# Descriptive study on the prevalence of Presbycusis among a population in the industrial belt of Barcelona by exploring a random sample of Primary Healthcare Center users

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Objective. To describe the state of hearing health in people over 64 years of age, autonomous, and residents of a town in the industrial belt of Barcelona, with an emphasis on data about the prevalence of Presbycusis. Participants. We started with a randomized sample of 139 people over 64 years of age, with no hearing problems diagnosed, resulting in 82 being the number of subjects being explored, with a mean age of 72.2 years. Method. We registered the most important sociodemographic data of the sample and their state of health. Subsequently, a hearing examination took place, and a neuropsychological test was performed using the MMSE. Results. It stands out that 54.87% (27 men and 18 women) of the people explored had hearing loss in both ears. Of this percentage, 32.92% corresponded to mild hearing loss and 21.95% to moderate hearing loss. A statistically significant relationship was observed between the presence of hearing problems and cognitive impairment; although this relationship was not very conclusive [(*t*=-2.33); *p*<.05]. Conclusion. Given the high prevalence of undiagnosed hearing loss in the elderly population and the importance of its early detection, the study reveals the need to promote hearing health measures and, specifically, to facilitate the detection of these problems in the Primary Healthcare Centres themselves.

Keywords: Hearing loss, Presbycusis, prevalence, Epidemiology, ageing.

Estudio descriptivo de la prevalencia de la presbiacusia en una población del cinturón industrial de Barcelona. Objetivo. Describir el estado de salud auditiva en personas mayores de 64 años autónomas y residentes en un municipio del cinturón industrial de Barcelona, destacando los datos sobre la prevalencia de la Presbiacusia. Participantes. Iniciamos el estudio con una muestra aleatoria de 139 personas mayores de 64 años, sin problemas de audición previamente diagnosticados, resultando en 82 el número de sujetos explorados, con una edad promedio de 72.2 años. Método. Se registraron los datos sociodemográficos más importantes de la muestra y su estado de salud. Posteriormente, se realizó un examen de audición y se realizó una prueba neuropsicológica utilizando el MMSE. Resultados. Destaca que el 54.87% (27 hombres y 18 mujeres) de las personas exploradas tenían pérdida auditiva en ambos oídos. De este porcentaje, el 32.92% correspondió a pérdida auditiva leve y el 21.95% a pérdida auditiva moderada. Se observó una relación estadísticamente significativa entre la presencia de problemas de audición y el deterioro cognitivo; aunque esta relación no fue muy concluyente [(t=-2.33); p<.05]. Conclusión. Dada la alta prevalencia de la pérdida de audición no diagnosticada en la población anciana y la importancia de su detección temprana, el estudio revela la necesidad de promover medidas de salud auditiva y, específicamente, facilitar la detección de estos problemas en los propios Centros de Atención Primaria.

Palabras clave: Pérdida de la audición, Presbiacusia, prevalencia, Epidemiología, envejecimiento.

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Presbycusis is a complex, under-diagnosed disease with a multifactorial etiology. It is the most frequent sensory impairment in the elderly, and can have detrimental effects on their quality of life and psychological well-being (Arlinger, 2003; López-Torres, Boix, Téllez, López del Campo, & Escobar, 2009; Yueh, Collins, Souza, Boyko, Loovis, Heagerty et al., 2010; Valero-García, Bruna, & Signo, 2012; Wilson, Tucci, Merson, & O'Donoghue, 2017). According to WHO sources, in 2011, hearing impairment was among the 6 disorders contributing to the global burden of disease. In 2012, the WHO reiterated, even more forcefully, the concern that hearing loss has a significant influence on maladaptive and pathological ageing (WHO, 2012). Finally, hearing loss in ageing has been ranked as the fifth leading cause of years lived with disability in the Global Burden of Disease Study 2015 (2016), higher than many other chronic diseases such as diabetes, dementia, and chronic obstructive pulmonary disease.

