La Medicina del Lavoro

Original article

Med. Lav. 2026; 117 (2): 18730
DOI: 10.23749/mdl.2026.18730

Self-Reported Non-Auditory Effects of High Sound Pressure Levels Exposure in Academic Musicians in Uruguay

Alice Elizabeth González[1,*], Fernando Tomasina[2], Julián Ortiz Umaña[1], Lady Carolina Ramírez[1], Bettina Tellechea[2], Myriam Adriana Pisani[2]

[1]Department of Environmental Engineering, Faculty of Engineering, Universidad de la República, Uruguay
[2]Academic Unit of Occupational Health, Faculty of Medicine, Universidad de la República, Uruguay

Keywords: Musicians' Health; Sound Exposure Effects; Symphonic Musicians; Extra-Auditory Effects of Noise; Anamnesis Data

Abstract

Background: *While hearing loss is the most emblematic effect of exposure to high sound pressure levels, it is not neither the first nor the only one. This article explores self-reported effects of exposure to high sound pressure levels among a population of 306 academic musicians (singers, choir members and instrumentalists) in Uruguay.* **Methods:** *A special anamnesis form was prepared for use in interviews of each of the participants. The collected information was anonymized and processed. Some interesting results were found, both through direct processing and PCA analysis.* **Results:** *Most participants reported several non-auditory effects. These were classified by sex, age, and role (singer or instrumentalist, voice type, or played instrument).* **Conclusions:** *Among the reported effects, the most prevalent were muscle contractures, fatigue/tiredness, difficulty sleeping, and noise sensitivity, followed by arthralgia and headaches. The most frequent effects in women were muscle contracture (86%), followed by tiredness/fatigue, noise susceptibility, and tinnitus. The most frequent effects in men were muscle contracture (68%), followed by tinnitus, noise susceptibility, and irritability after musical activity. It was possible to establish some "effects profiles" according to instrument and gender. For example, woodwind players experience muscle contracture, tinnitus, post-musical activity irritability, noise susceptibility, and decreased performance, while soprano singers have a higher prevalence of muscle contracture, tiredness/fatigue, noise sensitivity, difficulty sleeping, arthralgia, digestive disorders, headache, tinnitus, and vertigo. They are the second most affected category of musicians, according to their effect profile.*

1. Introduction

Noise is a pervasive workplace risk, evident in construction and manufacturing but also in call centers, schools, hospitals, and the arts, particularly among music professionals [1-3]. As an occupational pollutant, noise threatens health not only through hearing loss but also through a wide range of extra-auditory effects [2]. This has transformed a workplace issue into a public health problem, often referred to as recreational and environmental hearing loss [4].

Research highlights non-auditory impacts, including cognitive impairment (especially in children), sleep disorders, and cardiovascular conditions [5]. Subtle but continuous exposure can lead to discomfort, frustration, and stress-related symptoms, which contribute to cardiovascular disease [6]. According to the CCOHS, non-auditory effects include

*Corresponding Author: Alice Elizabeth González; E-mail: elizabet@fing.edu.uy
Arrived 20.02.2026 – Accepted 20.03.2026

physiological responses (muscle tension, respiratory changes, altered heartbeat) and performance-related issues [7].

Cognitive performance is also at risk; workers exposed to noise exhibit poorer results on mental tasks [8]. While short-term exposure might improve simple activities, it hinders complex ones like professional music performance. Musical intelligence is notably adversely affected [9]. Hypertension can appear at levels as low as 75 dBA—well below those typically considered safe for hearing [10]. Chronic exposure acts as a psychosocial stressor even when it doesn't damage the inner ear [5].

Occupational health services play a strategic role in worker protection [11]. Described extra-auditory effects include endocrine changes (elevated cortisol/catecholamine levels), elevated blood pressure, and altered heart rate. Impacts also extend to the central nervous system (changes in EEG), sleep quality, respiratory rate, and visual function. Effects during pregnancy include risks of premature birth and fetal hearing loss [12-14].

Noise can reduce salivary and gastric secretions, slowing digestion and increasing gastric acid [15, 16]. Studies show positive correlations with tinnitus, oxidative imbalance affecting the immune system, and hippocampal damage, which impacts memory and learning [17-19]. Further reported effects include annoyance, mental health issues, altered blood clotting, increased cholesterol, diabetes, and irritability [20-22]. Self-reported symptoms among workers include otalgia, insomnia, and the need to raise one's voice [23]. Noise also modifies social behavior, potentially reducing helping behavior and increasing aggression [24].

This article addresses extra-auditory effects in academic musicians in Uruguay. The interdisciplinary team "SAVEM" (Auditory, Vocal, and Ergonomic Health in Academic Musicians) comprises experts from Health, Social, Artistic, and Technical fields at the Universidad de la República (UdelaR) [25]. Since 2018, SAVEM has worked with the National Choir, the Montevideo Symphonic Band, the National Symphony Orchestra, and other professional groups. The team's goal is to understand the health consequences of occupational conditions (high noise, vocal strain, postural problems) and provide tools for auditory, vocal, and postural hygiene.

2. Methods

2.1. Study Design and Setting

This research was a cross-sectional study of academic musicians in Uruguay, part of SAVEM at Universidad de la República since 2018. The team used health check-ups, interviews, and environmental measures to identify non-auditory effects of noise exposure. Participants attended interviews at each stage for health info and personal insights.

