Searching for the association between misophonia symptoms, noise sensitivity, and noise annoyance

Katarina Paunović[1*], Sanja Milenković[1]

[1] University of Belgrade, Faculty of Medicine, Institute of Hygiene and Medical Ecology, Belgrade, Serbia

*Corresponding author's e-mail address: katarina.paunovic@med.bg.ac.rs

ABSTRACT

The association between noise annoyance, noise sensitivity, and misophonia symptoms is currently unknown. A cross-sectional study was performed among 531 medical students (aged 22±2 years). Noise annoyance from seven outdoor and indoor sources was self-reported using a verbal annoyance scale. Students were predominantly annoyed by the electrical appliances in the buildings (19.6% of all students), construction works on the streets (17.7%), humans or animals indoors or outdoors (15.3%), and road traffic (10.2%). Noise sensitivity was measured with Weinstein's Noise Sensitivity Scale. High noise sensitivity was an independent predictor for high annoyance from almost all sources. Misophonia symptoms (adverse reactions to specific provoking sounds emitted by humans) were reported using a modified Amsterdam Misophonia scale. High perceived misophonia doubled the chance of reporting high annoyance from road traffic, construction works on the streets, electrical appliances indoors, humans and animals, independently from age, gender, perceived anxiety, perceived depression, and noise sensitivity. Perceived depression was predictor for high annoyance from air traffic, construction works on the streets, and humans or animals. Perceived anxiety was not associated with high noise annoyance.

INTRODUCTION

Annoyance is a specific combination of emotional, attitudinal, cognitive, and behavioral responses to environmental noise. It arises from a series of stress-related fight-or-flight reactions inside the human body and is typically defined as a feeling of irritation, anxiety, frustration, provocation, displeasure, or disturbance due to noise [1]. As much as 22 million people suffer from high noise annoyance in the European Union [2]. In Serbia, however, the prevalence of high annoyance from road traffic noise is currently unknown. Recent small-scale studies were able to estimate the proportion of highly annoyed inhabitants in three major cities: Belgrade, Novi Sad, and Niš. In Belgrade, the proportion of highly annoyed residents was assessed in the city center – an urban, residential and administrative municipality (population size around 60,000). The estimates range from 2.4% in areas with noise levels below 49.9 dBA to 44.2% for urban areas with noise levels above 75 dBA [3]. In Novi Sad (population size around 290,000), the proportion of highly annoyed inhabitants fluctuates

between 20 and 25% in residential areas, city center, and next to traffic roads [4]. In Niš (population size around 190,000), the proportion of highly annoyed residents was obtained from the recently presented strategic noise map – the first of its kind in the whole country. The proportion of high noise annoyance equals 15.9% for the whole agglomeration and ranges from 11.7 to 17.7% in different urban municipalities [5].

Noise annoyance arises from various sound-related and non-sound-related factors. Among the latter, noise sensitivity, some personality traits, and general stress level play important parts. To the authors' knowledge, the role of misophonia in the development of noise annoyance has not been explored so far. Misophonia symptoms occur as an adverse reaction to specific provoking sounds emitted by humans, particularly to the sounds of breathing, coughing, chewing, spitting, and alike. The affected individual feels irritated, disgusted, anxious, and angry when hearing the provoking sounds, or even feels the urge to verbally or physically attack the person making these sounds [6,7]. We hypothesize that high perceived misophonia may predict annoyance to various environmental sources, independently from age, gender, perceived anxiety, perceived depression, and noise sensitivity level.

This study aimed to explore the predictive value of noise sensitivity and perceived misophonia on noise annoyance from different environmental sources in relation to age, gender, perceived anxiety, and perceived depression.

METHODS

This cross-sectional study was conducted in 2013 among first- and second-year medical students of the Faculty of Medicine, University of Belgrade. Out of 550 students approached, 531 participants filled out and returned the questionnaires (response rate 96.5%). The study was approved by the Ethics Committee of the Faculty of Medicine, University of Belgrade.

An anonymous questionnaire comprised age, gender, noise annoyance, subjective noise sensitivity, perceived anxiety scale, perceived depression scale, and misophonia symptoms. Students' annoyance by noise from seven different environmental sources during the preceding 12 months was estimated using a verbal annoyance scale, graded as 0 – 'not at all', 1 – 'slightly', 2 – 'moderately', 3 – 'very' and 4 – 'extremely'. This 5-point scale complies with the recommendations of the International Commission on the Biological Effects of Noise [8]. Students who reported being 'very' and 'extremely' annoyed by each source were categorized as "highly annoyed".

Subjective noise sensitivity was measured with Weinstein's Noise Sensitivity Scale. It is a 21-item, 6-point scale dealing with attitudes toward noise in general, and emotional reactions to a variety of sounds (minimum score equals 26, maximum score equals 126) [9]. Two noise sensitivity levels were defined according to the Median value, as follows: 'low' –score ≤ 80, and 'high' – score ≥ 81.

