# Impacto de la capacitación del uso correcto del protector auditivo tipo tapón desechable en la atenuación sonora.

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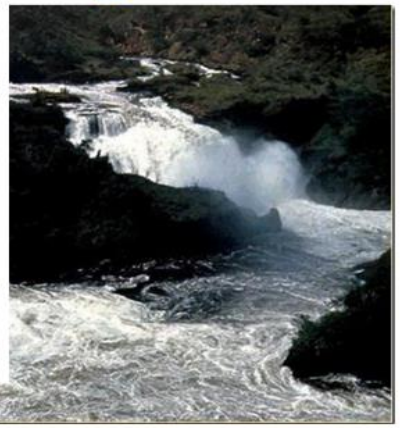
# Agenda

- **Antecedentes Históricos**
- Impacto de la HSNR
- Contexto en materia de Protección Auditiva
- Impacto capacitación uso correcto en la atenuación sonora
- Capacitación vs Control del Riesgo de HSNL
- Conclusiones

GSH 27
BOSCH

Plinio el Viejo
23 – 79 d.C



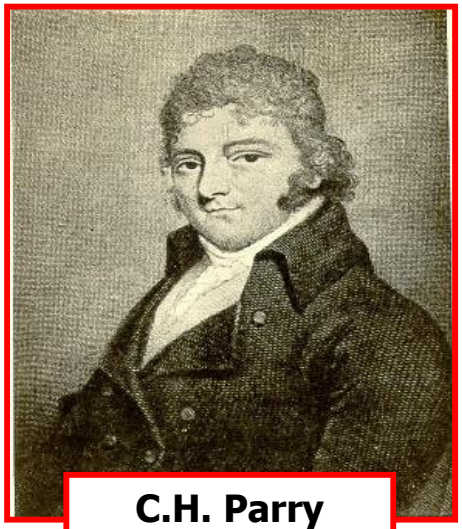
**Plinio el Viejo, naturalista y escritor romano, en su Historia Natural describió la sordera de los pobladores próximos a las cascadas del río Nilo (23-79 DC).**

**Ruido = Sordera**

B. Ramazinne
1633 - 1714

**La primera cita de sordera, como concepto de enfermedad laboral, se encuentra en la obra clásica sobre enfermedades profesionales de Ramazzine (1700), considerado el fundador de la medicina del trabajo.**

**Caleb Parry, médico, describe casos de pérdida parcial o total de la audición de forma temporal o permanente ocasionados por el ruido (1825).**

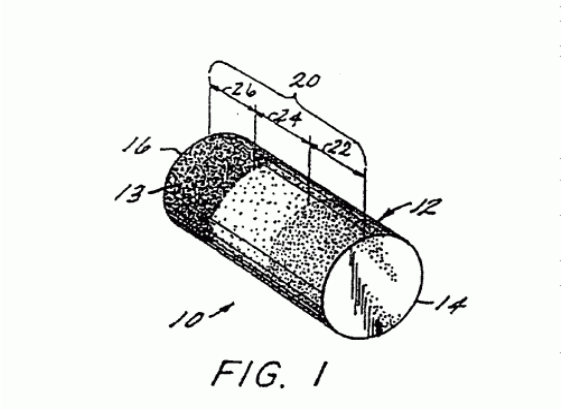


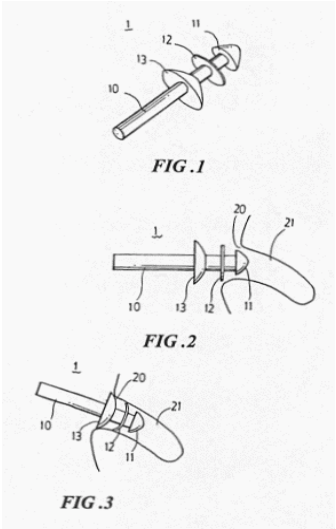
C.H. Parry
1755 - 1822

**Exposición Ruido = Pérdida Auditiva**

# Antecedentes históricos

- **Antes de la Segunda Guerra Mundial, Vern Knudsen estaba trabajando en un dispositivo "defensor de la oreja " , que consistía en un tubo de goma insertado en el conducto auditivo externo y un conector de metal exterior ; el que reducía la sonoridad en una décima**
- **Durante la Segunda Guerra Mundial, los investigadores de Harvard desarrollaron cojines auriculares como los de orejeras acústicas que sellan el sonido.**
- **Ross Gardner (1972) patentó el tapón de espuma , y creció rápidamente en popularidad.**



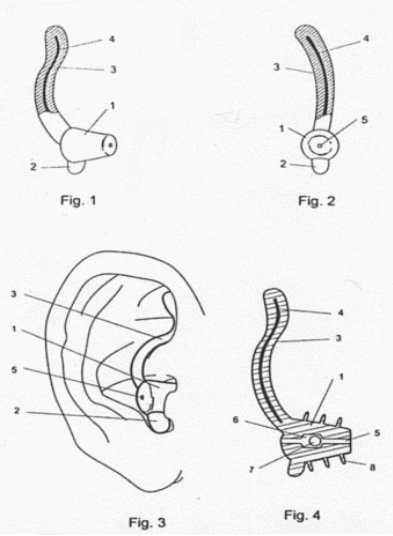



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**TABLE III.** Estimated Prevalence of Hearing Loss by Time Period and Industry Sector, 1981–2010, for 1,816,812 Workers

| | Period 1 1981–1985 | | Period 2 1986–1990 | | Period 3 1991–1995 | | Period 4 1996–2000 | | Period 5 2001–2005 | | Period 6 2006–2010 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Industry Sector (NAICS 2007 Code)** | **(%)** | **95% CI[a]** | **(%)** | **95% CI** | **(%)** | **95% CI** | **(%)** | **95% CI** | **(%)** | **95% CI** | **(%)** | **95% CI** |
| All industries | 19.80 | 19.48–20.12 | 19.66 | 19.46–19.86 | 18.71 | 18.57–18.85 | 17.96 | 17.86–18.06 | 19.15 | 19.07–19.23 | 19.37 | 19.29–19.45 |
| Agriculture, Forestry, Fishing, and Hunting (11) | 32.64 | 30.19–35.09 | 29.89 | 28.07–31.71 | 27.34 | 25.94–28.74 | 16.44 | 15.75–17.13 | 13.25 | 12.59–13.91 | 14.18 | 13.52–14.84 |
| Mining, Quarrying, and Oil and Gas Extraction (21) | ISS[b] | | ISS | | 24.04 | 19.48–28.60 | 26.78 | 24.38–29.18 | 26.98 | 25.28–28.68 | 25.22 | 23.73–26.72 |
| Construction (23) | 27.59 | 24.89–30.29 | 26.17 | 24.45–27.89 | 21.07 | 20.03–22.11 | 22.07 | 21.30–22.84 | 24.46 | 23.86–25.06 | 24.67 | 24.13–25.21 |
| Manufacturing (31–33) | 19.34 | 18.98–19.70 | 19.93 | 19.70–20.16 | 19.55 | 19.39–19.71 | 18.79 | 18.67–18.91 | 20.18 | 20.08–20.28 | 20.40 | 20.30–20.50 |
| Wholesale and Retail Trade (42, 44–45) | 20.21 | 18.91–21.51 | 20.56 | 19.71–21.41 | 19.88 | 19.27–20.49 | 19.20 | 18.76–19.64 | 19.65 | 19.34–19.96 | 20.06 | 19.77–20.35 |
| Transportation, Warehousing, and Utilities (48, 49, 22) | 17.63 | 16.36–18.90 | 12.79 | 12.22–13.36 | 10.25 | 9.92–10.58 | 11.13 | 10.88–11.38 | 11.83 | 11.63–12.04 | 11.65 | 11.46–11.84 |
| Healthcare and Social Assistance (62) | ISS | | 11.86 | 8.94–14.78 | 16.82 | 14.45–19.19 | 18.94 | 17.13–20.76 | 19.13 | 18.13–20.13 | 18.47 | 17.46–19.48 |
| Services (51–56, 61, 71–72, 81, 92) | 20.24 | 19.09–21.39 | 21.02 | 20.29–21.76 | 19.66 | 19.16–20.16 | 17.91 | 17.56–18.26 | 19.03 | 18.76–19.31 | 19.60 | 19.34–19.86 |

[a]CI = 95% confidence interval.
[b]ISS = insufficient sample size.

