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Anxiety and depression among Canadian undergraduates with decreased sound tolerance

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ABSTRACT

Decreased sound tolerance (DST) is an encompassing term for conditions marked by a reduced tolerance to everyday sounds. Misophonia, sensitivity to specific trigger sounds which cue aversive responses, is one DST subtype. Hyperacusis, another DST subtype, occurs when people are irritated by general sounds that are not bothersome to others. Research suggests that those with DST face heightened mental health challenges. Psychometrically validated measures aligned with the recent misophonia consensus definition have not assessed the relationship between misophonia and mental health. There is also a complete dearth of DST-mental health research in Canadian universities. Here, 2095 Canadian undergraduate students completed DST and mental health questionnaires. We explored the relationship between anxiety and depression and DST. We found strong, positive correlations between DST symptoms and mental health difficulties. These findings highlight DST's detrimental effects and the need for future research on strategies for managing and treating DST in post-secondary institutions.

1. Introduction

Humans encounter various forms of auditory stimuli every day. From music on the radio to ticking clocks, sounds are varied and volatile. For some, the nature of auditory stimuli can be distressing, interfering with many facets of their life. Decreased sound tolerance (DST) is an umbrella term that encompasses various sound sensitivities (Williams et al., 2021). For those with DST, auditory stimuli that may be inconsequential to others are bothersome (Scheerer et al., 2022; Williams et al., 2021). Earlier research shows that DST can impair overall life quality, including occupational, academic, and social functioning (Claiborn et al., 2020; Scheerer et al., 2022; Wu et al., 2014). Further, past work has found that DST strongly correlates with increased instances of mental illness (such as anxiety, depression, and more) and, in some cases, suicidal ideation (Cassiello-Robbins et al., 2021; Jager et al., 2020; Simner and Rinaldi, 2023). This work investigates whether two forms of DST, *misophonia* and *hyperacusis*, are related to anxiety and depression in a Canadian undergraduate sample. This work is timely given the recent development of consensus definitions of misophonia (Swedo et al., 2022) and hyperacusis (Adams et al., 2021). Understanding how DST may influence aspects of the mental health of university students will highlight the impact of DST on these students and point to potential intervention strategies, such as changes in post-secondary design from the classroom to the dormitory.

1.1. Misophonia

Misophonia is a DST subtype where specific sounds are particularly bothersome (Swedo et al., 2022). These sounds evoke discomfort or distress and typically lead to behavioural, emotional, and/or physiological responses (Swedo et al., 2022). Often called *trigger sounds*, aversive stimuli can range from dogs barking to people chewing (Claiborn et al., 2020). Distinct from other DST subtypes where one may suffer from exposure to sounds in general, only specific triggers or classes of triggers cause distress in those with misophonia. Misophonia can contribute to a variety of undesirable outcomes like social isolation, concentration difficulties, and various mental health difficulties across populations (e.g., anxiety, depression, obsessive-compulsive disorder, etc.; Almadani et al., 2024; Cassiello-Robbins et al., 2021; Cusack et al., 2018; McKay et al., 2018; Rosenthal et al., 2022; Siepsiak et al., 2020; Smit et al., 2021; Swedo et al., 2022; Wu et al., 2014; Zhou et al., 2017).

Depression and anxiety are common outcomes for those with

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misophonia. Misophonia frequently cooccurs with clinical diagnoses of depression (Jüris et al., 2013; Smit et al., 2021) and anxiety (Rosenthal et al., 2022). Across assessment types, individuals with misophonia consistently report elevated depressive and anxious symptoms (e.g., Frank and McKay, 2019; Jager et al., 2020; Rouw and Erfanian, 2018; Schröder et al., 2013). Correlations between self-reported misophonia severity and symptoms of depression and anxiety further underscore this link (Almadani et al., 2024; Cusack et al., 2018; McKay et al., 2018; Rosenthal et al., 2022; Scheerer et al., 2024; Siepsiak et al., 2020; Wu et al., 2014; Zhou et al., 2017).

1.2. Hyperacusis

Those who suffer from hyperacusis, another type of DST, have a reduced tolerance to sounds that most people perceive as innocuous (Adams et al., 2021). Those with hyperacusis are not attuned to specific sounds, as in misophonia; instead, they show discomfort with sounds at levels that others find tolerable. The broad array of problematic sounds can range from distant traffic to nearby electric mixers (Potgieter et al., 2020). Often, those with hyperacusis report irritation, annoyance, distraction, stress, fatigue, pain, and fear, to name only a few emotions (Scheerer et al., 2024). On top of these undesirable emotional states, hyperacusis affects daily functioning, such that those with hyperacusis may withdraw from social situations, experience occupational or academic interference, or wear earplugs to regain a sense of control over noises (Tyler et al., 2014; Scheerer et al., 2024).

Earlier work suggests that hyperacusis co-occurs with mental health difficulties. Across different assessment types, individuals with hyperacusis frequently report elevated levels of depression and anxiety, and symptom severity tends to increase alongside the severity of hyperacusis (Aazh and Moore, 2017; Goebel and Floetzinger, 2008; Guzick et al., 2023; Jüris et al., 2013; Lewin et al., 2024; McKay et al., 2019; Paulin et al., 2016; Smit et al., 2021). Hyperacusis has also been linked to poorer quality of life (Scheerer et al., 2024). Moreover, in a five-year study on healthy aging, higher levels of depression and anxiety predicted greater interference in daily functioning associated with hyperacusis (Smit et al., 2021). Like misophonia, hyperacusis can substantially disrupt everyday life.

