
Title: Ear and hearing.
ArticleTitle: Misophonia and Hearing Comorbidities in a Collegiate Population
ArticleAuthor: Brennan
ISSN - 01960202; LCN - 80644108;
Publisher: 2023-10-04
Source: LibKeyNomad

Misophonia and Hearing Comorbidities in a Collegiate Population

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Objectives: Misophonia is a little-understood disorder in which certain sounds cause a strong emotional response in those who experience it. People who are affected by misophonia may find that noises like loud chewing, pen clicking, and/or sniffing trigger intense frustration, anger, or discomfort. The relationship of misophonia with other auditory disorders including loudness hyperacusis, tinnitus, and hearing loss is largely underexplored. This project aimed to investigate the prevalence and hearing-health comorbidities of misophonia in a college-aged population by using an online survey.

Design: A total of 12,131 undergraduate and graduate students between the ages of 18 and 25 were given the opportunity to answer an in-depth online survey. These students were sampled in a roughly 50 of 50 sex distribution. The survey was created using Qualtrics and included the following components: electronic consent, demographics questionnaire, Misophonia Questionnaire (MQ), Khalfa's Hyperacusis Questionnaire (HQ), Tinnitus and Hearing Survey, and Tinnitus Functional Index (TFI). To be eligible for compensation, answers for each of the above components were required, with the exception of the TFI, which was only presented to students who indicated that they experienced tinnitus. Respondents were determined to have high or possible likelihood of having misophonia if they gave specific answers to the MQ's Emotion and Behavior Scale or the MQ Severity Scale.

Results: After excluding duplicate responses and age-related outliers, 1,084 responses were included in the analysis. Just over 20% (n = 217) of the sample was determined to have a high or probable likelihood of having misophonia. The sample was primarily White, female, and of mid-to-high socioeconomic status. There was a strong positive correlation between MQ total scores and HQ total scores. High likelihood misophonia status showed a significant relationship with self-reported hearing loss and tinnitus. No statistically significant relationship was found between misophonia and age, ethnicity, or socioeconomic status. MQ total scores differed significantly when separating respondents by sex, self-reported tinnitus, and loudness hyperacusis. White respondents had significantly higher MQ total scores than Asian/Asian American respondents.

Conclusions: The estimated prevalence of misophonia was about 8% to 20% of the sample, which agrees with most of the currently published research examining misophonia symptoms in collegiate populations. Results of data analysis suggest that misophonia severity may be related to loudness hyperacusis, sex, and possibly tinnitus. Future studies are needed to further examine the characteristics of these relationships, possibly in populations more optimized to reflect the general population or those with hearing-health disorders.

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Key words: Decreased sound tolerance, Hyperacusis, Misophonia, Survey study, Tinnitus, Young adults.

(Ear & Hearing 2023;XX;00–00)

INTRODUCTION

Misophonia, initially defined by Jastreboff and Jastreboff in 2001, is a decreased sound tolerance disorder that causes patients to have a negative involuntary emotional and physical response to specific sounds. Since its initial description, there has been an increased clinical and academic interest in misophonia and other sound tolerance disorders to better understand the nature of misophonia and its symptoms. Current attitudes reflect that misophonia is not the hatred of sounds in general, but rather adverse reactions to a select set of specific auditory stimuli that vary between individuals, without a known relation to a person's hearing thresholds (Jastreboff & Jastreboff 2001; Siepsiak & Dragan 2019). Despite the surge of interest in the disorder, misophonia is still critically under-researched and its prevalence is still unclear.

Misophonic Trigger Sounds and Reactions

Common misophonic trigger sounds include chewing, slurping, pen-clicking, breathing, lip-smacking, sniffing, and tapping, among others (Edelstein et al. 2013; Wu et al. 2014; Potgieter et al. 2019). Sources of misophonic triggers may be specific to or heightened by familiar people, such as family members, friends, and coworkers (Edelstein et al. 2013). Individuals with misophonia may have multiple triggers, each causing a unique variety of emotional and physical reactions. Emotional reactions to trigger sounds can present in a wide range from disgust, repulsion, and anxiety to anger and violent thoughts (Kumar et al. 2014; Wu et al. 2014). It has been observed that somatic responses may also accompany these emotions, including difficulty breathing, increased body temperature, increased heart rate, and pressure in the chest based on patient self-report (Edelstein et al. 2013) and in-person lab testing (Kumar et al. 2017). Consequently, misophonia symptoms can lead to maladaptive and avoidance behaviors, which may significantly impair an individual's level of functioning (e.g., social and occupational).

Evaluation and Diagnosis of Misophonia

Swedo et al. (2022) developed a consensus definition using the Delphi method to describe misophonia. They defined misophonia as a disorder of decreased tolerance to specific sounds or trigger stimuli, which are unpleasant or distressing and elicit negative emotional, physiological, and behavioral responses. Swedo et al. (2022) also described reactions to triggers,

<zdoi; 10.1097/AUD.0000000000001435>

influences on reactions, functional impairments, relationships to other conditions/disorders, and misophonic triggers. However, the thresholds at which reactions to such triggers rise to the level of a disorder, such as misophonia, are not defined. The introduction of a consensus definition is a promising step forward in the arena of misophonia research. It is expected that as understanding of misophonia and the amount of research surrounding it grows, this definition will continue to evolve and change.

Present literature supports a differential diagnosis approach to evaluate whether a patient is presenting with misophonia or not (Siepsak & Dragan 2019). Although it is a distinct disorder, misophonia's similarities to other decreased sound tolerance disorders, such as hyperacusis, provide a challenge for accurate identification. Hyperacusis refers to when an individual experiences discomfort listening to a broad range of sounds that are acceptable to individuals with normal hearing (Khalfa et al. 2002). In addition, hyperacusis has been further categorized into four categories: (1) loudness hyperacusis, discomfort to moderately loud sounds, (2) annoyance hyperacusis, negative emotional reaction to sound, (3) fear hyperacusis, avoidance, or anticipatory response to sound, and (4) pain hyperacusis, experience pain at lower sound levels than individuals with normal-hearing (Tyler et al. 2014). Situating misophonia within this framework, involves very specific trigger sounds akin to fear and/or annoyance hyperacusis, whereas loudness hyperacusis involves heightened sensitivity to a broad range of sounds and may be treated as the more general form of hyperacusis. In this article, the discussion of hyperacusis will pertain to loudness hyperacusis. Note Tyler et al. (2014) describe subcategories of hyperacusis but the overlap between categories is not characterized, nor is there an assumption in the framework that having one subtype of hyperacusis correlates with having another subtype. Furthermore, Swedo et al. (2022) do not mention loudness hyperacusis. Thus, distinguishing between these commonly occurring conditions is important.

