



Original article

Prevalence and Factors Associated with Hearing Disorders among Students Using Smartphones at the University of Parakou

Prévalence et facteurs associés aux troubles auditifs chez les étudiants utilisateurs de smartphone de l'Université de Parakou

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Résumé

Introduction : L'objectif de cette étude était de déterminer la prévalence et les facteurs associés aux troubles auditifs chez les étudiants utilisateurs de smartphone de l'Université de Parakou en 2021.

Méthodes : Il s'est agi d'une étude transversale à visée descriptive et analytique. La technique de sondage en grappes selon l'OMS a été utilisée. La collecte des données a été effectuée d'avril à juin 2021, au moyen d'un questionnaire individuel. Un examen clinique otologique et une audiométrie tonale liminaire ont été réalisés chez chaque étudiant inclus.

Résultats : Au total, 450 étudiants ont été colligés. L'âge moyen était de 20,86 ans ± 2,86 ; le sex-ratio était de 1,78. La prévalence des troubles fonctionnels auditifs était de 40,89%. Les acouphènes et le ressenti d'hypoacousie ont concerné respectivement 184 (40,89%) et 150 étudiants (33,33%). La majorité des étudiants (72%) avait une durée d'écoute avec

le smartphone de moins d'une heure par jour. Une proportion de 66,44% des étudiants préférerait une intensité modérée d'écoute lorsqu'ils n'associaient pas les équipements d'écoute à leur smartphone. Concernant les équipements d'écoute (écouteurs, casques), l'étude a retrouvé que 438 étudiants enquêtés soit 97,33% avaient eu à les utiliser avec leur smartphone. Une proportion de 71,69% préférerait les écouteurs intra auriculaires ; 70,78% préféreraient une intensité modérée d'écoute. À l'audiométrie tonale liminaire, 445 étudiants (99,11%) ont présenté une audition normale et 05 (1,11%) une surdité de perception de degré variable. Les facteurs associés aux acouphènes étaient la durée quotidienne totale d'appels sur le réseau mobile GSM entre 02 et 03 heures (OR=3,45 ; IC95% = 1,14-8,19 ; p=0,026), l'intensité sonore élevée sans équipement d'écoute (OR= 1,96 ; IC95% = 1,24-3,10 ; p=0,004) et l'intensité sonore faible avec un équipement d'écoute

(OR= 1,80 ; IC95% = 1,04-3,10 ; p=0,035).

Conclusion:L'utilisation prolongee des smartphones a une forte intensite de son favoriserait des troubles auditifs surtout des acouphenes.

Mots-clés : Smartphone, troubles auditifs, acouphenes, audiometrie, Parakou.

Abstract

Introduction:The objective of this study was to determine the prevalence and factors associated with hearing disorders among students using smartphones at the University of Parakou in 2021.

Methodology:This was a cross-sectional study with descriptive and analytical aims. The cluster sampling technique validated by WHO was used. Data collection was carried out from April to June 2021, using an individual questionnaire. An otological clinical examination and a preliminary pure tone audiometry were performed for each student included.

Results:A total of 450 students were collected. The mean age was 20.86 years \pm 2.86 and the sex ratio was 1.78. The prevalence of functional hearing disorders was 40.89%. Tinnitus and perceived hearing loss affected 184 (40.89%) and 150 (33.33%) students respectively. The majority of students (72%) had less than one hour of listening time per day on the smartphone. A proportion of 66.44% of students preferred moderate listening intensity when they did not use listening devices with the smartphone. Regarding listening devices (earphones, headphones), the study found that 438 students surveyed, or 97.33%, had used them with their smartphone. A proportion of 71.69% preferred in-ear earphones; 70.78% preferred moderate listening intensity. In terms of preliminary pure tone audiometry, 445 students (99.11%) presented normal hearing and 05 (1.11%) had sensorineural hearing loss of variable degree. Factors associated with tinnitus were total daily call duration on the GSM mobile network between 2 and 3 hours (OR=3.45; 95% CI = 1.14-8.19; p=0.026), high sound intensity without listening devices (OR= 1.96; 95% CI = 1.24-3.10; p=0.004) and low sound intensity with a listening device (OR= 1.80; 95% CI

= 1.04-3.10; p=0.035).

Conclusion:Prolonged use of smartphones at high sound intensity may cause hearing disorders, especially tinnitus.