1.3. DST across the lifespan

Much of the research on hyperacusis has either not reported the sample age or only includes older adults (40–59 years or older; e.g., Jüris et al., 2012; Smit et al., 2021), leaving young adults unexamined. Though there is more work on misophonia at various ages, the age range is incredibly variable, extending from children (as young as 1 year old; Rinaldi et al., 2022; Scheerer et al., 2022) to middle-aged individuals (45 years old; Erfanian et al., 2019). As such, there is a gap when it comes to understanding misophonia's impact on young adulthood or student populations. Relatedly, there have been few studies specifically investigating DST and mental health in undergraduate or young adult (18–30 years old) samples.

University and college campuses are sensory rich environments. From lecture halls, to dining halls, and dormitories, there are few spaces where one can escape elevated levels of auditory stimulation. Given the potential for this auditory stimulation to interfere with learning (Klatte et al., 2013) and social outcomes (Scheerer et al., 2022; Wickie et al., 2025), and the fact that it may exacerbate already present mental health challenges (Sharp and Theiler, 2018), it is of particular interest to examine the relation between DST and anxiety and depression in these young adults attending university.

1.4. The current study

The current study employs psychometrically validated measures of misophonia that align with the recent consensus definition to examine the relation between misophonia and both anxiety and depression in a student population. We also examine the relation between hyperacusis and anxiety and depression to ascertain whether misophonia and hyperacusis may have different relations to anxiety and depression. We expect that students who experience misophonia and/or hyperacusis, or experience it more severely, will also tend to show higher anxious and/or depressive tendencies (Wu et al., 2014; Zhou et al., 2017). We expect this relationship to be apparent in both correlations to misophonia and hyperacusis symptoms severity, and when comparing those with clinical or subclinical classifications of misophonia. The relative relation between misophonia and hyperacusis to anxiety and depression is exploratory in nature.

2. Method

2.1. Participants

An initial sample of 3096 undergraduate student participants (M_{age} = 19.6, SD_{age} = 2.7, 697 male, 2275 female, 47 non-cis-gendered) were recruited at WLU. However, after removing careless responses aligned with protocols outlined in the *Data Integrity Check* section, the final sample included 2095 undergraduate students (M_{age} = 21.7, SD_{age} = 2.7). The final sample included 1615 participants who identified as female, 436 participants who identified as male, and 44 participants who were non-cis-gendered. We framed this study for participant recruitment as a project investigating factors influencing the quality of life of undergraduate students. There was no mention of DST in the recruitment materials. This strategy controlled for any sampling bias wherein participants interested in DST sign up at higher frequencies than those unfamiliar with DST. Since this study used a sample from an undergraduate population, the only inclusion criteria were that participants were undergraduate students at WLU, were enrolled in a psychology course, and had access to a device to complete an online survey.

2.1.1. Data integrity check

Here, multiple methods ensured data accuracy. Before participants began completing questionnaires, a "commitment check" was presented. We informed participants that honest, deliberate, and careful responses were paramount to the research. The commitment check stated, "Do you commit to providing thoughtful answers to all the questions in this survey?" Response options were "Yes, I will," "No, I will not," or "I can't promise either way". The intention of this check was to prime participants to answer honestly. Next, we administered four attention check questions throughout the study to promote adequate attention and reading. For example, "Please select 'Often true' to confirm you are reading these questions closely". If participants incorrectly responded to any attention check questions, we removed them from further analyses. Finally, after completing all the measures, we administered a penalty-free "honesty check". The question asked, "Did you answer any of the above questions randomly?" We removed those who answered "yes" to the honesty check or failed the attention checks from further analyses. Once respondents meeting the stated exclusion criteria were removed (n = 1001), we retained a final sample of 2095 participants.

2.2. Procedure

Over eight months (September 2023-April 2024), eligible participants completed an online survey via Qualtrics. After providing informed consent, participants completed a demographics questionnaire that collected information such as gender, age, ethnicity, and more. Next, we presented a series of questionnaires including the Misophonia Questionnaire (MQ; Wu et al., 2014), Duke-Vanderbilt Misophonia Screening Questionnaire (DVMSQ; Williams et al., 2022), Duke Misophonia Questionnaire(DMQ; Rosenthal et al., 2021), Inventory of Hyperacusis Symptoms (IHS; Greenberg and Carlos, 2018), Beck Depression Inventory (BDI; Beck et al., 1961), Beck Anxiety Inventory

(BAI; Beck et al., 1988a), Adult/Adolescent Sensory Profile (AASP; Brown & Dunn, 2002), Autism Spectrum Quotient (AQ; Baron-Cohen et al., 2001), and the Multidimensional Social Competence Scale (MSCS; Yager and Iarocci, 2013). We report only DVMSQ, DMQ, IHS, BDI, and BAI data here since these measures align best with the proposed research question. Discussion of the additional measures can be found elsewhere (Manning et al., 2025; Wickie et al., 2025). Once these questionnaires were complete, participants were debriefed and received compensation via course credit.

2.3. Measures

2.3.1. Duke-Vanderbilt misophonia screening questionnaire (DVMSQ)

The DVMSQ (Williams et al., 2022) was used to assessed misophonia symptomology. This measure is a modification of an earlier, much longer measure used to evaluate misophonia symptoms. The DVMSQ does not rely on theoretical caseness or empirical cut-off scores, differing from other misophonia measures. Instead, an algorithm determines if an individual shows symptoms of functional impairment (Williams et al., 2022). The DVMSQ focuses on clinical significance and assesses misophonia symptom status in an individual (i.e., non-clinical, sub-clinical, and clinical levels of misophonia). An individual is placed into a discrete category by meeting certain criteria, assessed by an algorithm. Differently from other questionnaires like the DMQ, there is no range of scores that classify misophonia severity. Therefore, a quantitative range is not reported here since it is not meaningful.

