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Research Report
Research Report

A study on the prevalence of hyperacusis among university students 1 : From the perspectives of sound hypersensitivity and sound aversion

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A study of the prevalence of auditory hypersensitivity in university students: Aspects of hyperacusis and misophonia

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This study aims to reveal the characteristics of auditory hypersensitivity among Japanese university students with a particular focus on two elements of auditory hypersensitivity: hyperacusis and misophonia. We conducted an investigation of the prevalence and interrelationship of these conditions in a non-clinical sample of 439 indi-viduals using self-reported measures. Additionally, we performed a meta-analysis to compare our findings on hy-peracusis and misophonia with the existing literature. Our results revealed a prevalence of 8.2% for hyperacusis, 40% for misophonia, and a 7.2% comorbidity rate for both conditions. Our meta-analysis indicated that our hy-peracusis and misophonia scores are consistent with those reported in previous studies, but also suggested vari-ability in these conditions across different countries. This implies that cultural and gender-related factors might influence the prevalence rates of hyperacusis and misophonia in the general population.

Key words: auditory hypersensitivity, hyperacusis, misophonia, meta-analysis.

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In recent years, social consideration for the sound environment has begun to spread. Airports have installed calm-down spaces that reduce surrounding noise, and drugstores have introduced quiet hours that limit sound and lighting for certain hours. The background to these efforts is the spread of understanding of developmental disorders, as well as consideration for the sensitivity to various stimuli that often accompany developmental disorders (Asahi Shimbun, 2023). For people who are sensitive to auditory stimuli, even everyday environmental sounds that are generally not noticeable can be unbearable. This state of reduced tolerance to sound is called hyperacusis (Henry et al., 2022). Hyperacusis is frequently seen in autism spectrum disorders (ASD) (Khalfa et al., 2004; Rosenhall et al., 1999). Many studies on ASD have demonstrated the existence of specific sensory processing, including sensory hypersensitivity (Ben-Sasson et al., 2009; Leekam et al., 2007). In response, the items of sensory hypersensitivity/hyposensation and sensory seeking were added to the diagnostic criteria of ASD in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (American Psychiatric Association, 2013 (translated by Takahashi and Ohno, 2014) and is considered one of the characteristics of ASD.

Hearing hypersensitivity is expressed as "acusis hypersensitivity" in Japan, but in the West it is also called Decreased Sound Tolerance (DST), which means "a state in which one cannot tolerate everyday sounds that are no problem for others," and is classified as hyperacusis and misophonia (Jastreboff & Jastreboff, 2014). Hyperacusis is a state in which everyday sounds are perceived as louder than they actually are. The response to a stimulus depends only on its physical properties, is unrelated to the context or meaning of the sound, and may be accompanied by discomfort or pain (Aazh et al., 2014; Fackrell et al., 2019). On the other hand, sound aversion is not caused by the physical properties of sounds, but by specific patterns or meanings of sounds (Jastreboff & Jastreboff, 2002; Swedo et al., 2022), and the sounds that are aversive vary from person to person. The aversive sounds are often sounds made by other people (Jastreboff & Jastreboff, 2014; Palumbo et al., 2018), such as the sounds of others eating, breathing, coughing, clicking a pen, or typing (Henry et al., 2022; Zhou et al., 2017). Furthermore, when exposed to such sounds, sound aversion sufferers experience negative emotions such as anger and anxiety, and show autonomic nervous system symptoms such as increased heart rate and sweating.

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It has also been noted that there is increased neurological arousal (Rinaldi et al., 2023; Swedo et al., 2022).

