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# Prevalence of Noise-Induced Hearing Loss Related to the Mills in the Markets of the Municipality of Parakou in 2021

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## Abstract

**Introduction**: Noise is the second leading cause of hearing loss in adults after presbycusis. The objective of this work was to study hearing loss induced by the noise of mills in the markets of Parakou. **Methods**: This was a descriptive and analytical cross-sectional study, conducted from February 3 to June 3, 2021 in the markets of Parakou. It concerned millers and sellers located within a 5 meter radius around the mills and among whom pure-tone audiometry was performed to detect a hearing loss. Subjects with no particular medical health history, under 55 years of age and having been working in these markets since more than 12 months, were included. **Results**: In this study, 103 subjects were selected, including 43 millers and 61 sellers. Their average age was 29 ± 13 years. The sex ratio was 0.49. The average length of service in the profession was 8 years with the extremes of 3 months and 47 years. They were exposed to noise on average 10 hours per day and 6 days a week. The average duration of weekly noise exposure was 23 h 28 min ± 13 h 32 min with the extremes of 5 h 00 min and 52 h 30 min. The average level of noise exposure was 90 dB with the extremes of 72 and 110 dB. 24 subjects reported symptoms related to noise such as headache, tinnitus, and hearing loss, with respective proportions of 22.33%, 20.39% and 06.80%. The prevalence of noise-related hearing loss was 26.21% (n = 27/103). Subjects with a notch at 4000 Hz and normal Average Hearing Loss (AHL) (20.39%) had a seven-time greater risk of developing noise-induced hearing loss (OR = 6.58; 95% CI [2.54 - 18.8], p < 0.001). The predictive factors for noise-induced hearing loss were the length of service beyond 10 years; (OR ≥ 3.89; 95% CI

[1.11 - 14.1], p < 0.03) and the duration of weekly noise exposure beyond 21 hours (OR ≥ 2.83; 95% CI [1.04 - 24.5], p < 0.047). **Conclusion:** Hearing loss related to the noise of mills affected both millers and sellers near the mills in markets, hence the importance of regulating mills.

## Keywords

Noise-Induced Hearing Loss, Mills, Markets, Parakou

## 1. Introduction

Noise-induced hearing loss is an irreversible sensorineural hearing loss associated with exposure to high levels of excessive noise. Preventive measures are not well established in developing countries. According to the World Health Organization (WHO) in 2017, 5% of the world's population suffers from disabling hearing loss and almost 90% of people with hearing loss live in low- and middle-income countries [1]. Globally, noise is the second leading cause of hearing loss in adults after presbycusis and is responsible for 16% of disabling hearing loss [2] [3]. Noise-induced hearing loss ranks 4th among the most common occupational diseases. It causes irreversible cochlear damage, following prolonged exposure to high levels of noise. It is characterized by bilateral, symmetrical, sometimes asymmetrical and pure sensorineural hearing loss [4].

Regulations require to maintain noise exposure among workers at a level compatible with the protection of their hearing. It sets two limits for daily noise exposure: the alert level which is 85 dB (A) and the dangerous level which is 87 dB (A). From these levels, preventive measures against hearing loss must be taken. According to the 4th edition of the SUMER survey, there would be an obvious increase in the exposure of employees to occasional or regular noise pollution, going from 7% of employees in 2003 to 31.6% in 2017 [5] [6]. In Benin, Hinson *et al.* in 2017, during a study relating to the evaluation of noise pollution among workers in a steel production company, reported that 30% of workers exposed to noise pollution greater than 85 dB (A) had a hearing anomaly [7].

In developing countries like ours, the informal sector is very developed and escapes any regulation. This is the case of the mills, a significant source of noise pollution in our cities and mainly in the markets. In Parakou, mills of markets are grouped in the same areas. This potentiates their harmful effect on the hearing of millers, but also of sellers permanently located near the mills. The scarcity of work on noise pollution in Benin and the absence of published data on noise-induced hearing loss due to the mills in Parakou, justify the interest of the present study, which aims to study the hearing damage caused by the noise of the mills in the markets of the municipality of Parakou in 2021.