**Fuente: Masterson y col. AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 58:392–401 (2015)**

**TABLE IV.** Estimated Incidence of Hearing Loss by Time Period and Industry Sector, 1986–2010, for 560,320 Workers

| | Period 2 1986–1990 | | Period 3 1991–1995 | | Period 4 1996–2000 | | Period 5 2001–2005 | | Period 6 2006–2010 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Industry Sector (NAICS 2007 Code)** | **(%)** | **95% CI[a]** | **(%)** | **95% CI** | **(%)** | **95% CI** | **(%)** | **95% CI** | **(%)** | **95% CI** |
| All industries | 8.82 | 8.53–9.11 | 7.86 | 7.69–8.03 | 7.47 | 7.35–7.60 | 7.80 | 7.69–7.91 | 6.64 | 6.56–6.72 |
| Agriculture, Forestry, Fishing, and Hunting (11) | 11.20 | 8.98–13.42 | 12.81 | 11.04–14.58 | 8.17 | 6.90–9.44 | 5.84 | 4.84–6.84 | 5.73 | 4.89–6.57 |
| Mining, Quarrying, and Oil and Gas Extraction (21) | ISS[b] | | ISS | | ISS | | 7.88 | 5.41–10.35 | 8.02 | 6.41–9.63 |
| Construction (23) | 12.38 | 9.76–15.00 | 8.62 | 7.21–10.03 | 7.38 | 6.38–8.39 | 9.70 | 8.85–10.56 | 9.17 | 8.50–9.84 |
| Manufacturing (31–33) | 8.69 | 8.37–9.01 | 7.98 | 7.78–8.18 | 7.70 | 7.55–7.85 | 8.06 | 7.93–8.19 | 6.83 | 6.73–6.93 |
| Wholesale and Retail Trade (42, 44–45) | 9.35 | 8.17–10.53 | 7.07 | 6.37–7.77 | 7.75 | 7.20–8.31 | 7.91 | 7.46–8.36 | 6.73 | 6.42–7.04 |
| Transportation, Warehousing, and Utilities (48, 49, 22) | 8.99 | 7.84–10.14 | 5.58 | 5.05–6.11 | 5.09 | 4.75–5.43 | 5.86 | 5.56–6.16 | 4.77 | 4.56–4.98 |
| Healthcare and Social Assistance (62) | ISS | | ISS | | 5.73 | 3.51–7.96 | 9.05 | 6.93–11.17 | 7.26 | 5.88–8.65 |
| Services (51–56, 61, 71–72, 81, 92) | 8.18 | 7.06–9.30 | 8.58 | 7.94–9.22 | 7.70 | 7.24–8.16 | 7.45 | 7.09–7.81 | 6.85 | 6.58–7.13 |

[a]CI = 95% confidence interval
[b]ISS = insufficient sample size

**Fuente: Masterson y col. AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 58:392–401 (2015)**

**TABLE I.** Prevalence (%) of Hazardous Workplace Noise Exposure Among Current Workers by Selected Characteristics—NHANES Subjects Aged 16 or Older, United States, 1999–2004 (n = 9,275)

| Characteristic | No. in sample | Population estimate[a] (%) | No. of workers exposed in sample[b] | Estimated no. of exposed workers[c] | Estimated prevalence[d] (SE) |
|---|---|---|---|---|---|
| Total | 9,275 | 130.3 (100.0) | 1,462 | 22.4 | 17.2 (0.7) |
| Gender | | | | | |
| Male | 5,003 | 71.2 (54.6) | 1,161 | 18.5 | 26.3 (1.0) |
| Female | 4,272 | 59.1 (45.4) | 301 | 3.9 | 6.7 (0.6) |
| Race/ethnicity | | | | | |
| Non-Hispanic white | 4,219 | 91.8 (70.5) | 713 | 16.8 | 18.3 (0.8) |
| Mexican American and other Hispanic | 2,786 | 18.2 (13.9) | 468 | 3.0 | 16.7 (1.1) |
| Non-Hispanic black | 1,899 | 13.8 (10.6) | 238 | 1.8 | 12.7 (0.9) |
| Other race including multiracial | 371 | 6.5 (5.0) | 43 | 0.8 | 12.6 (2.3) |
| Age (years) | | | | | |
| 16–24 | 2,439 | 21.1 (16.2) | 325 | 3.2 | 15.0 (1.2) |
| 25–34 | 1,883 | 29.8 (22.9) | 314 | 5.4 | 18.1 (1.1) |
| 35–44 | 1,874 | 33.4 (25.6) | 361 | 6.6 | 19.7 (1.1) |
| 45–54 | 1,624 | 29.2 (22.4) | 291 | 5.4 | 18.4 (1.4) |
| 55+ | 1,455 | 16.8 (12.9) | 171 | 1.9 | 11.4 (1.2) |
| Education | | | | | |
| 16 years or more | 4,216 | 55.8 (42.8) | 519 | 9.9 | 13.2 (0.8) |
| Less than 16 years | 5,059 | 74.5 (57.2) | 943 | 12.6 | 22.6 (0.9) |

63,2%

SE, standard error.
[a]Estimated number of US workers in millions.
[b]Number of respondents who reported hazardous workplace exposure in sample.
[c]Estimated number of US workers who are exposed to hazardous workplace noise in millions.
[d]per 100.

**Fuente: Tak y col. AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 52:358–371(2009)**

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OHH
ENTIENDO QUE LOS
EPI SON IMPORTANTES
PARA LA
SEGURIDAD DE LOS
TRABAJADORES

**TABLE IV.** Estimated Proportion (%) and Rate Ratios of Workers Not Wearing HPDs in Hazardous Workplace Noise by Industrial Sectors and Other Characteristics, NHANES Subjects Aged 16 or Older, United States, 1999–2004 (n = 1,458)

| | Noise exposed in sample | Non-use of HPDs in sample | Weighted number of non-users of HPDs[a] | Weighted proportion of non-use of HPDs (%)/(SE) | Adjusted rate ratio (95% CI)[b] |
|---|---|---|---|---|---|
| Total | 1,458 | 530 | 7,674 | 34.3 (1.8) | |
| Sex | | | | | |
| Male | 1,158 | 390 | 5,737 | 31.1 (2.0) | 1.00 |
| Female | 300 | 140 | 1,937 | 49.3 (4.8) | 1.29 (0.96–1.73) |
| Race/ethnicity | | | | | |
| Non-Hispanic white | 711 | 261 | 5,664 | 33.7 (2.2) | 1.00 |
| Mexican American and other Hispanic | 467 | 166 | 1,084 | 35.7 (3.4) | 1.06 (0.81–1.38) |
| Other race—including multiracial | 43 | 15 | 263 | 31.9 (3.0) | 1.06 (0.66–1.71) |
| Non-Hispanic black | 237 | 88 | 664 | 37.9 (3.6) | 1.06 (0.81–1.37) |
| Age (years) | | | | | |
| 16–24 | 324 | 141 | 1,266 | 40.0 (4.2) | 1.17 (0.86–1.59) |
| 25–34 | 313 | 109 | 1,795 | 33.3 (2.6) | 1.04 (0.78–1.38) |
| 35–44 | 359 | 131 | 2,223 | 33.9 (3.2) | 1.02 (0.79–1.33) |
| 45–54 | 291 | 89 | 1,674 | 31.2 (3.4) | 1.00 |
| 55+ | 171 | 60 | 716 | 37.5 (5.4) | 1.11 (0.83–1.48) |
| Education | | | | | |
| 16 years or more | 517 | 177 | 3,107 | 31.6 (2.6) | 1.00 |
| Less than 16 years | 941 | 353 | 4,567 | 36.3 (2.9) | 1.28 (1.03–1.61) |

[a]Estimated population who reported not wearing HPDs in their current job (in thousands).
[b]Rate ratios and the 95% CIs (confidence interval) were adjusted for all other variables.
[c]In all manufacturing sub-sectors combined, the number of noise-exposed workers who never wear HPDs in their current job is 1.36 million, the proportion of non-HPD usage is 23.8%, and the rate ratio is 1.73 (95%CI: 0.88, 3.40).

