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Auditory and vocal symptoms: an analysis of the self-perception of digital game players

Sintomas auditivos e vocais: uma análise da autopercepção de jogadores de jogos digitais

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ABSTRACT

Purpose: to identify factors associated with tinnitus, auditory perception and risk of voice disorders among digital game players. **Methods:** cross-sectional study carried out with digital game players through electronic procedures to collect data related to hearing and vocal health. Three main outcomes were analyzed: tinnitus; auditory perception (sensation of diminished hearing) and risk of voice disorders, measured by the Vocal Symptoms Scale (VSS). The independent variables were related to sociodemographic characteristics, player profile and signs and symptoms. Pearson's chi-square test and Fisher's exact test were applied. **Results:** the sample consisted of 59 players. Most were male (79.7%) and ages between 18 and 24 years (69.5%). Regarding the terms, 27.6% had tinnitus, 57.6% were at risk of vocal disorder and 13.6% reported hearing loss. There was an association between tinnitus and headache (p=0.024), tinnitus and smartphone use (0.012), hearing loss and anxiety (p= 0.049). A risk of voice disorder(s) was associated with more hours played per week (p=0.020). **Conclusion:** self-perceived tinnitus was associated with headache and smartphone use; there was also an association between anxiety and the feeling of hearing impairment, in addition to the risk of voice disorders and more hours played per week.

Keywords: Hearing; Voice; Games; Tinnitus; Noise

RESUMO

Objetivo: identificar os fatores associados a zumbido, percepção auditiva e risco de distúrbio vocal entre jogadores de jogos digitais. **Métodos:** estudo transversal realizado com jogadores de jogos digitais por meio de questionários eletrônicos para coletar dados relacionados à saúde auditiva e vocal. Foram analisados três desfechos principais: zumbido, percepção auditiva (sensação da diminuição da audição) e risco de distúrbio de voz, mensurado pela Escala de Sintomas Vocais. As variáveis independentes referiram-se às características sociodemográficas, perfil dos jogadores e sinais e sintomas. Aplicaram-se os testes Qui-quadrado de Pearson e Exato de Fisher. **Resultados:** a amostra foi composta por 59 jogadores, sendo a maioria do gênero masculino (79,7%), com idade entre 18 e 24 anos (69,5%). Com relação aos desfechos, 27,6% dos participantes apresentaram zumbido, 57,6%, risco de distúrbio vocal e 13,6% referiram sensação de diminuição da audição. Observou-se associação entre zumbido e cefaleia (p=0,024), zumbido e uso de *smartphone* (0,012), sensação de diminuição da audição e presença de ansiedade (p=0,049). O risco de distúrbio de voz associou-se ao maior tempo de horas jogadas por semana (p=0,020). **Conclusão:** a autopercepção de zumbido esteve associada à cefaleia e ao uso de *smartphone*. Houve, ainda, associação entre ansiedade e sensação de diminuição da audição, além de risco de distúrbio de voz e maior tempo de horas jogadas por semana.

Palavras-chave: Audição; Voz; Jogos; Zumbido; Ruído

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INTRODUCTION

The digital games industry has shown significant growth in recent years due to the possibilities that technological innovations have provided[1]. Consequently, it reaches ever more diversified audiences, increasing the number of consumers and overcoming barriers related to age, gender, and social class[2].

Currently, there are several studies on the possible effects that digital games may cause, ranging from positive ones, such as the development of cognitive, social, emotional, and motivational skills[3], to negative effects, such as addiction and depression, among others[4]. Therefore, it is necessary to pay attention to the possible adverse health effects when there is excessive consumption. A study conducted in the United States found that the average playing time among casual North American gamers is eight hours a week, possibly reaching six hours per day, approximately[5]. Allied with this, it is undeniable that sounds, music, and sound effects play an essential role in games, promoting a sense of reality, immersion, and emotional involvement[6]. For this reason, many players choose to use listening devices, further amplifying the experience and the involvement and communication with other players in voice calls[7].