Misophonia may also be comorbid or share characteristics with certain psychological conditions, like anxiety disorders and obsessive-compulsive disorder (OCD), furthering the challenge of untangling misophonia and its symptoms from other diagnoses (Wu et al. 2014; Bruxner 2015). Complexity of misophonia comes from the lack of consensus on a universally accepted definition used in past misophonia research and evaluation tools and comorbidity and association with other psychological conditions.

In the past decade, several clinical tools have been developed with the purpose of gauging the severity of a person's misophonia symptoms. The Amsterdam Misophonia Scale (A-MISO-S) is an adaptation of the Yale-Brown Obsessive-Compulsive scale and features six items meant to assess the level of impact misophonia has on various aspects of a patient's social life and emotions. The A-MISO-S scoring method groups patients into subclinical, mild, moderate, severe, and extreme symptom categories based on the patient's overall score on the six items (Schröder et al. 2013). Wu et al. (2014) developed the Misophonia Questionnaire (MQ), a three-part self-report questionnaire that aims to identify specific trigger sounds, emotional and behavioral misophonic reactions, and overall sensitivity to sound. A third questionnaire developed in Polish, the MisoQuest, was created and validated in 2020 by Siepsiak, Śliwerski, & Dragan and displayed excellent reliability and features items based on the diagnostic criteria for misophonia proposed by Schröder et al. (2013). Most recently, the Duke Misophonia Questionnaire was developed and initially validated by Rosenthal et al. (2021), and aimed to measure five different facets of an adult's misophonia: the frequency at which they are affected by misophonic sounds; the degree of their misophonic response across domains of functioning; impairment caused by misophonia; coping mechanisms used before, during, and after exposure to a misophonic sound; and beliefs about self, others, and the world in relation to misophonia symptoms.

Although the development of these questionnaires is beneficial to misophonia diagnosis and assessment, their reliance on subjectivity and lack of universally agreed-upon scoring cutoffs and groupings means that a complete picture of a person's misophonia is not yet attainable. Further research is needed to replicate and validate the results of the studies to improve or confirm their reliability, accuracy, and generalizability. Due to the different tools used in the published literature and differing criteria for identifying clinically significant misophonic symptoms, estimating the prevalence of misophonia is especially challenging. More research and more validated tools are needed to estimate the prevalence of misophonia in the greater population.

Misophonia Prevalence

Current literature posits that the onset of misophonic symptoms typically occurs in late childhood and adolescence (Potgieter et al. 2019), making young adults an optimal demographic to examine for studies interested in prevalence of misophonia. The majority of information on prevalence from large-scale studies comes from three studies that focus on the incidence of misophonia among college-aged university students, which estimates that misophonia affects between 20 and 50% of their samples with limited generalizability to the larger population (Wu et al. 2014; Zhou et al. 2017; Naylor et al. 2020).

A sample of 482 undergraduate students at the University of South Florida completed the MQ along with other self-report measures of OCD, depression, impairment/disability, and sensory defensiveness to give a picture of the dynamics and prevalence of misophonia in a large sample. The study determined that around 20% of survey participants reported clinically significant misophonia symptoms (Wu et al. 2014). It should be considered that the criteria for distinguishing clinically significant misophonia symptoms from subclinical misophonia symptoms were the score indicated on a single item, the MQ Misophonia Severity Scale, in which participants rated their overall sensitivity to sound on a visual analog scale from 1 to 15 (minimal-very severe).

Later, Zhou et al. (2017) completed an article-and-pencil survey study in a group of 415 college students at Shanghai Normal University and Shanghai Polytechnic University using a similar test battery to Wu et al. (2014). Although the cutoff to identify clinically significant misophonia symptoms using the MQ remained the same as it was in the 2014 study, a score of 12 or higher on the Sheehan Disability Scale—Misophonia (SDS-M) was added to the inclusion criteria for the clinically significant group. The results of this study without the additional impairment criterion were consistent with the previous findings by Wu et al. (2014), with around 20% of the students who participated in the study indicating clinically significant misophonia symptoms (Zhou et al. 2017). When the impairment

criterion was considered, the levels of impairment decreased to only 6% of the study, suggesting that while sound sensitivity may affect a large percentage of the sample, a much smaller portion experienced moderate impairment attributed to decreased sound tolerance (Zhou et al. 2017).

Most recently, in 2020 a sample of 336 students from the School of Medicine at the University of Nottingham were recruited to complete an online test battery examining misophonia using the A-MISO-S with a total score of five or more indicating clinically significant misophonia symptoms (Naylor et al. 2020). Estimations of misophonia incidence among the sample were markedly higher than those established by previous studies (Wu et al. 2014; Zhou et al. 2017), with 49.1% of the sample indicating clinically significant misophonia (Naylor et al. 2020). It should be noted; however, that the definition for clinically significant misophonia in the study included people who scored in mild to extreme categories, whereas the previous studies only considered those who displayed moderate to severe misophonia symptoms as defined on the MQ.

Recently, studies have begun examining the prevalence of misophonia in the general population. Jakubovski et al. (2022) used MQ and A-MISO-S Revised (AMISOS-R) to conduct a large-scale representative population survey in Germany. In a sample of 2519 participants, clinically significant misophonia was found in 5% as measured by the MQ and 5.9% as measured by the AMISOS-R. Similarly, Kılıç et al. (2021) sampled 541 participants from 300 Turkish households. Using their own diagnostic criteria, they found that misophonia was found in 12.8% of the Turkish population. Vitoratou et al. (2023) estimated misophonia in a large representative sample of the UK general population. They estimated that 18.4% of UK participants had misophonia which causes significant burden. These studies typically do not report on any comorbid hearing issues, although Kılıç et al. (2021) did examine a history of tinnitus and misophonia symptoms but did not find a significant relationship.

