Music, sound, or noise?
Sonic culture in Ghana and its public health implications

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Abstract

The sonic culture of any place is always locally specific. Yet, beyond cultural differences, there are more general health implications of sound production and exposure, particularly where high sound levels with potentially damaging effects to the inner ear are concerned. The purpose of this study was to investigate further into the socio-cultural, psychological, and physiological dimensions of sound production, exposure and perception in a Ghanaian context. Specifically, we aimed to examine how people who regularly deal with electronic sound equipment evaluate sound stimuli in different contexts. We used three different instruments: first, we measured ambient noise levels at live music events and during band rehearsals; we then conducted air conduction threshold tests to assess participants' status of hearing; and, as a complementary instrument, we used a structured questionnaire to assess levels of sound exposure as well as participants' evaluation of environmental noise. Our results revealed that amateur and professional musicians are indeed a high risk group with regard to potential hearing damage. We therefore concluded that awareness campaigns and counter-measures with regard to sound/noise pollution need to be designed more specifically for different target groups to address their respective needs.

Keywords: sonic culture; sound exposure; noise; hearing loss; public health

Introduction

Noise is increasingly recognized as an environmental problem and a public health issue. In the recent past, various noise-related issues have made the news in Ghana. For example, in September 2013, ten churches in the Ga West Municipality were reported to have been issued with summons to be prosecuted for noise nuisance

(Ghana News Agency, 2013). Also, the Daily Graphic's issue of February 15, 2013, reported the demolition of a church by the Accra Metropolitan Assembly (AMA) for making excessive noise (Wireko, 2013). However, despite a number of recent campaigns by government agencies to raise public awareness about the negative health effects of noise pollution as well as isolated actions against offenders in the Greater Accra Region, the enforcement of existing laws seems to remain a major challenge. In an article dubbed "Ghana, a nation of noise makers", which appeared in the Ghana Herald, Adorsu-Djentu (2013) expresses his frustration over daily noise nuisances by describing the mélange of sounds that surround the Ghanaian city dweller day in, day out: the muezzin's call at dawn, the cacophonous assembly of street noises, the singing and preaching through megaphones by self-appointed evangelists, the shouting of street sellers, the piercing sounds of PA systems used at lorry stations, loud amplified music played in drinking spots and from moving vehicles to advertise various products – the list goes on. It seems that in order to deal with noise pollution in Ghana a more profound cultural change is needed.

While there are a number of studies investigating environmental noise and its mostly non-auditory psychosocial effects, studies examining the more direct auditory effects of noise exposure in the Ghanaian context are still scarce. Particularly the effects of exposure to loud music have, so far, not attracted the attention of researchers in Ghana. Targeting professional and lay musicians within the Cape Coast metropolitan area, the objective of this study was therefore to find out how people regularly exposed to loud music evaluate and behave towards noise. By examining the audiograms particularly of people regularly dealing with electronic sound equipment, the study endeavoured to ascertain whether there are connections between listening behaviour, sound exposure, and people’s status of hearing. Towards this end, we conducted listening tests and administered a structured questionnaire, comparing in our analysis the audiograms of people with their self-reported exposure and behaviour towards amplified sound. Specifically, this study aimed to:

- Evaluate how people perceive environmental sounds.
- Measure sound levels at live music events and during band rehearsals.
- Find out about professional and lay musicians' behaviour towards amplified sound and high noise levels.

- Assess the status of hearing of professionals and laypeople regularly working with electronic sound equipment.

Review of Literature

The health effects of noise on the human body, which include both physical and psychosocial responses, have been well documented (e.g., Godlee, 1992; Guéguen et al., 2008; Halononen et al., 2012; Lercher, Evans, Meis & Kofler, 2002; Westman & Walters, 1981; McBride, 2010; van Kempen et al., 2002). They range from risk of hearing loss, hypertension, indigestion, heart burn, ulcers, heart disease, mental illness, fatigue, damages to the nervous system, stress, insomnia, reduced efficiency at work places and general decrease of performance. In understanding these noise-related health effects, it is important to bear in mind the basic evolutionary function of the auditory system, which is actually an alarm system constantly monitoring the sonic environment for potential dangers and threats. This warning function, in human beings as in other mammals, regulates fundamental auditory responses to sound stimuli and includes an orientation reflex as well as a startle reflex, both of which then initiate a defensive response that eventually sets off a so-called fight-or-flight reaction (Westman & Walters, 1981).