Keywords:Smartphone, hearing disorders, tinnitus, audiometry, Parakou.

Introduction

The smartphone is a communication tool that, through its multiple functions and accessory gadgets, has found a privileged place in the daily lives of people who use it, especially young people. Listening to music and telephone conversations are functions regularly used by its users.

In 2018, a study conducted by the IFPI (International Federation of the Phonographic Industry) in 20 countries worldwide indicated that in South Africa, 57% of respondents most often listen to music while studying and 25% before falling asleep [1]. The WHO (World Health Organization) estimates that 1.1 billion young people worldwide could be at risk of hearing loss due to dangerous listening habits [2].

Indeed, excess noise, by affecting the hair cells, that is, the sensory cells of the ear, has direct effects on the auditory system, including tinnitus and hearing loss [2,3]. The IFOP (French Institute of Public Opinion) in collaboration with the JNA association (National Hearing Day), conducted several surveys in France related to hearing. These studies reported an increase in the prevalence of tinnitus from 31% in 2017 to 39% in 2021, an increase of 8% in three years [4,5].

In Cote d'Ivoire, a study conducted by Kouassi-Ndjeundo JE et al. in 2018 highlighted a prevalence of hearing disorders of 43.50% among smartphone users. Tinnitus was reported in 68.97% of respondents and hearing loss in 24.71% of respondents [6]. The study by Lawal AO et al. in 2017 found a proportion of 15.4% of Nigerian adolescents, mobile phone users, presenting with different degrees of hearing loss [7].

The subject of the auditory impact of mobile phone use in general and smartphones in particular has

hardly been the subject of a study in Benin in recent years. In order to contribute to the evaluation of the impact of smartphone use on hearing, we undertook this work whose main objective was to determine the prevalence of hearing disorders among students using smartphones at the University of Parakou and to identify the factors associated with them.

Methodology

This was a cross-sectional study with descriptive and analytical aims conducted over three (03) months, from April 1, 2021 to June 26, 2021 at the University of Parakou. Students enrolled at the University of Parakou for the 2020-2021 academic year, smartphone users for at least five (05) years, and who gave their oral and written consent to participate in the study and to undergo a pure tone audiometry were included. Students with a history of deafness, otitis, drug ototoxicity, acoustic trauma, or those who had an ongoing ENT infection, earwax plugs were excluded from the study.

The dependent variable was “hearing disorders,” which are tinnitus and deafness. The independent variables were sociodemographic characteristics; anamnestic and clinical data; characteristics related to smartphone use without and with listening devices; characteristics related to functional hearing exploration data; and diagnostic characteristics.

The sample size of 450 was obtained using the Schwartz formula. The sampling technique was cluster sampling at three (03) levels. The sampling base was constituted by the list of training entities of the University of Parakou with their respective target populations. This information was provided by the central academic service of the University of Parakou. The 30 clusters were constituted from the 11 training entities of the University of Parakou. The 1st level consisted of selecting the 30 clusters in accordance with WHO. Then for the seven selected entities, the numbers of students surveyed by year were retained. Then at the 3rd level, a random sampling of subjects who met the inclusion criteria was performed until the

planned size for each entity was reached (depending on the number of clusters).

The data collection technique consisted of an individual interview with each survey participant; an otological examination of each survey participant; completion of an individual questionnaire; and a preliminary pure tone audiometry for each student included in the study.

The preliminary pure tone audiometry was performed in a soundproof booth installed for the occasion in the university laboratory of performance and expertise in surgical sciences-UP. The test was first performed in so-called air conduction (AC), then in bone conduction (BC). At the end of each day, the completeness and consistency of the data were verified. The severity of deafness was assessed using the audiometric classification proposed by the International Bureau of Audiophonology (BIAP). It was considered mild, moderate, severe, and profound when the average tonal loss was between 21 and 40 dB, between 41 and 70 dB, between 71 and 90 dB, and between 91 and 119 dB respectively [8,9]. All pure tone audiometries performed were examined and interpreted by an ENT physician.

Data were collected and recorded in the Epi-Data Entry client v2.0.7.22 software. They were analyzed using Stata version 15.1 software.

Comparison of proportions was performed using the Pearson's Chi-square test or Fisher's exact test as appropriate. The significance threshold of variables was a p-value less than 0.05. A multivariate analysis was performed using binary logistic regression for the adjustment of factors associated with tinnitus.

