Research Article

Prevalence of otomycosis in patients with cerumen impaction due to earphone usage during COVID-19

Sunethra Suresh^{1*}, Suraj Suresh², Sudha Sivasamy³

¹Medical Student, MBBS (Western Sydney University)

²2nd Year BSc (Hons) Economics (University College London)

³MBBS, DLO, FRCS (Consultant ENT Surgeon)

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*Corresponding author:

E-mail:

suredr@yahoo.com

ABSTRACT

Background: Otomycosis affects about 9% of patients with otitis externa. One of the predisposing factor is impacted cerumen. Earphone usage causes cerumen impaction. In the light of the recent COVID-19 pandemic, people are housebound due to prolonged lockdown. Hence people are more technology dependent as working from home and studying online has become the norm. Therefore, usage of earphones has proportionately increased, and the impacted cerumen cases have increased. **Methods:** This cross-sectional study aimed to analyze data from questionnaire to assess the prevalence of otomycosis among patients with impacted cerumen due to excessive earphone usage, establish associations between otomycosis and symptoms such as pain and hearing loss as well as the correlation between fungal growth and the long hours of earphones usage. The relationship between the age of participants and the usage of earphones during the pandemic was also explored. The data was collected from 100 individuals aged 14 to 51 years who sought treatment for symptomatic impacted wax at an ENT clinic in Malaysia. **Results:** The mean age of participants was 25.9 years. There was a 31% prevalence of otomycosis among these patients. Otalgia was present in 60% of patients with otomycosis (t value 2.94, coefficient 0.27). Approximately 37% of patients had a large air-bone gap indicating conductive hearing loss. There was an insignificant correlation between otomycosis and the longer hours of earphones usage (t value 1.51, coefficient 0.00015). No correlation was found between age of participants and the total hours of earphone usage (t value 0.63, coefficient 0.0012). **Conclusion:** This study offers initial evidence that earphone usage could be a predisposing factor in developing otomycosis. However, there was no evidence of longer hours of earphones usage increasing the chances of developing otomycosis. Additionally, symptoms like otalgia and conductive hearing loss could be present in both earwax impaction and otomycosis.

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Background

Otomycosis is a common fungal infection of the external auditory canal that is complex for both patients and otolaryngologists to cure since it requires long-term management and follow-up [1,2,3]. This infection has reported to be prevalent in 9% of patients who present with clinical features of otitis externa [1]. Evidence suggests that the most common pathogens contributing to this disease process are *Aspergillus* (41% from *Aspergillus fumigatus* and 36% from *Aspergillus niger*) and *Candida* causing 8% of infections [1,2]. Previously explored predisposing factors include a humid climate, the presence of cerumen, ear instrumentation, increased use of topic antibiotics or steroid preparations, immunocompromised patients and hearing aid users [1,4,5]. Furthermore, patients suffering from otomycosis usually present with unilateral inflammatory pruritis as well as otalgia [6,7].

In the light of the COVID-19 global pandemic, many countries opted for complete lockdowns due to an increasing number of cases [8]. In order to continue businesses while complying with the strict lockdown measures, the work-from-home concept has been implemented [8,9,10]. Furthermore, schooling students also require online learning to ensure learning is not interrupted [9,10]. Due to approximately 80% of the population working or studying from home, there is proven evidence in increase in the use of electronic devices such as earphones for these activities [10]. It is known that the prolonged usage of earphones causes cerumen impaction, which in turn predisposes to otomycosis [1,4,5], due to the inability of wax extrusion. [11]. Additionally, there has also been concerns about hearing loss due to prolonged usage of this device [12].

However, due to the paucity of research in this area, it is unknown whether prolonged earphone usage could be a factor for otomycosis development. This association is important to be investigated as otomycosis has a complicated management plan and a high recurrence rate despite adequate management [1]. This warrants further investigation of the correlation between these variables to provide clinical information to patients to potentially decrease risk factors of developing otomycosis.

This study aimed to investigate the prevalence of otomycosis among patients with cerumen impaction, the association of otomycosis with symptoms like pain and hearing loss, the correlation between fungal growth and the long hours of earphones usage as well as to explore the relationship between the age of participants and the usage of earphones during the pandemic.

