent for publication

Informed consent was obtained from all the participants.

### Ethical approval and consent to participate

The researchers sought approval from Taibah University, the college of medicine, research ethics committee (CM-REC) with a register number (TU-21-024). Participation was voluntary, and participants were permitted through their consent to participate in the study. All data from the questionnaire was kept confidential, and only researchers could access the participants' information.

### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

### Authors' contributions

As authors, we certify that we have contributed sufficiently to the intellectual content, conception, design, analysis, and interpretation of the data, as well as the writing of the manuscript, to accept responsibility for it in the public eye and that we have given our consent to have our name listed as a contributor. All those who have contributed significantly to the work described in the manuscript.

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# Conflict of interest

The authors declare that there is no conflict of interests

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