However, this scenario becomes worrisome as this leisure activity may become harmful to the health of these players, especially their hearing health, given the combination of time, frequency, and high sound pressure levels[7]. The most commonly reported auditory symptoms are tinnitus, otalgia, difficulty understanding speech, ear fullness, discomfort with intense sounds, and hearing loss. Symptoms such as headaches, insomnia, stress, irritability, fatigue, anxiety, inattention, and vision, memory, sleep, and mood disorders are also reported[8-10].

Another aspect to be highlighted in the context of digital games is the voice, which plays an important role, given that social interaction in this environment is essential and has become one of the biggest reasons for their current success. One of the most used communication methods is voice chat, either in the game itself or through external programs[11], in which case players may spend extended periods chatting and interacting while playing. Vocal alterations caused by inappropriate behaviors and habits are common and may be associated with the misuse of the voice and the development of dysphonias, more precisely, behavioral dysphonias[12].

Studies on exposure to high sound pressure levels and the potential abusive use of voice by this audience are still scarce. Therefore, getting to know the players of digital games and their auditory and vocal habits and behaviors is important. The need for more debates and research on the subject is notorious, given the significant number of practitioners of this activity, who are likely unaware of the need for hearing and voice care and the possible adverse effects on long-term health.

Given the above, the present study aimed to identify the factors associated with tinnitus, auditory perception, and risk of vocal disorders among digital game players.

METHODS

This is a cross-sectional study approved by the Human Research Ethics Committee of the Federal University of Santa Catarina under Opinion No. 5.453.308. All individuals signed the Informed Consent Form (ICF) to begin data collection.

The sample was non-probabilistic and by convenience, meeting the following inclusion criteria: people who played digital games through any platform (computer, console, smartphone, etc.) of both genders and over 18 years old. Individuals with a history of current or previous exposure to occupational noise and professional voice use were excluded based on the affirmative answer by the participant to one of these questions initially presented in the questionnaire. In total, 118 responses were obtained during the collection period, and those that reported current or previous exposure to noise and professional voice use were excluded. Thus, 59 digital game players participated in the research.

Data collection was performed online from June to July 2022 through two electronic questionnaires. The participants were recruited through the social media of the researchers and in communities, groups, and servers intended for players of digital electronic games on the Internet.

Participants answered a questionnaire regarding sociodemographic characteristics, player profiles, and auditory signs and symptoms. Subsequently, they responded to the Voice Symptom Scale (VoiSS) in its version translated to and validated for Brazilian Portuguese[13].

Three primary outcomes were analyzed: tinnitus, auditory perception (self-reported sensation of decreased hearing), and risk of voice disorder measured by the Voice Symptom Scale. The independent variables were sociodemographic characteristics, player profiles, and signs and symptoms.

Dependent variables

Tinnitus, auditory perception, and risk of voice disorders were the dependent variables of this study. The variable tinnitus was obtained through a question about the self-perception of the presence of this symptom (no; yes). To assess auditory perception, the participants were asked if they had the sensation of decreased hearing (no; yes).

The risk of voice disorders was assessed using the Voice Symptom Scale[13]. The scale has 30 statements analyzed according to the frequency of occurrence of vocal symptoms, reported through a Likert scale from 0 (never) to 4 (always). The total score was obtained by the simple summation, and the cutoff value that identified individuals at risk for developing vocal disorders in the entire domain was greater than or equal to 16 points[13,14].

Independent variables

The independent variables of this study were gender (male; female), age (18 to 24; 25 or more), how long they had been playing in years (zero to ten; 11 years or more), hours played per week (zero to nine; ten to 19; 20 hours or more), type of listening device used (earbuds; headphones and headsets; did not use), perception of volume used in the listening device/equipment (Likert scale referring to the perception of the player of the intensity used: low volume; medium; high/very high), and use of voice chats voice while playing (no; yes). Voice chats are understood as a set of tools/resources based on the use of the players' voices that may be part of the game itself or external to it, such as applications (Discord, Skype, TeamSpeak, etc.).