Results

Sociodemographic Characteristics

The most represented age group was between 20 and 25 years: 243 cases or 54%. The mean age of participants included in this study was 20.86 years \pm 2.86 years with extremes of 16 years and 38 years.

Among the students surveyed, there were 288 men and 162 women, giving a sex ratio of 1.78. The

majority of surveyed smartphone users were of Fon and related ethnicity (44.67%), were single (94.84%), and of Christian religion (73.56%). The smartphone was the most used type of mobile phone over the past five (05) years by 66.89% of respondents.

Most smartphone users preferred the “music listening” function (41.78%), the “hands-free” mode (35.33%) for telephone conversations. The total daily duration of calls on Global System for Mobile (GSM) mobile networks and internet was less than one hour in 72.00% and 58.22% of cases respectively. A proportion of 66.44% of students preferred moderate listening intensity when they did not associate listening devices with their smartphone.

Regarding listening devices (earphones, headphones), the study found that 438 students surveyed, or 97.33%, had used them with their smartphone. A proportion of 71.69% preferred in-ear earphones; 70.78% preferred moderate listening intensity.

The prevalence of functional hearing disorders among students using smartphones at the University of Parakou in 2021 was 40.89%. Indeed, the prevalence of tinnitus among respondents was 40.89% and that of hearing loss was 1.1% (Table I).

Pure tone audiometry was normal in 445 respondents. In 05 respondents, or 1.11%, pure tone audiometry revealed unilateral or bilateral sensorineural hearing loss of mild degree.

After univariate analysis, it was revealed that the occurrence of tinnitus among respondents was significantly linked to the following factors: total daily duration of calls on GSM mobile network (p=0.05), preferred sound intensity without listening devices (p=0.017), preferred sound intensity with a listening device (p=0.009).

Table II provides information on factors associated with tinnitus following univariate analysis of data related to smartphone use (Table II).

In multivariate analysis, at a significance level of 5%, the factors associated with the occurrence of tinnitus among smartphone users were: total daily call duration on GSM mobile network between 2h and 3h (OR=3.45; 95% CI = [1.14-8.19]; p=0.026); high sound intensity without association with a listening device (OR= 1.96; 95% CI = [1.24-3.10]; p=0.004); low sound intensity with association “smartphone-listening device” (OR= 1.80; 95% CI = [1.04-3.10]; p=0.035). The data are presented in Table III.

Table I: Distribution of students using smartphones according to functional hearing disorders; Academic year 2020-2021, University of Parakou, Benin (N=450)

Functional Hearing Disorders	Number (n)	Percentage (%)
Right unilateral tinnitus	36	8.00
Left unilateral tinnitus	26	5.78
Bilateral tinnitus	122	27.11
Tinnitus (total)	184	40.89
Hearing loss	5	1.1

Table II: Factors associated with tinnitus among students using smartphones; Academic year 2020-2021, University of Parakou, Benin (Univariate analysis of data related to smartphone use)

Variables	N	Yes	%	p
Total daily call duration on GSM mobile network (hours)				0.054
< 1	324	126	38.89	
1-2	76	29	38.16	
2-3	25	17	68.00	
3-4	12	5	41.67	
>= 4	13	7	53.85	
Preferred call listening mode				0.098
Smartphone speaker held to ears	158	55	34.81	
Hands-free	159	64	40.25	
With earphones	129	63	48.84	
Other means	4	2	50.00	
Media used for music listening				0.077
Smartphone with earphones	231	109	47.19	
Smartphone with speaker	140	48	34.29	
Smartphone connected to Bluetooth speaker	59	22	37.29	
Smartphone with mp3 headset	8	1	12.50	
Mp3 player	9	3	33.33	
Personal or work computer	3	1	33.33	
Preferred sound intensity without listening device				0.017
Low	38	15	39.47	
Moderate	299	110	36.79	
High	113	59	52.21	
Use of listening devices with smartphone				0.134
Yes	438	182	41.55	
No	12	2	16.67	
Daily continuous music listening duration with listening device (hours)				0.094
< 1	3	0	0.00	
1-2	230	87	37.83	
2-3	120	51	42.50	
3-4	33	15	45.45	
>= 4	52	29	55.77	
Preferred sound intensity with listening device				0.009
Low	46	20	43.48	
Moderate	310	116	37.42	
High	82	46	56.10	
Most used ear for music listening with listening device				0.106
Right ear	70	36	51.43	
Left ear	73	33	45.21	
Both ears simultaneously	295	113	38.31	