The DVMSQ begins with a screening item where participants can indicate if certain sounds are bothersome. If participants answer "no" to this item, the questionnaire is complete, and the DVMSQ total score is "0." If answered "yes", participants can list specific sounds in a free-text field. Those who respond affirmatively to the first screening question go on to complete 18 items, measured on 5-point Likert scales from 0 (e.g., "Never") to 4 (e.g., "Very often"). The DVMSQ divides the 18 items into two theoretically distinct groups. The *Symptom Frequency* category has 11 items, while the *Interference* category has seven items. For reliability, the omega-total score (ω_T) for the DVMSQ total score has been reported as high as 0.98 (Williams et al., 2022).

While there is no empirical cut-off score for this measure, DVMSQ scores fall into three categories: non-clinical, sub-clinical, and clinical levels of misophonia. The main distinction between clinical and sub-clinical misophonia is the impairment due to symptoms. One may have sub-clinical levels of misophonia if they have supra-threshold symptoms of misophonia but experience no impairment in their lives, while those with clinical levels experience supra-threshold symptoms and deal with impairment. Due to the three discrete categories, we treated DVSMQ scores as categorical.

2.3.2. Duke misophonia questionnaire (DMQ)

The DMQ is an 86-item measure that examines a variety of constructs relating to misophonia symptomology (Rosenthal et al., 2021). This measure assesses specific triggers, trigger frequency, specific coping strategies, impairment due to misophonia, and dysfunctional beliefs about misophonia. Through combining various misophonia constructs, two composite scales, Symptom Severity (SS) and Symptom Coping (SC), are generated. The DMQ positively correlates with various misophonia measures like the MQ (Wu et al., 2014) and the MISO-S (Schröder et al., 2013).

This study used the full 86-item measure, capturing scores from both the SS and SC composite scales. The SS composite includes *Affective, Physiological, and Cognitive* subscales (e.g., "My heart pounded or raced") and has 23 items. The SC composite combines temporally relevant subscales defined as *Coping Before, Coping During, and Coping After* (e.g., "I produced an alternate sound") and has 21 items. For both scales, items consisted of both "yes" or "no" responses and 5-point Likert scales from 0 (e.g., "Never") to 4 (e.g., "Extremely"). Higher scores on the Duke Misophonia Severity scale indicate more severe misophonia symptoms during trigger sound exposure. Higher scores on the Duke Misophonia Coping scale indicate more effective coping skills and greater coping strategy use. The SS and SC measures produce two scores used for correlational analyses. To classify clinical misophonia, we used a suggested average cut-off score of 1.8 for the SS only. The researchers suggest using these scores to assess caseness rather than providing a clinical diagnosis.

The reliability of the SS composite scale is excellent ($\rho_{xx} = 0.93$, Rosenthal et al., 2021). Earlier work suggests that interpreting the SS composite as a whole scale rather than a series of subscales is best since the reliability of specific factors ($\rho_{xx} = 0.62$, Rosenthal et al., 2021) was lower than the general factor reliability. The reliability of the SC composite ($\rho_{xx} = 0.93$, Rosenthal et al., 2021) was excellent. Again, however, the reliability of the specific factors (when viewed as a series of subscales) was lower than the general factor reliability, showing that the SC composite is also best interpreted as a single composite score (Rosenthal et al., 2021).

2.3.3. Inventory of hyperacusis symptoms (IHS)

The IHS is a 25-item questionnaire assessing hyperacusis symptoms (Greenberg and Carlos, 2018). The IHS examines a variety of domains such as severity, loudness perception, psychological functioning, fear, social, cognitive, and occupational hindrances, quality of life, and mental health. This questionnaire uses a 4-point Likert scale with scores ranging from 1 ("Not at all") to 4 ("Very much"). Participants report the frequency and intensity of experiences concerning sound sensitivities (e.g., "My increased sound sensitivity can make me feel hopeless"). Higher scores on the IHS indicate higher hyperacusis symptom severity. A recent analysis of IHS cut-off scores shows that, in a clinical population, a cut-off score of 56 or greater produces refined patient classifications (Aazh et al., 2021). We use this suggested score to classify hyperacusis severity. Upon first formation, Greenberg & Carlos (2018) found excellent internal consistency for the IHS ($\alpha = 0.93$). More recent work has shown even greater internal consistency for the IHS ($\alpha = 0.96$, Wickie et al., 2025).

We argue that using these measures was the best way to assess misophonia and hyperacusis in our sample. First, there are few standardized measures aligned with the misophonia consensus definition. Importantly, the DVMSQ and DMQ align with the consensus definition and have never been used to assess DST subtypes and mental health. Using these measures therefore fills an important theoretical gap.

Practically, these measures were the only feasible way to assess misophonia and hyperacusis in such a large sample. Since other methods like interviews can be highly subjective and experimental manipulations are infeasible with such a large sample, we used the best available standardized questionnaires.

2.3.4. Beck depression inventory (BDI)

The BDI (Beck, 1961) is a classic instrument used by clinicians and researchers to assess symptoms of depression. This measure is supported by earlier literature suggesting strong internal consistency and a single-factor structure (Beck et al., 1988b; Faraci and Tirrito, 2013). The BDI contains 21 items that are all scored on 4-point Likert scales ranging from 0 (e.g., "I do not feel sad") to 3 (e.g., "I am so sad or unhappy that I can't stand it"). Research has established empirical cut-off scores for severity. Raw scores of 10–18 indicate mild depressive symptoms, 19–29 moderate depressive symptoms, and 30–63 severe depressive symptoms (Beck, 1961). We used these cut-off scores during the data analysis stage. Faraci and Tirrito (2013) found that the BDI has an internal consistency of $\alpha = 0.83$ in a non-clinical adult sample.