Misophonia symptoms were self-reported using the adapted version of the Amsterdam Misophonia scale (A-MISO-S) [10]. Students reported the following five symptoms ('yes' or 'no'): 1) the feeling of an impulsive aversive reaction, irritation, disgust or anger when hearing the provoking sounds; 2) the feeling of irritation or distress to the point of screaming or attacking the person making the sounds; 3) the loss of control when hearing the sounds with a desire to hurt the person making the sounds; 4) the tendency to react in an unreasonably excessive way to the provoking sounds; 5) the tendency to avoid social situations, to avoid hearing the provoking sounds. Positive responses were counted (total range 0 to 5) and further categorized into two perceived misophonia levels, as follows: 'low'– 0-2 positive

responses, and 'high'– 3-5 positive responses. The authors modified the original scale and proposed criteria for high perceived misophonia recently [11].

Perceived anxiety was measured using the Hamilton Anxiety Rating Scale (HAMA), Serbian version [12]. It is a 29-item, 5-point scale covering somatic and psychic symptoms of anxiety (minimum score equals 0, maximum score equals 116). Two anxiety levels were defined according to the Median value, as follows: 'low' – score ≤ 36, and 'high' – score ≥ 37.

Perceived depression was measured using the Hamilton Depression Rating Scale (HRSD), Serbian version [12]. It is a 20-item, 5-point scale covering somatic and psychic symptoms of depression (minimum score equals 0, maximum score equals 80). Two depression levels were classified according to the Median value, as follows: 'low' – score ≤ 13, and 'high' – score ≥ 14.

Descriptive statistic was presented as mean values ± standard deviation (SD) for numeric variables, or as percents (relative numbers) for categorical variables. Differences between groups in parametric data were tested using Student's t-test for parametric data, and Mann-Whitney U-test and Chi-square test for nonparametric data. Multiple logistic regression models were fitted to calculate odds ratios (OR) and 95% confidence intervals (95% CI) for the occurrence of high noise annoyance from different sources, concerning age, gender, perceived anxiety level, perceived depression level, noise sensitivity level, and perceived misophonia level. SPSS 15.0 for Windows software (SPSS Inc. 1989-2006) was applied for statistical analyses.

RESULTS

General characteristics of the participating students by gender are presented in Table 1. In total, there were 186 male students and 345 female students, aged 22±2 years. Students were of similar age and reported a similar number of misophonia symptoms. Students had similar noise sensitivity score, and perceived depression score. Female students had significantly higher perceived anxiety score than male students. In total, 242 students (45.6%) reported no misophonia symptoms, 145 students (27.3%) reported 1-2 symptoms; 144 students (27.1%) who reported 3-5 symptoms were categorized high perceived misophonia level. The proportion of high perceived misophonia was similar between male and female students (Pearson's chi-square test=1.239, p=0.266).

Table 1: Characteristics of the investigated students by gender

Parameters	Male students	Female students	p value
Number of participants (%)	186 (35%)	345 (65%)	
Age (years)	22.15±2.02	21.99±1.92	0.357*
Perceived anxiety score	36.05±21.79	40.31±22.45	0.047†
Perceived depression score	16.02±14.68	18.66±16.62	0.078†
Noise sensitivity score	78.03±17.15	78.59±17.81	0.727*
Number of reported misophonia symptoms	1.27±1.49	1.41±1.58	0.496†

* Student's t-test; † Mann-Whitney U test

There was a moderately strong positive correlation between the reported number of misophonia symptoms and students' mean noise sensitivity score (Spearman's rho = 0.364, p<0.001), mean anxiety score (Spearman's rho=0.264, p<0.001), mean depression score (Spearman's rho=0.302, p<0.001), but no correlation with students' age. The correlation was significant in both sexes (data not shown).

The prevalence of high noise annoyance from different noise sources is presented in Table 2. In the 12 months preceding the survey students were dominantly annoyed by the electrical appliances in the buildings (19.6% of all students), construction works on the streets (17.7%), humans or animals indoors or outdoors (15.3%), and road traffic noise (10.2% of all students). Other sources of noise were less frequently reported: industrial facilities (5.6%), entertainment facilities (4.9%), and air traffic (3.2%). No differences were observed between male and female students.