Hyperacusis is known to be a common symptom in ASD (Khalfa et al., 2004; Rosenhall et al., 1999), but it has also been shown to be present in a certain percentage of the general population. However, the frequency varies by country, with a self-report questionnaire survey showing that 6.8% of subjects in Sweden (Andersson et al., 2002), 15.2% in Poland (Fabijan-ska et al., 1999), and 4.6% in Japan were found to be hyperacusis (Kumagaya et al., 2013). Regarding gender differences, many studies have reported a higher rate in females (Khalfa et al., 2002; Paulin et al., 2016; Yilmaz et al., 2017), but some studies have reported a higher rate in males (children) (Hall et al., 2016) and no gender differences (Kumagaya et al., 2013), and the results are not consistent. The prevalence of sound aversion has been reported to be 20-23.4% in the United States (Brennan et al., 2024; Wu et al., 2014), 23.1% in China (Zhou et al., 2017), and 41.4% in Japan (Tada et al., 2022), based on surveys using self-report questionnaires. Many studies have shown that there is no gender difference in sound aversion (Jakubovski et al., 2022; Wu et al., 2014; Zhou et al., 2017), but it has been reported that women in Japan score higher (Tada et al., 2022). Thus, sound hypersensitivity and sound aversion are characterized by a large gap between countries. In particular, the prevalence of sound aversion is remarkable in Japan, but the number of reports is limited. In addition, there have been no consistent results regarding gender differences in sound hypersensitivity and sound aversion. Although it has been shown that sound hypersensitivity and sound aversion are different pathologies, it has been pointed out that the two can coexist (Henry et al., 2022). Jager et al. (2020) found that the proportion of

people with sound aversion who had previously been diagnosed with sound hypersensitivity was about 1%, but in a survey using a self-administered questionnaire, the comorbidity rate of sound hypersensitivity among participants classified as sound aversion was 71% (Enzler et al., 2021). A strong correlation between the two was also shown in a survey by Brennan et al. (2024). On the other hand, the concept of sound aversion is hardly known in Japan, and there are no studies on the coexistence of sound hypersensitivity and sound aversion. In addition, Sakata (2017) explains that hyperacusis "often accompanies negative emotions such as discomfort, fear, and irritation. ... The triggering sound may or may not be limited, and the volume may vary (Sakata, 2017, p.1184)." Sound hypersensitivity and sound aversion are comprehensively considered as hyperacusis (for example, Matsui and Sakuma, 2020; Tsuji, 2018). Sound hypersensitivity and sound aversion are different characteristics and should be considered separately, but in Japan, the two have not been sufficiently clarified. In light of the above situation, the purpose of this study is as follows. First, in Japan, sound hypersensitivity and sound aversion have not been sufficiently distinguished from each other, so it is necessary to clarify the relationship between the two.

The cause of the comorbidity is unclear. Therefore, in this study, we conducted a survey of the same university students, distinguishing between sound hypersensitivity and sound aversion, to clarify the prevalence and comorbidity rates in Japan. Secondly, we examined gender differences. Thirdly, although differences in prevalence rates have been shown by country, the standards for calculating prevalence rates differ from study to study, so in this study, we targeted literature that used the same scale and used meta-analysis to make a comparison based on the scale scores.

method

Eligible people and procedures

The survey was conducted from July to October 2023. The survey subjects were 440 university students (257 men, 183 women) taking psychology classes at a private university in Tokyo, and 439 people (256 men, 183 women, average age 19.57 years (SD = 1.35)) who responded to all items were analyzed.

Questioning Project

To evaluate sound hypersensitivity, we used the Japanese version of Khalfa's (2002) Hyperacusis Questionnaire (HQ) (Kumagaya et al., 2013). It consists of 14 items in total and is divided into three factors: attention, social, and emotional. Khalfa (2002) used a four-point scale with a maximum score of 42 points, while the Japanese version uses a six-point scale with a maximum score of 70 points. The higher the score, the greater the degree of sound hypersensitivity, with 40 points being the cutoff point. In this study, we followed the scoring and analysis methods of the Japanese version.