Goals of the Study

The goal of this study was to further examine misophonia in a large and heterogeneous collegiate sample using an extensive survey test battery of audiological and psychological questionnaires, with the goal of further understanding the prevalence and hearing-health comorbidities of the disorder. This allowed us to partially replicate existing studies (using the Wu et al., MQ, which was used in both Wu et al. (2014) and Zhou et al. (2017). In addition, in a misophonia sample group, we discuss the proportion of demographic characteristics and comorbid hearing-related conditions such as loudness hyperacusis, tinnitus, and hearing loss; and their relationship to misophonia.

MATERIALS AND METHODS

Survey Construction and Surveys Used

The survey was constructed using Qualtrics and included the following components: electronic consent, demographics questionnaire, MQ, Khalfa's Hyperacusis Questionnaire (HQ), Tinnitus and Hearing Survey (THS), Tinnitus Functional Index (TFI), and the Obsessive-Compulsive Inventory-Revised (OCI-R). For the purpose of this article, the results of the OCI-R will not be discussed, as a more in-depth analysis of that data will be included in a forthcoming article. Although the study used a different test battery than previous research into misophonia prevalence (Wu et al. 2014; Zhou et al. 2017; Naylor et al. 2020), the age range used for the study remained similar, to allow for a replication of the college-aged respondents recruited in previous studies.

The MQ is an assessment tool that aims to assess a patient's misophonia symptoms, misophonic reactions, and overall severity of sound sensitivity (Wu et al. 2014). It contains three sections with good internal consistency as reported in the initial publication: the Misophonia Symptom Scale (Cronbach's $\alpha = 0.86$), the Misophonia Emotions and Behaviors Scale (Cronbach's $\alpha = 0.86$), and the Misophonia Severity Scale (Cronbach's $\alpha = 0.89$). The Misophonia Symptoms Scale provides insight into the presence of sound sensitivities and that specific sounds prompt a misophonic response from the respondent. The final item on the survey, the Misophonia Severity Scale, was based on the National Institute of Mental Health Global Obsessive-Compulsive Scale and is a single visual analog scale that allows the participant to indicate their subjective perception of overall sound sensitivity from a score of 1 indicating "minimal" sound sensitivity to a score of 15 indicating "very severe" sound sensitivity; a score of 7 or higher was determined to indicate clinically significant misophonia symptoms (Wu et al. 2014). The MQ is one of the most widely used tools to assess misophonia severity and its impact on an individual's quality of life.

The HQ is a screening tool used to assess a patient for symptoms of loudness hyperacusis, a decreased sound tolerance disorder in which a person experiences extreme sensitivity to sounds that may be perceived as normal intensity by the average listener. The HQ evaluates loudness hyperacusis in three different dimensions: attentional, social, and emotional; but the extent to which these dimensions characterize subcategories as discussed in Tyler et al. (2014) is not known. Often, hearing thresholds in patients with loudness hyperacusis are within normal limits and, much like misophonia, most of the assessment and diagnosis of hyperacusis is based on subjective patient self-report, and there are currently no universally agreed-upon measures to diagnose the disorder. Aazh and Moore (2017) suggest an HQ total score of 22, whereas Khalfa et al. (2002) recommend a cutoff score of 28. Because the study intended to recruit both hyperacusis participants and participants who experience hyperacusis comorbid with misophonia, this was a useful tool to include in the survey. The internal consistency of the HQ was acceptable ranging from Cronbach's $\alpha = 0.66$ to 0.68.

The THS is a brief 10-item survey intended for use to screen patients for symptoms of three auditory conditions: tinnitus, hearing loss, and decreased sound tolerance disorders. It was included to supplement information on whether a respondent has hearing loss, tinnitus, or both, should the determination be needed for the in-person portion of the study. The THS reported good to excellent internal consistency with Cronbach's α of 0.86 to 0.94 (Henry et al. 2015).

Participant Recruitment

This research study was conducted at the University of Illinois at Urbana-Champaign (UIUC). Because the onset of misophonia symptoms typically occurs in late childhood and into early adulthood (Potgieter et al. 2019), a college-aged young adult population was selected for participant recruitment. A total of 12,131 undergraduate and graduate students at

UIUC between the ages of 18 to 25 were given the opportunity to answer an in-depth online survey. A total number of 10,000 of these students were randomly sampled with the assistance of the Dean of Students of the institution in a roughly 50/50 sex distribution. The number of students contacted in each round of recruitment using samples from the Dean of Students, ranged from 1000 to 3000 per email blast. The remaining 2131 students were undergraduate and graduate students currently enrolled in the home college of several of the investigators of this study and were invited to complete the survey to increase survey yield; all students in the college between the ages of 18 and 25 were invited to complete the survey.

Study participants were compensated with a $5 Amazon eCard if the surveys were completed in full. To be eligible for compensation, answers to the electronic consent, demographics questionnaire, MQ, HQ, THS, and the OCI-R were required. The only survey that did not need to be completed for every student was the TFI, which was only presented to students who indicated that they experienced tinnitus. This study was approved by the relevant UIUC institutional review board protocol number 21268.

Data Organization and Participant Categorization

A total of 1084 complete responses were included in the data analysis. Once the HQ and MQ responses were formatted, the data were analyzed using SPSS (IBM SPSS Statistics for Windows, Version 27.0) analytic software to identify participants who fit each of the following criteria: high likelihood of having misophonia, possible likelihood of having misophonia, high likelihood of having hyperacusis, and possible likelihood of having hyperacusis. Respondents with an overall score of 29 or greater on the HQ were considered to have a high likelihood of hyperacusis and respondents with an overall score between 23 and 28 on the HQ were considered to have a possible likelihood of having hyperacusis. Criteria for inclusion were determined with the aim of encompassing some of the wide spectrum of possible trigger sounds, reactions, and symptoms related to misophonia, so as not to exclude anyone with misophonia-like symptoms. Single-item indicators of misophonia that assessed impairment and/or severity were incorporated into the present study's respondent classification schema for different likelihoods of misophonia, which is thought to parallel the criteria of Zhou et al. (2017) with only the MQ.