2.2. Participants

The study population included professional and student musicians from several institutions and ensembles [25]: (i) National Choir of Uruguay; (ii) Montevideo Symphonic Band; (iii) Lyric Singing Department of the Faculty of Arts; (iv) National Symphony Orchestra (approx. 95 musicians); (v) Montevideo Philharmonic Orchestra (approx. 95 musicians). Over the course of the project stages, three datasets were compiled, comprising 163, 86, and 59 individual records, respectively. The participants included a broad spectrum of musical roles, such as singers, string players, woodwind players, brass players, percussionists, keyboardists, and conductors.

2.3. Data Collection Procedures

2.3.1 Individual Interviews and Anamnesis

A structured interview guide, developed by the research team, was used. It included variables related to occupational health as well as music-specific factors (such as instrument played, vocal register, frequency of artistic activity, daily practice hours, and use of amplification). Individual interviews were conducted by an occupational physician and a speech therapist. The appointments were made in advance.

2.3.2 Clinical and Audiological Examination

Participants were instructed regarding precautions prior to audiometric testing.

2.3.3 Environmental Measurements

Sound pressure levels (SPL), vibration, carbon monoxide concentration, temperature, and humidity recorded during rehearsals. Observation sessions were also carried out. Acoustic maps of rehearsal rooms were constructed to determine exposure profiles (minimum $L_{AF,eq}$ levels of 85 dBA were recorded). See Figure 1.

2.4. Ethical Considerations

All participants signed informed consent prior to inclusion. Data was anonymized for analysis. Each participant received individual feedback on results, in accordance with medical confidentiality standards.

The protocol was reviewed under the ethical framework of Udelar, in line with institutional and national occupational health regulations.

2.5. Data Analysis

Quantitative analysis included descriptive statistics (distribution by sex, age, and musical role), prevalence of self-reported extra-auditory effects (e.g., tinnitus, irritability, vertigo, musculoskeletal complaints, sleep disturbances, cardiovascular and cognitive symptoms).

Comparative analyses were conducted to explore associations between effects and demographic variables (gender, age, role). Multivariate analysis was performed, including:

- Principal Component Analysis (PCA) to identify effect clusters (e.g., cognitive vs. psychological profiles);
- Hierarchical cluster analysis to examine associations between reported symptoms and population characteristics.

Results were stratified by dataset and presented in figures to illustrate prevalence patterns.

3. Results and Discussion

3.1. Acoustic Maps

First, the acoustic maps generated in the rehearsal rooms of the National Choir and the Montevideo Symphonic Band are shown, providing a quantitative starting point for the sound exposure of academic musicians in their daily work. As it can be seen in Figure 1, the lowest levels recorded among the musicians' groups are $L_{AF,eq}$ = 85 dBA. These high sound pressure levels lead to the expectation of both auditory and non-auditory effects on musicians.

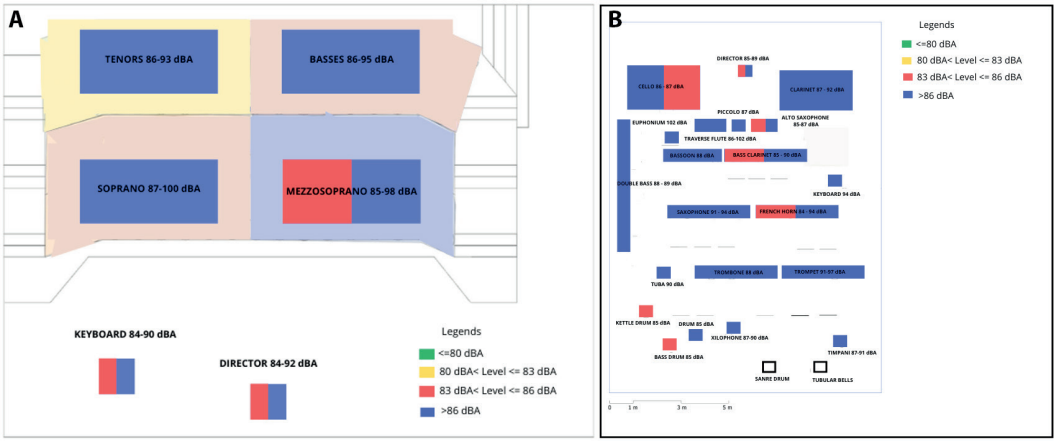

Figure 1. Maps of Sound Pressure Levels: (a) at the National Choir rehearsal; (b) at the Montevideo Symphonic Band rehearsal (redrawn from Tomasina et al. 2025) (26).

It is worth noting that the Montevideo Symphonic Band has incorporated an important preventive measure: a "street" between the brass and woodwind instruments to reduce the latter's sound exposure levels.

3.2. First Data Set Processing: 163 Records

3.2.1 General Information

This data set includes 86 women (53%) and 77 men (47%). 37% of the sample corresponds to individuals under 35 years of age, while the remaining 63% are over 35 years of age. Regarding gender distribution, the sample is fairly balanced.

Regarding the percentage distribution of the participants' roles, singers are 47% of respondents, constituting the largest group, followed by bowed string players (22%) and woodwind players (13%). Brass players represent 10% of the participants. It is worth noting that the roles of keyboard, conductor and plucked strings, and cases without data, represent approximately 5% of the total records.