To evaluate sound aversion, we used the Japanese version of the Misophonia Questionnaire (MQ) by Wu et al. (2014) (Tada et al., 2022). It is composed of two scales: the sound aversion symptom scale, which evaluates aversion to specific sounds, has seven items, and the affective and behavioral scale, which evaluates emotional responses and behavior, has 10 items. A five-point scale was used, with the maximum score being 68 points, and the higher the score, the stronger the degree of sound aversion. Wu et al. (2014) established a cutoff score of 14 points for the sound aversion symptom scale, and this was also followed in this study.

Literature collection

Literature was selected to compare the mean scores of sound hypersensitivity and sound aversion using meta-analysis. To collect literature, Google Scholar and PubMed were searched using the keywords "Hyperacusis" and "Misophonia". For domestic studies, Google Scholar and CiNii were searched using the keywords "Hyperacusis", "Misophonia", and "Sound Aversion". The selection criteria for literature were (a) that HQ or MQ was used, and (b) that the general population was targeted, and those targeting clinical groups were excluded.

Table 1

Studies included in the meta-analysis of hyperacusis

Study	*n*	Mean	*SD*
Khalfa (2002)	201	15.00	6.70
Kumagaya et al. (2013)	216	10.14	6.96
Yilmaz et al. (2017)	536	16.34	7.91
Erinc & Derinsu (2020)	529	15.69	6.63
Cogen (2024)	333	10.86	6.76
Current study	439	12.94	7.54

Note. As Kumagaya et al. (2013) and the current study used a six-point scale, the values were converted to scores using the four-point scale.

Table 2

Studies included in the meta-analysis of misophonia

Study	*n*	Mean	*SD*
Wu et al. (2014)	483	19.76	10.78
Zhou et al. (2017)	415	19.58	10.23
Jakubovski et al. (2022)	2,519	8.91	8.65
Tada et al. (2022)	180	33.30	10.80
Current study	439	26.89	11.70

The results showed that there were five cases of sound hypersensitivity (Table 1) and five cases of sound aversion.

Four studies were selected regarding this disease (Table 2).

Analytical methods

Prevalence and correlation analysis of sound hypersensitivity and sound aversion

The prevalence was based on the cutoff values of HQ and MQ.

The Pearson correlation coefficient between the HQ score and the MQ score was also calculated.

The product-moment correlation coefficient was calculated.

Gender differences Regarding gender differences in sound hypersensitivity and sound aversion ,

Regarding the total score and subscale scores of each MQ

An unpaired *t* -test was performed.

Comparison with previous studies: Comparison of sound transmission in previous studies and this study

To compare the mean scores for sound sensitivity and sound aversion, meta-analysis was performed.

The effect size was calculated as the average of each study and

Confidence intervals were calculated and compared with the average across all previous studies.

Means across studies were estimated using a random-effects model

In addition, the meta-analysis of sound hypersensitivity included

Tani et al. (2013) and this study used a six-item questionnaire to answer HQ.

Since the survey asked for answers, the analysis was conducted by converting the answers into four-point scores.

went.

Analysis software: For meta-analysis, statistical analysis software R 4.3.2 was used.

We used the metafor package (Viecht-baur, 2010) in R (R Core Team, 2023).

Correlation analyses and gender differences were performed.

IBM SPSS Statistics 29.0ýSPSS Inc. , Chicago, IL,

United States) was used.

Ethical considerations

The survey was conducted using Google Forms.

The following ethical considerations were explained: Participation in the survey was voluntary.

Yes, and you will not suffer any disadvantages regardless of whether you participate or not.

The results of the survey will not be made public in a manner that identifies individuals.

and their response was deemed to be consent to participate.

This study was conducted under the Human Subjects Research Ethics Program at Chuo University.

The study was approved by the Clinical Trial Review Board (approval number: 2023-94(2)).

result

Prevalence of sound hypersensitivity and sound aversion

A scatter plot of the HQ and MQ scores is shown in Figure 1.

The Pearson product-moment correlation coefficient was calculated, showing a moderate correlation.

A significant correlation was observed (r=.649, p<.001).