Table III: Factors associated with tinnitus among students using smartphones; Academic year 2020-2021, University of Parakou, Benin (Final model of multivariate analysis)

Variables	N	OR	95% CI (OR)	p
Total daily call duration on GSM mobile network (hours)				
< 1	324	1.10	[0.66-1.90]	0.672
1-2	76	1.00	Reference	
2-3	25	3.45	[1.14-8.19]	0.026
3-4	12	1.31	[0.36-4.82]	0.667
>= 4	13	2.75	[0.62-7.05]	0.230
Preferred sound intensity without listening device				
Low	38	1.15	[0.56-2.36]	0.695
Moderate	299	1.00	Reference	
High	113	1.96	[1.24-3.10]	0.004
Preferred sound intensity with listening device				
Low	46	1.80	[1.04-3.10]	0.035
Moderate	310	1.52	[0.89-2.61]	0.124
High	82	1.00	Reference	

Discussion

The mean age of students included in this study was 20.86 years +/- 2.86 with extremes of 16 years and 38 years. This result is similar to that of Kanagamuthu et al. [10] in India in 2018 who also found a mean age of 20 years among medical students. Male respondents represented 64% with a sex ratio of 1.78. These results are similar to those of Kwon et al. [11] in South Korea in 2013 and Kouassi-Ndjeundo et al. [6] in Cote d'Ivoire in 2018 who reported male predominance with proportions of 63.52% and 68.80% respectively. On the other hand, Kanagamuthu et al. [10] in India in

2018 noted female predominance of 58.10% in their series in India.

The smartphone was found to be the most used type of mobile phone over the past five (05) years among most students surveyed in this study (66.89%). This could be explained by marketing and the increase in sales locations for smartphones in Benin, but also by the fact that the smartphone has become increasingly a work tool. It should also be noted that some brands of smartphones are affordable. Music listening is the most used function among 41.78% of respondents in this study. These results are different from those of Kouassi-Ndjeundo et al. [6] in Cote d'Ivoire in 2018

who reported that the “call” 69.25% and “music” 24% functions were the most used. This could be explained by the fact that the two study populations have different ages and interests. Younger people prefer to listen to music while older people prefer to use their smartphone for calls.

The smartphone associated with earphones is preferred for music listening among 51.33% of respondents. This result seems to be closer to that of the IFOP-JNA survey in 2017 which also found that the mobile phone associated with earphones is the most used for music listening among 43% of respondents [4]. On the other hand, Kouassi-Ndjeundo et al. [6] in Cote d’Ivoire in 2018 reported that 61.49% of respondents preferred to listen to music directly from the smartphone. This difference could be explained by our study population being younger.

The majority of respondents overall make calls of less than one hour per day on both the GSM mobile network (72.00%) and the internet mobile network (58.22%). In recent years, GSM operators in Benin have updated call package plans, making them accessible. Nevertheless, the majority of students still have several relatives who do not connect to the internet at all or not often, justifying the preference for the GSM mobile network for calls. Also, financial means are sometimes limited for some students, not allowing them to activate internet and call packages as they would like.

The study conducted by Kanagamuthu et al. [10] in India in 2018 also reported that the duration of calls per day was less than one hour in 95.30%. This proportion is higher than that of this study.

It emerges from this study that 97.33% of respondents used listening devices for music listening with their smartphone. These figures are higher than those of the study by Mohammadpoorasl et al. [12] conducted in Iran in 2015 and Kanagamuthu et al. [10] in India in 2018 who found proportions of 89.6% of earphone users for music and 67.4% who preferred using the smartphone with earphones respectively.

Regarding music listening with a listening device, most respondents prefer to use them simultaneously

in the right and left ears (67.35%). A study was conducted by Philip et al. [13] in India in 2015 on the effects of mobile phone use on hearing in the adult population in India. It reports that the majority of participants prefer to use both ears simultaneously but with a lower proportion than this study (37.3%).

In-ear earphones (wired) are preferred (71.69%) by the majority of students using listening devices. The study by Mohammadpoorasl et al. [12] conducted in Iran in 2015 found a proportion of 51.3% of users preferring in-ear earphones.