3.2.2 Reported Effects

This set of data assessed the presence of tinnitus, vertigo, ear pain, and other effects such as hypertension. The effects in the surveyed population showed tinnitus being the most prevalent effect, present in 90 of the respondents (55%), followed by post-musical activity irritability with 64 cases (39%). Only 28 people (17%) reported not experiencing any of the effects assessed. The high prevalence of tinnitus found in our data set is much higher than the 27% reported for classical musicians by Di Stadio et al. (2018) [27].

Regarding the proportion of people experiencing at least one effect, in all roles with 10% or more participants, the presence of some effect exceeds 75%, with woodwind instrument players showing the highest percentage (91%).

3.2.3 Prevalence of Effects by Sex and Age

The prevalence of the reported effects was shown by age group and sex. The results for women revealed a clear trend in the prevalence of tinnitus: its prevalence was lower among those under 35 years of age and increased progressively thereafter, reaching values above 60% in the over-56 age group. In contrast, irritability after musical activity was most prevalent in the 26-35 age group, decreased among those under 25, and declined with increasing age. Regarding vertigo, no clear pattern was identified, and otalgia was not present in participants over 56 years of age. In men, tinnitus was recorded in all age groups, with a prevalence exceeding 50%. Irritability after musical activity exhibited a similar pattern, remaining at levels above 40% in most age groups, except for those over 56 years of age, where it decreased considerably. Vertigo was more prevalent in the extreme age ranges (under 25 years of age and over 56 years of age), while, as in women, ear pain was not present in participants in the oldest age group.

3.2.4 Prevalence of Effects by Role

Regarding the effects by role, of the 40 women with tinnitus, 24 were singers (60%), 9 string instrumentalists (23%), and 6 wind instrumentalists (15%). Of the 50 men with tinnitus, 12 were singers (24%), 12 string instrumentalists (24%), and 18 wind instrumentalists (36%), of whom 13 (26%) were brass instrumentalists. Of the 8 violinists with tinnitus, 6 were bilateral and 2 were left-handed. In addition, 4 viola players had tinnitus: 3 bilateral and 1 right-handed.

Regarding those who experienced irritability after musical activity, of the 33 women, 13 were singers (39%), 10 string instrumentalists (30%), and 10 wind instrumentalists (30%). Of the 31 men who experienced the effect, 3 were singers (10%), 8 (26%) were string musicians (6 of them violinists), and 13 were wind musicians (42%), of whom 9 (29%) were brass musicians.

40 people experienced vertigo, with a higher prevalence in women (27 cases, 68%) than in men. Among the women who experienced vertigo, 19 were singers (70%), and of these, 10 were sopranos (53%). Among the 13 men who experienced vertigo, 5 were wind musicians (38%) and 4 of them were brass musicians (80%). Ear pain occurred primarily in string and brass musicians (35% in each case).

String musicians with ear pain were more men, and brass musicians were women.

Only 5.5% of participants had high blood pressure (9 cases). Of these, 8 (89%) were men, primarily string and brass musicians (43% each). High blood pressure in men was distributed more or less evenly across all age groups from 26 years of age.

3.3. Second Data Set Processing: 84 Records

3.3.1 General Information

In this second data set, 43 women and 41 men participated (51% and 49% respectively). 50% of this population were under 35 years old, while approximately 11% were over 56. The remainder of the sample is made up of participants between 36 and 55 years old.

49% of respondents were singers, constituting the largest group, followed by bowed string (27%), brass (9%), and woodwind (6%) instrumentalists. As in the first data set, roles such as percussion and plucked strings, and records without data, represent less than 10% of the total population.

3.3.2 Reported Effects

18 of the participants (21%) reported needing a conversation to be repeated; the number of cases was equal between men and women. In the case of women, this effect was reported more frequently among singers, while in men it was reported equally among singers and instrumentalists. In both sexes, 4 of the 9 cases (44%) occurred before the age of 35.

On the other hand, 13 of the participants (15%) reported having hearing problems. The effect was more common in younger women and older men. Most cases occurred among singers (69%), and of these, the majority (56%) were sopranos. Furthermore, 12 of the participants (14%) reported having to turn up the television volume. The effect was more evident in men (58%) than in women (42%) and more in singers (75%) than in instrumentalists (25%).

In contrast, 71% of respondents reported no effect.

3.4. Third Data Set Processing: 59 Records

3.4.1 General Information

In this set of data, the sampled population has very few participants under 25 years of age. Two clearly differentiated groups are identified: on the one hand, people over 46 years of age, who represent 54% of the population, with a majority of men; on the other hand, people under 46 years of age, where there is a greater presence of women in the 26-35 age range and men in the 36-45 age range.

Related to the proportion of participants' roles: 29% are singers, followed by woodwind instrumentalists at 27%, bowed string players at 19%, and brass players at 14%. Finally, conductor, percussion, keyboards, and plucked strings make up the remaining percentage.

3.4.2 Prevalence of Effects by Sex, Age and role

The most common effect was muscle contractures, reported by 45 individuals (76%). Of the 24 women who presented contractures, 11 (46%) were singers and 13 (54%) instrumentalists, with a similar prevalence across string and wind instruments (46% in each case). Of the 21 men who reported contractures, 20 (95%) were instrumentalists, primarily wind instruments (65%) and among them, the majority were brass instruments (85%).