The following signs and symptoms were also analyzed: ear pain; headaches; stress; anxiety; irritability; insomnia; difficulty concentrating (all variables were categorized into no and yes).

Also, the main types of games and platforms used by the participants were evaluated: shooting games; horror; simulators; Role-Playing Games (RPGs); sports games; Multiplayer Online Battle Arenas (MOBA); puzzles; fighting games; incremental games; card games; use of desktop console; portable console; computer; smartphone; tablet.

Data analysis

The categorical variables were represented by absolute (n) and relative (%) frequencies. Pearson's chi-square hypothesis test was used to evaluate the association between the dependent and independent variables of the study. Fisher's exact test was applied when the test assumptions were not met. The data were stored in Microsoft Excel spreadsheets and exported for analysis in the Stata 14 software. The significance level considered in this study was $p \leq 0.05$.

RESULTS

Fifty-nine digital game players participated in the study. Most were male (79.7%) and were 18 to 24 years old (69.5%). Regarding the profile of the players, 78% of the sample had been playing for over 11 years, and 94.9% used listening devices. Among the participants who used listening devices, headphones and headsets were mentioned the most (84.7%). In addition, 89.8% of the players used voice chats while playing, and most classified the volume of the listening device or equipment they used as medium (54.2%) (Table 1).

Regarding the primary outcomes of this study, 27.6% of the sample reported tinnitus, 57.6% presented a risk of vocal disorders, and 13.6% reported a sensation of decreased hearing. A high prevalence of headaches (45.8%) was observed after playing digital games, followed by stress and insomnia (40.7%) (Table 1).

Relative to the types of games preferred by the sample, equal prevalences were observed for shooting games and MOBAs (71.2%), followed by RPGs (64.4%). Regarding the platforms used, 94.9% of the players used computers, and none mentioned using tablets (Figure 1).

Associations were observed between tinnitus and headaches ($p = 0.024$) and tinnitus and smartphone use ($p = 0.012$). There was a higher prevalence of tinnitus among individuals who reported headaches (42.3%) compared to individuals without pain (15.6%), with this difference being statistically significant. Regarding the use of smartphones, a higher proportion of tinnitus was observed among those who used them (42.8%) ($p = 0.012$) (Table 2).

In addition, there was a higher prevalence of the sensation of decreased hearing among individuals with anxiety (27.8%) compared to individuals without anxiety (7.3%) ($p = 0.049$). The risk of voice disorders was associated with the number of hours played per week, with a higher prevalence of risk among those who played for 20 hours or more per week (70.4%) ($p = 0.020$) (Table 2).

Table 1. Description of the sociodemographic characteristics, auditory self-perception, player profile, signs and symptoms, and total score on the Voice Symptom Scale. Florianópolis, 2022

Variables	n	%
Gender		
Male	47	79.7
Female	12	20.3
Age		
18 to 24	41	69.5
25 or more	18	30.5
How long they had been playing (years)		
Up to 10 years	13	22.0
11 years or more	46	78.0
Hours played per week		
0 to 9	15	25.4
10 to 19	17	28.8
20 hours or more	27	45.8
Type of listening device		
Earphones	6	10.2
Headphones and headsets	50	84.7
Did not use	3	5.1
Volume of the listening device/equipment		
Low	4	6.8
Medium	32	54.2
High/very high	23	39.0
Uses voice chats		
No	6	10.2
Yes	53	89.8
Tinnitus		
No	42	72.4
Yes	16	27.6
Ear pain		
No	41	69.5
Yes	18	30.5
Sensation of decreased hearing		
No	51	86.4
Yes	8	13.6
Headaches		
No	32	54.2
Yes	27	45.8
Stress		
No	35	59.3
Yes	24	40.7
Anxiety		
No	41	69.5
Yes	18	30.5
Irritability		
No	40	67.8
Yes	19	32.2
Insomnia		
No	35	59.3
Yes	24	40.7
Difficulty concentrating		
No	44	74.6
Yes	15	25.4
VoiSS		
≤ 15 points	25	42.4
≥ 16 points	34	57.6