Respondents classified as high likelihood of misophonia had at least one of the following characteristics: a score of 12 or higher on the MQ Severity Scale; self-report of always having to leave the room in the presence of trigger sounds; self-report of actively avoiding trigger sounds; self-report of always having violent thoughts in the presence of trigger sounds, self-report of always becoming verbally aggressive in the presence of trigger sounds, or self-report of often becoming physically aggressive in the presence of trigger sounds. Cutoff scores of 12 and 10 on the MQ Severity Scale were chosen to designate high and possible likelihoods of having misophonia, respectively, as they designate moderate to severe sound sensitivity and would provide a higher level of confidence that participants selected for the in-person portion of the study were experiencing clinically significant symptoms of misophonia. These characteristics of high likelihood misophonia reflect intense reactions to trigger sounds. For a respondent to be classified as possibly having misophonia, one or more of the following characteristics were present: a score of 10 or 11 on the MQ Severity Scale; self-report of sometimes becoming physically aggressive in the presence of trigger sounds; self-report of often becoming verbally aggressive in the presence of trigger sounds; or self-report of often experiencing violent thoughts in the presence of trigger sounds. The categorization criteria for those with a possible likelihood of having misophonia involved a self-report of milder, but still impactful, symptoms than those of the high likelihood misophonia group. Our categorization criteria (other than the MQ Severity Scale score) emphasized aggression, which is typically precipitated by anger and which can be used as an indicator of anger severity (that does not require the respondent to explicitly acknowledge angry feelings). This was based on the salience of anger in so many sets of proposed diagnostic criteria for misophonia (e.g., Schroeder et al. 2013; Lewin et al. 2015; Dozier et al. 2017).

Assessment of hearing loss was changed into a dichotomous variable where positive responses for "no hearing loss" and "not sure about hearing loss" were combined as "no hearing loss." Tinnitus was also transformed into a dichotomous variable where "no tinnitus" and "not sure about tinnitus" were combined as "no tinnitus." The response options for self-reporting tinnitus and hearing loss were formatted similarly because representing respondents with uncertainty as positive indications of each disorder would drastically overestimate the presence of these disorders in a young collegiate sample.

Data Analysis

Pearson correlation between the MQ and HQ total scores was computed first. Pearson Chi-Square test of independence was also used to examine associations between respondents categorized as having a high likelihood of misophonia and other categorical variables such as hyperacusis, tinnitus, hearing loss, race, ethnicity, sex, and parental education. Independent sample *t*-tests were used to determine whether there were differences in MQ total score and MQ severity for individuals for the presence or absence of hyperacusis, tinnitus, and hearing loss separately. Due to large differences in sample size, equal variances were not assumed. One-way analysis of variance was employed to determine differences in MQ total score and MQ severity for categorical variables with more than two levels. Cohen's *d* and *r* criteria were used to interpret effect sizes (Cohen 1988).

Exclusionary Criteria

On the self-report survey, participants were given the following options to report gender identity: female/primarily feminine, male/primarily masculine, both male and female, neither male nor female, or do not know. A very small number of respondents (n = 28) responded with one of the latter three answers. For this reason, responses from these participants were excluded for the purpose of analyzing the data, and misophonia was instead examined in relation to felt female/primarily feminine or male/primarily masculine sex. Similarly, there was a small sampling in the study of American Indian (n = 2) and Native Hawaiian/Pacific Islander (n = 7); these responses were excluded from data analysis. In addition, although participants were advised to complete the survey only once, several participants submitted multiple responses; all additional responses beyond the initial submission were excluded for the purpose of data analysis.

RESULTS

Descriptive Analysis

Proportional data for respondents categorized as having a high and possible likelihood of misophonia and a high likelihood of hyperacusis are shown in Table 1. Using the operationalizations described earlier, 8.12% (n = 88) of respondents had a high likelihood of misophonia, and 11.9% (n = 129) of respondents had a modest likelihood of misophonia. Respondents with a high likelihood of having hyperacusis comprised 3.9% (n = 42) of the sample, with those having symptoms indicative of possible hyperacusis comprising 8.2% (n = 89) of the sample. Demographic information on the respondents' race, age, gender, and parental education is shown in Table 2. Race demographics revealed slightly over half of respondents were White, just under a third were Asian/Asian American, a tenth were Black or multiracial, and the remainder were American Indian or Native Hawai'ian/Pacific Islander. Slightly more than a tenth of our sampling identified as Latinx. In our sample, just under two-thirds were female; slightly less than a third were male; and the remainder identified as a different gender. This sample of students had well-educated parents, with slightly less than half holding a graduate degree; over a third holding a bachelor's degree; and the remainder having an associate's degree, high school, or grade school education. Tinnitus was reported in 27.7% (n = 300), hearing loss was reported in 3.3% (n = 36), and hyperacusis was reported in 23.9% (n = 259) of all participants. See Table 2 for complete details. The study sample's MQ revealed Cronbach's α values comparable to Wu et al. (2014) for each subscale: Misophonia Symptoms Scale (Cronbach's α = 0.84), Misophonia Emotions and Behaviors Scale (Cronbach's α = 0.89), and MQ Total Score (Cronbach's α = 0.92). In addition, the present study's HQ internal consistencies were generally stronger than that reported in the study by Khalfa et al. (2002) values for each subscale: attentional (Cronbach's α = 0.77), social (Cronbach's α = 0.76), and emotional (Cronbach's α = 0.81).

