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Research Article

Assessment of Hearing Loss in People Living with HIV Followed in Hospital of Kabinda, Democratic Republic of Congo: Cross-Sectional and Observational Study

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ABSTRACT

Background and Purpose: Assessment of hearing function in people living with HIV is important, as good hearing is important for social participation and inclusion in employment and education. The purpose of this study was to systematically examine data on the frequency and characteristics associated with hearing loss in people living with HIV followed at Kabinda Hospital.

Methods: Cross-sectional and observational study including 120 PLHIV followed at Kabinda hospital during the years 2019 and 2020 in which audiometry was performed. Hearing loss was diagnosed by the presence of otology signs or pathologic audiometry.

Results: the frequency of hearing loss was 11.7%, the risk factors associated with this hearing loss were the profession in a public sector (adjusted OR 6.74; 95% CI: 1.25 - 9.24, *p* = 0.026), WHO stage III and IV (adjusted OR 4.55; 95% CI: 2.11- 8.38; *p* = 0.026); CD4 count <200 cells / mm3 (adjusted OR 2.06; 95% CI: 1.55 - 7.65, *p* = 0.028) and RHEZ treatment (adjusted OR 5.22; 95% CI: 1 , 68-7.06, *p* = 0.016).

Conclusion: Hearing loss is one of the complications of HIV infection. Its pathogenesis is multifactorial, leading to the discussion of the role of the virus itself and the extrinsic factors.

Keywords: Hearing loss; HIV; Determinants; Kabinda hospital

INTRODUCTION

Sub-Saharan Africa is home to 70% of the 35.3 million people living with HIV worldwide [1]. Access to antiretroviral therapy (HART) has become widely available even in these countries over the past decade [2]. As a result, the life expectancy of people living with HIV has increased dramatically and HIV is increasingly becoming a chronic disease [3]. It is increasingly clear that with increasing life expectancy, the long-term consequences of HIV are emerging [4]. The focus of HIV programs must therefore shift from saving lives to improving the quality of life of people living with HIV. One of the potential long-term consequences of HIV is hearing loss. In high-income countries, up to 75% of adults infected with HIV experience various otolaryngology symptoms during their illness, including hearing loss [5]. Hearing loss is progressive in most cases, but can be sudden in others [6]. Studies in high-income countries in adults show that Sensorineural Hearing Loss (SNHL) occurs in about a third of all adults with HIV infection, and it can occur as a result of opportunistic infections of the nervous system central causing meningitis or encephalitis (toxoplasmosis, syphilis, herpes and CMV) or by the HIV virus itself [6-9]. Other sensorineural causes may be iatrogenic in nature, for example, following ototoxic drugs given for co-infections such as tuberculosis or ART [10]. SNHL in HIV is irreversible and therefore the focus should be on preventing it. Children infected with HIV are also at risk of hearing loss, and US studies estimate that about 20% of HIV-positive children have hearing loss [6]. Hearing loss in these children appears to be predominantly conductive (located in the middle ear), possibly because the immunocompromised child has a higher risk of developing otitis media and chronic suppurate otitis media [11]. This means that hearing loss in children living with HIV should be largely treatable, given the availability of services [12].

Assessment of hearing function in people living with HIV is therefore potentially important, as good hearing is important for social participation and inclusion in employment and education. However, in most low and middle income countries (PRFI) such as the Democratic Republic of Congo, access to otolaryngology care is limited, ENT doctors are scarce and often only available in the capital [12]. In addition, screening programs are virtually non-existent and access to hearing aids is very scarce. There is therefore a need to carefully examine the prevalence and cause of hearing loss in people living with HIV, in order to show how best to provide prevention and treatment services to alleviate hearing loss. The objective of this study was to systematically review data on the frequency and characteristics associated with hearing loss in people living with HIV followed in Hospital of Kabinda, in order to inform planning of HIV programs in these areas.