Subtitle: n = number of respondents; % = percentage; VoiSS = Voice Symptom Scale; ≤ = less than or equal to; ≥ = greater than or equal to

Table 2. Variables associated with tinnitus, the sensation of decreased hearing, and risk of voice disorders among digital game players. Florianópolis, 2022

Variable	Tinnitus		Decreased hearing		Risk of voice disorders	
	%	p-value	%	p-value	%	p-value
Headaches[a]		0.024		-		-
No	15.6		-		-	
Yes	42.3		-		-	
Use of *smartphones*[a]		0.012		-		-
No	13.3		-		-	
Yes	42.8		-		-	
Hours played per week[a]		-		-		0.020
0 to 9	-		-		66.6	
10 to 19	-		-		29.4	
20 hours or more	-		-		70.4	
Anxiety[b]		-		0.049		-
No	-		7.3		-	
Yes	-		27.8		-	

[a]Pearson's chi-square test; [b]Fisher's exact test
Subtitle: % = percentage

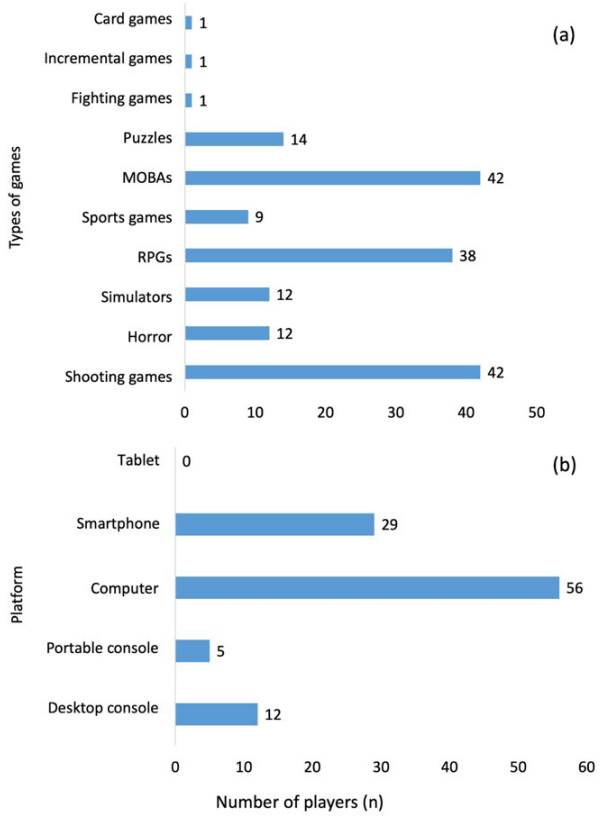

Figure 1. (a) Description of the types of games preferred by the digital game players; (b) Main platforms used. Florianópolis, 2022
Subtitle: MOBA = *Multiplayer Online Battle Arena*; RPG = *Role-Playing Game*

DISCUSSION

In the present study, tinnitus was associated with the presence of headaches and smartphone use. A higher prevalence of self-perception of decreased hearing was also observed among players with anxiety, and the risk of voice disorders was associated with longer hours played per week.

Tinnitus is a subjective symptom characterized by continuous or intermittent sound perception in the absence of a corresponding acoustic stimulus[15]. This symptom may be related to factors such as age, hearing loss, and exposure to high sound pressure levels[16]. Like tinnitus, headaches are a symptom often associated with noise exposure. A study conducted in Pakistan on exposure to noise pollution found that headaches and anxiety were mediating variables for other health complaints[17]. Tinnitus and headaches have been strongly associated, with it being described that headaches are a possible risk factor for the development of tinnitus and that they share similar pathophysiological mechanisms of alterations in the thalamocortical activity[18]. Thus, this may be an explanation for the higher prevalence of the self-perception of tinnitus among players with headaches.