Noise susceptibility was the second most reported effect (28 cases, 47%). The effect was reported in an equal number of men and women, but it appeared earlier (in age) in women than in men. Among women, 57% (8) were singers, and of these, 87% were sopranos. Among instrumentalists (43%), the majority (83%) were wind instrumentalists. Among men, the vast majority of cases occurred in instrumentalists (86%). Among them, 7 (58%) were wind instrumentalists, and most of them (71%) played brass instruments.

24 people (41%) reported having trouble sleeping, especially falling asleep. 13 of them (54%) were women and 11 (46%) were men. The women were more or less equally distributed between singers and instrumentalists. All the singers were sopranos, and the instrumentalists were predominantly woodwind.

The majority of the men were instrumentalists (91%), and among them, half were brass players.

Arthralgia was reported by 23 people (39%). The 13 women with arthralgia (56%) were equally distributed between singers and instrumentalists. All men (44%) were instrumentalists, and 50% of them played string instruments.

19 people (32%) reported tiredness or fatigue. Most of the cases (74%) were women. Of these, 8 (57%) were singers, 7 of whom were sopranos (87%). Among instrumentalists (43%), the majority (83%) were wind musicians. The effect was present in all age groups. In men (26% of the total cases), no singer reported the effect. 60% of cases occurred in wind instrumentalists, primarily brass instruments.

Headaches occurred in 17 cases (29%), primarily in women (76%). Among them, the majority (69%) were instrumentalists and 31% were singers (sopranos). In men, the effect occurred in instrumentalists, but not in singers.

15 cases reported a decline in performance (25%). Among men (53%), the effect was more common in instrumentalists, and 88% among them were brass musicians. Among women, the effect occurred in singers (43%) and instrumentalists (57%); among this second group, most of them also played wind instruments (75%).

In 13 cases (22%), digestive disorders, including heartburn and reflux, occurred. Most cases were men (54%), with majority (71%) of wind instrumentalists; among them, 60% played brass instruments. As in women, most cases occurred after the age of 45. In the case of women (46%), the effect was only reported in singers, with 67% sopranos.

The same number of cases (13, or 22%) reported difficulty concentrating. Most of the cases were women (62%), and a greater number of them were instrumentalists (75%), equally distributed between string and wind instruments. Among men, the majority (60%) were brass instrumentalists.

A slightly lower number of cases (12, or 20%) reported memory impairment. In this case, there were more men (58%) than women (42%). Most of the men were instrumentalists (86%), but most of the women (60%) were singers.

The results show that contractures reach values close to 80% in most groups, with the exception of those over 56 years of age. Effects such as difficulty sleeping, noise sensitivity, and headaches tend to decrease with age, while arthralgia, decreased performance, and digestive disorders tend to increase (see Figure 2).

3.5. Effect Profiles by Role and Gender

Given that in some roles the number of recordings was considerable, it was possible to determine profiles of the effects prevalent in these roles. In these profiles, the effects with a prevalence of 40% of more are mentioned in next paragraphs and synthetized in Figure 3.

Cases (a) and (b) show the effect profiles of female and male woodwind instrumentalists. As it can be seen, they are not the same. In the case of female, 89% reported irritability after noise exposure, 86% reported muscle contracture, 71% reported tiredness/fatigue and the same percentage reported noise susceptibility, difficulty sleeping; 56% reported tinnitus, 43% reported headaches, difficulty concentrating, arthralgia and performance decrease. In the case of male, 78% reported muscle contracture, 67% reported tinnitus, 50% irritability after noise exposure, 44% reported noise susceptibility and the same percentage reported performance decrease.

Case (c) presents the profile of extra-auditory effects in sopranos. Approximately 78% of them reported contractures and the same percentage reported fatigue/tiredness. 56% was the prevalence of noise sensitivity difficulty sleeping, arthralgia and digestive disorders. and. Subsequently, 44% reported headache, 40% reported tinnitus and the same percentage reported vertigo.

Case (d) shows the profile of extra-auditory effects in male brass musicians. Approximately 71% reported tinnitus, 67% of them reported contracture and 50% irritability after noise exposure and 44% reported difficulty sleeping.

Cases (e) and (f) show the effect profiles of bowed strings instrumentalists of both genders. As it can be seen, they are not the same. In the case of female, 100% reported muscle contracture and headache, 60% reported irritability after noise exposure, 50% reported difficulty concentration and 47% reported tinnitus. In the case of male, 100% reported muscle