**Fuente: Tak y col. AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 52:358–371(2009)**

**TABLE I.** Distribution of Selected Characteristics Among Workers in Workplace Hearing Conservation Programs 2005–2009 (n = 19,911)

| Characteristic | Number of workers (%) |
|---|---|
| Mean age, years (SE) | 46.1 (0.07) |
| Sex | |
| Male | 14,817 (74.4) |
| Female | 5,094 (25.6) |
| Mean duration of prior exposure, year (SE) | 5.87 (0.04) |
| Industry sector | |
| Agriculture, fishing, and forestry | 69 (0.4) |
| Construction | 892 (4.5) |
| Manufacturing | 17,127 (86.0) |
| Services | 770 (3.9) |
| Transportation, warehousing, and utilities | 190 (1.0) |
| Wholesale and retail trade | 863 (4.3) |
| Recreational shooting or hunting | |
| No | 15,932 (80.0) |
| Yes | 3,979 (20.0) |
| Other non-occupational hazardous noise exposure | |
| No | 13,338 (67.0) |
| Yes | 6,573 (33.0) |
| Hearing protection use | |
| Never | 563 (2.8) |
| Sometimes | 5,158 (25.9) |
| Always | 14,190 (71.3) |

**28,7%**

**Fuente: Grenewold, M y col. AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 57:1001-1010(2014)**

**TABLE III.** Adjusted Odds Ratios for OSHA Standard Threshold Shift (OSTS) and High-Frequency Threshold Shift (HFTS) Among Workers in Workplace Hearing Conservation Programs 2005–2009

| | Odds ratio (95% CI)[a] | |
|---|---|---|
| **Characteristic** | **OSTS** | **HFTS** |
| Age[b] | 1.05 (1.05–1.06) | 1.06 (1.05–1.06) |
| Sex | | |
| Male | 1.28 (1.12–1.47) | 1.28 (1.14–1.43) |
| Female | Ref | Ref |
| Hearing protection | | |
| Never | 1.23 (0.92–1.64) | 1.26 (1.00–1.59) |
| Sometimes | 1.08 (0.96–1.22) | 1.08 (0.98–1.20) |
| Always | Ref | Ref |

[a]Odds ratios statistically adjusted for the effects of all other variables in the table and the random effect of company.
[b]Change in odds associated with 1-year deviation from the mean in predictor.
[c]The median odds ratio is a measure of the degree to which the company effect resulting from the hierarchical, clustered nature of the data—in which workers are clustered within companies—influenced the odds of OSTS and HFTS. It is defined as the median value of the odds ratio between the higher and lower risk of any two randomly selected companies, that is, the median increase in the odds of OSTS or HFTS that would result from a worker moving to another, higher risk company.

**Conclusión: Subraya la importancia de entrenar a los trabajadores en el uso correcto de protectores auditivos**

**Fuente: Grenewold, M y col. AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 57:1001-1010(2014)**

# Pregunta de investigación

- **¿Existe relación entre la atenuación sonora y la capacitación del uso correcto del protector auditivo tipo tapón?**

**Figure 31** Correct fitting of earplugs

**Figure 32** Incorrect fitting of earplugs

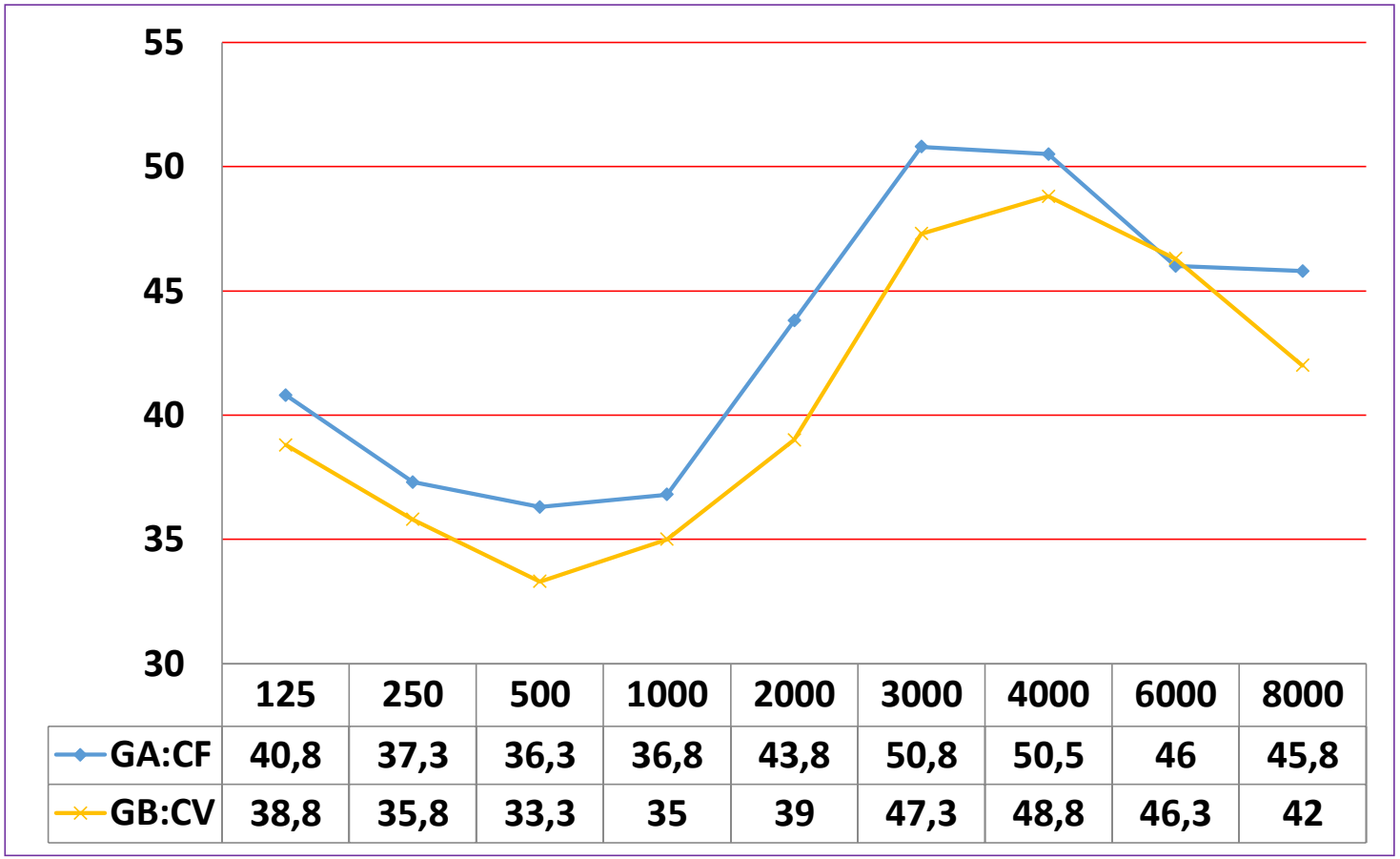
# Metodología

- Muestra: 40 jóvenes universitarios normo oyentes.
- Cámara sono amortiguada.
- Audiometría campo libre

| Grupo | Primera capacitación | Segunda capacitación | Tercera capacitación |
|---|---|---|---|
| A | Folleto | Video | Personal |
| B | Video | Folleto | Personal |

Fuente: Salazar, A.M; Rita, C y Garrido, P.