2.3.5. Beck anxiety inventory (BAI)

The BAI (Beck et al., 1988a) was used to assess symptoms of anxiety. This measure is widely used and is a shorter tool that draws on pre-existing measures of anxiety (Beck et al., 1988a). The BAI consists of 21 items that all use a 4-point Likert scale with scores ranging from 0 (e.

g., “Not at all) to 4 (e.g., “Severely”). Research has established empirical cut-off scores for severity. Raw scores of 0–7 indicate minimal anxiety, 8–15 mild anxiety, 16–25 moderate anxiety, and 26–63 severe anxiety (Beck and Steer, 1993). We used these cut-off scores during the data analysis stage. The BAI has an internal consistency of α = 0.92 (Beck et al., 1988a).

2.4. Data analysis

Before analysis, we reviewed the dataset for careless, invalid, or duplicate responses, as outlined in the *Data Integrity Check* section. Further, for any participant, if any items on a given measure were left incomplete, all data for the incomplete measure was omitted. This did not impact our final sample (N = 2095) because incomplete measures were excluded, not participants themselves. Our large sample allowed us to use this liberal exclusion technique to enhance the precision of the data while maintaining a large sample. If a respondent passed these checks, we included their data.

We used an alpha level of 0.05 for statistical significance for all analyses. However, given our large sample size, we are primarily interested in the magnitude of effect for correlational analyses and the magnitude of the difference when examining how various DST severity levels influence mental health. To this end, we employ and focus our interpretations on effect sizes. For epsilon squared, 0.01–0.06 indicated a small effect, 0.06–0.14 indicated a moderate effect, and 0.14 and greater represented a large effect (Ben-Shachar et al., 2020). For Spearman’s rho, $\rho \geq 0.4$ was considered a very strong correlation, $\rho = 0.3$–0.4 was strong, and $\rho = 0.2$–0.3 was moderate (Ben-Shachar et al., 2020). Finally, for Cliff’s Delta, $\delta \geq 0.47$ was considered a large effect, δ between 0.33 and 0.47 was a medium effect, and δ between 0.15 and 0.33 was considered a small effect (Meissel and Yao, 2024).

First, we examined the normality assumption in the data using Shapiro-Wilk tests. We discovered that all continuous variables were non-normal. Further, we used the Fligner-Killeen test to assess the assumption of homogeneity of variances. We also violated this assumption. Logarithmic and square root transformations did not change assumption violations.

We then generated descriptive statistics for age and each DST or mental health measure (see Table 1). Next, we conducted Kruskal-Wallis rank sum tests with DVMSQ scores as our independent variable (IV). The IV had three levels (non-clinical, sub-clinical, and clinical). We used BDI and BAI scores as continuous, dependent variables (DVs). We conducted Dunn’s post-hoc tests with a Bonferroni correction for significant main effects (Dinno, 2024). Since we are primarily interested in examining the magnitude of the difference on depression and anxiety measures between participants with differing DST severity, we employ various effect size statistics. For Kruskal-Wallis effect size, we report epsilon squared (ε^2) (Mangiafico, 2025) values with bootstrapped bias-corrected and accelerated (BCa) 95 % confidence intervals (CIs) using 5000 iterations (Canty and Ripley, 2024; Davison and Hinkley, 1997). For Dunn’s post-hocs, we report Cliff’s delta (δ) effect sizes (Torchiano, 2020). Finally, we used Spearman’s rho to assess correlations between variables. We calculated bootstrapped BCa 95 % CIs using 5000 resamples for Spearman’s correlations (Canty and Ripley, 2024; Davison and Hinkley, 1997). We examined the relationships between BAI scores, BDI scores, Duke Misophonia Severity Scores, Duke Misophonia Coping Scores, and IHS (Hyperacusis) Scores. All statistical analyses were conducted in *R* (R Core Team, 2025).

3. Results

Properties of the sample, like clinical significance, mean scores on various measures, percentages, and variability are in Table 1. Supplementary Materials contain reports of gender and age analyses for DVMSQ, DMQ, and IHS groups. We also direct the interested reader to Manning et al. (2025) for gender and age analyses on these data.

Table 1
Descriptive statistics.

Variable	*n*	*M*	*SD*	Range	Percentage (%)
Gender	2095				
Male	1615				
Female	436				
Other	44				
Age	2060	21.70	2.73	42	
BAI Total	1842	18.58	12.86	62	
BDI Total	1970	14.44	9.53	56	
DMQ SS	1699	23.12	19.82	92	
DMQ SC	1699	21.95	17.86	82	
IHS Total	1968	40.25	15.15	75	
DVMSQ Clinically Significant Misophonia	165				8
DMQ Clinically Significant Misophonia	325				16
IHS Clinically Significant Hyperacusis	327				16
DMQ Clinically Significant Misophonia & IHS Clinically Significant Hyperacusis	206				10

Note. Some variables are missing measures of central tendency because of measurement on a nominal scale. For Gender: “Other” includes 21 non-binary, 12 transgender, 7 “prefer not to answer”, 2 gender fluid, 1 gender binary, and 1 “I do not know” individuals. BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory; DVMSQ = Duke-Vanderbilt Misophonia Screening Questionnaire; DMQ = Duke Misophonia Questionnaire; IHS = Inventory of Hyperacusis Symptoms.