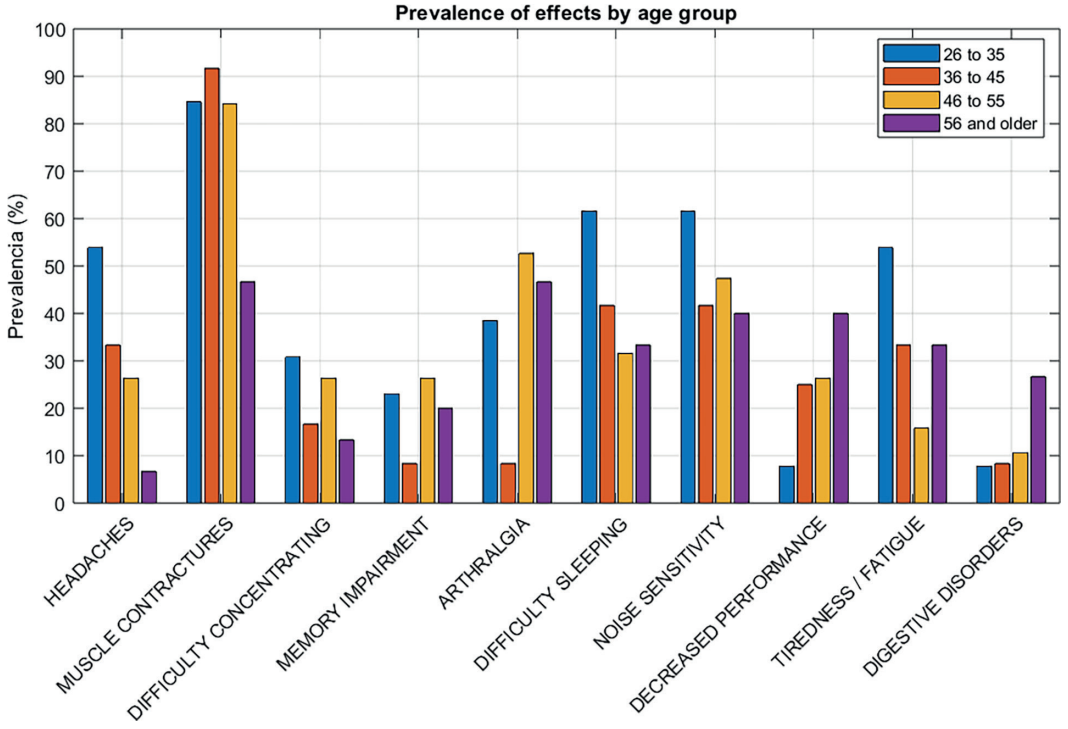

Figure 2. Prevalence of effects by age ranges (third data set).

contracture, 80% reported arthralgia, 60% reported sleeping difficulty, 55% reported tinnitus, 40% reported irritability after noise exposure and the same percentage reported noise susceptibility.

Case (f) refers to violinists of both genders. 100% reported muscle contracture, 50% reported arthralgia and the same percentage reported headache, 40% reported tinnitus and the same percentage reported irritability after noise exposure and difficulty concentration.

3.6. Multivariate Analysis

The objective of this analysis is to identify associations between the extra-auditory effects and some population characteristics, such as gender, age, and role. To this end, it was decided to omit certain effects with a low prevalence in the established age ranges, as well as those with a high prevalence in most age ranges, as they do not provide differentiating information. Consequently, the following effects were selected: vertigo, noise susceptibility, irritability after noise exposure (post-musical irritability), difficulty sleeping, difficulty concentrating, decreased performance, and memory impairment.

The first step in the analysis was to perform a principal components analysis (PCA). This method generates new variables, called principal components, which are linear combinations of the original variables. From PCA, several components were obtained. The top five of them were selected for use in further analyses, as they explain most of the variability in the data set.

Figure 4 shows the first two principal components along with the contributions of the selected variables. It can be seen that the variables "difficulty concentrating", "decreased performance", and "memory disturbance" are oriented toward the lower part of the graph, forming a kind of intellectual or cognitive profile. On the other hand, the variables "difficulty sleeping," "post-musical irritability," and "noise susceptibility" are oriented toward the positive part of the first principal component (PC1), forming a psychological profile associated with noise burden. In this case, gender also plays a significant role. Age and role appear to have little influence on the differentiation of the reported effects.