## 2. Methods

This was a descriptive cross-sectional study. The target population consisted of

millers located in the markets of the municipality of Parakou, as well as sellers located within a 5 meter radius around the mills and exposed to the noise. The study was conducted from February 3 to June 3, 2021. An exhaustive recruitment of respondents was carried out.

People meeting the following criteria were included in our study:

- Millers located in one of the five markets selected for the study in Parakou, or a permanent worker located within a 5 meter radius around the mills;
- People being exposed to the noise induced by crushing mills in the markets of Parakou since at least 12 months;
- Participants who gave their informed consent.

People meeting the following criteria were not included:

- An otological disease (acute or chronic otitis, etc.) or an otological malformation;
- A personal or family history of hearing loss;
- A duration of ototoxic medication intake under a month;
- An age over 50 years;
- Regular noisy leisure activities.

The dependent variable was noise-induced hearing loss. All of the following are considered noise-induced hearing loss:

- Bilateral and symmetric sensorineural hearing loss;
- Or bilateral and asymmetric sensorineural hearing loss, when the difference in average hearing loss between the two ears was greater than or equal to 10 dB (considering that the ear closest to the mill will be more affected than the other ear) [4].

The independent variables were:

- Socio-demographic characteristics: age, sex, ethnicity, religion, marital status, level of education;
- Socio-professional characteristics: profession, length of service, use of hearing protection devices (PPE), knowledge of the effects of noise on hearing, level of noise exposure among millers and sellers, duration of weekly exposure to noise;
- Clinical characteristics: symptoms, otoscopic signs of the eardrum;
- Audiometric characteristics: type of hearing loss (symmetry, laterality and degree of the hearing loss).

**Average hearing loss (AHL)**: quantitative variable obtained by calculation using the following formula [8]:

$$\mathrm{AHL} = \frac{(2\times 500\ \mathrm{Hz}) + (4\times 1000\ \mathrm{Hz}) + (3\times 2000\ \mathrm{Hz}) + (1\times 4000\ \mathrm{Hz})}{10}.$$

The data was collected from millers and sellers in the selected markets of Parakou. The collection was carried out using a pre-established survey form, then audiometry tests were performed. The questionnaire was tested and the research protocol was validated by the local ethics and research committee of the University of Parakou (0436/CLERB-UP/P/SP/R/SA). All audiograms were interpreted

by the ENT specialists of the department.

The collection tools and examination materials are made of:

- A survey form with an audiogram sheet;
- A sound level meter (SNDWAY-Sonometer SW-524): it is a digital decibel meter, measuring noises of 30 - 130 dB and equipped with a LCD + SD display and a memory card;
- An otoscope;
- A pure tone audiometer (KAMPLEX AD 27) with equipment meeting the following characteristics: manual operation, dynamic range from 0 to 90 decibels on frequencies in steps of 5 dB, continuous sound, noise-cancelling headphones. The frequencies explored are: 125 - 250 - 500 - 1000 - 2000 - 4000 - 8000 Hertz.

The data collected with a questionnaire were entered using EPI-Info software (version 7.0.2). Comparisons were made using the chi2 test or Fisher's exact test when the conditions for performing the chi2 test were not met. For quantitative ones, the means with their standard deviation, medians, minima and maxima have been described. Comparisons were made with the Student t-test. In order to determine the explanatory factors of noise-induced hearing loss, we used a logistic regression. The estimation of the Odds ratio allowed us to identify the determinants of noise-induced hearing loss. The significance level was 5% and the confidence intervals were 95%.

## 3. Results

The average age of the workers was 29 ± 13 years. Among the 103 millers and sellers surveyed, 34 (33%) were male and 69 (67%) female, *i.e.* a sex ratio of 0.49. Married subjects represented 55.34% of respondents. 52.43% of subjects had attended primary school. The average length of service was 08 years with the extremes of 1 year and 47 years. There was no significant difference between the seniority of millers and that of sellers ($p = 0.07$). Forty-five subjects (43.69%) knew that noise can be a source of hearing loss, while 58 subjects (56.31%) knew nothing about it. Two subjects (1.94%) owned noise-cancelling headphones but did not wear them regularly.