Methods

Data for this cross-sectional study was based on a paper-based questionnaire developed by an ENT doctor in Malaysia. The questionnaire was piloted a few months prior to study and received adequate response. It took approximately 10 minutes to complete it prior to consultation with the ENT specialist. The questions comprised of demographic information including the age of participants, their gender and ethnicity. Other questions asked were the presence of symptoms of otalgia, tinnitus and itchiness, the hours of earphone usage per day in the last year as well as past medical history and associated symptoms. The consultant completed the survey after the examination, investigation via otoendoscopy and assessing the air-bone gap via audiometry. The recruitment took place from (Oct 2020 to Mar 2021).

The data collection was done physically for the paper-based questionnaire which were completed by 100 patients of varying ethnicities, and the attending doctor in Clinic Dr Sudha, Taiping, Malaysia. The participants were de-identified by omitting their names on the questionnaire before handing data over to the analyzing team. Additionally, there were no ethical issues or conflicts when carrying out this study. No sponsors were involved in this study.

A brief summary of the methods was as follows. Respondents were eligible to participate in the survey if they were experiencing the symptoms of impacted cerumen and have been frequently using earphones due to COVID-19. Patients who had suffered from recurrent otomycosis or illnesses such as cancer, diabetes and immunocompromised were excluded.

Data was analyzed using State software and Excel. Descriptive statistics for age was presented as mean and standard errors were provided for other results. Numbers and percentages were provided for categorical data. Content analysis for continuous data was done with program regressed models and t-ratios were calculated at a 5% significance level. Assumptions for linear regression analysis (normality, linearity and homogeneity of variance) were fully met.

Associations between variables were examined by analyzing coefficients, R squared and t test for finding correlations between otomycosis with otalgia, tinnitus, total hours or earphone usage and race. The association between age of participants and the total hours of earphone usage was also explored. A p-value of less than 0.05 was considered statistically significant.

Result

The questionnaire was completed by 100 eligible individuals. Exclusion was done during

recruitment of participants. Table 1 outlines the demographic characteristics of the participants.

Table 1: Demographic data

Variable	Mean	Standard deviation (SD)	
Age	25.86	8.86	
Variable		Number (n=100)	Percentage (%)
Gender			
-	Male	55	55
-	Female	45	45
Ethnicity			
-	Malay	54	54
-	Indian	26	26
-	Chinese	20	20

The participants ranged from 14 to 51 years old with a mean age of 25.9 years. Of the 100 participants, majority of the participants (55%) were male. More than half of the respondents were of Malay ethnicity (54%).

Chart 1. Cerumen impaction

All participants (100%) presented with cerumen impaction. Chart 1 shows the affected side of cerumen impaction. Among these participants, 60% experienced bilateral impaction and 40% suffered with unilateral impaction.

About 53.3% (32 people) of the bilateral impaction patients were aged between 14 and 25. In this population, it is most likely attributable to bilateral use of earphones.

Chart 2. Presence of fungus

Chart 2 demonstrates the prevalence of otomycosis among earphone users with cerumen impaction. Fungus was reported in 31% of the participants. Of the 31 participants, 18 had

unilateral otomycosis (11 in the right ear and 7 in the left ear) whereas 13 experienced bilateral otomycosis.

Chart 3: Presence of otalgia

Otalgia was the most reported symptom affecting 60% of participants. This was present in patients with both cerumen impaction and otomycosis as well as patients with cerumen impaction only. Statistical analysis was performed to test for association between otomy-

cosis and pain. Table 2 shows a positive association was found between the two variables with a t-value of 2.94 and coefficient of 0.27. This is in keeping with the clinical features of otomycosis and cerumen impaction.

Table 2: Association between otalgia and otomycosis

. regress fungus pain

Source	SS	df	MS	Number of obs	=	100
Model	1.67364859	1	1.67364859	F(1, 98)	=	8.67
Residual	18.9163514	98	.193023994	Prob > F	=	0.0040
				R-squared	=	0.0813
				Adj R-squared	=	0.0719
Total	20.59	99	.207979798	Root MSE	=	.43934

fungus	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
pain	.2652375	.0900759	2.94	0.004	.0864849	.4439901
_cons	.1282051	.0703515	1.82	0.071	-.0114051	.2678154

Chart 4: Presence of tinnitus

Table 3: Association between fungus and tinnitus

. regress fungus tinnitus

Source	SS	df	MS	Number of obs	=	100
Model	.023333333	1	.023333333	F(1, 98)	=	0.11
Residual	20.5666667	98	.209863946	Prob > F	=	0.7395
				R-squared	=	0.0011
				Adj R-squared	=	-0.0091
Total	20.59	99	.207979798	Root MSE	=	.45811

fungus	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
tinnitus	-.0333333	.0999676	-0.33	0.740	-.2317158	.1650491
_cons	.3	.0547545	5.48	0.000	.1913415	.4086585

Tinnitus was reported among 30% of respondents as observed in Chart 4. However, statistical analysis in Table 3 concluded no association between tinnitus and otomycosis.