The most immediate consequence affects speech understanding, but the affected level of social participation can also be seen. For many authors, this leads to a significant tendency to depression and the decline in self-esteem (López-Torres et al., 2009) which can also be associated with some degree of dementia (Gurgel, Ward, Schwartz, Norton, Forter, & Tschanz, 2014; Lin, Metter, O'Brien, Resnick, Zonderman, & Ferrucci, 2011; Sung, Li, Blake, Betz, & Lin, 2016; Thomson, Auduong, Miller, & Gurgel, 2017). Some studies show how, depending on the severity of the hearing loss, the affected people tend to be two, three and up to five times more likely to suffer from cognitive impairment than others of a similar age but without deafness or a hearing loss corrected by auditory prosthesis and speech therapy (Amieva, Ouvrard, Giulioli, Meillon, Rullier, & Dartigues, 2015; Lin, Yaffe, Xia, Qian-Le, Harris, Purchase-Helzner, & Simonsick, 2013).

The prevalence of Presbycusis is highly variable but, according to various studies, it is supported that, in the developed countries, the percentage of people aged 65 to 75 years with hearing loss greater than 30 dB HL ranges between 15 and 25%, and between 27 and 44% in people older than 75 (Algaba & Altuna, 2013; Niklaus, Hanebuth, & Probst, 2011; Zhang, Gomaa, & Ho, 2013). It is estimated that, between 80-90 years, this percentage increases to 45% and 55%, respectively (Roth, 2015).

The economic costs of Presbycusis are quite significant, with a direct impact on patients and indirect on public administrations. According to Barberán and Sarriá (2013) in Spain only 25% of the population with Presbycusis usually engage in some type of treatment, with an estimation of 410 million euros of annual cost being devoted to their treatment in the year 2021. There are no studies, however, on the socio-healthcare costs that derive indirectly from the neglect of hearing problems in older people.

At the initial stages, this loss is very discreet and is so slow and gradual that, sometimes, people who suffer from it are not aware of their hearing impairment. This slow development, together with the lack of epidemiological studies on Presbycusis in terms of its distribution and prevalence among the population, is one of the main reasons for this problem of health and human communication not to be sufficiently explained in policies, plans, and intervention programs in public health.

Among the main risk factors with a direct influence on Presbycusis, the following variables stand out: age, genetic predisposition, being male, cardiovascular diseases, particularly hypertension, and different exogenous factors such as smoking, chronic exposure to noise, and low levels of education (Ortega & Duque, 2013; Montero, López-Giménez, Acevedo, & Mora, 2015).

In this study, a paradigmatic population from a metropolitan industrial belt was selected. This type of population is often characterized by presenting the following risk factors: medium/low socio-cultural level and high presence of environmental risk factors, both in the already completed working life as in the environment in which they live.

### **Objective**

The aim of this study was to know the prevalence of Presbycusis among a population from the industrial belt of Barcelona.

#### METHOD

A prospective and descriptive study was carried out. It was approved by the Committee of Ethics and Research of Ramon Llull University, Barcelona, and by the Ethics Committee and Clinical Research of IDIAP Jordi Gol by the Conselleria de Sanitat (P15/146).

## **Participants**

An evaluation was conducted on a total of 86 people older than 64, who complied with the requirements of health, cognition, and autonomy required for the study and were assigned to the Primary Healthcare Center in the town of La Llagosta (Barcelona). With a population over 64 of 2.441 people, an exclusion criteria was applied to those of Spanish nationality who had insufficient capacity to provide their voluntary cooperation in the study, with an essential condition being that they had to have the ability to autonomously attend the Center. In the same way, people who had had a stroke, traumatic brain injury in a period of less than 6 months; people with neurological effects or with multiple Sclerosis; people with serious disorders of personality or Schizophrenia; people with cognitive impairment (GDS $\geq$ 3), hearing loss>70dBHTL in both ears (n=343); patients with Alzheimer's or Parkinson's disease, with a history of otological pathology or hearing aid users were also excluded. From the resulting sample (n=1.685), during the period from September to December 2016, 139 susceptible subjects were contacted by phone to participate in the research, after having been randomly chosen among the

population of study. Of these, 18 refused to participate in the study; 6 were interested but the agreed day for the exploration was not presented and 27 were not located. Subsequently, those who agreed to participate in the study were informed about the type of study, the different tests, and the possible benefits of the research. Finally, their voluntary participation was requested in writing through the corresponding informed consent form.