# Atenuación sonora lograda según grupo en primera sesión

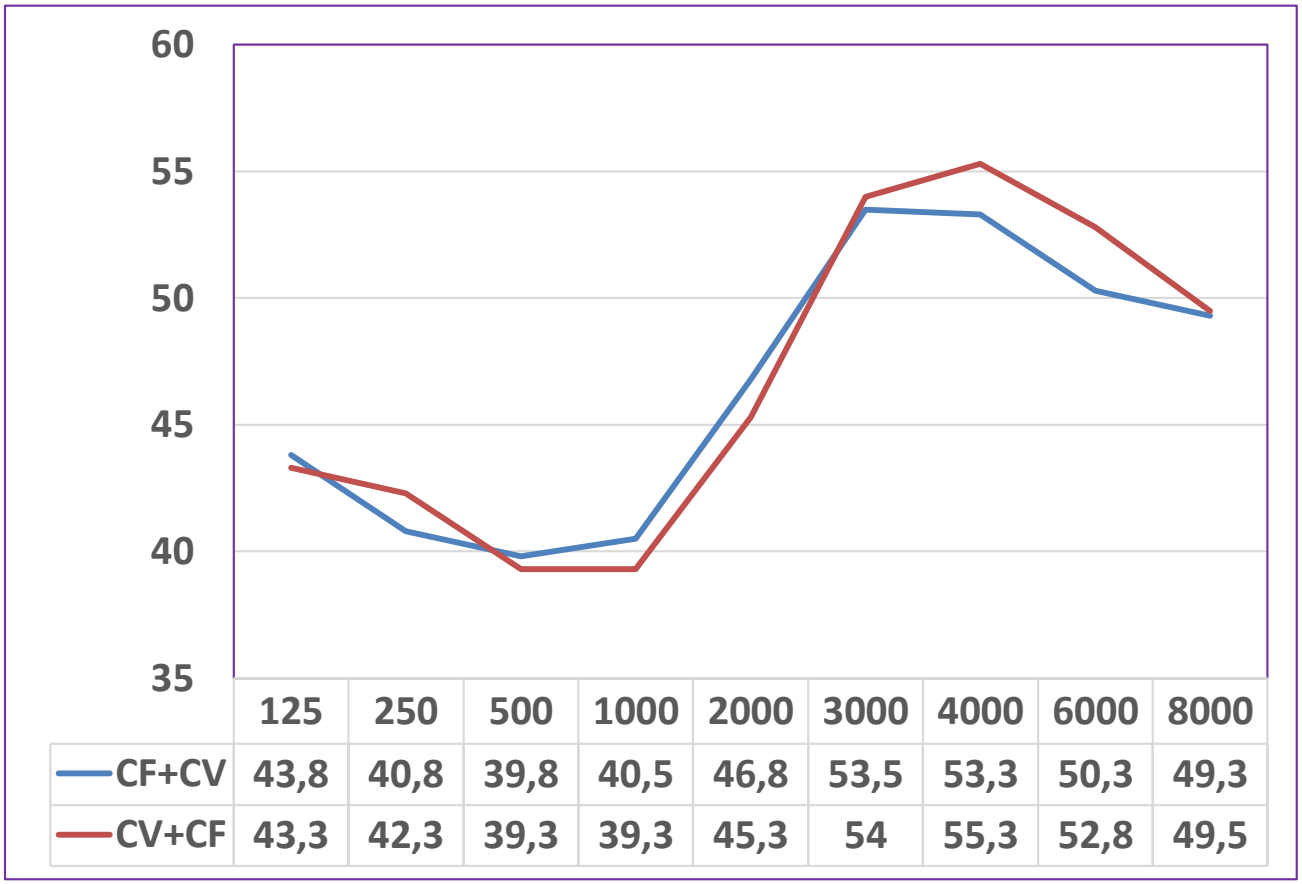



| | 125 | 250 | 500 | 1000 | 2000 | 3000 | 4000 | 6000 | 8000 |
|---|---|---|---|---|---|---|---|---|---|
| GA:CF | 40,8 | 37,3 | 36,3 | 36,8 | 43,8 | 50,8 | 50,5 | 46 | 45,8 |
| GB:CV | 38,8 | 35,8 | 33,3 | 35 | 39 | 47,3 | 48,8 | 46,3 | 42 |

P>0.05

Fuente: Salazar, A.M; Rita, C y Garrido, P.

# Atenuación sonora lograda según grupo en segunda sesión

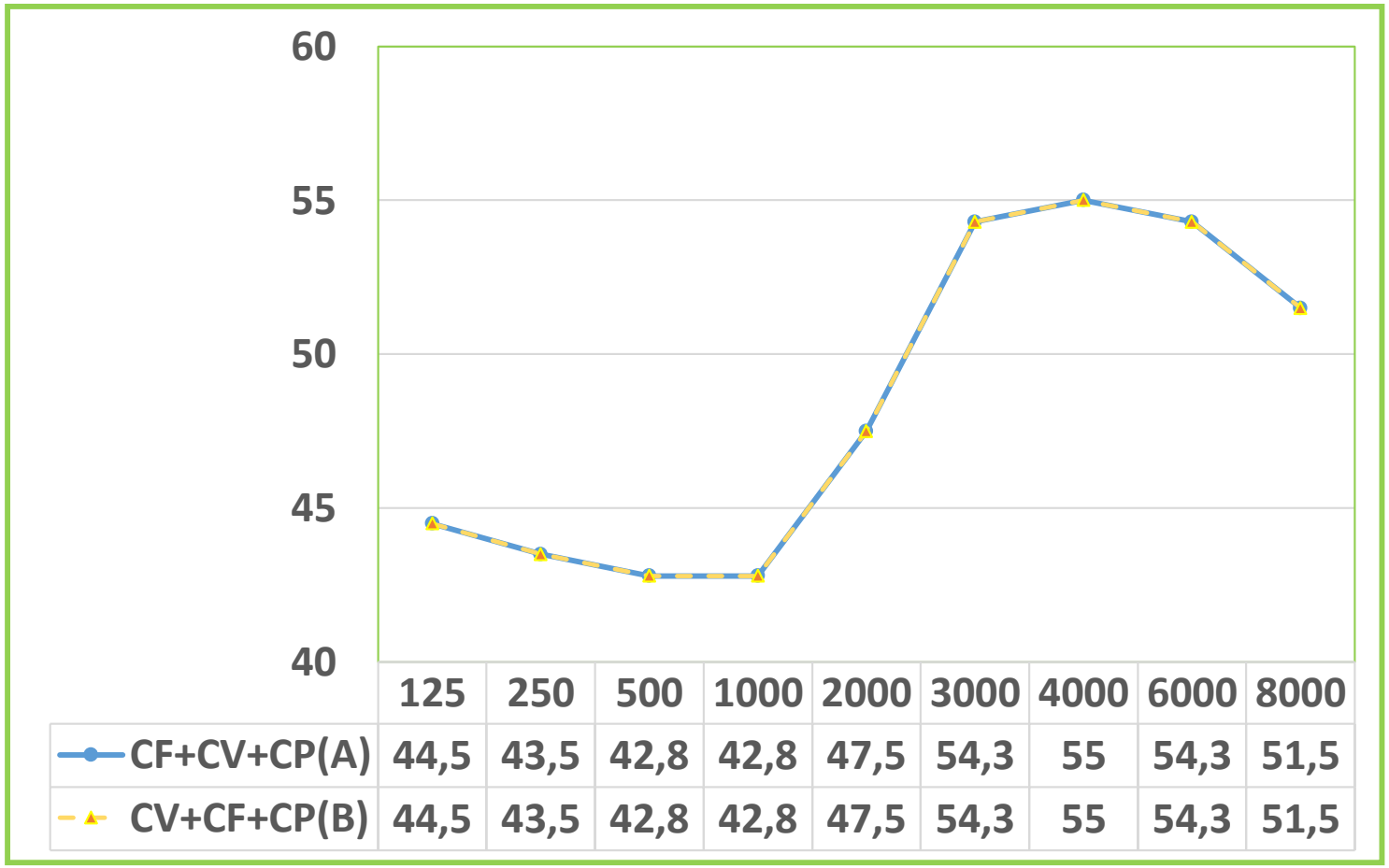



| | 125 | 250 | 500 | 1000 | 2000 | 3000 | 4000 | 6000 | 8000 |
|---|---|---|---|---|---|---|---|---|---|
| CF+CV | 43,8 | 40,8 | 39,8 | 40,5 | 46,8 | 53,5 | 53,3 | 50,3 | 49,3 |
| CV+CF | 43,3 | 42,3 | 39,3 | 39,3 | 45,3 | 54 | 55,3 | 52,8 | 49,5 |

**P>0.05**

**Fuente: Salazar, A.M; Rita, C y Garrido, P.**

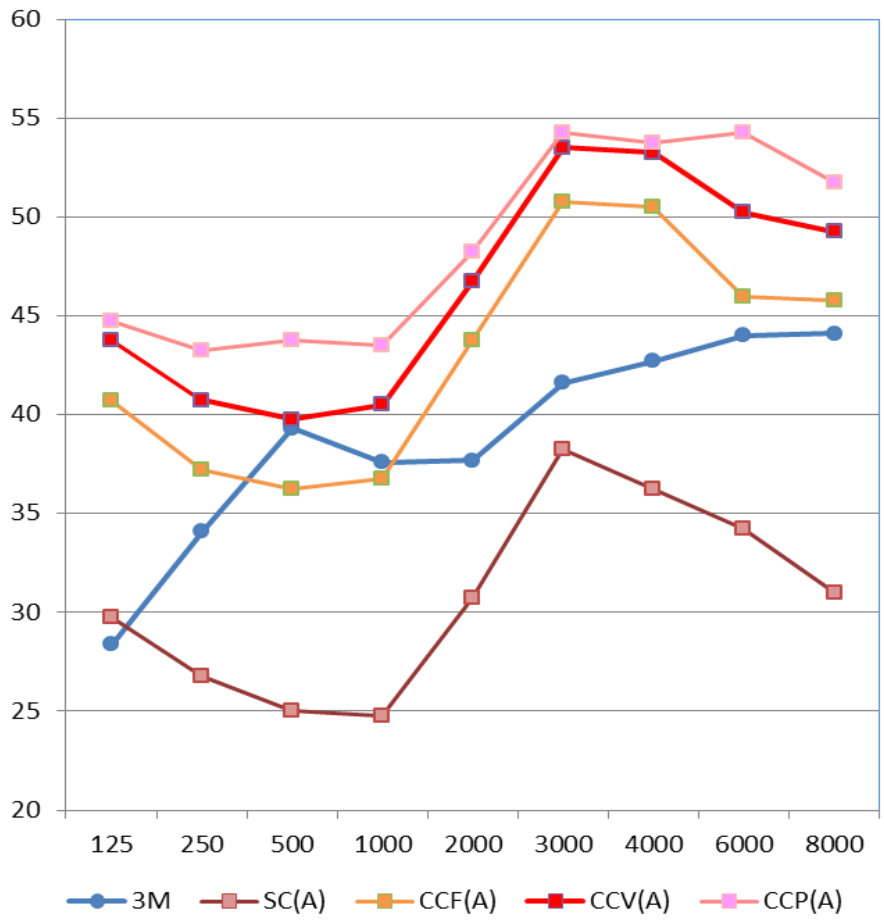
# Atenuación sonora lograda según grupo en tercera sesión