This is in keeping with data where tinnitus is a presenting symptom of participants with cerumen impaction only.

Chart 5: Presence of pruritis

Itchiness was experienced by 10% of the participants. Pruritis is likely due to cerumen impaction causing irritation to the ear.

Chart 6: Total hours of earphone usage

Based on the responses from the participants, females reported about 584 hours usage (Oct 2020 to Mar 2021) whereas males reported approximately 572 hours usage.

There is likely no significance between gender and number of hours using the electronic device.

Graph 1. Association between fungus and total hours of earphone usage

Table 4. Association between fungus and total hours of earphone usage

. regress fungus totalhoursofearphoneusagehrs

Source	SS	df	MS	Number of obs	=	100
Model	.465865594	1	.465865594	F(1, 98)	=	2.27
Residual	20.1241344	98	.20534831	Prob > F	=	0.1352
				R-squared	=	0.0226
				Adj R-squared	=	0.0127
Total	20.59	99	.207979798	Root MSE	=	.45315

fungus	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
totalhoursof~s	.0001482	.0000984	1.51	0.135	-.0000471 .0003434
_cons	.2051753	.0722846	2.84	0.006	.0617288 .3486217

Graph 1 shows fungus plotted against total hours of earphone usage unilaterally (indicated by 0 on x-axis) and bilaterally (indicated by 1). According to statistical analysis in Table 4, we concluded an insignificant correlation between

otomycosis and the total hours of earphone usage with a t-value of 1.51. This is unlikely to be clinically significant. This indicates that the amount of time earphones is being used does not influence the development of otomycosis.

Table 5: Association between fungus and ethnicity

. regress fungus race

Source	SS	df	MS	Number of obs	=	100
Model	.001417613	1	.001417613	F(1, 98)	=	0.01
Residual	20.5885824	98	.210087575	Prob > F	=	0.9347
				R-squared	=	0.0001
				Adj R-squared	=	-0.0101
Total	20.59	99	.207979798	Root MSE	=	.45835

fungus	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
race	.0045729	.0556695	0.08	0.935	-.1059014	.1150473
_cons	.2872105	.0570443	5.03	0.000	.174008	.400413

Table 5 demonstrates statistical analysis carried out to observe the prevalence of otomycosis among different races. However, it was

concluded that ethnicity does not affect the prevalence of otomycosis.

Graph 2 Association with age of participants and total hours of usage

Table 6: Association with age of participants and total hours of usage

. regress age totalhoursofearphoneusagehrs						
Source	SS	df	MS	Number of obs	=	100
Model	31.8467875	1	31.8467875	F(1, 98)	=	0.40
Residual	7810.19321	98	79.6958491	Prob > F	=	0.5288
				R-squared	=	0.0041
				Adj R-squared	=	-0.0061
Total	7842.04	99	79.2125253	Root MSE	=	8.9273

	age	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
totalhoursofearphoneusagehrs		.0012251	.0019381	0.63	0.529	-.0026209 .0050712
_cons		25.15867	1.424026	17.67	0.000	22.33273 27.9846

Graph 2 shows that regression line with a low coefficient which indicates that there is a weak relationship between the age of the participants and the total hours of earphone usage.

One possibility could be that due to the pandemic, people of all ages were more dependent on technology for work and study.

Chart 7: Air-bone gap

Hearing loss was assessed by air bone gap on audiometry. A gap of 0 indicates normal hearing. About 50% of participants had a gap of 0. An air-bone gap of 10db and more indicates conductive hearing loss. This is present in 37% of the participants. This is in line with the diagnosis of cerumen impaction.

Discussion

This cross-sectional study employed data from a paper-based questionnaire to investigate the prevalence of otomycosis in patients with impacted wax due to excessive earphone

usage during the COVID-19 pandemic. Over half of the respondents were male and were of Malay ethnicity. The mean age of participants was 25.9 years. Most patients experienced bilateral cerumen impaction. About one-third of the respondents suffered from otomycosis and most were unilateral. The most reported symptom by respondents was otalgia due to otitis externa. Tinnitus and pruritis were also reported due to impacted earwax. A large air-bone gap was found in about one-third of the participants. Furthermore, an insignificant correlation was identified between otomycosis and

longer hours of earphone usage. This is unlikely to be clinically significant. Findings of this study also concluded a weak relationship between the age of participants and the total hours of earphone use.