PATIENTS AND METHODS

This is a cross-sectional and analytical study carried out on elderly adult patients with HIV / AIDS as part of a follow-up of the Service specialized in the care of HIV / AIDS patients at the Kabinda Hospital, a Doctors Without Borders Hospital (MSF), which takes care of all People Living with HIV (PLHIV) from across the city of Kinshasa between 2019 and 2020. PLHIV aged 18 years or over, with an exploitable record and having consented or in writing to participate in the study were considered eligible for the study.

The present study is based on a sample of 120 participants who presented valid records. It turns out that only 3 of the suspected ENT patients performed audiometry.

The measurement of hearing loss was established using signs of ENT involvement and then confirmed by an audiometric test; it was defined as a one-sided or two-sided average of pure tones greater than 25 dB in the worst ear on high frequencies (3 kHz, 4 kHz, 6 kHz and 8 kHz). The degree of loss for prevalence estimates was defined as either mild (greater than 25 dB and up to 40 dB) or medium to deep (greater than 40 dB). Thresholds for hearing loss were based on the guidelines of the American Speech-Language-Hearing Association. The mean of pure tones at high frequencies was used as a continuous variable to check the degree of hearing loss in logistic regression models.

Survey participants who had hearing loss, tinnitus, earache, headache, dizziness, and audiometrically measured hearing loss and who met the following three criteria were classified as having hearing loss.

Statistical analyzes

Statistical analyzes were performed using IBM SPSS Statistic

Table 1: Different signs of hearing impairment.

Signs of hearing impairment	n = 102	Percentage
Dizziness	6	5.0
Headache	6	5.0
Hearing loss	5	4.2
Tinnitus	4	3.3
Otalgia	1	0.8

software, version 23, data were presented as measures of central tendency (mean, median, standard deviation, minimum and maximum) and proportions. The analysis of the association between clinical variables and deafness was carried out using chi-squared, Student's t and Logistic regression tests with 95% CI, being considered with statistical significance $p < 0.05$.

RESULTS

Hearing loss in the study population

Frequency of hearing loss: Out of a total of 120 pvvih examined, 14 had presented at least one sign of hearing impairment or pathological audiometry, ie a frequency of 11.7%.

Different signs of hearing impairment: The signs of hearing impairment found in the study population were vertigo, headache (5% respectively), hearing loss (4.2%), tinnitus (3.3%) and earache (0.8 %).

Audiometry of patients: In this curve, patient 1 has intensity

Table 2: Sociodemographic characteristics according to hearing impairment.

Variable	Over all n = 120	No hearing loss n = 106	Hearing loss n = 14	p
Age	46.9 ± 12.7	46.4 ± 12.8	50.9 ± 11.4	0.624
18-35 years	©28(23.3)	26(24.5)	2(14.3)	
36-48 years	36(30.0)	33(31.1)	3(21.4)	
49-58 years	37(30.8)	31(29.2)	6(42.9)	
59- 75 years	19(15.8)	16(15.1)	3(21.4)	
Gender				0.571
Male	50(41.7)	44(41.5)	6(42.9)	
Female	70(58.3)	62(58.5)	8(57.1)	
Residence				0.978
Lukunga	26(21.7)	23(21.7)	3(21.4)	
Mont Amba	32(26.7)	29(27.4)	3(21.4)	
Funa	47(39.2)	41(38.7)	6(42.9)	
Tshangu	15(12.5)	13(12.3)	2(14.3)	
Ethnic group				0.668
Kongo	59(49.2)	54(50.9)	5(35.7)	
Ngala	12(10.0)	10(9.4)	2(14.3)	
Luba	30(25.0)	25(23.6)	5(35.7)	
Swahili	19(15.8)	17(16.0)	2(14.3)	
Religion				0.254
Catholic	31(25.8)	30(28.3)	1(7.1)	
Protestant	15(12.5)	13(12.3)	2(14.3)	
Alarm clock	61(50.8)	53(50.0)	8(57.1)	
Followers	13(10.8)	10(9.4)	3(21.4)	
Marrital status				0.937
Single	48(40.0)	43(40.6)	5(35.7)	
Married	38(31.7)	33(31.1)	5(35.7)	
Divorced	34(28.3)	30(28.3)	4(28.6)	
Level of study				0.400
Primary	11(9.2)	10(9.4)	1(7.1)	
Secondary	66(55.0)	56(52.8)	10(71.4)	
University	43(35.8)	40(37.7)	3(21.4)	
Profession				**0.030**
Unemployed	23(19.2)	21(19.8)	2(14.3)	
Public sector	46(38.3)	36(34.0)	10(71.4)	
Private sector	51(42.5)	49(46.2)	2(14.3)	

Data are expressed as mean ± standard deviation, absolute (n) and relative (%) frequency.