The proportion exceeding the cutoff value of the sensitivity scale was *8.2% (n=36).*

The proportion exceeding the cutoff value on the sound aversion scale was 40% (n

= 176), and the cutoffs for both the sound hypersensitivity scale and the sound aversion scale

The proportion of cases exceeding the F value was 7.3% (n=32).

Sound aversion and gender differences in sound aversion

Table 3 shows the mean scores for the HQ, MQ and their respective subscales.

The mean, standard deviation and reliability coefficient of Cronbach's

The ÿ coefficient and t -test results are shown by gender.

There was no difference in age between the sexes.

When an unpaired *t* -test was performed, the HQ total score

No gender differences were observed in any of the subfactors.

On the other hand, the MQ score was significantly higher than the total score and all sub-scores.

Gender differences were observed in the factors, with women scoring more favorably in all cases.

I was very enthusiastic.

Comparison with previous studies through meta-analysis

To compare the mean values of HQ and MQ, a meta-analysis was performed.

The research that was the subject of the HQ score analysis was

There were six studies, including one in which the total sample size was 2,254.

The results of the meta-analysis of HQ scores were analyzed using Forest

The HQ score in this study is shown in Figure 2.

The results were within the range of the overall study average.

This is higher than Kumagai et al. (2013) and Cogen (2024), and Khalfa

(2002), Yilmaz et al. (2017), Erinc & Derinsu (2020)

In addition, the MQ scores were lower in the studies that were analyzed.

There were five studies, including this one, with a total sample size of 4,036.

The results of the meta-analysis of the MQ scores were

The MQ score of this study is within the average range of all previous studies.

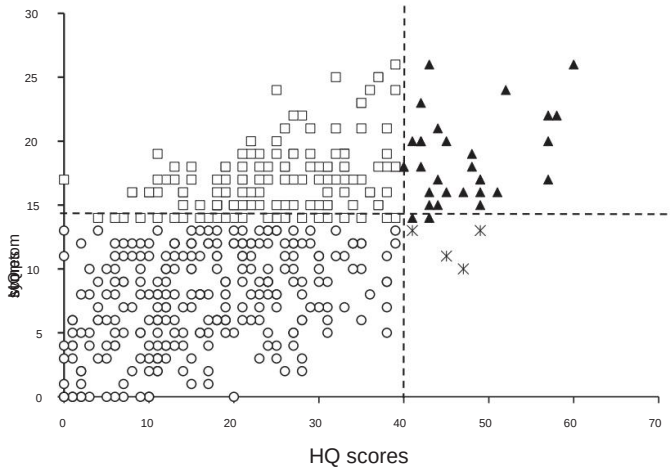
(Figure 3). Compared with individual studies, Wu et al.

(2014), Zhou et al. (2017), Jakubovski et al. (2022)

This was higher than that of Tada et al. (2022).

Figure 1

Scatterplot of overall scores on HQ and symptom scores on MQ



Note. ÿ = Groups with both hyperacusis and misophonia; ÿ = groups with misophonia; • = groups with neither hyperacusis or misophonia; * = groups with hyperacusis, The dashed lines indicate the cut-off points for HQ and MQ respectively.

Table 3

Means, standard deviations, reliability coefficients and t-test results for HQ and MQ by gender

	Male (*n* = 256)	Female (*n* = 183)	*t*	*p*	Cronbachÿs
	Mean (SD)	*Mean (SD)*			
Age	19.57 (1.43)	19.56 (1.23)	0.087	.099	
HQ total	21.32 (11.93)	21.92 (13.41)	0.491	.312	7.46 (4.54) 7.67 .88
Attentional dimension	(5.19)	0.444	.328	6.88 (5.11)	6.96 (5.91) 0.157 .438 .78
Social dimension	6.98 (4.34)	7.28 (4.51)	0.720	.236	MQ total 25.35 .77
Emotional dimension	(11.65)	29.05 (11.46)	3.305	.001	Symptom 10.60 (5.89) .73
12.61 (5.61)	3.587	.001	Emotions and behaviors	14.75 (7.24)	16.44 (7.26) 2.417 .008 .86
					.77
					.81

Note. HQ = Hyperacusis Questionnaire; MQ = Misophonia Questionnaire.