Studies have demonstrated that the physiological effects of this defensive mechanism, which translate into a stress response that might or might not be experienced as actual stress by the individual, also occur under real working conditions, particularly in noise-intensive industries, where patients showed heightened risk of gastric ulcer (McBride, 2010; Westman & Walters, 1981). A stress response, including increased blood pressure, acceleration of pulse rate, pupillary dilation, as well as reduction in salivary and gastric secretions and slowing of digestive processes, could be measured in patients under laboratory conditions after 25 minutes exposure to noise levels of 85 decibels (Westman & Walters, 1981). As a warning mechanism crucial to the survival of early man, our auditory system is on alert even when we sleep. A study conducted in Finland indicated that insomnia associated with night-time traffic noise occurs at levels from 50 decibels and above (Halonen et al., 2012). Other studies suggest that even noise levels at 45 dB and below can interfere with sleep patterns (Godlee, 1992). Summarising the various health effects of noise, Godlee (1992) writes:

> Noise damages hearing. Environmental noise probably contributes little to the overall risk of hearing loss, except where loud music is concerned. Low levels of noise in the environment can, however, damage health in the wider sense of wellbeing. Noise also contributes to the dehumanising effect of our increasingly urban society (p. 113).

One of the major challenges in dealing with noise pollution is the difficulty in defining what noise actually is. One person's music might, as we all know, well be another person's noise, and vice versa. The Oxford English Dictionary refers to 'noise' as an "unpleasant", "unwanted", or any "loud sound". In electronics and engineering, the term is also used to denote disturbances in signalling systems. We all know, however, that loud music, which would qualify as loud sound, can, under certain circumstances, also be experienced as pleasurable. Physically speaking, noise is sometimes defined by the absence of periodic vibrations, an understanding of noise as 'unmusical sound' which is still used in technical terms like 'white noise' or 'pink noise' (Schafer, 1994, p. 182). It is, however, important to note that even in the realm of music not all sounds are strictly musical in this narrow sense, as any music, to varying degrees, also includes sounds with non-periodic vibrations and no discernible pitch (see Figure 1).

In defining noise, law-makers have largely followed two opposed approaches, a qualitative and a quantitative one. Since the qualitative approach, defining noise as 'unpleasant' or 'unwanted' sound, is highly subjective – unpleasant for or unwanted by whom? –, in noise abatement legislations around the world, it is the quantitative approach that has gained greater acceptance. Many countries, however, still combine both a qualitative and a quantitative approach in their attempts to tackle the legal implications of noise pollution (Schafer, 1994, pp. 189-197). In Ghana, it is the Environmental Protection Agency (EPA) that, as per the EPA Act 490 of 1994, is mandated to prescribe standards and guidelines relating to environmental pollution, including noise. According to the Local Government Act 462, Section 296(7), of 1993, it is an offence, punishable by law, for noise to be made in any town. The EPA, following international standards, has adopted a quantitative approach to noise pollution, and set maximum permissible noise levels measured in decibel for variously defined urban areas (see Table 1).

In a number of studies conducted in Ghana, researchers have investigated ambient noise levels and their physical as well as psychosocial effects. A study carried out by Armah et al. (2010) investigated ambient noise levels emanating from religious activities in residential neighbourhoods in the Cape Coast metropolis. The results of this study show that most of the locations' recorded noise levels were above the maximum permissible limits set by the EPA and that the levels of noise exposure generally correlated with levels of annoyance of residents. Another study of ambient noise levels in the main commercial area of Cape Coast, Kotokuraba, showed that sound levels at all 10 measuring points exceeded the upper limits prescribed by the EPA by values of 1-15 dBA (Essadoh & Armah, 2011). In a similar study, the authors report that noise levels in halls of residence at University of Cape Coast, particularly in the mixed-gender halls, exceeded the permissible limits set by the EPA (Essandoh, Armah, Afrifa & Pappoe, 2011). And, finally, Omari, De-Veer and Amfo-Otu (2013) assessed the level of industrial noise and associated health effects on workers within the Tema Industrial Area. Their results indicate that more than half of the workers who participated in the study were suffering from occupational noise-induced hearing loss and reported difficulties to hear words clearly in normal conversations.

All of these studies point to the need for further investigations into the problematic of sound exposure and its associated health effects, to help direct the attention of people towards the dangers of loud music and noise. It is a common sight to see students these days with in-ear phones listening to music at high volume levels for many hours of the day, oblivious of the possible long-term consequences. As McBride (2010) opines, "exposure to music, both live through music systems and the use of personal stereos, may be hazardous for the few that listen for long periods at excessive levels" (p. 11). We need to remind ourselves that noise-induced hearing loss is irreversible, as the hair cells of the inner ear do not regenerate like, for instance, skin cells do.

Materials and Methods

Sample Group: The participants in this study were made up of 21 people purposively selected because of their involvement in musical activities that exposed them to amplified sound for many hours (M = 15 hrs.) weekly. Two groups of were involved: 1) Professional musicians who sang or played various musical instruments in a band and rehearsed for at least two hours daily and; 2) lay musicians who sang in a choir and rehearsed for about six hours a week accompanied by amplified synthesizers. The age range of the participants was between 20 and 54 with the majority (81%) falling within the range between 20 to 29 years. In all, there were four females and seventeen males who participated in the study. The number of years of participants' involvement in musical activities ranged from a minimum of 4 years to a maximum of 35 years (M = 15 years).