The respondents had noise exposure levels varying from 72 to 110 dB (A), with 42.72% of subjects exposed to more than 90 dB (A) of noise. The average noise exposure of all respondents was 90 dB (A). Millers had an average noise exposure level of 101.19 dB (A) with the extremes of 75 and 110 dB (A), while sellers had an average noise exposure level of 82.39 dB (A) with the extremes of 72 and 105 dB (A). The subjects exposed to noise worked on average 10 hours per day and 6 days a week. The average duration of weekly noise exposure was 23 h 28 min ± 13 h 32 min with the extremes of 5 h 00 min and 52 h 30 min. The duration of weekly noise exposure of sellers was significantly greater than that of millers ($p = 0.01$). **Figure 1** below, shows the distribution of millers and sellers according to the duration of weekly exposure to noise.

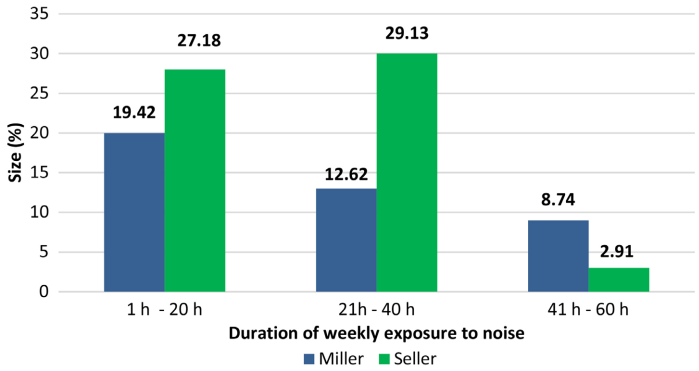


**Figure 1.** Distribution of millers and sellers exposed to the noise of the mills in markets, according to the duration of weekly noise exposure, Parakou, 2021. (p-value = 0.01)

Among the 103 subjects, 24 (23.30%) reported noise-related symptoms, namely: headache (22.33%), tinnitus (20.39%) and hearing loss (6.80%). The otoscopic examination was normal in 91 subjects (88.35%). In 12 subjects (11.65%) there was earwax impaction. Audiometry was performed in the latter after removal of the impacted earwax.

Among the 103 subjects, 64 had no hearing loss on pure-tone audiometry:

- Unilateral hearing loss was observed in 12 subjects (11.65%), including one mixed and 11 sensorineural cases;
- Bilateral sensorineural hearing loss was observed in 27 subjects (26.21%), including 20 symmetrical and 7 asymmetrical. The prevalence of noise-induced hearing loss was 26.21%. On the right ear, the average hearing loss ranged from 5 to 44.5 dB. The average hearing loss was 26.8 dB ± 6.86 dB for all cases of hearing impairment observed. On the left side, the average hearing loss ranged from 5 to 74.5 dB. The average hearing loss was 33.36 dB ± 15.64 dB for all cases of hearing impairment observed. Furthermore, the degrees of noise-induced hearing loss varied from mild to severe (first degree). The mild degree was the most represented, with a proportion of 88.89% of mild bilateral hearing loss.

Among the subjects with noise-induced hearing loss, 62.96% had a length of service greater than 10 years. There is no significant association with the occurrence of noise-related hearing loss in subjects under 10 years of seniority. Table 1 below is an illustration.

Subjects with a length of service varying from 10 to 20 years had 04 times the risk of developing noise-induced hearing loss, compared to those with less than 10 years of seniority. Likewise, subjects with more than 20 years of seniority also had 04 times more risk of developing noise-induced hearing loss, compared to those with less than 10 years of seniority. The noise exposure levels of the respondents were not significantly related to noise-induced hearing loss ($p = 0.458$). Furthermore, the noise exposure levels of millers were significantly higher than those of sellers ($p = 2.2e{-}16$).

Table 2 below, shows the distribution of respondents with noise-induced hearing loss according to the duration and level of noise exposure.