Table 3: Clinical and biological characteristics according to hearing loss.

Variable	Over all n = 120	No hearing loss n = 106	Hearing loss n = 14	p
BMI (Kg/m²)	23.6 ± 4.6	23.6 ± 4.7	23.4 ± 3.8	0.875
Obesity	12(10.0)	10(9.4)	2(14.3)	0.422
Overweight	26(21.7)	24(22.6)	2(14.3)	0.375
Denutrition	14(11.7)	12(11.3)	2(14.3)	0.509
Chronic diarrhea	9(7.5)	8(7.5)	1(7.1)	0.718
Tuberculisis	58(48.3)	48(45.3)	10(71.4)	**0.019**
Cryptococcosis	9(7.5)	7(6.6)	2(14.3)	0.282
Toxoplasmosis	2(1.7)	2(1.9)	0(0.0)	-
Chickenpox in childhood	45(37.5)	39(36.8)	6(42.9)	0.434
Shingles	41(34.2)	38(35.8)	3(21.4)	0.225
Candidiasis	9(7.5)	9(8.5)	0(0.0)	0.314
HBP	14(11.7)	12(11.3)	2(14.3)	0.509
Diabetes millitus	4(3.3)	3(2.8)	1(7.1)	0.395
Transfusion	40(33.3)	35(33.0)	5(35.7)	0.529
WHO Stage				**0.024**
Stage I & II	91(75.8)	84(79.2	7(50.0)	
Stage III & IV	29(24.2)	22(20.8	7(50.0)	
CD4 (elements/mm³)				**0.027**
<200	41(34.2)	35(33.0)	6(42.9)	
≥200	79(65.8)	71(67.0)	8(57.1)	
Treatment mode				0.434
2 INTI+1 IP	2(1.7)	2(1.9)	0(0.0)	
2 INTI+1 INI	63(52.5)	56(52.8)	7(50.0)	
2 INTI+1 INNTI	55(45.8)	45.3)	7(50.0)	
Bactrim	56(46.7)	50(47.2)	6(42.9)	
RHEZ	7(5.8)	4(3.8)	3(21.4)	**0.034**
INH	7(5.8)	7(6.6)	0(0.0)	0.410
Duration of the treatment				0.458
< 5 years	57(47.5)	53(50.0)	4(28.6)	
5-10 years	46(38.3)	40(37.7)	6(42.9)	
> 10 years	17(14.2)	13(12.3)	4(28.6)	
Evolution				0.327
Good	79(65.8)	71(67.0)	8(57.1)	
Bad	41(34.2)	35(33.0)	6(42.9)	

Data are expressed as mean ± standard deviation, absolute (n) and relative (%) frequency.
The frequency of hearing loss was higher in patients with tuberculosis (p = 0.019); in WHO Stage III and IV patients (p = 0.024), in patients with a CD4 count < 200 cells/mm3 and in patients on RHEZ.

varying between 90 and 70 dB in his right and left ear, even in acute sound with an average of 86 dB on the right and 76 dB on the left, he presents with severe bilateral deafness; patient 2 presents in both ears sound intensities varying between 30 and 55 dB with averages of 40 dB on the right and 39 dB on the left, he has mild bilateral deafness and for patient 3; he has intensities varying between 20 and 45 dB with an average of 23 dB on the right and 25 dB on the left, he has mild bilateral deafness.