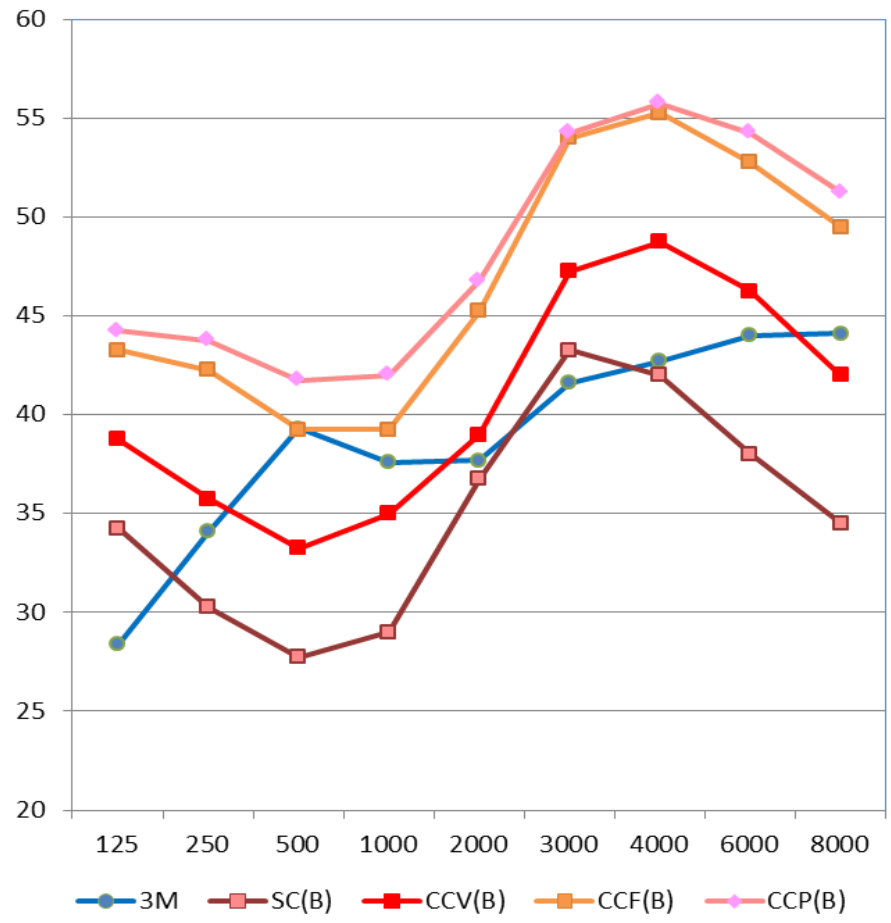



| | 125 | 250 | 500 | 1000 | 2000 | 3000 | 4000 | 6000 | 8000 |
|---|---|---|---|---|---|---|---|---|---|
| CF+CV+CP(A) | 44,5 | 43,5 | 42,8 | 42,8 | 47,5 | 54,3 | 55 | 54,3 | 51,5 |
| CV+CF+CP(B) | 44,5 | 43,5 | 42,8 | 42,8 | 47,5 | 54,3 | 55 | 54,3 | 51,5 |

**Fuente: Salazar, A.M; Rita, C y Garrido, P.**

# Atenuación Sonora




**Fuente: Salazar, A.M; Rita, C y Garrido, P.**

# Impacto de la capacitación en la atenuación sonora

| Atenuación Sonora (dB) | GRUPO A | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Frecuencia (Hz) | | | | | | | | |
| | 125 | 250 | 500 | 1000 | 2000 | 3000 | 4000 | 6000 | 8000 |
| **CF-SC** | 8.8 | 8.8 | 9.9 | 9.9 | 10.0 | 10.0 | 11.3 | 9.9 | 13.0 |
| **CV-CF** | 3.0 | 3.5 | 3.5 | 3.7 | 3.0 | 2.7 | 2.8 | 4.3 | 3.5 |
| **CP-CV** | 0.7 | 2.7 | 3.0 | 2.3 | 0.7 | 0.8 | 1.7 | 4.0 | 2.2 |
| **Global** | 12.5 | 15.0 | 16.4 | 15.9 | 13.7 | 13.5 | 15.8 | 18.2 | 18.7 |
| | **GRUPO B** | | | | | | | | |
| **CV-SC** | 6.8 | 7.3 | 6.9 | 8.1 | 5.2 | 6.5 | 9.6 | 10.2 | 9.2 |
| **CF-CV** | 4.5 | 6.5 | 6.0 | 4.3 | 6.3 | 6.7 | 6.5 | 6.5 | 7.5 |
| **CP-CF** | 1.2 | 1.2 | 3.5 | 3.5 | 2.2 | 0.3 | 0.3 | 1.5 | 2.0 |
| **Global** | 12.5 | 15.0 | 16.4 | 15.9 | 13.7 | 13.5 | 16.4 | 18.2 | 18.7 |

**Fuente: Salazar, A.M; Rita, C y Garrido, P.**

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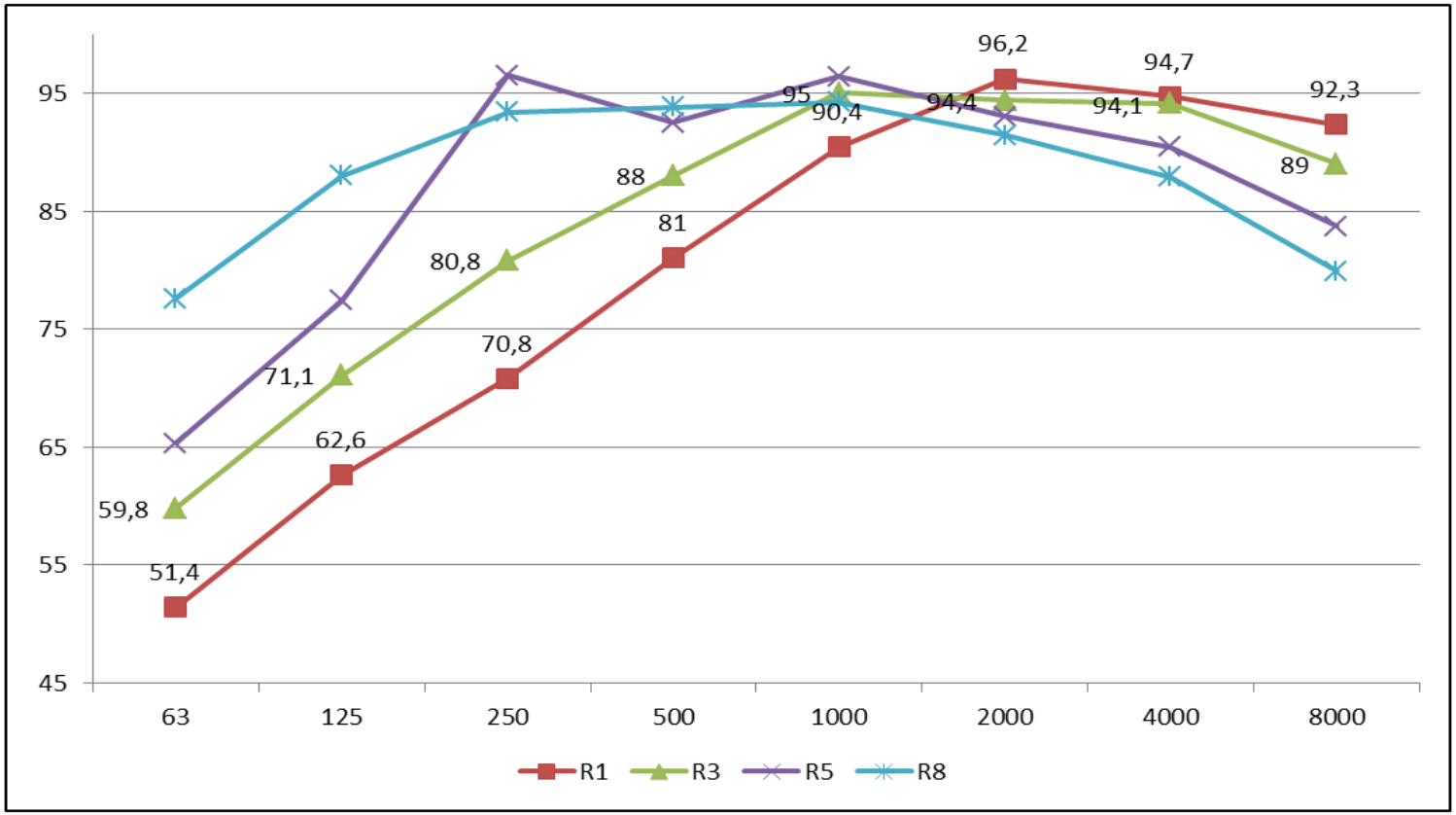
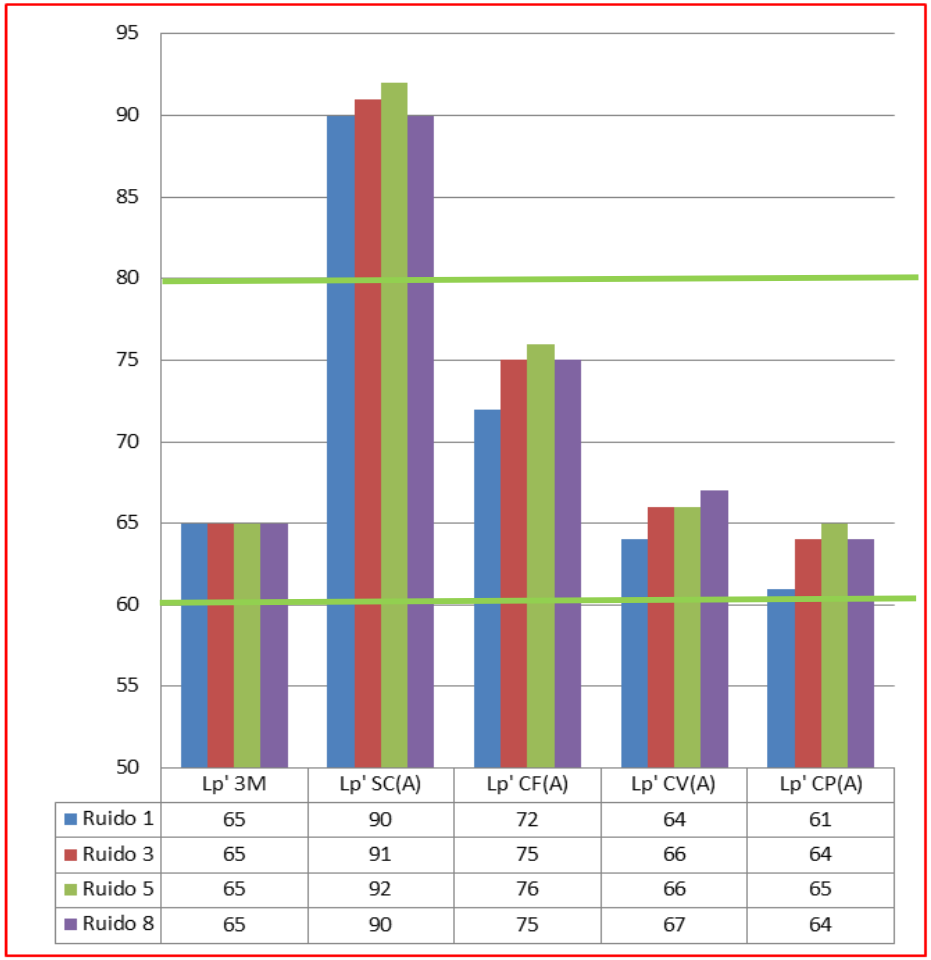
# Espectro de Frecuencia. (NPS= 100 dBA)