3.1. DVMSQ severity and mental health

The results of a Kruskal-Wallis rank sum test revealed significant differences between participants scoring at distinct levels of the DVMSQ on depression, $\chi^2(3) = 187.41$, $p < .001$, $\varepsilon^2 = 0.09$, bootstrapped 95 % CI [.07, 0.11] (see Fig. 1). Dunn’s post-hoc analyses revealed a large difference on depression scores between those with clinically significant misophonia (CM) (M = 23.6, SD = 10.4) and those with non-clinical misophonia (NCM) (M = 12.5, SD = 8.4), z = 12.74, $p < .001$, δ = 0.61, 95 % CI [.53, 0.67]. Further, we found a moderate difference on depression scores between those with CM (M = 23.6, SD = 10.4) and those with sub-clinical misophonia (SCM) (M = 16.2, SD = 9.51), z = 5.40, $p < .001$, δ = 0.41, 95 % CI [.28, 0.53]. Finally, there was a small difference on depression scores between those with SCM (M = 16.2, SD = 9.51) and those with NCM (M = 12.5, SD = 8.4), $z = -4.03$, $p < 0.001$, δ = 0.24, 95 % CI [.13, 0.34].

We found significantly different anxiety scores when participants scored differently on the DVMSQ, $\chi^2(3) = 221.39$, $p < .001$, $\varepsilon^2 = 0.11$ (moderate), bootstrapped 95 % CI [.08, 0.13] (see Fig. 1). Dunn’s post-hoc tests show a large difference on anxiety scores between those with CM (M = 30.4, SD = 12.6) and those with NCM (M = 15.3, SD = 11.1), z = 12.9, $p < .001$, δ = 0.63, 95 % CI [.56, 0.69]. Further, there was a small difference on anxiety scores between those with CM (M = 30.4, SD = 12.6) and those with SCM (M = 22.8, SD = 12.9), z = 4.07, $p < .001$, δ = 0.32, 95 % CI [.18, 0.45]. Lastly, there was a moderate difference between those with SCM on anxiety scores and those with NCM (M = 15.3, SD = 11.1), $z = -5.83$, $p < .001$, δ = 0.35, 95 % CI [.24, 0.45]. The results from both Kruskal-Wallis rank sum tests reveal that participants with higher misophonia scores show higher mental illness symptomology, marked by increased scores on depression and anxiety measures.

Please refer to the Supplementary Materials for mental health analyses where clinically significant DMQ and IHS scores are treated as categorical variables using indicated cut-offs.

3.2. Correlational analyses

Next, we conducted correlational analyses using Spearman’s rho. Of

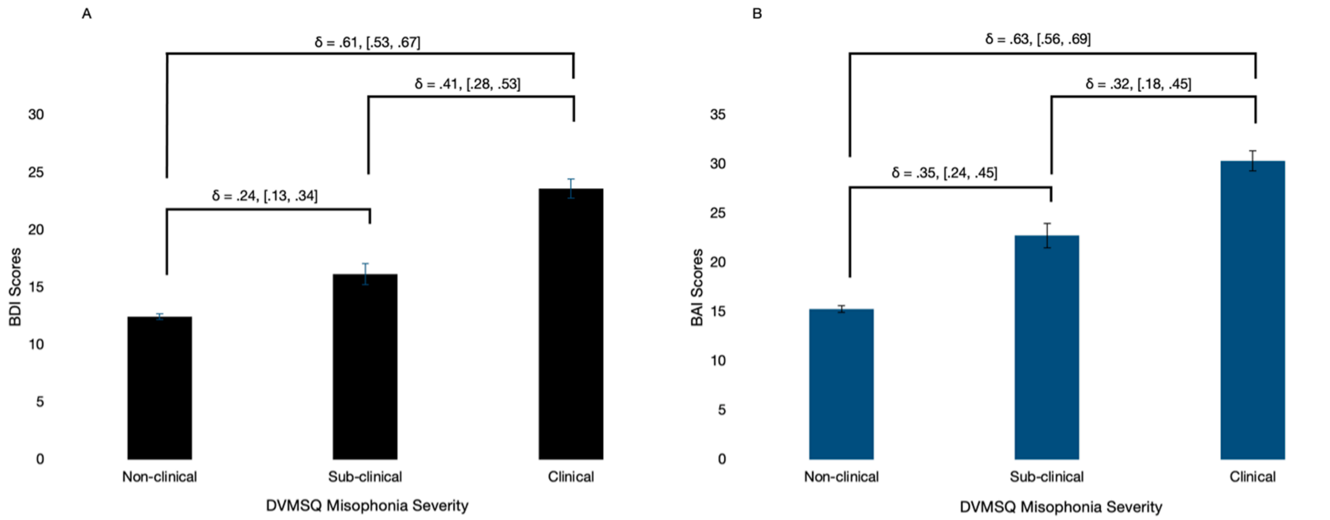

Fig. 1. DVMSQ severity and mental health.
Note. Depression and anxiety scores at varied levels of DST severity. (A) The effect of misophonia severity, measured by the DVMSQ, on depression scores. (B) The effect of misophonia severity, measured by the DVMSQ, on anxiety scores. Cliff's Delta (δ) denotes effect sizes for each comparison. Precision of effect size estimates indicated by 95 % CIs. All comparisons were significant at $p < .001$. Error bars represent the standard error of the mean (SEM). BDI = Beck Depression Inventory; BAI = Beck Anxiety Inventory.

note, we report disparate degrees of freedom for some correlations due to missing data for certain measures. We employed pairwise deletion for these data, which is a highly standard practice in psychological research. Since our samples were still large even with this missing data, we did not limit our analyses to only those with complete data. Our statistical measures would lose unnecessary power and may create a bias in our results if we only examine those who completed all measures. Finally, we opted to not use a data completion algorithm since missingness was limited.