Materials: For the measurement of noise levels at live music events and during band rehearsals, a professional calibrated Sound Level Meter (SLM) with a measuring range of 40-130 dB and an accuracy of ±3.5 dB (at 1 kHz and 94 dB) was used. Measurements were taken at various distances from the sound sources and, in some cases, ambient noise levels were measured, using an A-weighted decibel scale (dBA). For the testing of air conduction thresholds of hearing of participants, sound files based on the ISO 389-7:2005 international standard using third octave band warble tones at frequencies ranging from 250 Hz to 8 kHz on an ascending loudness scale from -5 dBHL to 80 dBHL (hearing level) were used. ISO 389-7:2005 is recommended by the British Society of Audiology and does not rely on a particular type of headphone. In this study, we used professional closed studio headphones (AKG K-66) with a frequency range of 18 Hz to 20 kHz. The listening tests took place in a sound-proof recording studio and the sound equipment was calibrated at 1 kHz and 50 dB.

Methods: The analysis of the data of air conduction thresholds was based on the guidelines formulated by Coles, Lutman and Buffin (2000) for the diagnosis of noise-induced hearing loss for medicolegal purposes. In addition to hearing tests, data for this study was also acquired through the use of a structured questionnaire. The use of the questionnaire as a complementary instrument to the hearing test was informed by the results of other similar studies. McBride (2010) indicates that "the history of noise exposure is elicited by taking a careful occupational history, noting 'significant' noisy jobs, tasks undertaken doing jobs and noisy equipment used. From this the likely noise exposure levels experienced can be defined" (p. 9). The questionnaire helped us to gather information on the occupational and other relevant history of the participants. Besides basic biographical information, the questions on the questionnaire were meant to solicit information that would help in the interpretation of the emerging audiograms from the hearing tests. We were interested in how the participants evaluated their own sonic environment and whether they were aware of any possible auditory effects of regular exposure to amplified sound. The results of the questionnaire and the hearing tests were analysed using Microsoft Excel and Statistical Package for Social Sciences (SPSS) software. To complement both self-reported sound exposure length and intensity and the data analysed in the audiograms, measurements of noise levels were conducted at various programmes, live music events within Cape Coast and during band rehearsals.

Discussion of Results

Asked about the sounds that were experienced as most disturbing, respondents mentioned, in descending order, traffic and vehicular sounds (car horns, sirens, speed ramps), human voices (market women, jama groups, quarrelling), machines (generators, PA systems, speaker feedbacks, spinners, television), religious sounds (church bells, singing, clapping, mosque calls), music played by others (apart from spinners or in a religious event), as well as animal sounds (crickets, crowing cock). Among the sounds experienced as pleasant by participants were, first of all, music (self-selected and played at desired levels), and, second, natural sounds (birds, streams, sea waves, crying baby).

Below, we grouped these sounds variously experienced as disturbing or pleasant by the frequencies with which they were mentioned into five broader categories, namely traffic noise/machine sounds, music (amplified as well as non-amplified), human-made sounds, religious sounds, and sounds of nature (see figure 2). What we can see in the chart is that traffic noise and machine sounds, human-made noise, as well as religious sounds such as congregational worship, church bells, and calls for prayer were almost unanimously experienced as disturbing by our respondents. Nature and animal sounds, on the other hand, were predominantly experienced as pleasant. The category that was evaluated most ambivalently by participants was music, which was frequently mentioned as both disturbing and pleasant. Music was experienced as pleasant when it was self-selected and played at desired levels, which could be low as well as high. Music was perceived as disturbance by participants when the element of control over the sound source was lacking, i.e. when it was played by others at undesired levels, times and locations.

Apart from one person, all other respondents found problems with the sound levels they were exposed to at public events and places where amplified music was being played, such as social gatherings, in restaurants and bars, or in churches. With the exception of one person, again, who reported that the sounds could be either too high or too low, the major problem with sound reported by participants was that the levels were too high. Overall, 52% of the participants said they sometimes found problems with sound levels, and at least a third (33%) reported to have found problems with sound levels often (figure 3). Coping strategies with too high sound levels at public events were to either avoid such events altogether or, where this was not possible, to choose a sitting position away from or behind the speakers. Overall 86.4% of participants considered the sound level as a factor in choosing a place to spend time, generally indicating a preference for quieter places.

In connection with the perceived problems of sound levels, it is, however, interesting to note that, again, a major criterion in participants' evaluation was control over the sound source and the question whether exposure was self-determined or not. Thus, while most participants said they had a problem with sound levels at public events, the majority did not have a problem with sound levels during rehearsals or performances in which they were themselves involved, despite the fact that the actual levels that we measured were in both cases similar and the levels during rehearsals even exceeded those at public events (table 2).