SOCIODEMOGRAPHIC CHARACTERISTICS

Determinants of hearing loss in PLHIV

The risk factors associated with hearing loss in PLHIV are described in table 4. In univariate analysis, the risk factors significantly associated with hearing loss, were occupation in a public sector, stage III and IV of the WHO, history of TBC, CD4 count <200 cells / mm3 and treatment with RHEZ. In statistical analysis by multivariate logistic regression, occupation in a public sector (adjusted OR 6.74; 95% CI: 1.25-9.24, p = 0.026), WHO stage III and IV (OR adjusted 4.55; 95% CI: 2.11-8.38; p = 0.026); CD4 count <200 cells / mm3 (adjusted OR 2.06; 95% CI: 1.55-7.65, p = 0.028) and RHEZ treatment (adjusted OR 5.22; 95% CI: 1 , 68-7.06, p = 0.016).

DISCUSSION

The frequency of hearing loss in HIV-infected patients was 11.7%, all of whom were already on antiretroviral therapy. This frequency is probably underestimated since only 3 patients were able to perform a tonal audiometry. Despite many studies done, it has been shown a relationship between HIV and hearing loss. Recently, van der Westhuizen, et al. [13] studied hearing loss in patients with and without HIV infection and found that HIV-positive patients had a higher prevalence of hearing loss (even with high frequency sound of 500, 1000 and 2000 Hz) and, in addition, found a positive relationship between HIV and hearing loss [13]. In other words, HIV can affect the central and peripheral auditory system [14]. HIV has been detected in auditory and vestibular hair cells, strial cells, and along the tectorial membrane. However, the otologic symptom, including sudden or progressive bilateral hearing loss, may represent a combination of the effects of HIV infection coupled with opportunistic infections, such as syphilis, Cytomegalovirus, Herpes, toxoplasmosis and others [15,16]. Therefore, it is essential to titrate the antibodies against the main agents linked to this morbidity, notably CMV, syphilis and toxoplasmosis, which are important causes of hearing loss in the population immunocompromised by AIDS.

Table 4: Determinants of hearing loss in PLHIV.

Variables	Univariate analysis		Multivariate analysis	
	p-value	OR (95%CI)	*p*-value	Adjusted OR (95%CI)
Profession				
Unemployer		1		1
Privqte sector	0.412	2.33 (0.38-6.87)	0.296	3.08 (0.37-5.44)
Public sector	**0.017**	6.81 (1.41-9.74)	**0.026**	6.74 (1.25-9.24)
WHO stage				
Stage I & II		1		1
Stage III & IV	**0.022**	1.95 (1.10-3.47)	**0.026**	4.55 (2.11-8.38)
Tuberculosis				
No		1		1
Yes	**0.018**	3.02 (1.89-10.24)	0.243	2.34 (0.56-9.80)
CD4 (cell/mm^3)				
≥200		1		1
<200	**0.005**	3.52 (1.49-4.73)	**0.028**	2.06 (1.55-7.65)
RHEZ				
No		1		1
Yes	**0.019**	6.96 (1.38-9.18)	**0.011**	5.22 (1.68-7.06)

Abbreviations: OR: Odd Ratio; WHO: World Health Organization; CI: Confiance Intervalle

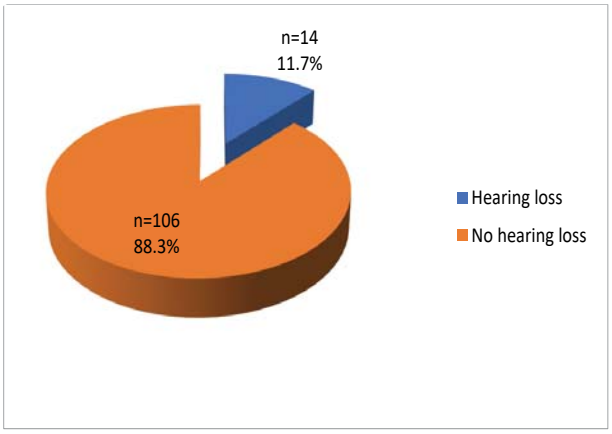

Figure 1: Frequency of hearing loss in PLHIV.

While our series consisted predominantly of women, other authors have reported a roughly equal ratio between the two sexes [16,17]. But the high frequency of HIV in women compared to men has already been proven by other authors [2,4] for several reasons: the anatomy of the female tract or the area of mucous membrane exposed to the virus during intercourse is larger in women and the fragility of the vaginal walls offers multiple entry routes for the virus [5].