First, we examined if the measures assessing depression and anxiety were correlated. We found a positive and very strong, correlation between depression and anxiety scores, $\rho(1754) = 0.57$, bootstrapped 95 % CI [.54, 0.61], $p < .001$. Our mental health measurements were aligned with the literature since depression and anxiety commonly cooccur and are theoretically similar.

To further support the notion that, although theoretically distinct (Swedo et al., 2022), misophonia and hyperacusis symptomology showed related outcomes, we examined the relation between the instruments used to assess these constructs. First, Duke Misophonia Severity scores were positively and very strongly correlated with Hyperacusis scores, $\rho(1618) = 0.82$, bootstrapped 95 % CI [.80, 0.84], $p < .001$. Further, we examined the Duke Misophonia Coping and Hyperacusis relationship, revealing a very strong and positive correlation, $\rho(1618) = 0.78$, bootstrapped 95 % CI [.76, 0.80], $p < .001$. Although these correlations may appear to suggest that the DMQ and IHS are measuring the same thing, we interpret this as support for examining hyperacusis in this study. That is, since people score similarly on the DMQ and IHS, it is vital to investigate the variability in the outcomes associated with these measures. If we treat DMQ and IHS scores as one, not only are we violating theoretical assumptions underlying decreased sound tolerance research (Adams et al., 2021; Swedo et al., 2022; Williams et al., 2021), we may also miss important discrepancies between whether each condition relates to mental health outcomes.

3.3. Misophonia and mental health correlations

To evaluate our primary hypothesis, we examined the correlation between misophonia symptomology and mental health disorders. First, we found a very strong and positive, correlation between anxiety scores and Duke Misophonia Severity scores, $\rho(1521) = 0.59$, bootstrapped 95 % CI [.55, 0.62], $p < .001$, suggesting that as participants report higher Duke Misophonia Severity scores, anxiety symptomology also increases. We found a very strong and positive correlation between anxiety scores and Duke Misophonia Coping scores, $\rho(1521) = 0.48$, bootstrapped 95 % CI [.44, 0.52], $p < .001$. Therefore, increased misophonia symptomology is associated with increased anxiety on both DMQ composite scales.

We also examined how DMQ Composite Scales correlated with depression scores. First, we found a very strong and positive correlation between depression scores and Duke Misophonia Severity scores, $\rho(1609) = 0.46$, bootstrapped 95 % CI [.42, 0.50], $p < .001$, showing that as scores on the DMQ SS increase, so do reports of depression. We discovered a strong and positive relationship between Duke Misophonia Coping scores and depression scores, $\rho(1609) = 0.34$, bootstrapped 95 % CI [.30, 0.39], $p < .001$. These findings suggest an intimate link between misophonia and depression, such that those who suffer more from misophonia also suffer more from depression. Fig. 2 illustrates all relationships between misophonia severity and coping abilities and mental health.

3.4. Hyperacusis and mental health correlations

To examine the relation between anxiety and hyperacusis symptomology, we correlated anxiety scores with Hyperacusis scores. There was a very strong and positive correlation, $\rho(1738) = 0.52$, bootstrapped 95 % CI [.48, 0.55], $p < .001$, such that anxiety increased as hyperacusis symptomology increased. We also investigated the relation between depression and hyperacusis symptomology. A very strong and positive correlation, $\rho(1851) = 0.41$, bootstrapped 95 % CI [.37, 0.45], $p < .001$, was found between depression and Hyperacusis scores. Similarly to DMQ scores, as hyperacusis symptomology increases, so do instances of mental health disorder symptomology. Fig. 3 displays the relationship between hyperacusis and depression and anxiety. Table 2 provides a summary of all correlations.