The sound intensity for music listening with the smartphone was moderate in 66.44% of respondents. This result is similar to that of Kouassi-Ndjeundo et al. [6] in Cote d’Ivoire in 2018 which revealed that the volume used for music listening was moderate in 66.25% of cases [6]. The preferred sound intensity for music listening with the “listening device-smartphone” association was moderate in 70.78% of respondents.

The prevalence of tinnitus among respondents was 40.89%. These results are similar to those of the IFOP-JNA survey in 2020 which found a percentage of 39% of French people aged 15 years and over suffering from tinnitus [5]. The study by Kouassi-Ndjeundo et al. [6] in Cote d’Ivoire in 2018 reported 68.97% of cases of perceived tinnitus, proportions higher than those of this study. This gap could be explained by the fact that those who rarely experience tinnitus were not counted in the prevalence calculated in this study. The prevalence of perceived hearing loss was 33.33%, slightly higher than that of the study by Kouassi-Ndjeundo et al. [6] in Cote d’Ivoire in 2018 which found a prevalence of 24.71%. After performing the preliminary pure tone audiometry in this study, only one case of hearing loss was confirmed, or 0.22%.

At the end of this study, the prevalence of functional hearing disorders among students using smartphones at the University of Parakou in 2021 was 40.89%, lower than that found for the study by Kouassi-Ndjeundo et al. [6] in Cote d’Ivoire in 2018 which was 43.50%. In this study, only cases of hearing loss confirmed by preliminary pure tone audiometry were

taken into account in the calculation of the prevalence of functional hearing disorders.

In this study, pure tone audiometry was performed for each respondent. The study reveals 1.11% of cases of sensorineural hearing loss. These results are lower than those of Lawal et al. [7] who conducted a similar study in Ibadan, Nigeria in 2017 which found 15.4% of hearing loss. This difference could be explained by the fact that for the Ibadan study, participants were volunteers and pure tone audiometries were only performed on participants who reported hearing loss. All cases of hearing loss (1.11%) found in this study were of mild degree. The study by Lawal et al. [7] in Nigeria in 2017 found 8.6% of mild hearing loss, proportions higher than those of this study.

Analytical Study

After multivariate analysis, this study reports that high sound intensity without a listening device is significantly linked to the occurrence of tinnitus among smartphone users (OR= 1.96; 95% CI = 1.24-3.10; p=0.004). Thus, with high sound intensity without a listening device, there is 1.96 times more risk of tinnitus occurrence compared to 1.15 times more risk in case of low sound intensity without listening devices. It should also be noted that tinnitus was mostly found in 52.21% of people preferring high sound intensity without listening devices. These results corroborate those of the study by Kouassi-Ndjeundo et al. [10] in Cote d'Ivoire in 2018 which highlighted an association between tinnitus and the sound volume used for music listening (p=0.004) but in univariate analysis rather. Listening to music with high sound volume from one's smartphone has a negative impact on users' ears. With listening devices, this danger seems to increase.

Indeed, a statistical link was also established between low sound intensity with a listening device and the occurrence of tinnitus among smartphone users (OR= 1.80; 95% CI = [1.04-3.10]; p=0.035). Low sound intensity with a listening device already induces a risk of 1.80 for the occurrence of tinnitus. Thus, even at low sound intensities, the use of the "smartphone-listening devices" association induces a non-

negligible auditory risk.

This study conducted in Parakou in 2021 found a significant link between the occurrence of tinnitus among smartphone users and the total daily call duration on the GSM mobile network between 2h and 3h (OR=3.45; 95% CI = [1.14-8.19]; p=0.026). With a total daily call duration on the GSM mobile network between 2h and 3h, the smartphone user has 3.45 times more risk of experiencing tinnitus compared to a risk of 1.10 if this daily duration is less than one hour. Telephone communications are essential today both for chatting with loved ones and in the work context. These results show us that poor use of the smartphone associated or not with listening devices seems to have a negative impact on the ears, particularly with the occurrence of tinnitus.

Conclusion

The smartphone is a device that has revolutionized the world and is very useful today in several fields including medicine. Tinnitus is revealed to be an early hearing disorder found in young smartphone users. The few cases of sensorineural hearing loss found at the end of this study should not be neglected. Deafness seems to be revealed, unlike tinnitus, as a late hearing disorder in smartphone users that could be better evaluated in a few years. Every user should know how to use their smartphone in order to get the best out of it without affecting the ears whose functions are precious.

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