**Table 1.** Distribution of subjects with hearing loss related to the noise of the mills in markets according to the length of service, Parakou, 2021.

| | Noise-induced hearing loss | OR | 95% CI | p-value |
|---|---|---|---|---|
| | **n = 27** | | | |
| 0 - 10 years | 10 | 1 | - | - |
| 10 - 20 years | 11 | 3.89 | 1.39 - 11.1 | **0.01** |
| >20 years | 6 | 3.98 | 1.11 - 14.1 | **0.03** |

**Table 2.** Distribution of millers and sellers with hearing loss related to the noise of the mills in markets, according to the duration and level of noise exposure, Parakou, 2021.

| | Noise-induced hearing loss | OR | 95% CI | p-value |
|---|---|---|---|---|
| | **n = 27** | | | |
| Average duration of exposure per week | | | | |
| 1 h - 20 h | 7 | 1 | - | - |
| 21 h - 40 h | 14 | 2.83 | 1.04 - 8.28 | **0.047** |
| 41 h - 60 h | 6 | 5.86 | 1.47 - 24.5 | **0.012** |
| Level of noise exposure | | | | |
| 71 - 90 dB (A) | 15 | 1 | - | - |
| >90 dB (A) | 12 | 1.1 | 0.45 - 2.66 | **0.8** |

Respondents exposed to noise between 21 hours and 40 hours per week, had approximately 3 times the risk of developing noise-induced hearing loss, compared to those with less than 20 hours of weekly exposure. Those exposed to noise for more than 40 hours per week were 6 times more likely to develop noise-induced hearing loss, compared to those who had less than 20 hours of weekly exposure.

## 4. Discussion

The participation of women in Beninese industry and professions that involve the use of machines, is very low according to Hinson *et al.* [7] in 2017 (96% of men). The same observation was made in millers by Kitcher *et al.* [9] who reported 99% of men among the millers in the markets of Accra in 2014. Folorunso *et al.* [10] also reported 56.1% of men among pepper grinders in Abuja in 2018. This study corroborates these data with 64.29% of men among millers in the markets of Parakou in 2021.

In the present study, the population was relatively young and the mean age was 29 ± 13 years. This could be explained by the fact that in Africa, the population is predominantly young. This result was similar to those of Folorunso *et al.* [10] in Nigeria in 2018 (30.5 years) and Kitcher *et al.* [9] in Ghana in 2014 (33.1

years ± 0.2 years). However, Olusanya *et al.* [11] in Nigeria in 2012, found a higher average age of 40.2 years ± 13.8 years.

More than half of the respondents (56.31%) were unaware of the harmful effects of noise on hearing and the use of hearing protection devices was almost non-existent (1.94%). Folorunso *et al.* [10], reported that no miller in the markets of Abuja wore personal protective equipment (PPE) and only two out of 66 millers were aware of the dangers of noise pollution on hearing. On the other hand, Kanji *et al.* [12] in 2019, in their study on South African miners' knowledge of noise-induced hearing loss, reported that the majority of participants (97%), acknowledged working in a noisy environment and were aware of the consequences of this exposure on their hearing. However, less than half of participants reported consistent use of PPE. This was the same observation according to Wouters *et al.* [13] in 2020.

The noise exposure levels related to the mills were above recommended limits in the markets of Parakou in 2021. The average noise exposure was 90 dB and 42.72% of respondents were exposed to more than 90 dB of noise. Data from the literature on noise levels in the mills of markets point in the same direction. Thus, Kitcher *et al.* [9] had recorded levels of noise ranging from 85.9 to 110.8 dB, induced by the mills in the markets of Accra. Olusanya *et al.* [11] in 2012, also reported higher noise levels, varying from 92.5 to 111 dB induced by the mills in the markets of Lagos.

In this study, subjects exposed to the noise of the mills in markets had spent an average of 08 years as a miller, or as a seller near the mills. There was no significant difference between the seniority of the millers and that of the sellers ($p = 0.07$). This shows that they were permanent workers. Olusanya [11] and Kitcher [9] found similar results with an average of 9.3 years and 10.78 years ± 1.84 years of seniority, respectively. Like the authors mentioned above, we therefore reported a significant association between the length of service and noise-induced hearing loss in subjects with a seniority between 10 and 20 years ($p = 0.01$; OR = 3.89; 95% CI [1.39 - 11.1]) and those with more than 20 years of seniority ($p = 0.03$; OR = 3.98; 95% CI [1.11 - 14.1]).