Individual misophonia symptom frequency was also assessed. The most common misophonia stimuli reported to be "often" or "always" bothersome among the sample included sounds of eating (39.5% of sample), nasal sounds (29.7% of sample), and throat and tapping sounds (both 25.4% of sample) followed by environmental sounds (17.0% of sample), sounds of rustling (14.8% of sample), other sounds not listed (14.6% of sample), and 4.1% to consonant/vowels sounds (4.1). See Table 3 for complete details.

Relationship of Misophonia and Hyperacusis

Pearson Chi-square test of independence demonstrated a significant association between high misophonia and hyperacusis classification [$\chi^2(1) = 87.17$, $p < 0.001$, phi = 0.284]. MQ total scores showed a strong positive correlation with HQ total scores [$r\ (1082) = 0.676$, $p < 0.001$]. These findings suggest a relationship between misophonia and hyperacusis. The scatterplot of HQ total scores and MQ total scores illustrates their possible relationship in Figure 1. Independent samples *t*-test revealed a statistically significant difference in MQ total scores [$t\ (173.75) = 18.69$, $p < 0.001$] between respondents with possible or high likelihood hyperacusis (M = 36.89, SD = 10.65) and respondents without hyperacusis (M = 19.26, SD = 11.16) with a large effect size (d =1.59), underscoring the high comorbidity between hyperacusis and misophonia. Similarly, respondents with hyperacusis (M = 8.78, SD = 2.62) had significantly larger MQ sound severity scale scores [$t\ (175.81) = 14.78$, $p < 0.001$] than respondents without hyperacusis (M = 5.09, SD = 2.89), with a large effect size (d = 1.3). In addition, there was a significant effect [$F(2, 1081) = 120.66$, $p < 0.001$)] for misophonia group status on HQ scores where those with a high likelihood of having misophonia (M = 21.5, SD = 9.47) scored significantly higher than those with possible likelihood of having misophonia (M = 18.1,

TABLE 1. Misophonia and hyperacusis proportions within the sample

	Frequency (n)	% of Sample
High misophonia	88	8.12
Possible misophonia	129	11.90
High hyperacusis	42	3.87
Possible hyperacusis	89	8.21
Control	813	75.00

Table illustrates participant categorizations based on this study's inclusion/exclusion criteria.

TABLE 2. Summary of demographics within the sample of respondents

	Frequency (n)	% of Sample
Hearing health comorbidities		
Tinnitus		
No Tinnitus	784	72.32
Tinnitus	300	27.68
Hearing loss		
No hearing loss	1048	96.68
Hearing loss	36	3.32
Hyperacusis		
No hyperacusis	825	76.11
Hyperacusis	259	23.89
Demographic information		
Race		
White	576	57.20
Asian/Asian American	319	31.70
Black	41	4.10
Multiracial	62	6.20
American Indian	7	0.70
Native Hawai'ian/Pacific Islander	2	0.20
Parent education		
Grade school	21	1.94
High school	165	15.22
Associate degree	61	5.63
Bachelor's degree	368	33.95
Graduate school	469	43.27
Ethnicity		
Latinx	138	12.86
Not Latinx	935	87.14
Age		
18 yrs old	138	12.70
19 yrs old	278	25.60
20 yrs old	268	24.70
21 yrs old	114	10.50
22 yrs old	67	6.20
23 yrs old	82	7.60
24 yrs old	70	6.50
25 yrs old	67	6.20
Gender		
Female	710	65.50
Male	346	31.90
Other	28	2.6

TABLE 3. Individual symptoms endorsed on the Misophonia Questionnaire

				Frequency of endorsement				
Misophonia Questionnaire item	Mean	SD	Range	0	1	2	3	4
People eating	1.95	1.33	0–4	197	219	279	216	173
Repetitive tapping	1.71	1.18	0–4	203	270	335	192	84
Rustling	1.19	1.15	0–4	387	304	233	118	42
Nasal sounds	1.69	1.31	0–4	262	250	250	207	115
Throat sounds	1.56	1.28	0–4	290	272	247	180	95
Consonants and/or vowels	0.55	0.88	0–4	705	220	114	33	12
Environmental sounds	1.23	1.22	0–4	399	281	220	120	64
Other sounds	1.17	1.16	0–4	415	266	245	116	42

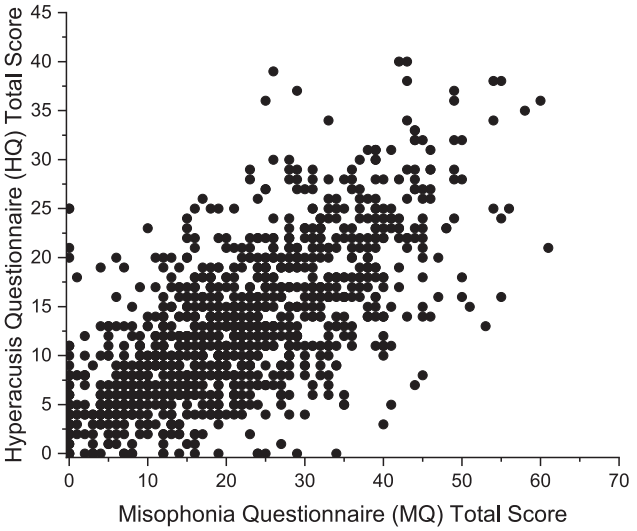

Fig. 1. Scatterplot comparing MQ total scores to HQ total scores. HQ indicates Khalfa's Hyperacusis Questionnaire; MQ, Misophonia Questionnaire.

SD = 7.23), with both groups scoring significantly higher HQ scores than the no misophonia likelihood group (M = 11.47, SD = 6.47). Thus, we observed that there was a high co-occurrence of hyperacusis and misophonia and that the severity of misophonic symptoms was higher in individuals with hyperacusis.

Relationship of Misophonia and Tinnitus

Individuals with a high likelihood of misophonia demonstrated a statistically significant relationship with self-reporting tinnitus [$\chi^2(1) = 5.75$, $p = 0.016$, phi = 0.073]. MQ total scores of respondents self-reporting having tinnitus (M=22.87, SD = 13.00) were significantly larger [t (514.23) = 2.38, $p = 0.018$] than respondents without tinnitus (M = 20.81, SD = 12.26) with a small Cohen's d of 0.166. A significant difference in means between respondents with tinnitus (M = 6.07, SD = 3.22) and respondents without tinnitus (M = 5.36, SD = 3.04) on the MQ sound sensitivity scale was also determined [t (496.64) = 3.24, p = 0.001] with a small Cohen's d of 0.231. These findings suggest there may be an association between misophonia and tinnitus, with a small effect size reflecting the need for further examination to determine the relationship between the conditions.