Of the 88 people evaluated, 6 were dismissed due to unilateral hearing loss or significant tubal problems. Thus, the sample was made up of 82 people, 42 men and 40 women, with the mean age for the entire sample being 72.2 years (SD=4.71; range: 65-87) 30.4% had schooling equal to or less than 8 years (not completed Primary education) 57.3% had completed 9-10 years of schooling (Primary education) and 12.2%, over 10 years of education (average and/or higher studies).

## Procedure

People who participated in the study were first interviewed about their sociodemographic data (age, gender, status, years of schooling, and usual language of communication). Then, the hearing and cognition tests were administered in the Primary Healthcare Center.

Hearing evaluation: An otoscopy was performed in each ear, in order to rule out possible problems in the ear canal. Then a preliminary pure tone audiometry was conducted to establish the hearing threshold by using the ascending method. The instrument used was a portable audiometer OTOPod version 2.2.1(B), with TDH39 earphones. As a sound stimulus, pure tones were used and the tested frequency range was between 250 Hz-8 kHz.

Cognitive assessment: A cognitive exploration was carried out using the Mini-Mental State Examination (MMSE), correcting the scores obtained with the adjustment criteria by Blesa, Pujol, Aguilar, Santacruz, Bertran-Serra, et al. (2001) depending on the subject's level of studies and age. The cut-off point to determine when mild cognitive impairment was observed was set at 24 points, (Escribano-Aparicio, Pérez-Dively, García-García, Pérez-Martín, Romero, Ferrer et al., 1999; Peña-Casanova, Gramunt, & Gich, 2004).

## Statistical analysis

Using the statistical package IBM SPSS Statistics, version 24.0, a descriptive statistical analysis and significance of differences was performed to summarize the characteristics of the population, using means and standard deviation in the continuous variables and percentages in the qualitative ones. For the comparison tests of categorical variables,  $\chi^2$  was used. For the calculations of relationships between continuous variables, Pearson's *r* was used, and, for the comparison of two means, Student's *t* was used assuming

the normality of the data, given the number of subjects in each of the subgroups (n>30). The level of statistical significance was established from 0.05.

## RESULTS

## Characteristics of the sample

Of the 82 subjects examined via otoscopy and PTA, 89.4% presented a normal otoscopy, with earwax being the main problem detected. On the other hand, results showed that 45 people -54.87% of the total sample (27 men and 18 women, with an average age of 73.18 and 74.38 years, respectively)- presented hearing loss in both ears; and 37 people-45.1% -, with an average age of 70.4 years, presented normalized hearing. The criteria of the Bureau International d'Audiophonologie -BIAP- (1997) were adopted to calculate hearing loss and, to determine the type of hearing loss, the criteria of the ASHA (Clark, 1981) were used, considering the presence of hearing loss from 25dB HL. Hearing was categorized as follows:  $\leq$ 25 dB, hearing within the normality parameters; 26-39 dB, mild hearing loss; and 40-69 dB, moderate hearing loss (WHO, 2012).