Table 2: The prevalence of high noise annoyance from different sources of noise by gender

Sources of noise	Male students	Female students	p value
Electrical appliances inside the buildings	34 (18.4%)	70 (20.4%)	0.576*
Construction works on the streets	40 (21.7%)	54 (15.7%)	0.087*
Humans or animals (indoors or outdoors)	25 (13.4%)	56 (16.2%)	0.393*
Road traffic	23 (12.4%)	31 (9.0%)	0.223*
Industrial facilities	12 (6.5%)	18 (5.3%)	0.574*
Entertainment facilities	9 (4.8%)	17 (4.9%)	0.964*
Air traffic	3 (1.6%)	14 (4.1%)	0.126*

* Pearson's chi-square test

Multiple logistic regression models were fitted to calculate odds ratios (95% confidence intervals) for the occurrence of high noise annoyance from the different sources of noise in relation to gender, age, perceived anxiety, perceived depression, noise sensitivity, and perceived misophonia (Table 3). High noise sensitivity was a significant predictor for high annoyance to five out of seven investigated sources of noise. Highly noise-sensitive students were at four-time higher risk of being highly annoyed by noise from entertainment facilities, and noise from humans or animals. Furthermore, they were at three-time higher risk of being highly annoyed by road traffic noise, and noise from electrical appliances in the buildings. High noise sensitivity doubled the odds for high noise annoyance from construction works on the streets in the presented models.

High perceived misophonia doubled the odds for high noise annoyance from four out of seven investigated sources of noise, such as noise from humans or animals (indoors or outdoors), noise from road traffic, electrical appliances in the buildings, and construction works on the streets (Table 3). High perceived depression was an independent predictor for high annoyance from humans or animals indoors and outdoors. Perceived anxiety was not associated with high noise annoyance. Male students were at higher risk of being highly annoyed by noise from construction works on the streets. (Table 3).

Table 3: Odds ratios (95% confidence intervals) for the occurrence of high noise annoyance from various sources in relation to noise sensitivity, perceived misophonia, perceived anxiety, perceived depression, age, and gender

Parameters	Electrical appliances inside the buildings	Construc-tion works on the street	Humans or animals (indoors or outdoors)	Road traffic	Industrial facilities	Entertain-ment facilities	Air traffic
High noise sensitivity	2.93 (1.79-4.80)	2.01 (1.22-3.30)	3.89 (2.16-7.02)	2.67 (1.40-5.09)	2.03 (0.90-4.57)	4.11 (1.48-11.40)	2.14 (0.74-6.19)
High perceived misophonia	1.98 (1.22-3.21)	1.80 (1.09-2.97)	2.28 (1.34-3.88)	2.19 (1.18-4.05)	0.59 (0.24-1.47)	1.02 (0.42-2.49)	0.59 (0.18-1.97)
High perceived anxiety	1.44 (0.86-2.44)	1.09 (0.64-1.86)	0.97 (0.54-1.74)	0.78 (0.40-1.53)	1.78 (0.73-4.36)	0.97 (0.38-2.48)	1.63 (0.85-3.14)
High perceived depression	1.25 (0.73-2.12)	1.71 (0.99-2.96)	2.27 (1.22-4.20)	1.39 (0.70-2.74)	1.40 (0.58-3.42)	1.92 (0.71-5.16)	1.82 (0.98-3.39)
Age (years)	0.89 (0.78-1.03)	1.05 (0.94-1.18)	0.94 (0.82-1.09)	1.08 (0.95-1.24)	0.98 (0.81-1.20)	0.96 (0.76-1.20)	0.89 (0.66-1.21)
Gender – male	1.00 (0.61-1.62)	1.68 (1.04-2.71)	0.92 (0.53-1.60)	1.61 (0.89-2.92)	1.20 (0.55-2.62)	1.17 (0.50-2.75)	0.40 (0.11-1.44)
Constant of the model	0.92	0.02	0.15	0.01	0.04	0.04	0.20

DISCUSSION

Noise annoyance depends primarily on the characteristics of noise – its intensity, frequency, roughness, as well as on the perception of its source. These acoustical and psychological factors may account for the fact that different noise sources give rise to different levels of annoyance. In a recent study among university students, those who were living outside the university dormitory campus were more annoyed by various community noises (except road traffic) and were more affected by noise in their academic activities [13]. In another study among university students, high residential noise exposure was also associated with higher annoyance, which, in turn, accounted for higher sleep disturbance and poor general mental health in the population [14]. Furthermore, the relationship between noise exposure and noise annoyance may be determined by the duration of noise exposure and the situation in which noise exposure occurs, as the noise at recreational and commercial places could be perceived as more intense but less psychologically stressful than noise at home [15].

Furthermore, noise annoyance depends on some personality traits. Studies typically report the association between noise annoyance and extroversion, introversion, and neuroticism. For example, in experimental settings, low-intensity, low-frequency noise provoked equal annoyance among the extroverted and the introverted participants; low-intensity, high-frequency noise (above 1000 Hz), however, affected the introverted persons more than the extroverted [16]. On the other hand, high-intensity noise of all frequencies induced annoyance among non-neurotic subjects, rather than those with high neuroticism [16]. In an experimental study, some personality traits (neuroticism and introversion) were shown to have more effect on noise sensitivity, annoyance, and the perception of loudness to high-frequency noise rather than to low-frequency noise [17]. In a recently published study in the occupational setting, workers' extroversion and neuroticism affected both noise annoyance and noise sensitivity significantly; their conscientiousness and openness to experience to a lesser extent though [18]. The authors implied that the importance of these traits can be attributed to the moral and

behavioral characteristics of individuals which may also account for the possible sociocultural differences in noise annoyance across populations [18].