As far as the status of hearing is concerned, ninety-five percent (95%) of the participants in this study said they had experienced tinnitus before, the majority (62%) more than once, 9% only once, and almost a quarter (24%) often (figure 4). Although participants were generally aware of the dangers of exposure to high sound levels, the majority (81.8%) never used ear protection kits and those who had tried ear protection before said that they had only used it briefly, but did not feel comfortable with it.

In relation to age, there was no statistically significant difference in the hearing thresholds of participants in this study (table 3).

When asked about their status of hearing, most participants (57%) indicated that they did not have difficulties to understand other people during a normal conversation. A third of the respondents (33%) said they sometimes experienced difficulties in hearing others during conversations, and 10% reported to have had such problems often (figure 5). Generally speaking, these percentages correspond with the results of the listening tests we conducted, where 57% had normal hearing, 24% showed signs of mild noise-induced hearing loss, and 19% moderate noise-induced hearing loss (figure 6). In two cases participants who showed signs of mild or moderate hearing loss reported to not have had problems of hearing during conversations, and in one case, a participant with a normal audiogram reported to sometimes have experienced difficulties in hearing during conversations. The perceived status of hearing does, therefore, not necessarily coincide with one's actual status of hearing.

While the audiograms of the majority of participants (57%) were within the normal range, at least 19% of these still showed at least slightly raised hearing levels (values of 20 dBHL) at 4 kHz (figure 7). Audiograms with a typical peak around 4 kHz ("noise notch") are usually interpreted as an indication of mild noise-induced hearing loss at hearing levels between 25-35 dBHL and of moderate noise-induced hearing loss for values of 40-55 dBHL (figure 8), which was the case for 24% and 19% of participants respectively.

Among the participants of the study we had one case where the audiogram turned out to be particularly irregular, with a mild to moderate asymmetrical hearing loss that only affected the right ear. Strangely enough, the participant perceived all sounds during the listening test with the left ear, even those that were played on the right side (figure 9). The results of this audiogram indicate a blockage of the right ear that might have been caused by the penetration with a cotton swab or ear bud. This could have led to a congestion of the outer ear and the hearing loss might therefore only be temporary, not due to a damage of the middle or inner ear. In any case, we advised the person to see an ear specialist.

According to studies examining the auditory effects of occupational noise (e.g. McBride, 2010: Omari et al., 2013), exposure to sound levels of 85 dbA and above over prolonged periods of time can cause noise-induced hearing loss. Our data clearly indicates that the status of hearing of professional as well as lay musicians who were regularly exposed to high levels of amplified sound – on an average 15 hours per week at levels often reaching 90-100 dbA – had been negatively affected. Overall, 43% of the participants showed indication of irreversible noise-induced hearing loss at mild or moderate levels. Given the fact that the effects of noise exposure are cumulative and, thus, increase over time, an additional 19% of participants showed signs of beginning noise-induced hearing loss with hearing thresholds of 20 dBHL at 4 kHz and can therefore be considered a high risk group. This adds up to a total of 62% of participants whose hearing had been negatively and irreversibly affected by noise exposure, which is particularly worrisome when one considers the overall relatively young average age of participants.

Conclusion and Recommendations

To conclude, the results of this study clearly show that both professional and lay musicians are a high risk group in terms of potential hearing loss. While study participants were aware of the potentially harmful effects of exposure to loud music, this knowledge did generally not result in behavioural changes that would, in the long run, prevent damage to the ears. Since hearing loss is a rather slow, gradual and cumulative process, professional and lay musicians seem to underestimate the negative effects of exposure to loud music. A problem with this might be unconcern or carelessness as well as the lack of availability of professional ear protection kits, which need to meet certain requirements to be viable for musicians, such as an undistorted frequency range while reducing the overall sound level.

To aid public awareness campaigns, we recommend that further studies of this nature be conducted that include larger sample groups. We also recommend that future studies should include the testing of bone conduction thresholds to get more precise data on people's status of hearing. Awareness campaigns about noise as a health risk need to be designed for specific target groups, as exposure and behaviour towards sound differs, depending on the occupation and leisure preferences of people. The status of hearing should regularly be tested in schools and parents and pupils be educated about the health effects of noise and sound exposure, so that potential threats can be detected at an early age and protective measures be taken. With regard to noise pollution more generally, a more rigorous and proactive role of law enforcement agencies is certainly in order. However, beyond law-enforcement there is, at the same time, the need to work towards a more fundamental change of the sonic culture and people's perception and behaviour towards sound in Ghana, so that in the mid- to long-term we will be able to create a healthier sonic environment for everybody.