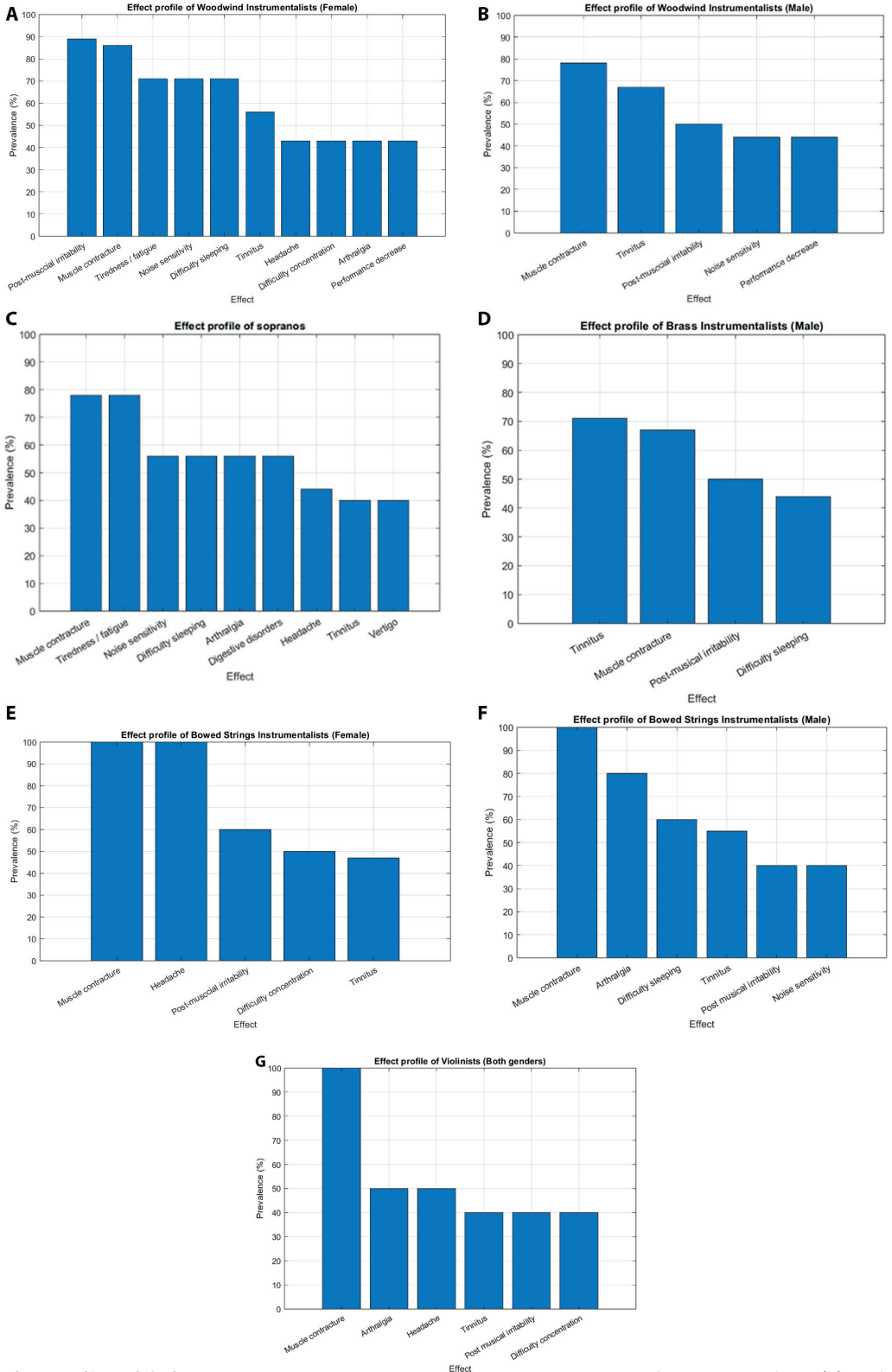

Figure 3. Effect profiles of different instrumentalists, by gender: (a) female woodwind instrumentalists; (b) male woodwind instrumentalists; (c) soprano singers; (d) brass male instrumentalists; (e) female bowed strings instrumentalists; (f) male bowed strings instrumentalists; (g) violinists (both genders).

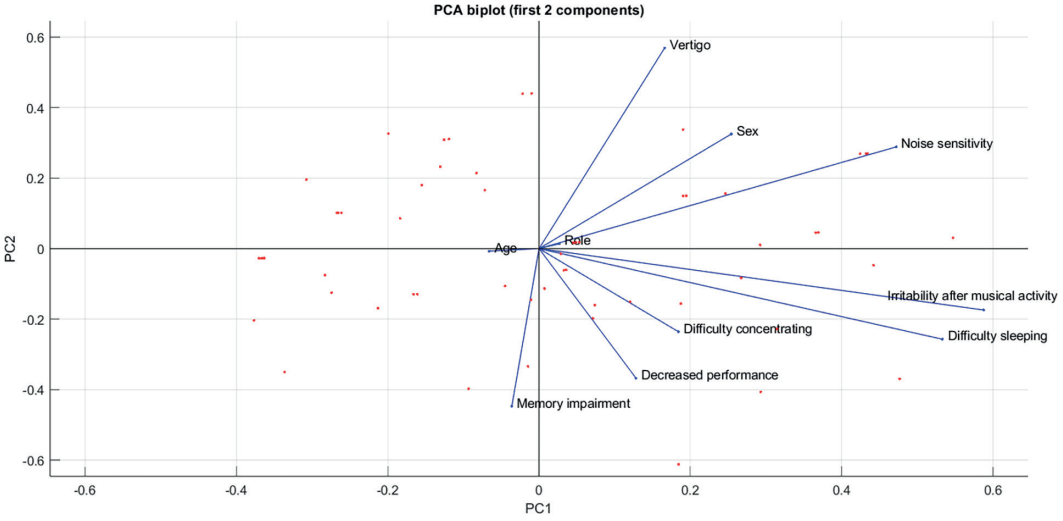

Figure 4. Biplot PCA (first two components).