Relationship of Misophonia and Hearing Loss

There was no statistically significant relationship between self-perceived hearing loss and a high likelihood of misophonia [$\chi^2(1) = 0.328$, $p = 0.567$, phi = –0.017]; it should be noted that the majority of respondents within this sample denied any perceived hearing loss. This sample is not optimized to examine the relationship between misophonia and hearing loss. There were no significant differences in MQ total scores based on self-reported hearing status [t (37.06) = 1.890, $p = 0.067$] or the MQ sound sensitivity scale [t(30.91) = 0.971, $p = 0.339$].

Relationship of Misophonia With Demographic Characteristics

Due to very limited data collected from participants with a felt gender of both female and male, neither female nor male nor "don't know," a dichotomous sex variable featuring solely female/primarily feminine and male/primarily masculine was created and used in the analysis. Pearson Chi-Square test found no significant relationship between dichotomous sex and dichotomous high likelihood misophonia group status [$\chi^2(1) = 3.07$, $p = 0.08$, phi = –0.054].

Independent samples t-tests showed a statistically significant difference in means between male (M = 17.40, SD = 12.00) and female (M = 23.15, SD = 12.29) participants for MQ total score [t (698.97) = 7.25, $p < 0.001$] with a medium effect size (Cohen's d = 0.47). Similarly, female subjects (M = 5.79, SD = 3.08) demonstrated significantly larger MQ sound sensitivity scale scores [t (614.21) = 4.16, $p < 0.001$] than did males (M = 4.93, SD = 3.06) with a small effect size (Cohen's d = 0.282). This suggests that misophonic symptoms may be more severe in females.

The statistical analysis for race was reduced to four categories (White, Black, multiracial, Asian/Asian American) due to limited sampling of American Indian and Native Hawaiian/Pacific Islander groups (n = 2 and n = 7, respectively). There were no significant relationships between participants categorized with high likelihood misophonia and race [$\chi^2(3) = 3.55$, $p = 0.314$, phi = 0.060], or parental education [$\chi^2(4) = 4.28$, $p = 0.370$, phi = 0.063], or age [$\chi^2(7) = 2.95$, $p = 0.89$, phi = 0.052], or ethnicity [$\chi^2(1) = 1.62$, $p = 0.203$, phi = –0.039]. When evaluating differences in MQ total score and MQ sound sensitivity scale on different categorical variables, there were no significant effects for parental education ("what is the highest level of education completed by your parent(s)") on MQ total score [F(4,1079) = 0.085, $p = 0.987$] or MQ Sound sensitivity [F(4,1026) = 0.255, $p = 0.907$]; no significant differences in ethnicity for MQ total score [t (168.63) = 0.183, $p = 0.855$] or MQ sound sensitivity scale [t (175.90) = 0.172, $p = 0.864$]. However, there was a significant effect for race when comparing MQ total scores [F (3, 994) = 5.621, $p = 0.001$], but not the MQ sound

sensitivity scale [F (3, 944) = 1.805, p = 0.145]. Post hoc comparison using the Bonferroni correction (p = 0.003) revealed the effect for race came from Whites (M = 22.67, SD = 12.71) having significantly larger MQ total scores [t (697.95) = 3.56, p < 0.001] than Asians/Asian Americans (M = 19.12, SD = 11.81).

DISCUSSION

The goal of this study was to estimate the proportion of misophonia in a collegiate population, as well as to explore possible links between misophonia and demographic information, tinnitus, HL, and hyperacusis. Estimated proportion of high likelihood misophonia and modest likelihood of misophonia was a combined 20% in our study. There was a positive correlation between HQ and MQ scores. Furthermore, our findings indicated there were significant differences in both MQ total scores and MQ sound sensitivity scores between male and female respondents, people who reported having tinnitus and those who did not, and people with and without hyperacusis.

Misophonia and Hearing Health Conditions

Discussion of hyperacusis and misophonia definition and boundaries that incorporate the wealth of research for each disorder are scant (Tyler et al. 2014; Swedo et al. 2022). Although misophonia may share characteristics of annoyance hyperacusis within Tyler et al., (2014) framework, its co-occurrence with loudness hyperacusis is not delineated in the literature. Our study found a positive significant correlation between MQ and HQ scores, suggesting misophonia and loudness hyperacusis may be often comorbid in the same individual. In addition, individuals with loudness hyperacusis may experience misophonia symptoms more severely, and vice versa.

In addition to suggesting that misophonia and hyperacusis (as measured by MQ and HQ, respectively) are associated, our results also suggested that these two conditions are distinct given that there was a large minority that had only one of the two conditions. It should be noted that there are similarities in the types of items included in the questionnaire measures of misophonia and hyperacusis, it is possible that the results of this study overestimated the strength of the association between them. It will be important for future research to use additional approaches to measuring misophonia and hyperacusis when estimating their association. Our findings are novel and clinicians interested in treating either disorder will need to be cognizant of the symptoms of both disorders when planning targeted interventions. In the same vein, brain imaging studies are needed to map out the similarities and differences in the neural correlates of loudness hyperacusis and misophonia.

Few studies have used specific questions or questionnaires to characterize hyperacusis and misophonia to examine their association with each other, and thus there are limited options within the currently published literature to compare with this study's results. Aazh et al. (2022) examined audiological and psychological characteristics in hyperacusis and tinnitus patients with or without misophonia symptoms. 23% of participants in their sample were categorized as having misophonia using question 4 of the sound sensitivity symptoms questionnaire (SSSQ4). SSSQ4 asks "Over the last 2 weeks, how often have you been feeling angry or anxious when hearing certain sounds related to eating noises, lip smacking, sniffling, breathing, clicking sounds, tapping?" and respondents reporting occurrences for seven or more days were categorized as having misophonia. They found that 73% of individuals categorized as having misophonia had a significant impact on hyperacusis and found that SSSQ4 strongly correlated with patient scores on the Hyperacusis Impact Questionnaire. In total, Aazh and colleagues reported 42% of their sample as having some misophonia symptoms.