Data from this study has shown 31% of participants with cerumen impaction and earphone usage suffering from otomycosis. Possible mechanisms include the increase in humidity causing an increase in moisture [1,4,5,13], the lack of ventilation due to prolonged usage [14] or infection introduced by earphones from external factors such as sharing devices [12,14]. Additionally, an American study has concluded that the increased humidity of the ear canal provides a medium for infiltration of organisms due to possible skin abrasions from earphone usage [13]. Conversely, a study involving 118 participants with constant earphone use found a lack of evidence of external canal infection after earphone use [12]. However, this study only included 4 participants with cerumen impaction which may have caused the difference in findings.

A positive correlation was found between otalgia and otomycosis (t value of 2.94). This is in keeping with a study conducted by Anwar stating that otalgia [15,16] is one of the primary symptoms [7]. This could be due to accumulation of thick and fibrous debris and granulation tissue formation in the external canal [7]. Otalgia could also be attributed to the cerumen impaction [15].

Furthermore, air-bone gap assessed by pure tone audiometry was also investigated in this study due to concerns of conductive hearing loss. Approximately 37% participants demonstrated an air-bone gap higher than 10db. These patients were questioned further to exclude noise-induced hearing loss [17]. Subha et al. have deduced that cerumen impaction causes statistically significant conductive hearing loss [18]. This is explained by the cerumen obstructing the external canal impeding sound travel through the external auditory meatus [18]. Similarly, otomycosis could also cause conductive hearing loss by accumulation of debris and granulation tissue [7]. In terms of prolonged earphone usage as a cause of hearing loss, Mazlan et al. found that prolonged exposure of more than 85dB for 8 or more hours

is significant in causing permanent hearing loss [12]. Additionally, Sharma has said that almost all headphones and earphones expose ears to high decibel sound waves which in turn causes damage to ears [14].

Findings from this study found a positive relationship between otomycosis and the total hours of earphone usage with a t value of 1.51. However, these values are unlikely to be clinically significant. Moreover, there was also no difference in otomycosis prevalence between different ethnicities.

A weak relationship between the age of participants and the total hours of earphone usage was also found in this study. This could be attributed to the current status during COVID-19 causing 80% of the population [10] to be more dependent on technology for work and study compared to pre-pandemic times. As World Health Organization has recommended social distancing and lockdowns, the population has been forced to adapt to this new situation of continuing online classes at home and working from home [8,9]. Technology mediums are also being increasingly used to connect with loved ones during these trying times to avoid loneliness and anxiety resulting from being unable to physically connect with others [8]. Dey et al. have explored that the average mobile phone usage has risen to more than 6 hours a day in India [8]. Therefore, this corresponds with the lack of age difference with earphone usage as people from all ages are required to use these mediums.

The findings from this study has clinical implications and has revealed earphone usage as an additional contributing factor to otomycosis. This data provides further insight to complications of increased earphone usage during this pandemic era. There was an insignificant association between otomycosis and long hours of earphones usage. Further research is needed to explore these two variables. In order to decrease predisposing factors, it is recommended that patients decrease earphone usage and practice good hygiene to prevent external sources of infection. Alternatively, patients could also take breaks between earphone usage to allow ventilation of the external ear canal and avoid moisture accumulation.

A sample size of 100 is large enough to increase statistical power of data [19]. The greater variability of the ethnicities has also allowed an increase in statistical power in addition to providing a closer data set to the general population [20]. On the other hand, the nature of the cross-sectional study allows room for information bias via data collection through questionnaire [21,22]. This information bias may also result from participant-interpretations of the questions [23]. Generalizing population to this study is difficult as participants may be experiencing more severe symptoms causing them to seek the expertise of an ENT consultant.

Conclusion

This study offers initial evidence that earphone usage could be a predisposing factor in developing otomycosis. However, there was no evidence that long term usage of earphones increasing the chances of developing otomycosis. This is unlikely to be clinically relevant. Further research should be conducted in this area. Additionally, statistical associations supported those symptoms like otalgia and conductive hearing loss could be present in both earwax impaction and otomycosis. Therefore, additional examination should be performed to adequately assess the cause. Overall, this study highlights the complications of earphones causing cerumen impaction and predisposing to otomycosis. It is recommended that patients decrease earphone usage and practice good hygiene to prevent external source of infection. Alternatively, patients could also take breaks between earphone usage to allow ventilation of the external ear canal and avoid moisture accumulation.

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