In this series, millers and sellers worked on average 10 hours per day and 6 days a week. This was similar to the duration of work among millers in Abuja. They worked on average 10.7 hours per day and 7 days a week [10]; while the millers in Lagos worked even longer, namely 13.3 hours per day and 7 days a week [11]. Furthermore, we also found a significant association between the duration of noise exposure and noise-induced hearing loss. The respondents had an average duration of weekly noise exposure of 23 h 28 min ± 13 h 32 min, while Wouters *et al.* [13] in Nigeria, reported among the workers of a brewery in Lagos, an average duration of weekly noise exposure greater than ours (51 h ± 15 h 57 min). It therefore appears that the subjects exposed to the noise of the mills in the markets of Parakou were mainly full-time workers, working for more than 8 hours in a noisy environment affecting their hearing.

According to Folorunso [10] and Kitcher [9], 18.2% and 37.6% of millers had tinnitus in Abuja and Accra, respectively; while 09.1% and 23.76% of these millers had a hearing loss in Abuja and Accra, respectively. Olusanya [11] stated that the following symptoms had a positive predictive value (66.7%) for noise-induced hearing loss: tinnitus; difficulty listening to television, radio, or talking on the telephone; difficulty speaking or hearing just after leaving the noisy area. Zaw [14] listed the following complaints: tinnitus (11.1%); headaches (08%) and hearing loss (7.1%). He also demonstrated that tinnitus was related to the presence of noise-induced hearing loss (OR = 2.88; 95% CI [1.13 - 7.37]).

In this study, only 24 subjects out of 103 (23.30%) had noise-related symptoms, namely: headaches (22.33%), tinnitus (20.39%), and hearing loss (6.80%). We did not find a significant link between noise-induced hearing loss and the presence of symptoms ($p = 0.87$). Hearing loss related to the noise of mills had therefore an insidious onset among the millers and sellers in the markets of Parakou. A study to determine the degree of noise-induced hearing loss at which one would begin to feel symptoms would be an excellent complement to this work.

The prevalence of noise-induced hearing loss in the markets of Parakou was estimated at 26.21%. This was similar to that of Kitcher *et al.* [9] in Ghana in 2014 (24.80%). There was no significant association between noise-induced hearing loss and occupation ($p = 0.7$). This allowed us to conclude that sellers located within a 5 meter radius around the mills were as affected by the noise of the mills as the millers. This can be explained by the fact that the sellers were exposed to noise for a longer time during their working time ($p = 0.01$), while the millers were exposed to higher noise levels than those of the sellers ($p < 0.05$). All this balanced the impact of noise on their hearing.

In the literature, we noted a great variability in the prevalence of noise-induced hearing loss, which may be due to the fact that:

- The duration and level of noise exposure due to the mills in markets varied from one study to another, as did the selection criteria and conditions for the performance of audiometry tests (presence of soundproof cabin, times between the performance of audiometry and the departure from the noisy environment);
- The definition of noise-induced hearing loss was not the same: some authors such as Folorunso [10], Kitcher [9] and Olusanya [11] had considered the hearing loss of the better ear. In this study, we considered bilateral symmetric or asymmetric sensorineural hearing loss, as suggested in the new recommendations [5].

The absence of audiometry tests at the start of this profession is a limitation in this study.

Like Folorunso [10], our study showed that the degrees of noise-induced hearing loss varied from mild to severe (first degree). The mild degree was the most represented, with a proportion of 88.89% of mild bilateral hearing loss. Similar results were found by Olusanya [11] with 85.88% of mild hearing loss on

the right ear and 68.93% on the left side. Kitcher [9] also found 95.65% of mild bilateral hearing loss. On the other hand, Folorunso [10] reported that the moderate degree was the most represented in his study (46.88%). We did not find a significant link between the degree of noise-induced hearing loss and occupation in this study (Fisher's exact test = 0.808). This allowed us to conclude that the noise of mills affected with the same intensity both millers and sellers located near the mills.

## 5. Conclusion

Noise-induced hearing loss due to the mills in the markets of Parakou in 2021 is a reality and affects a quarter of nearby millers and sellers. Pure-tone audiometry was the best means of early detection. The predictive factors for noise-induced hearing loss were the length of service and the duration of weekly noise exposure greater than 10 years and 21 hours, respectively. The absence of preventive measures and the ignorance of the subjects surveyed about the dangers of regular exposure to high noise levels were remarkable. It is therefore important that all stakeholders involved in this informal sector participate in effective prevention of noise-induced hearing loss.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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