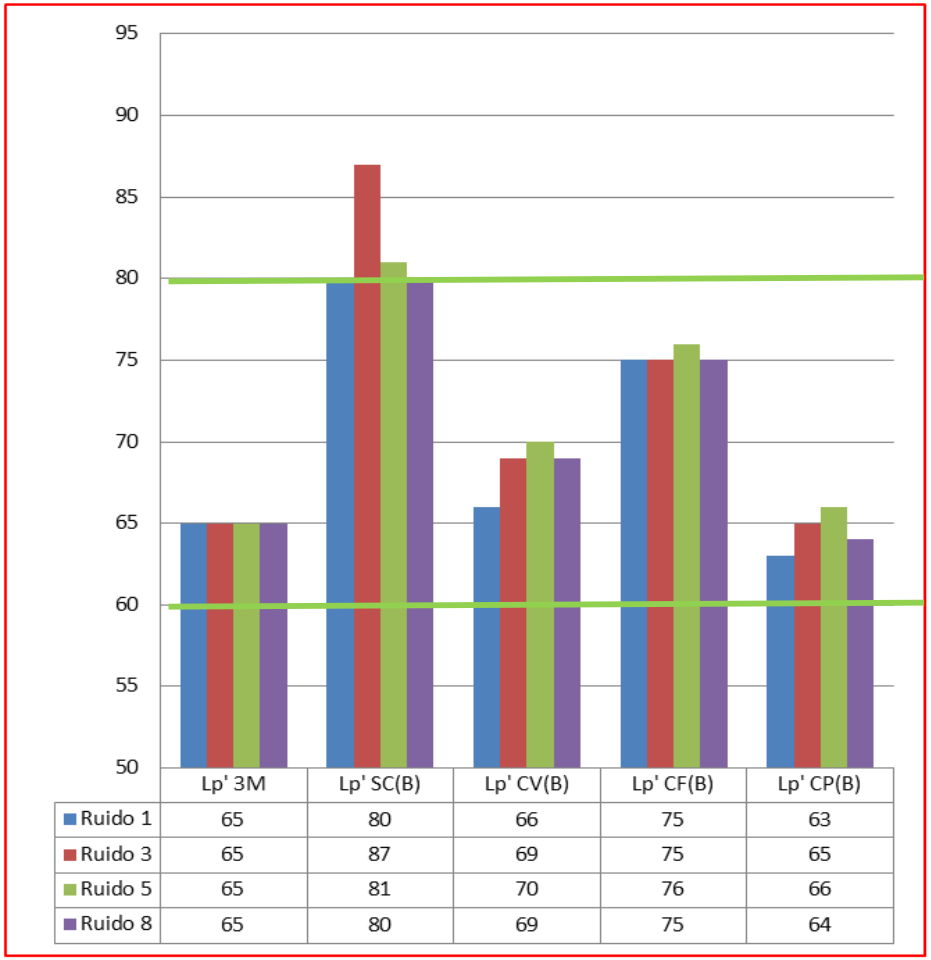



**Fuente: NCh 1331/6**

# NPS efectivo ponderado A. (α=1.64)



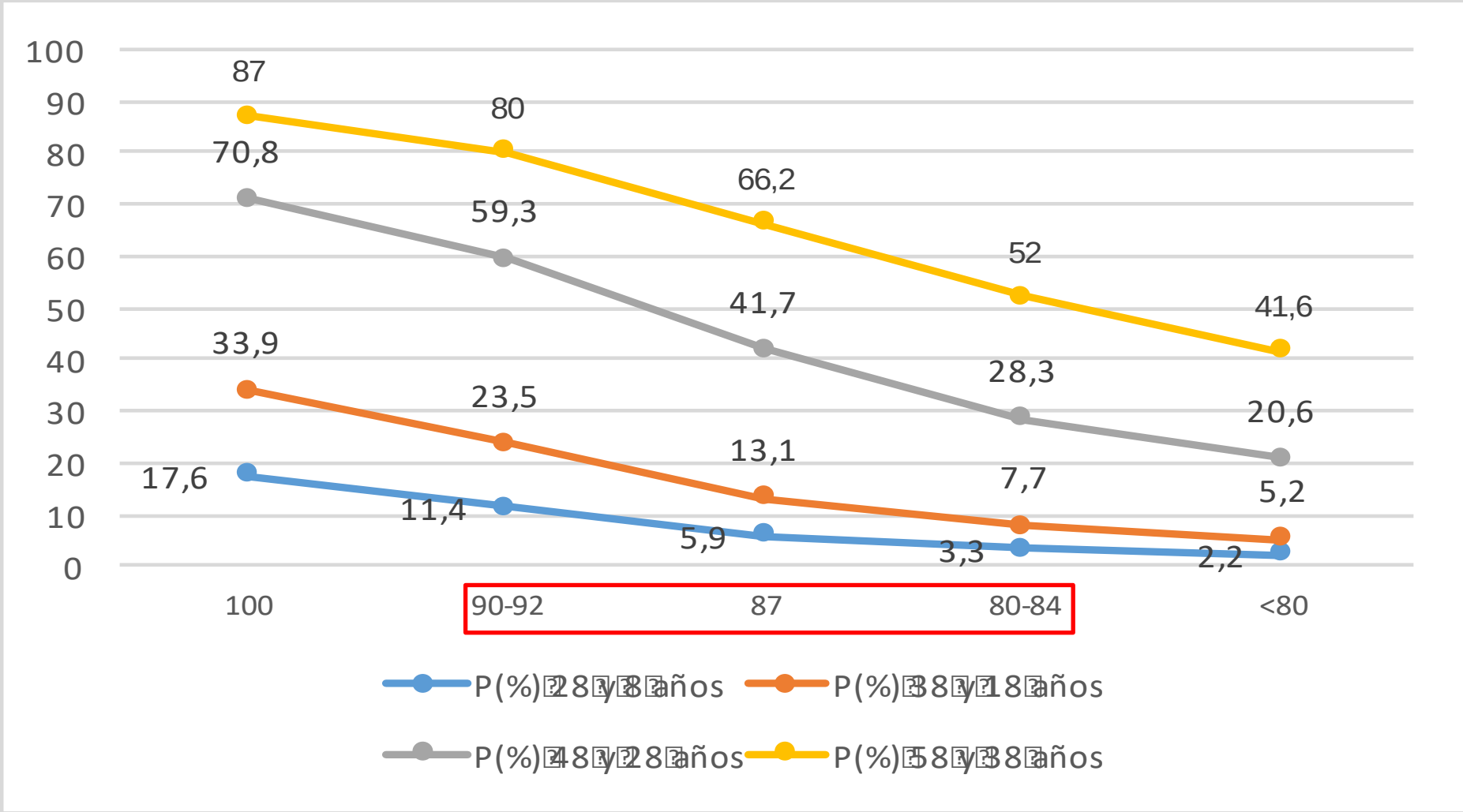

| | Lp' 3M | Lp' SC(A) | Lp' CF(A) | Lp' CV(A) | Lp' CP(A) |
|---|---|---|---|---|---|
| Ruido 1 | 65 | 90 | 72 | 64 | 61 |
| Ruido 3 | 65 | 91 | 75 | 66 | 64 |
| Ruido 5 | 65 | 92 | 76 | 66 | 65 |
| Ruido 8 | 65 | 90 | 75 | 67 | 64 |




| | Lp' 3M | Lp' SC(B) | Lp' CV(B) | Lp' CF(B) | Lp' CP(B) |