Investigation

The purpose of this study is to investigate whether sound sensitivity is a factor in Japanese university students.

To investigate the prevalence and relationship between hearing loss and sound aversion.

The first objective of this study is to clarify the gender differences in sound hypersensitivity and sound aversion.

Third, a meta-analysis was conducted to compare the results with the literature.

The purpose of this study was to compare these differences using the above.

The proportion of people with sound hypersensitivity who exceeded the HQ cutoff value was

In a previous study targeting university students,

The prevalence was 3.9-5.8% (Brennan et al., 2024; Kumagaya

Yilmaz et al., 2013; Yilmaz et al., 2017) were conducted on Japanese university students.

There is a clear difference in HQ scores between Kumagai et al. (2013) and this study.

No differences were observed.

The results of the study are within the average range of previous studies.

Furthermore, no gender differences were observed in sound hypersensitivity.

Studies have shown a higher proportion of women (Khalfa et al., 2002;

Paulin et al., 2016; Yilmaz et al., 2017), and male (children)

(Hall et al., 2016) or no gender difference.

There are reports that this is the case (Kumagaya et al., 2013), and the results are consistent.

However, these previous studies did not provide any

The age ranges vary widely, with Paulin et al. (2016)

It has been reported that the prevalence of sound hypersensitivity increases with age.

This suggests that sound sensitivity may be due to biological and cultural differences.

This may reflect the difference.

Regarding sound aversion, 40% of subjects met the MQ cutoff value.

The prevalence of sound aversion is high in overseas studies.

The deviation was about 20% (Brennan et al., 2024; Wu

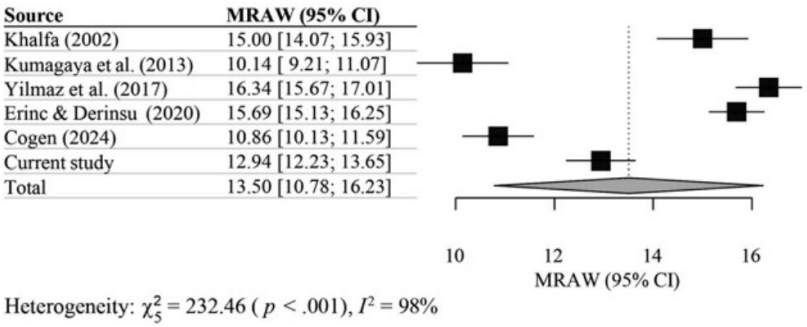
et al., 2014; Zhou et al., 2017), and the Japanese study by Tada et al.

(2022) found that the rate was 41.4%.

However, the results of this study were within the average range of previous studies.