	Group without MiHL group		MoHL group	TOTAL	
variable	HL (n=37)	HL (n=37) (n=27) (n=18)		IOTAL	
	70.4±3.6	73.3 ±4.1	74.1±6.2	72.20±4.7	
Mean Age±SD (range) years	(65-81)	(66-84)	(65-87)	(65-87)	
Gender					
-Female (n, %)	22(59.4)	10(37.1)	8(44.5)	40(48.7%)	
-Male (n, %)	15(40.6)	17(62.9)	10(55.5)	42(51.3%)	
Linguistic situation:					
-Monolingual (n,%)	8(27.4)	14(51.8)	6(33.4)	28(34.1%)	
-Bilingual (n,%)	29(78.3)	13(48.2)	12(66.6)	54(65.9%)	
Educational level					
8 of schooling, (n, %)	12(32.4)	7(25.9)	6(33.4)	25(30.4%)	
-10 of schooling, (n, %)	18(48.6)	17(62.9)	12(66.6)	47(57.3%)	
10 of schooling, (n, %)	7(19.0)	3(11.2)	0(0)	10(12.2%)	
Prior occupation					
-Administrator/Trade (n, %)	7(18.9)	4 (14.8)	2(11.1)	13(15.7%)	
-Liberal Professional (n, %)	1(2.7)	0	1(5.5)	2(2.5%)	
-Workshop Operator/Worker (n, %)	9(24.3)	12(44.4)	8(44.4)	29(35.7%)	
-Household chores, other (n, %)	20(54.0)	11(40.8)	7(38.9)	38(46.1%)	
Diagnosed comorbidities*					
-Diabetes mellitus (n, %)	7(18.9)	10(37.1)	10(55.5)	27(32.9%)	
-Heart disease (n, %)	5(13.5)	4(14.8)	4(22.2)	14(17.0%)	
-High blood pressure (n, %)	21(56.7)	17(62.9)	12(66.6)	50(60.9%)	
-Dyslipidemia (n, %)	23(62.1)	22(81.4)	13(72.2)	58(70.7%)	
-Other (n, %)	7(18.9)	5(18.5)	6(33.4)	18(21.9%)	
-Smoking					
-Never (n, %)	28(75.6)	14(51.8)	7(38.8)	49(59.8%)	
-In the past (n, %)	7(19.0)	12(44.4)	10(55.5)	29(35.4%)	
-Usually (n, %)	2(5.4)	1(3.7)	1(5.5)	4(4.8%)	
MMSER	28(SD=1.9)	27.5(SD=1.6)	27.3(SD=2.3)	27.9(SD=2.0)	

Table 1. Main demographic data of the sample

Note. HL, hearing loss; MiHL, mild hearing loss; MoHL, moderate hearing loss; *SD*, standard deviation; MMSER, Mini-Mental State Examination revised. \* The percentages calculated for this dimension are not cumulative. Of the 45 people with hearing problems, 27 people had mild hearing loss (MiHL) and 18 moderate hearing loss (MoHL). Table 1 shows the socio-demographic characteristics of the sample according to the group.

Out of the 45 people with hearing loss 9% had a non-symmetric hearing loss in both ears, thus failing to comply with one of the principles highlighted by the BIAP (1997) for Presbycusis, in the sense that the difference between both ears cannot be higher than 20dB HL; while the remaining 91% did meet this requirement. In this sense, we can affirm that, of the total valid sample (N=82), 41 people (50%), 24 men (mean age of 73.65 years) and 17 women (mean age of 74.70 years), presented Presbycusis.

Comparing the means obtained in the group without hearing problems and the group with hearing problems for the variables age, gender, linguistic situation, and educational level by using Student's T, there were statistically significant differences only for age (t=3.30; p<.001), in the logical sense that, the older the subject, the greater the hearing loss.

### **Comorbidities**

Practically all the people in the sample presented some of the registered comorbidities. In table 1, the percentages found can be observed, being of note that, as the hearing loss increases, the percentage of people who have some disease also increases. Nevertheless, the most common conditions were metabolic problems (77.7%), compared to 62.1% for those who did not have hearing problems; arterial hypertension (64.4%), compared to 56.7%; and diabetes Mellitus (44.4%), compared to 18.9%. However, only diabetes mellitus appears as a disease whose distribution among the population with hearing problems studied is significantly higher than for the population without hearing problems ( $\chi^2$ =6.602; *p*<.05). For the rest of the registered diseases, the relationship turns out to be statistically non-significant [heart disease ( $\chi^2$ =1.861; *p*=.39); hypertension ( $\chi^2$ =2.927; *p*=.23); and dyslipidemia ( $\chi^2$ =2.021; *p*=.36)].

In relation to tobacco, the distribution observed was statistically significant in the sense that, among the population without hearing problems, people who have never smoked (75.6%) predominate compared to smokers in the past ( $\chi^2$ =6.667; *p*<.05). Similarly, among people with Presbycusis, those who smoked in the past stand out (75.8%) ( $\chi^2$ =10.474; *p*<.01). In this sense, there seems to be some relationship between the habit of smoking and the subsequent appearance of Presbycusis.