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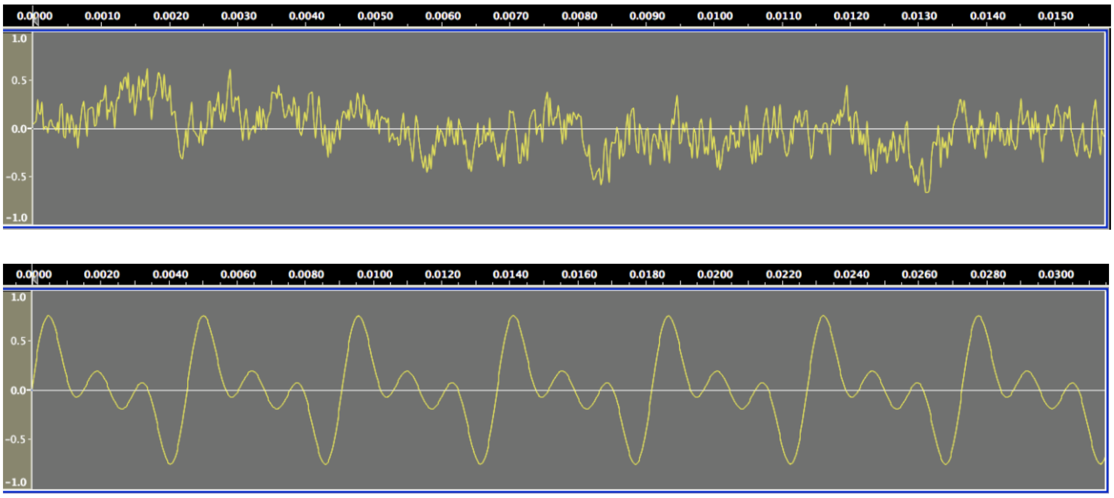

Figure 1: 'Pink noise' showing typical non-periodic vibrations (top) as compared to a sound with discernable pitch and periodic vibrations (bottom)

Table 1: Ambient Noise Level Guidelines of the EPA, Ghana

Zone	Description of Area of Noise Reception	Permissible Noise Level in dBA	
		0600 - 2200 hrs	2200 - 0600 hrs
A	Residential areas with negligible or infrequent transportation	55	48
B1	Educational (school) and health (hospital) facilities	55	50
B2	Area with some commercial or light industry	60	55
C1	Area with some light industry, place of entertainment or public assembly and place of worship such as churches and mosques	65	60
C2	Predominantly commercial areas	75	65
D	Light industrial areas	70	60
E	Predominantly heavy industrial areas	70	70