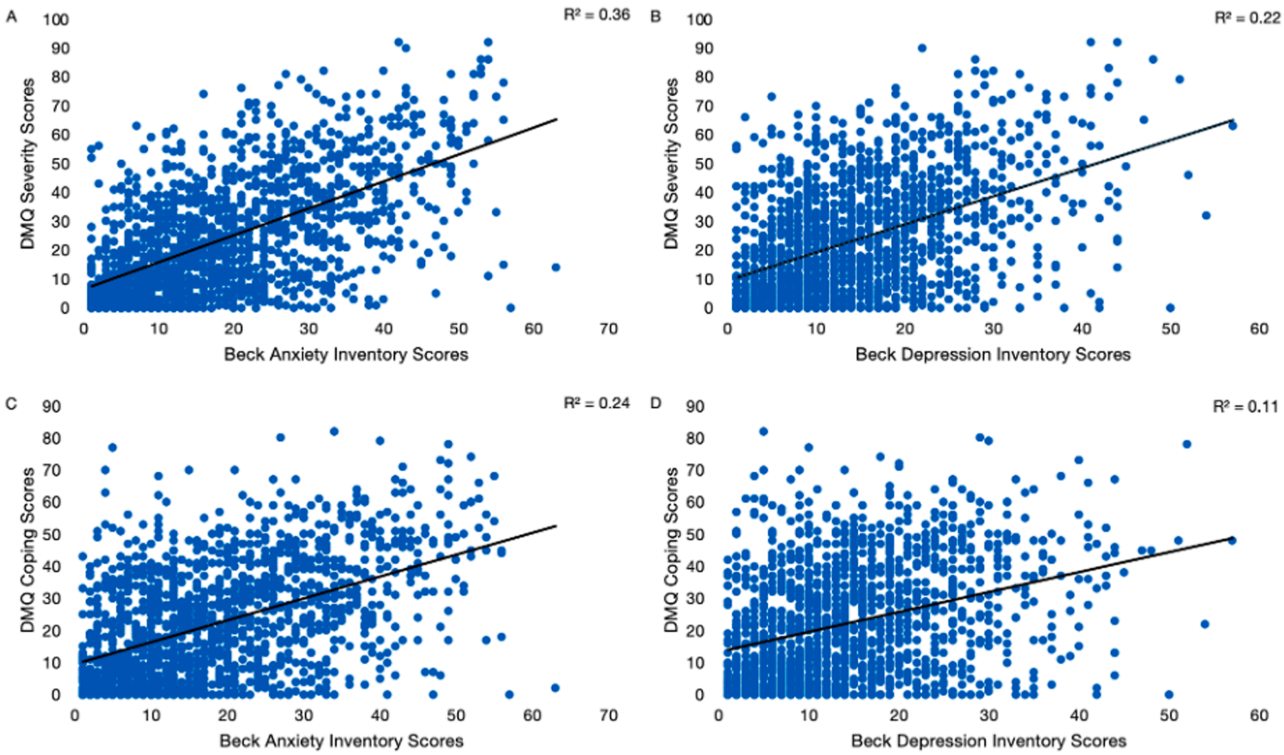

Fig. 2. DMQ severity & coping scores and mental health.

Note. Correlations between misophonia severity and coping abilities and mental health. (A) The relation between DMQ Severity Composite scores and BAI scores. (B) The relation between DMQ Severity Composite scores and BDI scores. (C) The relation between DMQ Coping Composite scores and BAI scores. (D) The relation between DMQ Coping Composite scores and BDI scores. DMQ = Duke Misophonia Questionnaire; BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory.

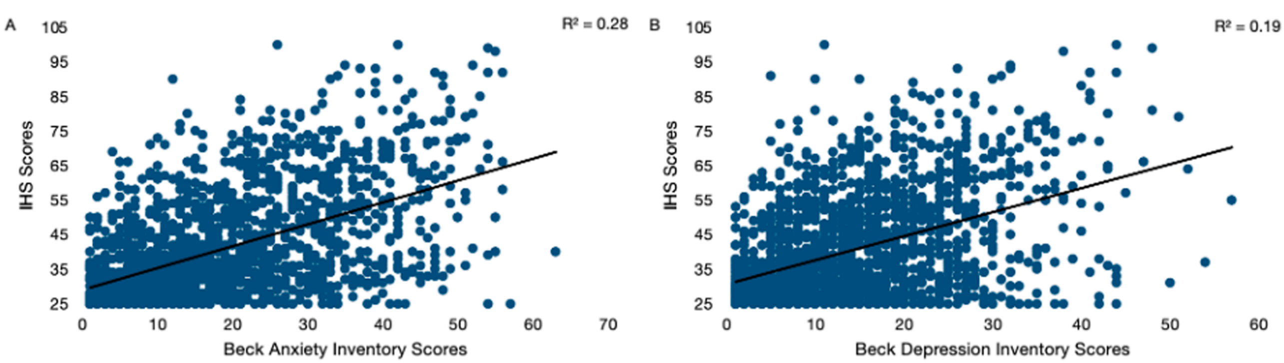

Fig. 3. IHS scores and mental health.

Note. Correlations between hyperacusis symptoms and mental health. (A) The relation between IHS scores and BAI scores. (B) The relation between HIS scores and BDI scores. IHS = Inventory of Hyperacusis Symptoms; BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory.

Table 2
DST and mental health spearman’s correlations.

Variable		BAI Score	BDI Score	DMQ Severity Score	IHS Score	DMQ Coping Score
1. BAI Score	n	—				
	Spearman's rho	—				
2. BDI Score	n	1754	—			
	Spearman's rho	0.57***	—			
3. DMQ Severity Score	n	1521	1609	—		
	Spearman's rho	0.59***	0.46***	—		
4. IHS Score	n	1738	1851	1618	—	
	Spearman's rho	0.52***	0.41***	0.82***	—	
5. DMQ Coping Score	n	1521	1609	1699	1618	—
	Spearman's rho	0.48***	0.34***	0.81***	0.78***	—

Note. BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory; DMQ = Duke Misophonia Questionnaire; IHS = Inventory of Hyperacusis Symptoms*$p < .05$, ** $p < .01$, *** $p < .001$.

4. Discussion

4.1. Main findings

In this study we were interested in exploring the relation between misophonia and hyperacusis and anxiety and depression in post-secondary students given its potential relevance to accessibility in these environments. Both misophonia and hyperacusis severity were found to be related to elevated levels of depression and anxiety. Additionally, those with clinically significant levels of misophonia (CM) tended to have more depression and anxiety symptoms than those with sub-clinical misophonia (SCM) or non-clinical misophonia (NCM). These findings support the notion that post-secondary students with DST often experience mental health difficulties (Almadani et al., 2024; Rosenthal et al., 2022; Wu et al., 2014; Zhou et al., 2017).

4.2. Mental health and misophonia

Broadly, the results of the current work align with previous studies, finding that clinically significant misophonia tends to scale with increased depression and anxiety (Almadani et al., 2024; Cassiello-Robbins et al., 2021; Cusack et al., 2018; Guzick et al., 2023; McKay et al., 2018; Scheerer et al., 2024; Rosenthal et al., 2022; Woolley et al., 2024; Wu et al., 2014; Zhou et al., 2017). Our findings specifically highlight the mental health difficulties that post-secondary students with misophonia face over students without misophonia.