## Sensitive hearing

Individuals presenting Presbycusis in the hearing screening test (n=41) obtained an average 39.51dBHL (SD=11.2dB) for the hearing threshold of the right ear and 39.54dBHL for the left ear (SD=10.8dB). In table 2, the mean hearing thresholds for each screened frequency for each ear are presented, considering the subjects' gender.

			Men RE						
250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	6 kHz	8 kHz			
20.0dB	22.4dB	22.3dB	27.7dB	51.9dB	61.0dB	67.4dB			
Men LE									
250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	6 kHz	8 kHz			
19.5dB	22.5dB	23.6dB	32.9dB	53.6dB	68.0dB	69.8DB			
Women RE									
250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	6 kHz	8 kHz			
22.5dB	23.1dB	23.6dB	27.1dB	36.9dB	51.0dB	57.4dB			
Women LE									
250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	6 kHz	8 kHz			
21.5dB	23.3dB	22.5dB	27.0dB	37.9dB	53.4dB	56.0dB			

Table 2. Mean hearing results for the total sample, according to frequency, ear and gender

Note. RE, right ear; LE, left ear; Hz, Hertz; dB, decibel.

So much for men as for women, hearing sensitivity declines as the screened frequency increases. It is globally observed that, both in men and women, the threshold with hearing loss higher than 25dBHL appears from the 2KHz frequency, in both ears, with the exception that for men from 4KHz the hearing loss is somewhat more marked.

## Relationship between hearing and cognitive examination

Once the MMSE was administered, and the scores obtained were corrected based on the age and level of studies (MMSER), results show that, of the 82 people examined, only 6 (7.3%) have a score equal to or greater than 24 points, which is considered the limit from which the existence of mild cognitive impairment can be suspected (Escribano-Aparicio et al., 1999; Peña-Casanova et al., 2004). Figure 1 shows the distribution of the results according to hearing situation.



The MMSER average score for the 45 subjects in the sample with hearing loss was 27.47 (SD=1.94), whereas it was 28.49 (SD=1.99) for the 37 subjects without hearing loss according to the pure tone audiometry (PTA). The comparison of these average scores highlights the existence of a statistically significant difference between the two groups (t=-2.33; p<0.05), in the sense that, as the hearing loss increases, MMSER scores are lower. In this respect, an ANOVA between both groups was performed, which gave slightly different scores in the cognitive examination conducted in these two groups that make up the independent variable, and the DMS test shows that the differences are statistically significant (F=5.442; p<.05). However, if the groups with present hearing loss (between 25-39dB and <39dB) are subdivided, the resulting ANOVA indicates that the scores are statistically equivalent (F=2.721; p=.73). These data reinforce the idea that, despite observing a relationship between hearing and cognition in the subjects, this does not seem to be very robust, possibly due to the wide dispersion of MMSER scores obtained by people with greater hearing loss.

## DISCUSSION AND CONCLUSION

The prevalence of hearing loss (threshold higher than 25dB in the best ear) in the population over 64 who complied with the requirements of health, cognition, and autonomy required for the study and were assigned to the Primary Healthcare Center in the town of La Llagosta was 54.87%. To this percentage, we should exclude those people who, despite presenting hearing loss, do not comply with one of the fundamental characteristics of Presbycusis: the difference between both ears must be less than 20dB. In this case, the percentage is reduced to 50%, a figure that is higher than that in other studies conducted in Western countries, especially if we consider that the average age of our subjects does not exceed 75 years. Thus, Niklaus, Hanebuth and Probst (2011) in an exhaustive literature review on studies conducted in European Union countries, cite a percentage that can range between 18% and 25% for the 65-75 age group.

Zhang, Gomaa, & Ho (2013) agree with these data and estimate the prevalence of Presbycusis in people over 80 years old at 50%. Finally, Spiby (2014) carries out another exhaustive review of more recent works published in English and reaches the conclusion that, although the prevalence of hearing loss depends on the criteria used in its definition, for people under 75, it would range from 27% to 31.6%; and 46% for those over this age. All this would highlight the uniqueness and vulnerability of the population explored, in our opinion, extrapolated to many other populations with similar characteristics: medium/low sociocultural level, work history with high exposure to noise. This data could present a certain bias, since a large number of people randomly selected did not agree to the exploration. It could happen that the people who agreed to participate in the study thought that they did have hearing problems.