The average age varies depending on the series and concerns both young adults and elderly patients. In the present series, the mean age was 46.9 ± 12.7 years while Va der Westhuizen Y and Torre P reported a mean age of 37.99 years and 57 years respectively [13,17].

The determinants of hearing loss during HIV infection are the subject of much controversy. Indeed, some authors have reported cases of deafness observed just after antiretroviral treatment [18], while others have reported it in immunosuppressed patients without antiretroviral treatment [19]. Thus several factors such as viral or bacterial co-infection, ototoxicity of antiretroviral, or even the direct effect of the virus itself on the auditory nerve can explain the occurrence of deafness in patients infected with HIV. Just like what is found in the literature [17-20], we have highlighted as risk factors for hearing loss the profession in a public sector (adjusted OR 6.74; 95% CI: 1.25-9 , 24, p = 0.026), WHO stage III and IV (adjusted OR 4.55; 95% CI: 2.11-8.38; p = 0.026); CD4 count <200 cells / mm3 (adjusted OR 2.06; 95% CI: 1.55-7.65, p = 0.028) and RHEZ treatment (adjusted OR 5.22; 95% CI: 1 , 68-7.06, p = 0.016).

Concerns the profession in the public sector as a factor related to hearing loss, a clear explanation may justify this finding, exposure to noise in this sector could influence the occurrence of hearing loss. A study by Torre et al had shown exposure to noise multiplied the risk of hearing loss in PLHIV by 2.18 [Relative Risk (RR) 2.18; 95%

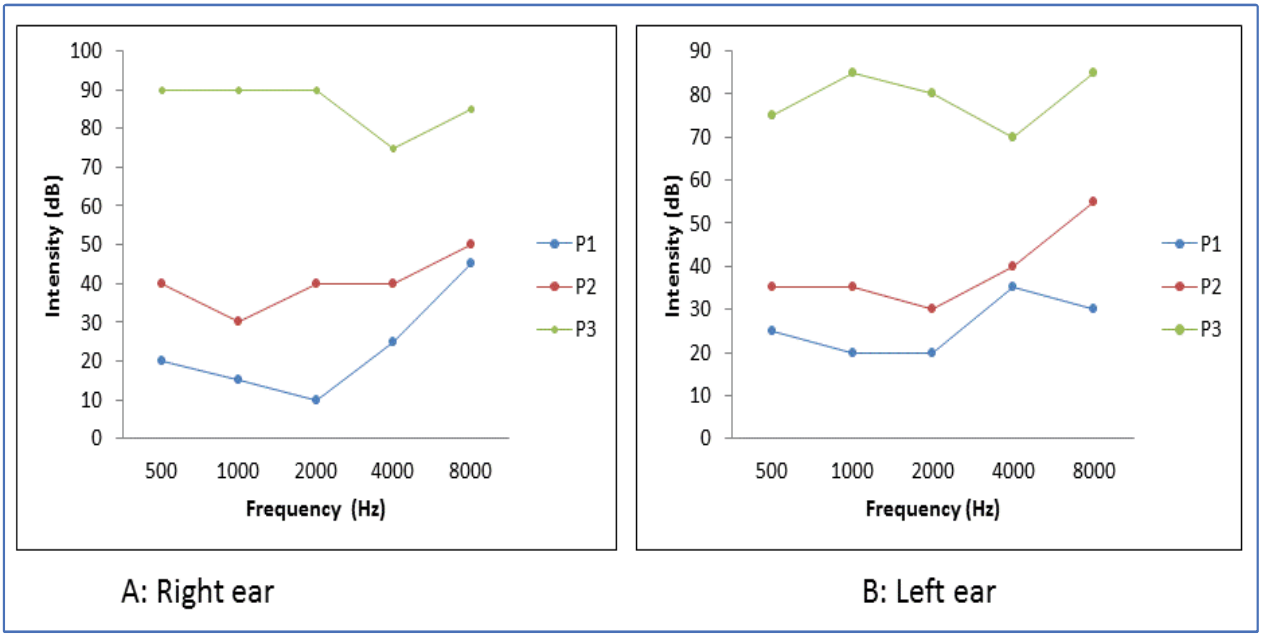

Figure 2: Audiometric curve of 3 patients with HIV.