To the authors' knowledge, this is the first study to introduce misophonia as a possible risk factor for noise annoyance. Misophonia is a recently recognized condition, characterized by an abnormally intense reaction to specific sounds made by humans, such as eating or breathing sounds. The prevalence of misophonia symptoms among young adults ranges from 6% (clinically significant symptoms) in China [19], to about 20% among university students in the USA [20], to almost 50% among undergraduate medical students in the UK [21]. The prevalence depends on the population examined, as it may be higher among persons with comorbid tinnitus, hyperacusis or some psychiatric disorders [7]. Furthermore, it varies by the assessment criteria, i.e. whether the authors applied the original A-MISO-S scale [10], a proposed modification of that scale [11], or presented a new scale [22].

Given the definition of misophonia, we expected it to provoke noise annoyance from human-voice-related sources, such as the humans themselves and the entertainment facilities. Nevertheless, high perceived misophonia happened to be a significant predictor of annoyance from humans or animals (indoors or outdoors), electrical appliances in the buildings, as well as from road traffic noise and the construction works on the streets, but not from noise emitted from the entertainment facilities (cafes, bars, etc.). The explanation may lie in the proportion of highly annoyed students, which ranged from 10 to 20% for the four above-mentioned sources, to only 5% annoyed by the entertainment facilities. However, we were not able to control for noise sources, as the students resided in various parts of the city where they could have been exposed to diverse environmental sounds that annoyed them.

So far, misophonia has been linked with predispositions to obsessive-compulsive symptoms [23], personality disorder symptoms [24], mood disorders, attention-deficit (hyperactivity) disorder [25], anxiety disorders [26], perfectionism, and neuroticism [25]. Some of these tendencies, including the noted personality traits, may bring the three entities together. First, we hypothesize that misophonia and noise sensitivity act independently on the development of noise annoyance. Whereas noise sensitivity represents attitudes toward a wide range of everyday sounds, misophonia represents attitudes toward specific man-made noises. What they have in common is the fact that they are both determined by human activities under specific circumstances. Other factors that play a role in the association between them include emotional reactions to the sound and/or its source (fear, anger, displeasure), cognitive reactions (familiarity, predictability, controllability), and behavioral reactions (verbal or physical aggression, loss of self-control). Not surprisingly, all three entities are associated with the impaired physical and mental quality of life [25,26,27], and poor psychological and physical health [28,29]. However, the possibility of reverse causation between the quality of life and noise annoyance or misophonia symptoms cannot be completely ruled out.

We further hypothesize that misophonia, subjective noise sensitivity, and noise annoyance lie on a spectrum of environment-related intolerances, including sensitivities to electromagnetic fields, chemicals, infrasound, visual, and tactile stimuli [30]. Treatment options for environmental intolerances should, therefore, easily be applied to the management of annoyance and misophonia; in short, subjects should learn how to deal with environmental stressors, control their physiological and psychological responses, and work on their behavioral reactions to triggering sounds [30].

The results of the presented survey may not be easily generalizable to other populations for several reasons. First, our study population consisted of young adults, whose noise sensitivity, anxiety, depression, misophonia and annoyance levels may differ from those of other

populations. Second, we may have failed to identify some other demographic, socio-economic, or personality traits that may account for noise annoyance in this sample. Third, the exact physical nature of sounds under the circumstances of noise exposure varies between the sources of noise, the duration of exposure, and the possible abatement measures. We were not able to identify source-specific noise characteristics provoking annoyance among our participants. Fourth, we failed to consider participants' exposure to other sources of noise to understand their daily noise exposure. Finally, the presented study design and the statistical analysis do not allow us to determine the causative relationship between noise annoyance, noise sensitivity, and misophonia symptoms. The progression from the perception of a provoking sound to the development of a specific psychological response called annoyance with modifying factors in between deserves to be explored in the future.

CONCLUSION

Noise sensitivity and misophonia are independently connected to noise annoyance in a small-scale study. Students with high noise sensitivity and high perceived misophonia are at higher risk of reporting high noise annoyance from the most prevalent environmental sources, both outdoors (road traffic and construction works on the streets), and indoors (electrical appliances inside the buildings), as well as from noise coming from humans and animals. The association was independent of their age, gender, perceived anxiety, and perceived depression. High perceived misophonia does not predict noise annoyance from the entertainment facilities, unlike high noise sensitivity. None of them predicts annoyance from industrial facilities or air traffic in this study.

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