Enzler et al. (2021) developed a psychoacoustic test for misophonia and recruited participants through misophonia and audiology-specific communities. They categorized participants with misophonia who had a MisoQuest score of ≥ 61 and also self-reported misophonia. Their sampling revealed that in participants with misophonia, 73% self-reported hyperacusis, 19% self-reported tinnitus, and 22% self-reported hearing issues. It should be noted that Aazh et al. (2022) and Enzler et al. (2021) examined a broad range of ages (17 to 97 years in the former and a mean age of 33 years in the latter). The present study found that among collegiate students who self-reported misophonia, 23.9% self-reported hyperacusis, 27.7% self-reported tinnitus, and 3.3% self-reported hearing loss.

This study noted statistically different means on both the MQ and the MQ Sound Sensitivity Severity Scale within the tinnitus self-report variable. Aazh et al. (2022) reported that 74% of their patients categorized with misophonia had severe tinnitus and found that the SSSQ4 strongly correlated with Tinnitus Impact Questionnaire scores. The present study found a significant relationship between our categorization of misophonia status and self-reported tinnitus. In addition, respondents with tinnitus had higher MQ total scores than those without tinnitus. While this finding suggests that people with tinnitus may experience misophonia differently or more severely than those who do not have tinnitus, it is important to note that the self-report of tinnitus was extremely high for this sample and may not be reliable (n = 300, 27.67%, age range = 18 to 25 years). In Jarach et al. (2022) recent meta-analysis, tinnitus prevalence in young adults (age range 18 to 44 years) was found to be 9.7%. The question regarding tinnitus may have been confusing in that it did not seek to differentiate between chronic or temporary tinnitus and could be answered in the affirmative in either case (i.e. "Yes" or "Not sure"). Our findings are also different from those of Kılıç et al. (2021), who did not observe any association between a history of tinnitus and misophonia in their study.

Other in-person studies have examined the relationship between misophonia and hearing-related disorders. Schröder et al. (2013) randomly selected 5 of 42 participants to complete a measure of loudness discomfort levels (LDL) and audiometry but found no hearing disorders. Jager et al. (2020) evaluated hearing thresholds in 109 of 575 participants referred for misophonia. They found the prevalence of hearing loss in their sample was less than the general population, which may suggest no relationship between misophonia and hearing loss. Siepsiak et al. (2022) measured pure-tone audiometric thresholds and LDL in participants who reported misophonic or misophonic-like symptoms and healthy controls. They found no significant group differences in LDL or hearing loss. In general, the prevalence of hearing disorders observed in the misophonia population is relatively small.

LDLs or a measure of loudness growth are endorsed as a method of assessing loudness hyperacusis, apart from self-reports, whereas the other subcategories of hyperacusis may only be evaluated by questionnaires on interviews (Pienkowski

et al. 2014). Nevertheless, instructions on patient's internal criteria and hearing sensitivity may vary, which makes it difficult to compare across studies and establish norms based on loudness level. Patient self-reporting, questionnaires, and interview-style questions may lack the objectivity desired for targeted diagnosis of loudness hyperacusis but would reveal the other subcategories of hyperacusis. This variability of each measure emphasizes the importance of using multiple measures to characterize all subcategories of hyperacusis.

Misophonia in a Large Collegiate Sample

This study estimated the proportion of misophonia within a large (n > 1000) sample of collegiate students to be between 8% and 20.02%. This finding is in agreement with the conclusions of Wu et al. (2014) and Zhou et al. (2017) who found, in their college-aged samples, a misophonia prevalence of about 20% when using the study by Wu et al. original criteria, and a prevalence of about 6% when including an impairment criterion. The tools used to evaluate participants as well as the criteria used to determine whether a participant would be categorized as meeting the threshold for "clinically significant" misophonia for the purpose of this study were most similar to that of Wu et al. (2014) study than that of the Naylor et al. (2020) study, which used more liberal criteria to determine what constitutes "clinically significant" misophonia and had a much higher estimated prevalence among their sample.

The present study identified a statistically significant difference in MQ total score means and overall sound sensitivity between men and women. This finding diverges from the results of Wu et al. (2014), who found no significant relation between gender and MQ total score. To further compare the findings of the present study to that of Wu et al. (2014), the present sample was categorized using Wu et al.'s (2014) criteria of the MQ Severity Scale ≥7 indicating clinically significant symptoms. This study's criteria found that the proportion of women with a high likelihood of misophonia exceeded that of men (8.9% women vs. 5.8% men), but respondent sex was not a factor when considering the possible likelihood of misophonia (11.7% women vs. 11.8% men). Using Wu et al.'s (2014) criteria in the present sample resulted in 29.1% of men and 39.1% of women being identified as having misophonia-like traits. Using Wu et al.'s (2014) criteria in the present sample resulted in 29.1% of men and 39.1% of women being identified as having misophonia-like traits. This suggests that whereas in our study the proportion of females reporting misophonia far outnumbered males when using the study by Wu et al. (2014) criteria, such observations are sensitive to the criteria used and broader claims about gender disparity should be carefully examined in future studies. Literature reviews previously have not found consistent information regarding misophonia occurrence and severity disparities between men and women (Brout et al. 2018; Potgieter et al. 2019); however, recent reports have noted a higher prevalence of misophonia in young women compared with other demographic groups (Kılıç et al. 2021; Ertuerk et al. 2023).

No statistically significant relationships were found between our categorization of high likelihood misophonia and ethnicity, parental education level, or age. In regard to parental education level, US census data for 2021 cited by the National Center for Education Statistics (2022), the proportion of US parents holding a graduate degree (22.3%), or bachelor's degree (24.4%) was much lower than parents of respondents in the present study who held a graduate degree (43.3%) or bachelor's degree (34.0%). The present study also found that Whites had significantly higher MQ total scores than Asians/Asian Americans. Wu et al. (2014) found no significant relationships between age or race/ethnicity and misophonia symptoms; they did not consider parental education level.