Confidence Interval (CI) 1.02-2.36 p <0.05] [17]. With regard to the RHEZ scheme, as a determining factor in hearing loss, a justifiable explanation in the literature could be given, in particular the long duration of exposure to aminoglycosides administered to PLHIV, a drug of the composition of the scheme, which is toxic to vestibular and cochlear cells.

The collapse of CD4 and the advanced stage of the disease play a similar role in the occurrence of hearing loss in PLHIV. Both conditions lead to exposure to opportunistic infections such as syphilis, cytomegalovirus, herpes, toxoplasmosis and others which can colonize the inner ear and lead to destruction of vestibular and cochlear cells [15, 16].

The interpretation of the results of the present study should take into account some limitations. First, the small sample size did not allow sufficient power to statistical tests to identify association between variables of interest. Second, the observational design of the study precludes any cause-effect relationship between exposure and outcome. Third, single measurement of hearing loss could lead to regression dilution bias and misclassification of patients. Fourth, the lack of audiometry measurements to all patients could have underestimated the frequency of hearning loss.

CONCLUSION

Hearing loss can be considered one of the complications of HIV infection. It is bilateral, symmetrical, of varying degrees at low and high frequencies. Its pathogenesis is multifactorial, leading to debate on the role of the virus on the auditory nerve, ototoxicity of drugs and opportunistic viral or bacterial diseases with neuro-meningeal localization.

AUTHOR'S CONTRIBUTIONS

SGJ, ANN and NAG designed and analyzed the statistical data for the study. LMB, MNR, BZP and MMTC, TKH supervised the study. All authors have read and approved the final and revised version of the manuscript.

REFERENCES

1. UNAIDS, Global Report: UNAIDS report on the global AIDS epidemic 2013. 2013: UNAIDS Switzerland.
2. Mahy M, Stover J, Stanecki K, Stoneburner R, Tassie JM. Estimating the impact of antiretroviral therapy: regional and global estimates of life-years gained among adults. Sex Transm Infect. 2010 Dec;86 Suppl 2(Suppl_2):ii67-71. doi: 10.1136/sti.2010.046060. PMID: 21106518; PMCID: PMC3173805.
3. Bor J, Rosen S, Chimbindi N, Haber N, Herbst K, Mutevedzi T, Tanser F, Pillay D, Bärnighausen T. Mass HIV Treatment and Sex Disparities in Life Expectancy: Demographic Surveillance in Rural South Africa. PLoS Med. 2015 Nov 24;12(11):e1001905; discussion e1001905. doi: 10.1371/journal.pmed.1001905. PMID: 26599699; PMCID: PMC4658174.
4. Banks LM, Zuurmond M, Ferrand R, Kuper H. The relationship between HIV and prevalence of disabilities in sub-Saharan Africa: systematic review (FA). Trop Med Int Health. 2015 Apr;20(4):411-29. doi: 10.1111/tmi.12449. Epub 2015 Jan 14. PMID: 25495989.
5. Prasad HK, Bhojwani KM, Shenoy V, Prasad SC. HIV manifestations in otolaryngology. Am J Otolaryngol. 2006 May-Jun;27(3):179-85. doi: 10.1016/j.amjoto.2005.09.011. PMID: 16647982.
6. Chandrasekhar SS, Connelly PE, Brahmbhatt SS, Shah CS, Kloser PC, Baredes S. Otologic and audiologic evaluation of human immunodeficiency virus-infected patients. Am J Otolaryngol. 2000 Jan-Feb;21(1):1-9. doi: 10.1016/s0196-0709(00)80117-9. PMID: 10668670.
7. Marra CM, Wechkin HA, Longstreth WT Jr, Rees TS, Syapin CL, Gates GA. Hearing loss and antiretroviral therapy in patients infected with HIV-1. Arch Neurol. 1997 Apr;54(4):407-10. doi: 10.1001/archneur.1997.00550160049015. PMID: 9109742.
8. Birchall MA, Wight RG, French PD, Cockbain Z, Smith SJ. Auditory function in patients infected with the human immunodeficiency virus. Clin Otolaryngol Allied Sci. 1992 Apr;17(2):117-21. doi: 10.1111/j.1365-2273.1992.tb01056.x. PMID: 1587025.