|---|---|---|---|---|---|
| Ruido 1 | 65 | 80 | 66 | 75 | 63 |
| Ruido 3 | 65 | 87 | 69 | 75 | 65 |
| Ruido 5 | 65 | 81 | 70 | 76 | 66 |
| Ruido 8 | 65 | 80 | 69 | 75 | 64 |

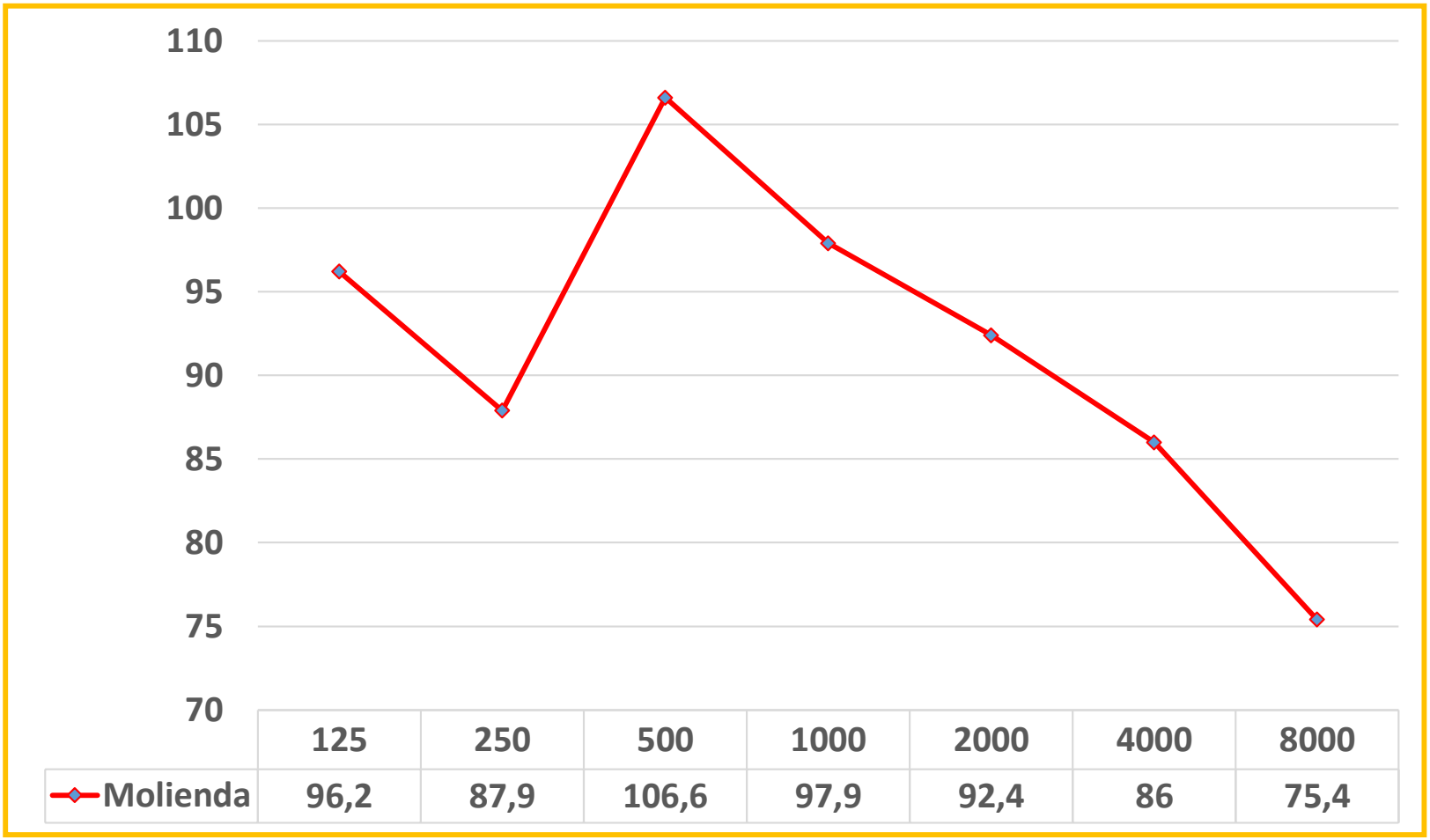
**Fuente: Salazar, A.M**

# Probabilidad de daño auditivo según NPS




Fuente: Salazar, A.M

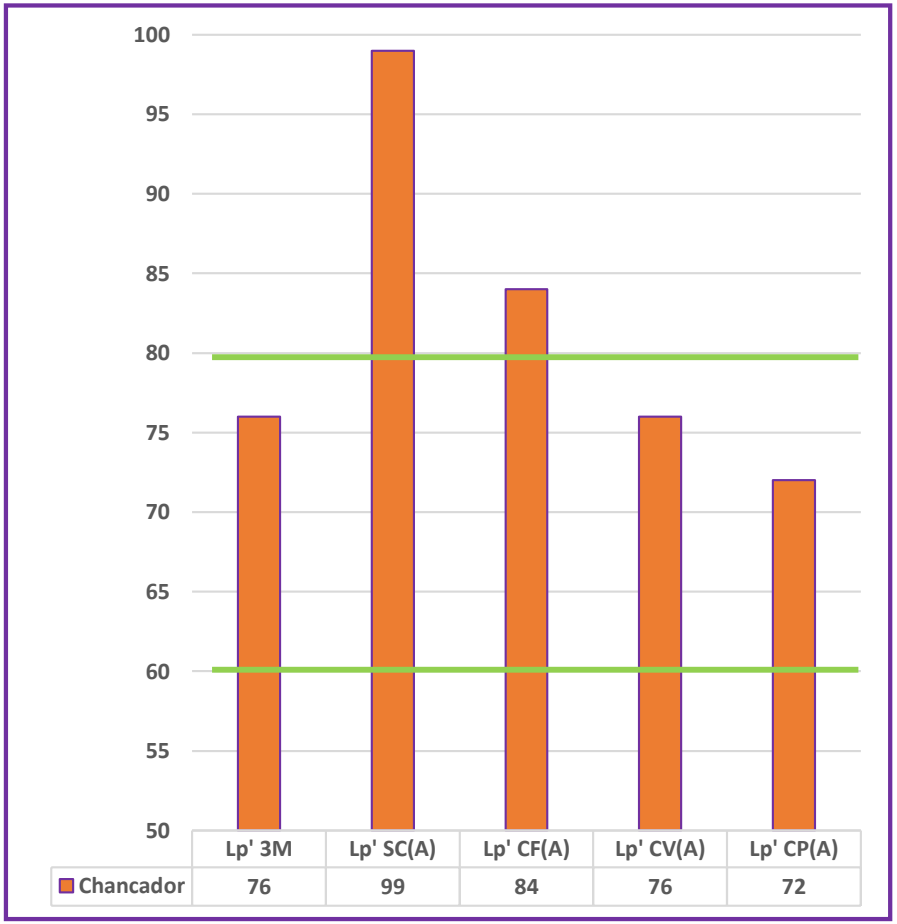
# Molienda: Espectro de Frecuencia (NPSeq= 105 dBA)