4.3. Mental health and hyperacusis

Similar to misophonia, our findings on hyperacusis and mental health generally match the limited previous work examining this relationship (Jüris et al., 2013; Scheerer et al., 2024; Smit et al., 2021). Though no study has investigated hyperacusis in the student population, nor its relation to anxiety and depression in this population, our findings that hyperacusis severity strongly relates to increases in anxiety and depression symptomology mirrors findings in clinical and ageing populations (Jüris et al., 2013; Scheerer et al., 2024; Smit et al., 2021).

As we examined both misophonia and hyperacusis in the same sample, these data also allow us to compare whether misophonia or hyperacusis show a stronger relation to mental health outcomes. When comparing the 95 % confidence intervals for both subtypes of DST, misophonia and hyperacusis, and both anxiety and depression, we find overlapping confidence intervals across similar comparisons (each DST subtype with both anxiety and depression). As such, these data suggest both misophonia and hyperacusis are exerting similar effects on the measured mental health outcomes.

Together, highlighting the relations between misophonia and hyperacusis and anxiety and depression is particularly important for those advocating for better accessibility in post-secondary environments. University students are already at elevated risk for anxiety and depression, and the added burden of sensory intolerance may further compromise their academic performance, class attendance, and overall well-being. In these contexts, overwhelming and mandatory sensory environments (e.g., lecture halls, cafeterias, group work settings) can exacerbate emotional distress and reinforce avoidance behaviours, potentially contributing to academic disengagement or dropout. Recognizing these sensory–mental health links is therefore critical for universities aiming to create more inclusive learning environments—through sensory-friendly spaces, flexible participation options, and increased awareness among instructors and accessibility staff.

4.4. Mediation & causality

Although unanswered by the current study, this work produces interesting questions about *how* DST fosters mental health challenges. DST itself is focused on the abnormal perceptions and/or reactions to sounds (Williams et al., 2021). Avoiding social or academic situations where triggers are often present has been shown to be a strategy that those with DST employ to manage their symptoms (Scheerer et al., 2022; Williams et al., 2021). However, it is unclear whether it is the negative impact of this coping strategy (e.g., social isolation), or DST itself, that influences anxiety or depression. Past work has focused on how anxiety mediates DST, finding that anxiety mediates the relationship between misophonia severity and rage reactions (Wu et al., 2014) and partially mediates the relationship between personality disorder symptoms and misophonia (Cassiello-Robbins et al., 2021). However, there is little work on possible mediating effects between misophonia or hyperacusis and mental health difficulties. Future work should investigate whether there are other factors that may drive the relationship between DST and mental health, working to isolate the specific factors that cause DST to affect quality of life.

4.5. Limitations

The current study uses one of the largest samples to date to examine the relation between misophonia and hyperacusis and depression and anxiety symptomology. While we report robust relations between DST and mental health, this study is not without limitations.

Our study was first limited by relying on self-report measures. Estimations of mental health challenges and DST relied on the beliefs of respondents. We implemented rigorous data integrity checks to limit the effects of careless responses. Still, there is a possibility that some measures are over or underestimated. For example, anxiety and depression estimates may differ if assessed through a clinically structured interview (Cassiello-Robbins et al., 2021). In fact, some argue that measuring anxiety and depression is best done via structured psychiatric interview (Hammen, 2005). However, overall, this study aligns with the DST-mental health literature in that most DST work follows this self-report approach as there are no currently validated objective measures of DST (Scheerer et al., 2024). However, our study has the strength of using the most updated misophonia measures that are psychometrically validated and aligned with the consensus definition. Further, online self-reports allowed us to gather one of the largest samples in the DST-mental health literature.

Another limitation involves the use of the IHS to examine hyperacusis. Despite the IHS being a psychometrically validated and routinely employed measure for assessing hyperacusis (Greenberg and Carlos, 2018), it was developed prior to the consensus definition (Adams et al., 2020) and thus may not accurately measure hyperacusis as we currently understand it.

Previous work has suggested that, in the context of mechanism and treatment analyses, researchers should not examine hyperacusis and misophonia together to avoid conflating the two conditions (Swedo et al., 2022). However, since mental health outcomes in post-secondary students with DST are largely unexplored, it was valuable to examine these conditions together. Exploring the relations between mental health and hyperacusis and misophonia allowed for the consideration of the relative differences between the association of mental health and different subtypes of DST.

5. Conclusion

Overall, this study shows that DST is a concerning condition in Canadian universities and its impact is associated with mental health challenges in sufferers. Our findings align with previous research, indicating that misophonia and hyperacusis are not only an issue in clinical or ageing populations, but student populations too. This work specifically highlights the powerful negative effects of DST on students' mental health. Students are an understudied population in the field of DST, however, given students' lack of control over their surroundings (i.e. lecture halls, study spaces, dormitories), they are an important population to consider. With various negative mental health, social, and academic outcomes at stake, it is important that we continue to study DST and its correlates in students, and work towards better accommodating and supporting them.

Data availability

The data that support the findings of this study are available upon reasonable request from the corresponding author. The data are not publicly available due to privacy and ethical restrictions.

CRediT authorship contribution statement

Carter M. Smith: Writing – review & editing, Writing – original draft, Visualization, Formal analysis, Data curation. **Natalia Van Esch:** Writing – review & editing, Formal analysis, Data curation. **Nichole E. Scheerer:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that there were no conflicts of interest with respect to the authorship or the publication of this article.

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