9. Cohen BE, Durstenfeld A, Roehm PC. Viral causes of hearing loss: a review for hearing health professionals. Trends Hear. 2014 Jul 29;18:2331216514541361. doi: 10.1177/2331216514541361. PMID: 25080364; PMCID: PMC4222184.

10. Schouten JT, Lockhart DW, Rees TS, Collier AC, Marra CM. A prospective study of hearing changes after beginning zidovudine or didanosine in HIV-1 treatment-naïve people. BMC Infect Dis. 2006 Feb 20;6:28. doi: 10.1186/1471-2334-6-28. PMID: 16504011; PMCID: PMC1402303.

11. Miziara ID, Weber R, Araújo Filho BC, Pinheiro Neto CD. Otitis media in Brazilian human immunodeficiency virus infected children undergoing antiretroviral therapy. J Laryngol Otol. 2007 Nov;121(11):1048-54. doi: 10.1017/S0022215107006093. Epub 2007 Feb 26. PMID: 17319998.

12. Fagan JJ, Jacobs M. Survey of ENT services in Africa: need for a comprehensive intervention. Glob Health Action. 2009 Mar 19;2. doi: 10.3402/gha.v2i0.1932. PMID: 20027268; PMCID: PMC2779942.

13. van der Westhuizen Y, Swanepoel de W, Heinze B, Hofmeyr LM. Auditory and otological manifestations in adults with HIV/AIDS. Int J Audiol. 2013 Jan;52(1):37-43. doi: 10.3109/14992027.2012.721935. Epub 2012 Oct 8. PMID: 23043519.

14. Cohen BE, Durstenfeld A, Roehm PC. Viral causes of hearing loss: a review for hearing health professionals. Trends Hear. 2014 Jul 29;18:2331216514541361. doi: 10.1177/2331216514541361. PMID: 25080364; PMCID: PMC4222184.

15. Lin C, Lin SW, Weng SF, Lin YS. Increased risk of sudden sensorineural hearing loss in patients with human immunodeficiency virus aged 18 to 35 years: a population-based cohort study. JAMA Otolaryngol Head Neck Surg. 2013 Mar;139(3):251-5. doi: 10.1001/jamaoto.2013.1709. PMID: 23429891.

16. Patricia Fener Vulnérabilité des femmes au VIH/sida et aux Infections sexuellement transmissibles – SidaSciences [En ligne] 2017 Juin 1,isponible https://tinyurl.com/y6o65kxr

17. Torre P 3rd, Hoffman HJ, Springer G, Cox C, Young MA, Margolick JB, Plankey M. Hearing loss among HIV-seropositive and HIV-seronegative men and women. JAMA Otolaryngol Head Neck Surg. 2015 Mar;141(3):202-10. doi: 10.1001/jamaoto.2014.3302. PMID: 25541676; PMCID: PMC4369193.

18. Schouten JT, Lockhart DW, Rees TS, Collier AC, Marra CM. A prospective study of hearing changes after beginning zidovudine or didanosine in HIV-1 treatment-naïve people. BMC Infect Dis. 2006 Feb 20;6:28. doi: 10.1186/1471-2334-6-28. PMID: 16504011; PMCID: PMC1402303.

19. Oburra H O. Hearing disorder in HIV-positive adult patients not taking antiretroviral drugs at kenyatta national hospital. East Afr Med J 2010; 8: 87-92.

20. Torre P, Springer G, Cox C, Young MA, Hoffman HJ, Margolick JB and al. Hearing loss in perinatallly human immunodeficiency virus-infected and human immunodeficiency virus-exposed but uninfected children and adolescents. Pediatr Infect Dis J. 2012; 18 (5): 130-8.