Source: Environmental Protection Agency, 2008

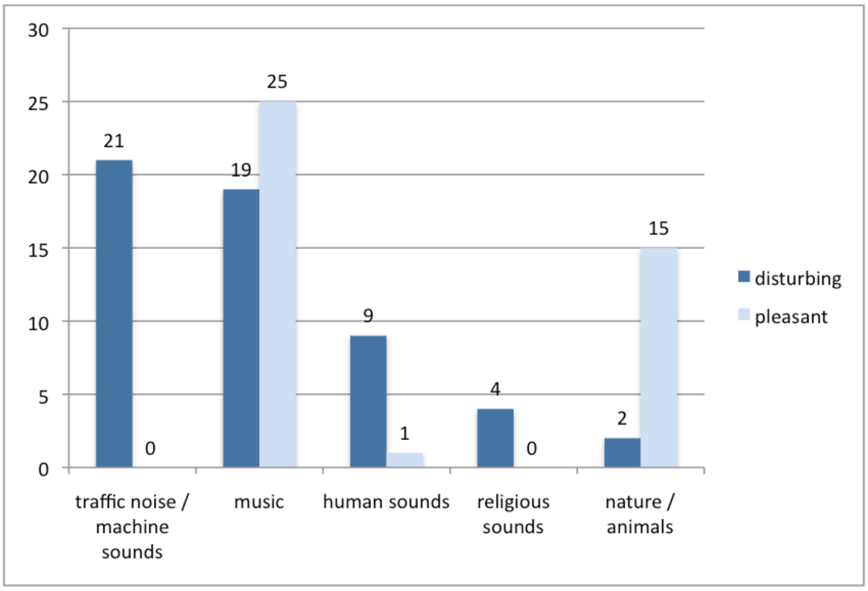

Figure 2: Perception of sounds as disturbing or pleasant

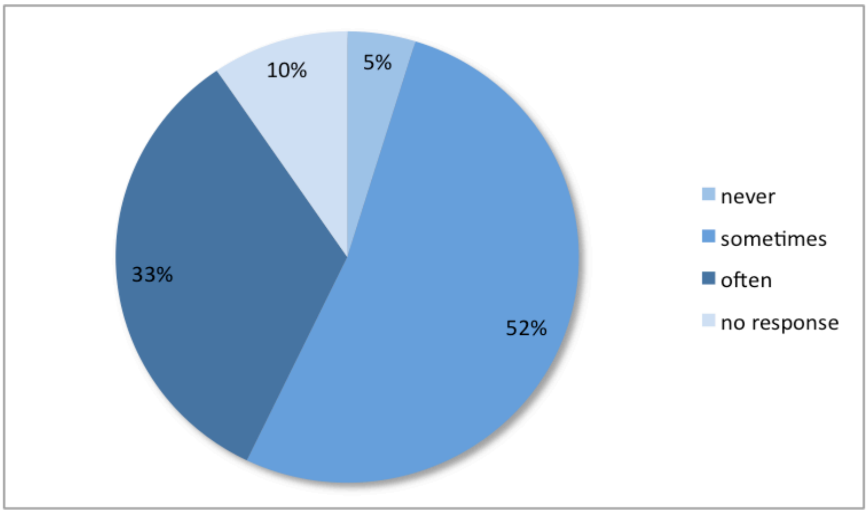

Figure 3: Perceived problems with sound levels at public events

Table 2: Sound Levels of Music Measured at Various Events in Cape Coast

Description of Event		measured sound levels		
		distance	range	average
Live band playing outdoors (Faculty of Arts, UCC, end-of-year party)		5 m	94-103 dBA	100 dBA
		10 m	92-99 dBA	95 dBA
		25 m	88-98 dBA	92 dBA
Live band playing Friday night at Goil Filling Station	around 8 p.m.	15 m	82-92 dBA	87 dBA
	around 9 p.m.	15 m	88-96 dBA	93 dBA
	around 10 p.m.	15 m	89-97 dBA	95 dBA
Congregational singing accompanied by keyboard during 31st-night service		ambient	72-93 dBA	87 dBA
10-member band rehearsal, indoors (medium sized room)		ambient	95-105 dBA	100 dBA
Music played at outdoor sports program, Ankaful prisons park		150 m	54-65 dBA	59 dBA
		50 m	51-76 dBA	71 dBA
		10 m	72-100 dBA	91 dBA

Source: Field Survey (2013-14)

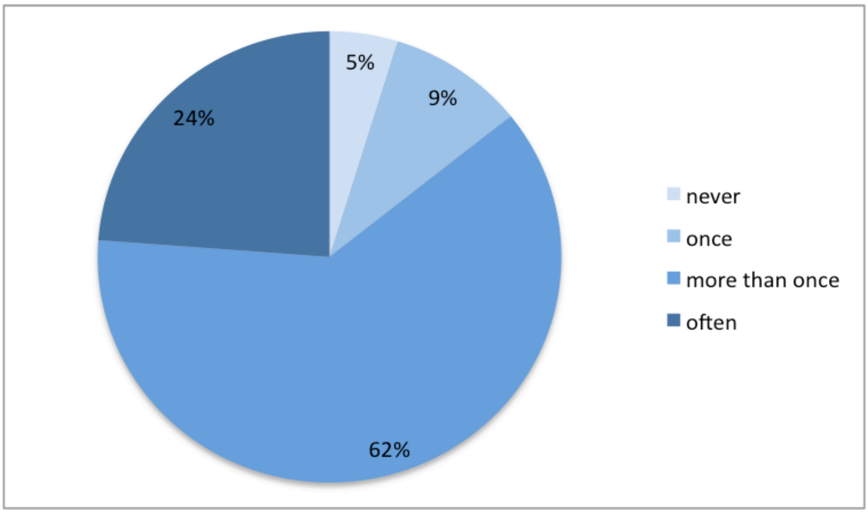

Figure 4: Experience of tinnitus

Table 3: ANOVA of hearing threshold of participants in relation to age

		Sum of Squares	df	Mean Square	F	Sig.
Left ear at 250 Hz	Between Groups	8.097	5	1.619	1.687	.195
	Within Groups	15.357	16	.960		
	Total	23.455	21			
Left ear at 500 Hz	Between Groups	5.116	5	1.023	.902	.504
	Within Groups	18.157	16	1.135		
	Total	23.273	21			
Left ear at 1000 Hz	Between Groups	13.034	5	2.607	3.459	.026
	Within Groups	12.057	16	.754		
	Total	25.091	21			
Left ear at 2000 Hz	Between Groups	11.100	5	2.220	.618	.688
	Within Groups	57.490	16	3.593		
	Total	68.591	21			
Left ear at 4000 Hz	Between Groups	29.139	5	5.828	.970	.465
	Within Groups	96.133	16	6.008		
	Total	125.273	21			
Left ear at 8000 Hz	Between Groups	22.116	5	4.423	1.226	.342
	Within Groups	57.748	16	3.609		
	Total	79.864	21			
Right ear at 250 Hz	Between Groups	8.207	5	1.641	1.155	.373
	Within Groups	22.748	16	1.422		
	Total	30.955	21			
Right ear at 500 Hz	Between Groups	13.311	5	2.662	2.669	.061
	Within Groups	15.962	16	.998		
	Total	29.273	21			
Right ear at 1000 Hz	Between Groups	13.534	5	2.707	1.153	.374
	Within Groups	37.557	16	2.347		
	Total	51.091	21			
Right ear at 2000 Hz	Between Groups	8.462	5	1.692	.419	.829
	Within Groups	64.629	16	4.039		
	Total	73.091	21			
Right ear at 4000 Hz	Between Groups	43.071	5	8.614	2.214	.104
	Within Groups	62.248	16	3.890		