When comparing the frequency of misophonic trigger sounds in this study's sample with that observed in the studies by Wu et al. (2014) and Zhou et al. (2017), eating sounds, nasal sounds, throat sounds, and repetitive/tapping noises were the four most commonly observed trigger sounds in all three samples. However, this study recorded a higher proportion of respondents noting eating sounds as triggers (39.5%) compared with that of Zhou et al. (16.6%) and Wu et al. (22.8%).

Limitations of the Study

Although the sample size of this study was large and the survey was extensive, there were several limitations to the analysis and generalizability of the study. It should be acknowledged that this study is exploratory; there are currently no widely endorsed clinical guidelines to diagnose misophonia. This study used unvalidated hyperacusis and misophonia evaluative tools out of necessity. At the time of this study's conception, there were no validated tools to evaluate misophonia and the hyperacusis questionnaire has not been validated in English. Fackrell et al. (2015) attempted to validate the HQ in a tinnitus population but could not confirm the structure of the questionnaire. They recommended the English-language HQ be validated in the general population.

The variables used for tinnitus and hearing loss were based entirely on patient self-report and the number of positive indications for tinnitus seemed exceptionally large for a young collegiate sample (n = 300, age range = 18 to 25 years). This may be due in part to the wording of the survey questions, which did not specify what type of "ringing in the ears" constituted a participant having tinnitus (e.g., chronic, constant, nonbothersome, etc.). In addition, based on hyperacusis self-report, a similar overestimation was observed (n = 259, reported having hyperacusis). It should be noted that respondents who experience hearing health conditions, including tinnitus and hyperacusis, may have been more motivated to answer the survey since the content is closely related to their personal experience, which could also have contributed to the large amount of self-reported comorbidities in this sample. Although hearing loss is one of the hearing health comorbidities examined for the purpose of this study, the number of participants who reported having hearing loss was small (n = 35; 3.23% of the total sample; age range = 18 to 25 years). This is expected for a young, healthy collegiate population, but nonetheless limits the reliability of analysis when considering misophonia's relationship to hearing loss. This sample was not optimized to examine participants with hearing loss.

All students recruited for this study belonged to a very specific age range, were attending a prestigious 4-year university at the time of their response, and the majority came from highly educated home backgrounds and high socioeconomic statuses which inherently limits potential generalizability to the general population.

Future Directions for Research and Clinical Practice

Moving forward, research into decreased sound tolerance disorders should continue to examine hearing loss, tinnitus, and hyperacusis in relation to misophonia. Developing a standardized set of diagnostic guidelines for misophonia is crucial for both people with misophonia and the health professionals who care for them. Clinically speaking, it is key that healthcare professionals who may interact with people experiencing misophonia are educated on similar decreased sound tolerance disorders and comorbidities that may accompany misophonia so that this can be accounted for in the evaluation and treatment of their symptoms.

Individuals with misophonia may seek out hearing health professionals for help with their symptoms. Being aware of their strong reaction to auditory stimuli, they may appropriately consult an audiologist for evaluation and counseling due to their expertise in hearing and auditory-related concerns. Although a clinical diagnosis of misophonia may involve a semi-structured interview (Schröder et al. 2013), an interprofessional approach involving audiologists will often include ruling out associated neurological or psychiatric disorders and other decreased sound tolerance disorders like hyperacusis (Swedo et al. 2022).

It is within an audiologist's scope of practice to determine if a patient's symptoms stem from misophonia, a combination of disorders like loudness hyperacusis which may co-occur with misophonia, or a different condition entirely, in which case a physician or otolaryngologist would be necessary for further evaluation to determine the root cause of the patient's symptoms. Some audiologists consider misophonia to be akin to "annoyance hyperacusis" and treat them accordingly (Tyler et al. 2014). It is important that audiologists identify patients who may have misophonia and counsel them on treatment options or appropriately refer them. Too often patients with misophonic symptoms are passed between clinicians without any diagnosis or treatment, which can leave those who experience misophonia feeling frustrated or defeated. It is crucial that audiologists feel comfortable and confident assessing a patient's symptoms and getting them the help they need. It is also important to acknowledge that, whereas cognitive-behavioral therapy is available and used to treat misophonia therapeutically, there are currently no evidence-based treatments available for the disorder.

Continued education for audiologists, psychologists, allied health professionals, and the public on the disorder is needed to increase awareness and clinical competence. Validation of new and existing evaluative tools for misophonia (including those focused on the functional impact of misophonia, similar to what has been done in the case of tinnitus) should take place and small-scale studies should continue to be replicated to confirm findings.

Conclusions

Around 8 to 20% of this study's sample reported symptoms consistent with the formulated criteria for "clinically significant" misophonia. Results of data analysis indicated that misophonia was more likely to affect people who had loudness hyperacusis, with increasing severity of misophonia symptoms correlated with worse hyperacusis. In addition, misophonia symptoms were reported to be more severe in women than in men and in those with self-reported tinnitus. The findings of the present study advance our knowledge about misophonia and other sound sensitivity disorders, but further research is needed to establish a well-defined and universally agreed-upon characterization of misophonia and loudness hyperacusis and their differences for appropriate diagnosis and treatment.

ACKNOWLEDGMENTS

Research funding was generously granted by the Misophonia Research Foundation to PI Husain.

C.B. designed the study, conducted the statistical analysis, and wrote the article; R.L. designed the data analysis, interpreted the results, and contributed to the writing of the article; G.B., R.K., and A.C. contributed to the study design, analysis, and writing of the article; H.B. provides expert advice on the design, statistical analysis, interpretation of the results, and writing of the article; F.H. secured funding, planned the study, designed the analysis, interpreted the results, and contributed to the writing of the article.

The authors have no conflicts of interest to declare.

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Received January 22, 2023; accepted July 20, 2023

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