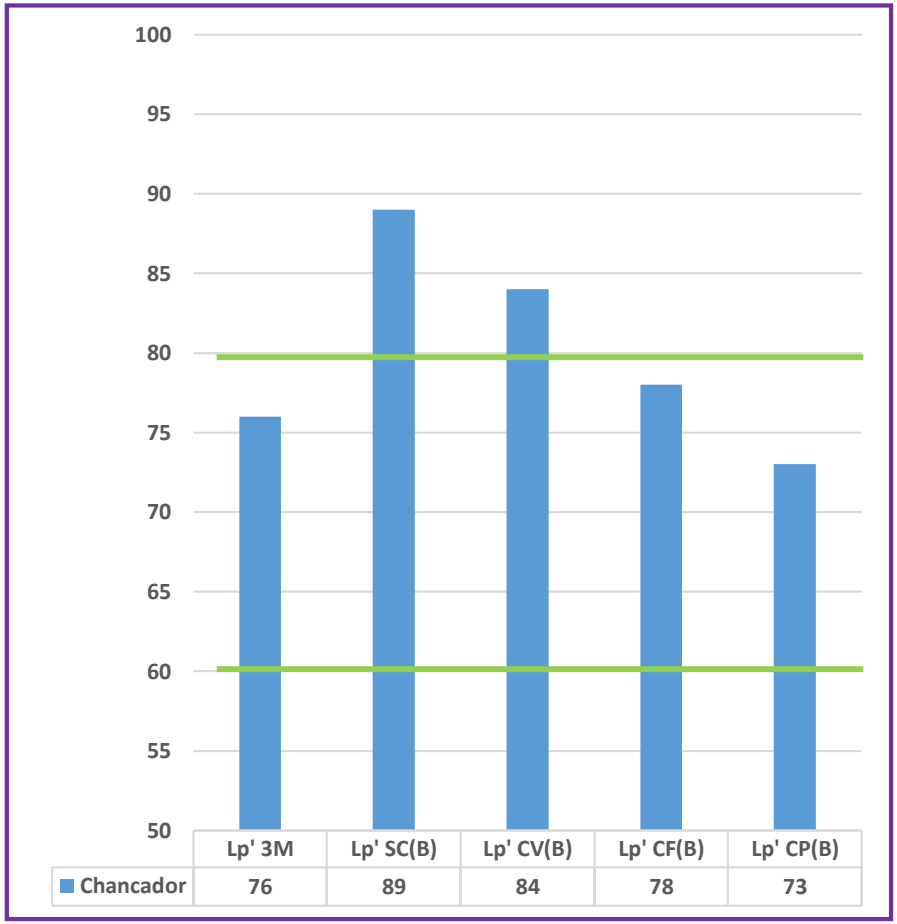



| | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|
| Molienda | 96,2 | 87,9 | 106,6 | 97,9 | 92,4 | 86 | 75,4 |

Fuente: Salazar, A.M

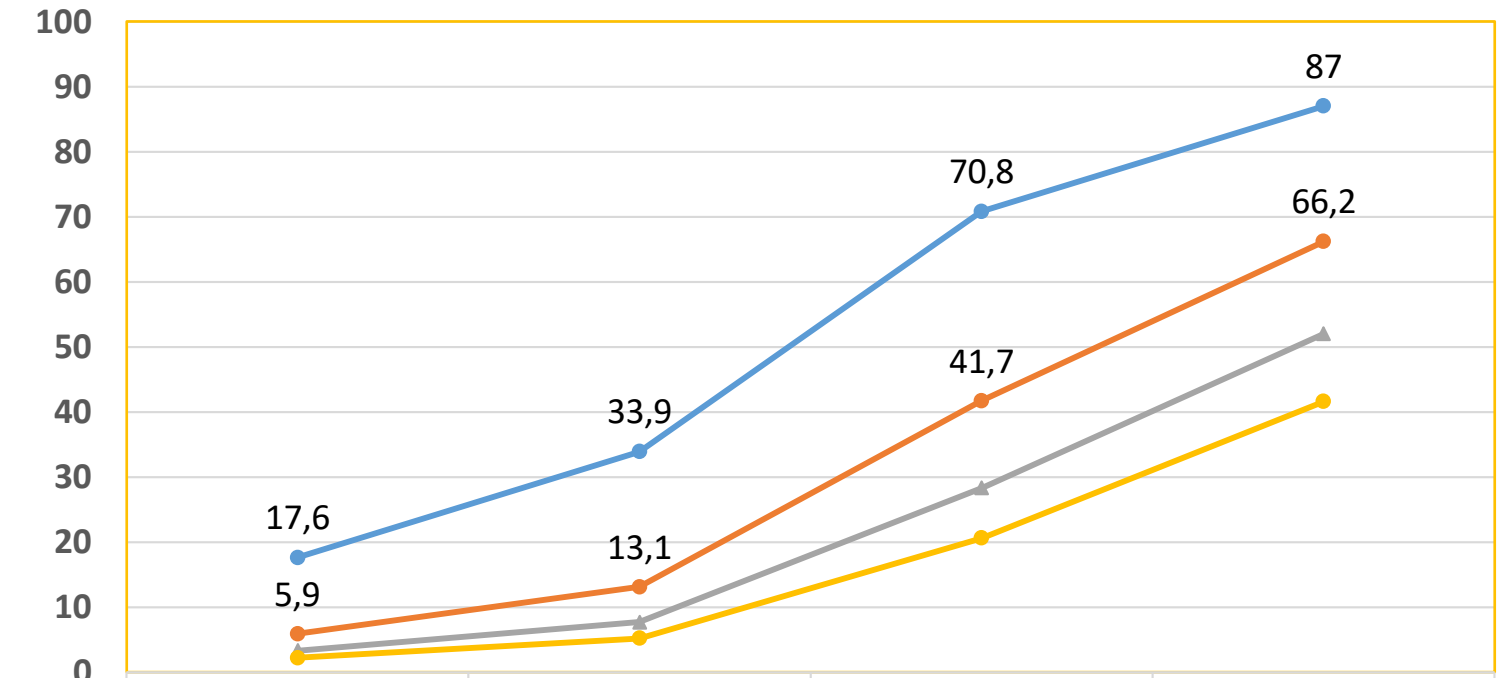
# NPS efectivo ponderado A. Fuente Sonora: Molienda (α=1.64)




Fuente: Salazar, A.M

# Probabilidad de daño auditivo según NPS, edad y tiempo exposición




| | P(%) 28 y 8 años | P(%) 38 y 18 años | P(%) 48 y 28 años | P(%) 58 y 38 años |
|---|---|---|---|---|
| 99 | 17,6 | 33,9 | 70,8 | 87 |
| 89 | 5,9 | 13,1 | 41,7 | 66,2 |
| 84 | 3,3 | 7,7 | 28,3 | 52 |
| <80 | 2,2 | 5,2 | 20,6 | 41,6 |

Fuente: Salazar, A.M., 2013

# Agenda

- Antecedentes Históricos
- Impacto de la HSNR
- Contexto en materia de Protección Auditiva
- Impacto capacitación uso correcto en la atenuación sonora
- Capacitación vs Control del Riesgo de HSNL
- **Conclusiones**

# Conclusiones (1)

- ***La capacitación sobre el uso correcto*** del protector auditivo tipo tapón desechable tiene un ***efecto positivo*** en la curva de atenuación sonora; ya sea con folleto, video o personalizada.
- ***Una ausencia o mala capacitación*** al trabajador se traduce en una ***ineficiente protección auditiva***, lo que ***implica riesgo de pérdida auditiva atribuible a ruido***.(Grenewold, M y col.2014).

# Conclusiones (2)

- Considerando que los trabajadores son los principales usuarios de este tipo de protector, es importante ***considerar su nivel educacional*** para *seleccionar el método* a utilizar; para que así puedan comprender e internalizar como se coloca correctamente el protector auditivo tipo tapón; así como sus cuidados.
- No se encontraron diferencias significativas en la atenuación sonora lograda, entre ambos grupos, en las dos primeras sesiones, sin embargo, considerando que en el ***caso del folleto*** se requiere ***comprensión lectora***, y que la ***capacitación personalizada,*** para lograr ***igual cobertura***, toma ***mayor tiempo***, se estima que el ***video sería la mejor opción***.

**Gracias por su atención**

# Impacto de la capacitación del uso correcto del protector auditivo tipo tapón desechable en la atenuación sonora.

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