	Total	105.318	21			
Right ear at 8000 Hz	Between Groups	37.802	5	7.560	3.178	.035
	Within Groups	38.062	16	2.379		
	Total	75.864	21			

Source: Field Survey (2013-14)

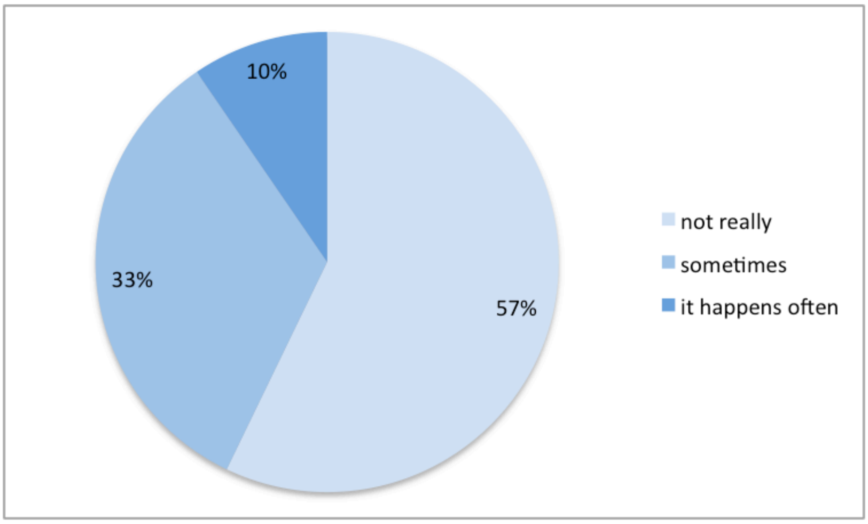

Figure 5: Self-reported difficulties in hearing during conversations

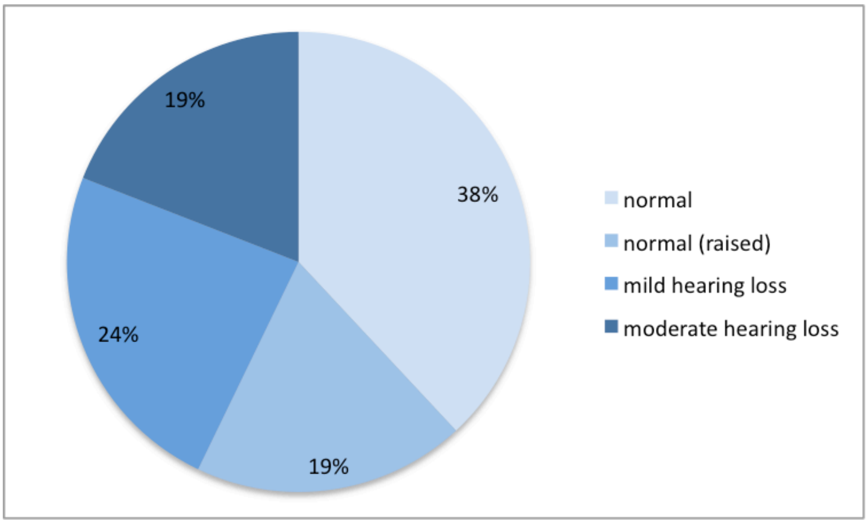

Figure 6: Status of hearing based on listening test

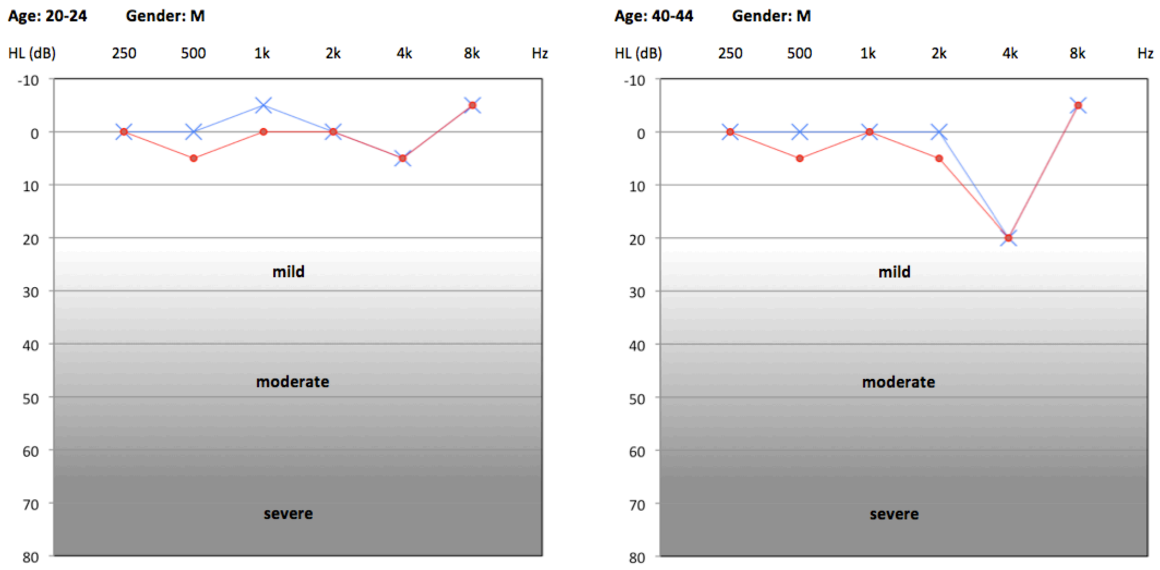