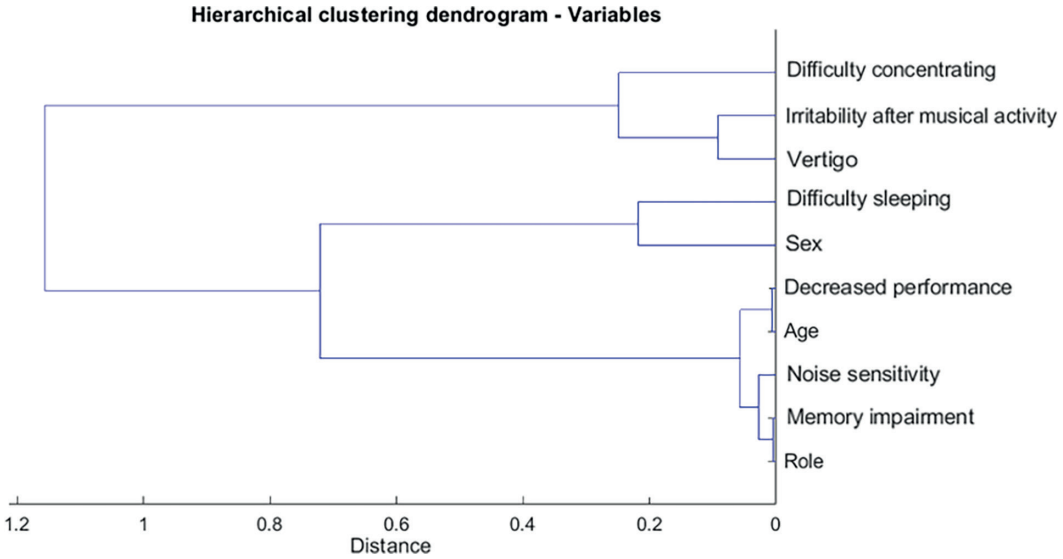

Figure 5. Hierarchical dendrogram (cluster analysis).

To further explore the relationships between the effects and the demographic characteristics of the population, a hierarchical dendrogram was constructed (see Figure 5). The dendrogram shows that certain effects are clearly associated with each other; for example, "memory impairment" and "noise susceptibility" are related to roles (i.e., the instrument played). Similarly, a relationship is identified between age and decreased performance. On the other hand, some variables, such as difficulty concentrating or post-musical activity irritability, appear further separated in the dendrogram, indicating that they are less correlated with the other variables analyzed, as if they were independent of gender, age, or the instrument played.

4. Conclusions

Three data sets about extra-auditory effects of high sound pressure levels exposure of musicians

were analyzed. The distribution by sex and age range was balanced in most cases, and a significant group of those over 46 years of age was observed.

Singers constituted the largest group in all sets (45-50%), followed by bowed string, woodwind, and brass players. Other roles, such as percussion, keyboard, conducting, or plucked strings, generally represented less than 10% of the samples.

Among the reported effects, the most prevalent were contractures, fatigue/tiredness, difficulty sleeping, and noise sensitivity, followed by arthralgia and headaches. Tinnitus was also common, especially among singers and some instrumentalists. Tinnitus increased with age in women and remained high in men; irritability was higher in young women and decreased in men over 56 years of age.

The most frequent effects in women were muscle contracture (86%), followed by tiredness/fatigue (50%), noise susceptibility (50%) and tinnitus (47%).

The most frequent effects in men were muscle contracture (68%), followed by tinnitus (65%), noise susceptibility (45%) and post-musical activity irritability (40%).

Role and gender profiles showed that:

- Soprano singers have a higher prevalence of muscle contracture, tiredness/fatigue, noise sensitivity, difficulty sleeping, arthralgia, digestive disorders, headache, tinnitus and vertigo. They are the second most suffering category of musicians, according to their effect profile.
- Male brass musicians experience tinnitus, muscle contracture, post-musical activity irritability and difficulty sleeping.
- All woodwind instrumentalists experiment muscle contracture, tinnitus, post-musical activity irritability, noise susceptibility and decreased performance.
- Female woodwind musicians also experiment tiredness/fatigue, headache, difficulty sleeping, difficulty concentration and arthralgia. They are the most suffering category of musicians, according to their effect profile.
- Bowed strings instrumentalists of both genders reported muscle contracture, post-musical activity irritability and tinnitus. Men also experienced arthralgia, difficulty sleeping and noise sensitivity, while woman presented headache and difficulty concentration.
- Violinists, regardless of gender, have a high prevalence of muscle contracture, arthralgia, headache, tinnitus, post-musical activity irritability and difficulty concentration.

Funding: This research was funded as Semillero Interdisciplinario in the 2018 call and as Núcleo Interdisciplinario in the 2020 call of the Espacio Interdisciplinario of the Universidad de la República.

Institutional Review Board Statement: Although the research involved anamnesis data, all subsequent analysis were based on anonymized data. For this, the participants were informed and signed an informed consent form that detailed the purpose of the study and the use of the data for research purposes.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Acknowledgments: The authors would like to thank all those who participated in the experimental work, both the singers and musicians and those who collaborated on the interviews and logistics.

Declaration of Interest: The authors declare no conflict of interest.

Author Contribution Statement: AEG, FT, AP, LCR and BT contributed to the conception and design of the research. FT, AP and BT performed the interviews. AEG, JOU and LCR performed the data processing and management. AEG, FT, JOU, LCR, BT and AP contributed to the analysis of the results and to the writing of the manuscript.

References

1. González A. E. Contaminación Sonora y Derechos Humanos. Serie Investigaciones: Derechos humanos en las políticas públicas. N° 2. Available at https://www.colibri.udelar.edu.uy/jspui/bitstream/20.500.12008/38860/1/Gon12.pdf
2. World Health Organization. Occupational health: Noise [Internet]. Ginebra: OMS; 2021 [Last Accessed 2025 sep 24]. Available at: https://www.who.int/news-room/fact-sheets/detail/noise
3. International Labour Organization. Safety and health at the heart of the future of work: Building on 100 years of experience [Internet]. Geneva: ILO; 2019 [Last Accessed 2025 Sep 24]. Available at: https://www.ilo.org