Still with regard to tinnitus, a higher prevalence of the self-perception of tinnitus was observed among those who played using smartphones. This direct association is still lacking in research; however, a possible inference concerns the wide use of listening devices, which may reach up to 130 dB of sound intensity. It should be noted that the maximum volume admitted for occupational purposes by Regulatory Standard 15 is 85 dB (A)[19], corresponding to 65% of the total capacity of these types of equipment[20]. Listening devices are often misused, at high intensities, and for long periods[21], as made evident by a study that showed that most youths use the equipment at maximum volume[22], possibly exceeding the limit of 85 dB (A) and increasing the risk of symptoms and damage to the auditory system[23].

The present study demonstrated a higher prevalence of self-perception of decreased hearing among those who reported anxiety. Manifestations of anxiety, stress, irritability, insomnia, and difficulty concentrating are common symptoms caused by exposure to high sound pressure levels[8-10]. A study conducted in Canada by Bishop's University demonstrated that situational anxiety increases significantly when the individual is exposed to 75 dB of environmental noise[23]. The decrease in hearing is related to the reduction of the rigidity of the outer hair cell

stereocilia, characterized by the temporary alteration of the auditory thresholds resulting from the phenomenon of auditory fatigue caused by exposure to high sound pressure levels[24]. A possible explanation for this association is the relationship between the auditory pathway and the reticular formation, a nerve region present in the brain stem involved in functions related to the activation of the cerebral cortex and regulation of attention, alertness, and sleep[25]. In a study on the auditory and psychic effects resulting from the use of listening devices, the authors attributed the anatomical relationship between the auditory pathway and the reticular formation to the fact that exposure to high sound pressure levels can cause, in addition to auditory symptoms, various systemic changes, such as stress, tension, irritability, and increased levels of nervousness and aggressiveness[26].

The Voice Symptom Scale (VoiSS) used to assess the risk of vocal disorder in the present study is a rigorous protocol for voice self-assessment that provides information on functionality, emotional impact, and physical symptoms[13]. Regarding vocal aspects, a higher prevalence of risk of vocal disorders was found among those who played for 20 hours or more per week. Digital games can arouse diverse emotions, both positive and negative, such as fear, anger, joy, euphoria, tension, pleasure, and happiness[27]. In turn, the voice is a way of expressing emotions, which can interfere with the control of breathing, the vertical positioning of the larynx, the relative relaxation of the vocal folds, and the positioning and relaxation of the muscles of the pharynx and tongue[28]. Talking in noisy environments enhances the misuse of the voice. A study conducted with reporters exposed to noise found that background noise promoted changes in the voice characterized by increased loudness, pitch, tension, and articulatory accuracy since this environmental condition makes auditory voice monitoring difficult. This phenomenon is described as the Lombard effect, defined as an automatic response of increased vocal intensity due to the presence of environmental noise[29]. It is possible that this situation happens while playing digital games and in the communication between players while playing, increasing the risk of vocal disorders, especially if they occur for a long time, causing symptoms such as hoarseness, hawking, and sore throat, as well as emotional problems and difficulty communicating[13].

Regarding the vocal aspects of players of digital games, an experimental study investigated the effect of playing violent games on emotional stress, detected by a new methodology: automated voice stress analysis. The results pointed out that violent digital games have physiological consequences among French players, especially men, thus confirming previous research that showed that violent digital games tend to increase physiological arousal[30].

Some elements of the present research should be observed for the interpretation of the results. As a limitation, one may consider the use of a non-probabilistic sample by convenience, in addition to the use of bivariate tests without adjustment for confounding variables. However, it stands out as a potential the fact that the study identified factors associated with tinnitus, auditory perception, and risk of vocal disorders among digital game players, which will help characterize the auditory and vocal health of this audience in future research and may contribute to the reflection and substantiation of actions aimed at promoting and preventing auditory and vocal health among digital game players. In the future, it is suggested to conduct research with larger samples obtained using probabilistic techniques.

CONCLUSION

Self-perception of tinnitus was associated with headaches and smartphone use. There was also an association between anxiety and the sensation of decreased hearing, as well as between the risk of voice disorders and longer hours played per week. It is understood that these factors may be related to prolonged exposure to high sound pressure levels associated with the use of listening devices and the misuse of the voice while playing.

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