Figure 7: Audiograms indicating normal hearing (right: 4 kHz slightly raised to 20 dBHL) (red = right ear / blue = left ear)

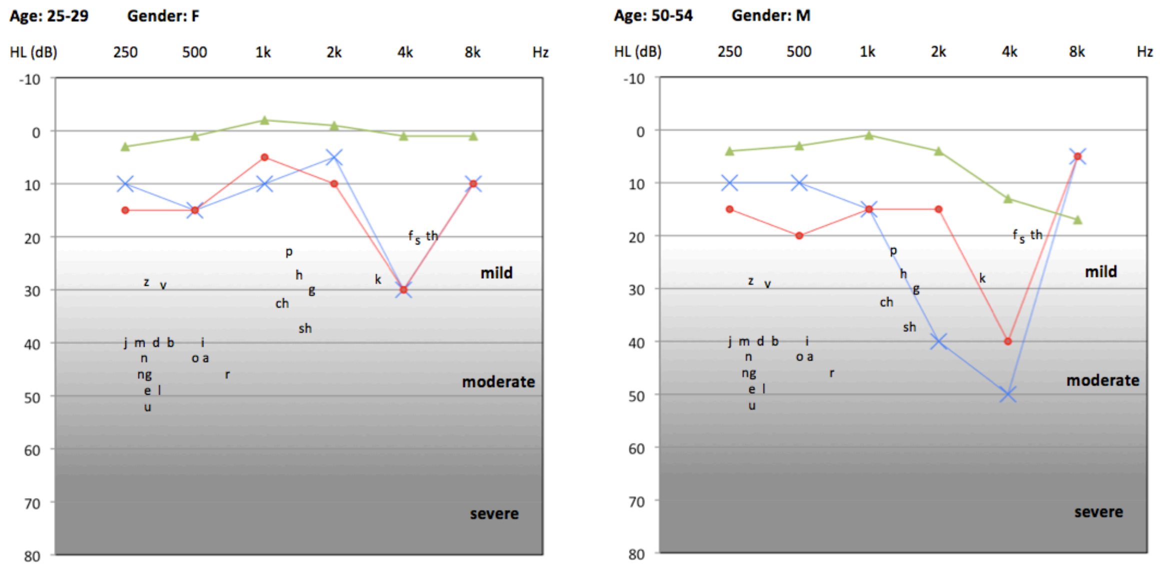

Figure 8: Typical audiograms indicating mild (left) and moderate (right) noise-induced hearing loss, including levels and frequencies of speech sounds

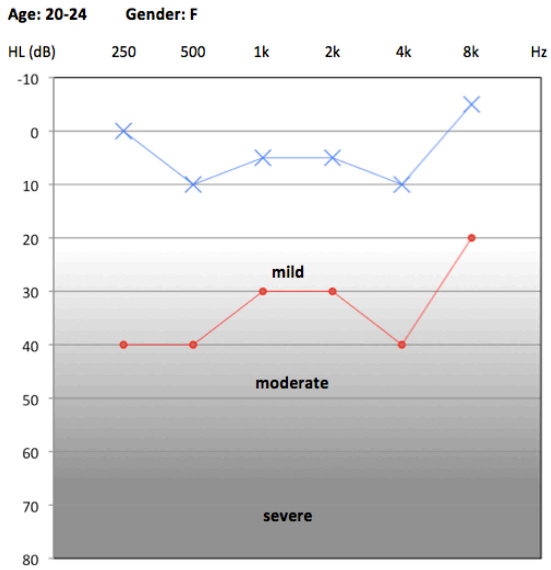

Figure 9: Asymmetrical mild to moderate hearing loss of the right ear