Figure 2

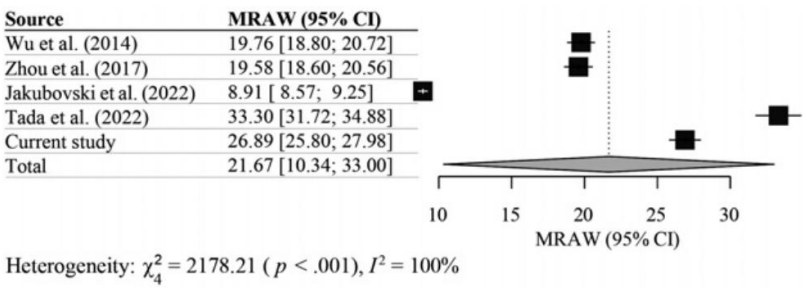
Meta-analysis for HQ scores



Heterogeneity: $\chi^2_5 = 232.46$ ($p < .001$), $I^2 = 98\%$

Figure 3

Meta-analysis for MQ scores



Heterogeneity: $\chi^2_4 = 2178.21$ ($p < .001$), $I^2 = 100\%$

However, this study and Tada et al. (2022), both conducted in Japan, had relatively high scores, suggesting that cultural factors may be influencing the results. In addition, most of the studies included in the meta-analysis were conducted on young people, whereas the study by Jakubovski et al. (2022), which had significantly lower scores, had a wide age range of subjects, from 16 to 96 years old. Kÿlÿç (2021) reported that the incidence of sound aversion decreases with age, and it is possible that the age of the subjects may have influenced the differences in scores between the studies. In an analysis of the questionnaire items, the most disgusting sounds in the United States and China were "repeated sounds" and "sounds of people eating" (Bren-nan et al., 2024; Wu et al., 2014; Zhou et al., 2017), whereas in this study, it was "surrounding noise." Norena (2023) points out that sounds that cause sound aversion are sounds that must be suppressed from the perspective of etiquette, and that sound aversion is caused by increased sensitivity to others deviating from social norms. Therefore, it can be inferred that the sounds that are disgusted by sound aversion and the degree of disgust differ between cultures. Although there are no studies that directly compare cultural differences in sound aversion,

Brennan et al. (2024) investigated the differences in MQ scores by race in American college students and found no racial differences in MQ scores or types of sounds that were disgusting. This suggests that sound aversion is not determined by biological differences but by the environment and culture.

It is determined by the nature of the sound, and the results of Tada et al. (2022) and this study suggest that Japanese culture may have a tendency to promote sound aversion in particular. This susceptibility to cultural influences is thought to be one of the reasons for the large difference in the prevalence of sound hypersensitivity. Sound hypersensitivity is said to be a state that depends only on the physical properties of sound, and no clear differences were observed between different cultures, while sound aversion shows large differences between different cultures. Namba et al. (1991) reported that the daily sound environment is diverse and there are differences in noise awareness depending on the country, and such studies also suggest that sociocultural factors are related to the difference in the prevalence of sound

aversion. A moderate correlation (r = .649) was observed between sound hypersensitivity and sound aversion, and the proportion exceeding the cutoff value for both was 7.3%. In a report by Jager et al. (2020), the proportion of people with sound aversion who had previously been diagnosed with sound hypersensitivity was 0.7%. On the other hand, studies using self-report questionnaires have reported that more than 70% of individuals who meet the criteria for sound aversion also meet the criteria for sound hypersensitivity (Aazh et al., 2022; Enzler et al., 2021). Although the coexistence of these conditions varies greatly depending on the listening method and cutoff value, a correlation between the two has been observed in Japan, suggesting that sound hypersensitivity and sound aversion share a common background and coexist to a certain extent. In addition, both sound hypersensitivity and sound aversion have been linked to ASD and mod

2020; Khalfa et al., 2004; Paulin et al., 2016; Rinaldi and
al., 2023), these biological factors exist as background.
It is possible that different pathological conditions are expressed after
can be done.

One limitation of this study is that the survey subjects were university students in Tokyo.
There are some limitations and cultural backgrounds that have not been considered.
In comparison with previous studies, the effects of sound aversion were particularly pronounced.
It is possible that cultural differences may be the cause.
There may be differences in living conditions between the capital and the regions.
In addition, the cultural background of the subjects is unknown.
The results of the survey reflect the overall trends among young people in Japanese culture.
It remains to be seen whether this is the case.
Expand the scope to all age groups and consider cultural backgrounds, etc.
By doing so, the presence or absence of cultural influence will become clearer.
It is possible.

Until now, auditory hypersensitivity has been a common symptom of developmental disorders.
It was known to occur with a high frequency, but this study
It has been confirmed that a certain percentage of the general population
In Japan, sound hypersensitivity and sound aversion are considered to be the same condition.
Although these have never been studied simultaneously for both
Since these are considered to be different phenomena,
Developmental disorders are also lumped together as hyperacusis.
I think that these should be considered separately, rather than being treated as one entity.
can be done.

Conflicting interests

Conflicts of interest to be disclosed regarding this paper
There is none.

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