4. Orbe M, Betancourt Ó. Epidemiología de los trastornos auditivos. Servicios integrales de salud y seguridad en el trabajo, Herramientas y técnicas, manejo electrónico de la información. 1er edición, Quito Ecuador, 2021. P 199.
5. Basner M, Babisch W, Davis A, et al. Auditory and non-auditory effects of noise on health. *The Lancet*. 2014;383(9925):1325–32. Doi: 10.1016/S0140-6736(13)61613-X
6. Hubspotusercontent-na1.net. [Last Accessed 2025 September 26]. Available at: https://2841087.fs1.hubspotusercontent-na1.net/hubfs/2841087/DKV-%20IC%20Ebook%20/IC%20-%20Ebook%20-%20Ruido%20y%20salud/DKV-Ebook-Observatorio-ruido-2023.pdf
7. CCOHS. Noise. Non-auditory effects (2022). Fact sheet last revised 2022-04-27.
8. Jones, K (2010). Environmental noise and health: a review. ERCD Report 0907, Environmental Research and Consultancy Department, UK Civil Aviation Authority. Published by TSO (The Stationery Office) on behalf of the UK Civil Aviation Authority.
9. Díaz Torrealba, Mariana (2012). Efectos neurológicos y psicológicos producidos por ruido en la población que ocupa el centro de Barquisimeto, PhD Thesis, Universidad Politécnica de Madrid, Escuela Técnica Superior de Ingenieros Industriales.
10. Fernandes de Souza TC, Santos Périssé AR, Moura M. Noise exposure and hypertension: investigation of a silent relationship. *BMC Public Health* (2015);15:328 Doi: 10.1186/s12889-015-1671-z
11. Randolph SA. Promoting Hearing Health. *Workplace Health Saf.* 2018;66(8):412. Doi: 10.1177/2165079918782720. Epub 2018 Jun 17. PMID: 29909742.
12. Stansfeld S, Clark C. Health effects of noise exposure in children. *Curr Environ Health Rep.* 2015;2(2):171-8. Doi: 10.1007/s40572-015-0044-1
13. World Health Organization, Regional Office for Europe. Environmental noise guidelines for the European region [Internet]. Copenhagen: WHO; 2018 [Last Accessed 2025 September 24]. Available at: https://www.euro.who.int
14. Tomasina F, Stolovas N. Manual técnico básico de Salud Ocupacional. 2022. Available at: https://proyectoecho.fmed.edu.uy/wp-content/uploads/2022/12/Manual-tecnico-basico-de-Salud-Ocupacional_Version-digital-1.pdf
15. Anticaglia JR, Cohen A. Extra-Auditory. Effects of Noise as a Health Hazard, *Am Ind Hyg Assoc J.* 1970;31(3):277-281. Doi: 10.1080/00028899708506243
16. Lee Y, Lee S, Lee W. Occupational and environmental noise exposure and extra-auditory effects on humans: A systematic literature review. *GeoHealth,* 2023;7:e2023GH000805. Doi: https://doi.org/10.1029/2023GH000805
17. Tekriwal RP, Dharitri M. Extra Auditory Effect of Noise – A study on textile workers of Surat city. *Nat J Physiol Pharm Pharmacol*. 2012;2(1):45-51.
18. Molina SJ, Miceli M, Guelman LR. Noise exposure and oxidative balance in auditory and extra-auditory structures in adult and developing animals. Pharmacological approaches aimed to minimize its effects. *Pharmacol Research*. 2016;109:86-91.
19. Molina SJ, Guelman LR. Noise-induced hippocampal damage: potential mechanisms. *Neural Regen Res.* 2022;17(3):563-564.
20. Mehrotra A, Shukla SP, Shukla AK, et al. A Comprehensive Review of Auditory and Non-Auditory Effects of Noise on Human Health. *Noise Health*. 2024;26:59-69.
21. Themann, Christa L, Masterson, Elizabeth A. Occupational noise exposure: A review of its effects, epidemiology, and impact with recommendations for reducing its burden. *J Acoust Soc Am.* 2019;146:3879. Doi: 10.1121/1.5134465
22. De Sio S, Perri R, Durel Tchaptchet F, et al. Extra-auditory effects of noise exposure in school workers and preventive measures: a systematic review. *Eur Rev Med Pharmacol Sci.* 2023;27:1467-1473.
23. Taoussi AA, Yassine AA, Malloum MSM, Assi C, Fotclossou T, Ali YA. Effects of noise exposure among industrial workers in power plants of the National Electricity Company in N'Djamena, Chad. *Egypt J Otolaryngol.* 2022;38:63. Doi: https://doi.org/10.1186/s43163-022-00253-7
24. Stansfeld, Stephen A, Matheson, Mark P. Noise pollution: non-auditory effects on health. *Br Med Bull*. 2003;68:243-257. Doi: 10.1093/bmb/ldg033
25. González AE, Tomasina F, Gianoli Kovar P, et al. (2023). Núcleo Interdisciplinario SAVEM, Informe Final.
26. Tomasina F, González AE, Pisani A, et al. Audiometric Database of Academic Musicians in Uruguay. *Med Lav*. 2025;116(3):16424. Doi: 10.23749/mdl.v116i3.16424
27. Di Stadio A, Dipietro L, Ricci , et al. Hearing Loss, Tinnitus, Hyperacusis, and Diplacusis in Professional Musicians: A Systematic Review. *Int J Environ Res Public Health.* 2018;15:2120. Doi:10.3390/ijerph15102120

Mattioli 1885