Regarding the epidemiological profile of the sample, it should be noted that no statistically significant differences were observed between the group of people without hearing problems and those with Presbycusis in the categorical variables of gender, linguistic situation, educational level, and most diagnosed diseases. We can only conclude that, regarding diabetes mellitus, the distribution among the different groups is not uniform, in the sense that there is a certain relationship between Presbycusis and the fact of suffering from this disease (Table 1). With greater power, there still appears a certain tendency for people who in the past were smokers to present Presbycusis. However, we must highlight the idea that, since it is not the objective of this study to analyze the relationship between these variables, the number of cigarettes that were habitually consumed was not controlled, for example. On the other hand, following such authors as Ortega & Duque (2013) despite the fact that the data point to a certain comorbidity between hearing loss and other types of health problems quite common in older people (Hypertension, Diabetes Mellitus, Heart disease, Dyslipidemia...), the size of the sample does not allow us to reach sufficiently valid results as to establish cause-effect relationships. Surely, when the population with greater hearing loss coincides with the elderly population, we should be prudent and consider that the relationship between hearing and some health problems is also conditioned by the variable age of the subjects.

In table 2, we also observe how hearing loss is usually very common in higher frequencies (greater than or equal to 4KHz), both for people with Presbycusis and for those who maintain hearing within normal parameters. This coincides with other studies with similar characteristics (Parham, McKinnon, Eibling, & Gates, 2011). The difference between both populations is fundamentally that, for the population affected by Presbycusis, the registered loss starts from the 1KHz frequency. The immediate consequence of this type of hearing loss would be the difficulty to perceive the medium and high acoustic features of words with sufficient clarity; however, they do not usually have problems perceiving these words in a more generic way. This would explain the fact that, despite having a remarkable hearing loss, many people in the sample were not sufficiently aware of the problem.

On the other hand, with regard to the cognitive examination, results show that, although there is a certain relationship between hearing and cognition, it is statistically insignificant. The large dispersion of scores obtained in the group of people with greater hearing loss (MoHL) and the reduced size of this sample (18 subjects) possibly conditions the results of the statistical tests carried out. Surely, another factor that helps these data to be not as significant as other studies indicate is the fact that the average age of the population studied is not excessively high (72.2 years) in comparison with other studies of similar characteristics (Gurgel et al., 2014; Lin et al., 2011; Sung et al., 2016; Thomson et al., 2017). This fact suggests that, in the face of the hearing problems that a significant part of the studied sample presents, they still maintain the resource of mental

substitution to "understand" the oral language of their interlocutor, especially when communicative exchanges take place in slightly noisy environments. For this reason, the awareness of the hearing problem is still scarce.

It is necessary to define Presbycusis as a public health problem in Spain, which makes it necessary to promote, execute, and evaluate epidemiological research with results that contribute to defining policies and their consequent standards and programs of hearing health for the benefit of all citizens. We consider it important that simple screening tests can be carried out to allow greater control of this problem periodically and the early initiation its rehabilitation.

The prevalence of Presbycusis found in the studied sample of 82 people, with an average age of 72.2 years, was 50%. This figure is higher than that reported by specialized literature, which usually ranges from 18% to 31%, according to studies, for people under 75 years of age. This is probably due to the special characteristics of this population with high comorbidity, compared to those diseases or habits reported by literature as frequently associated with hearing problems in older people.

#### Acknowledgments

We have to thank the professionals of the CAP of La Llagosta for their collaboration in the collection of the data that made this study possible. We also thank the people who participated in the study for their contribution and especially Dra. Angels Valero and Dra. M. Alicia Burgos for the help provided.

## Financing

The present investigation has not received any specific scholarship from agencies of the public, commercial, or non-profit sectors.

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Received: 11<sup>st</sup> July 2018 Reception modifications: 20<sup>th</sup> July 2018 Accepted: 24<sup>th</sup> July 2018