

Original Article

# COVID-19 era: Hearing handicaps behind face mask use in hearing aid users

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**BACKGROUND:** The aim of this study was to assess the effect on speech perception and lack of hearing devices gain with surgical masks worn in hearing aid users.

**METHODS:** This prospective cohort study enrolled consecutive patients between November 2020 and February 2021 in a tertiary care medical center from Spain. Fifty-five subjects have been included, 10 as control group, with normal hearing, and 45 patients with sensory-neural hearing loss and hearing aid users, ranging in age between 31 and 83 years old, and were recruited randomized in 4 months. Appropriate test was done previously to check adequate functioning from devices and suitable adaptation. Control group had no hearing impairment neither otologic disease.

**RESULTS:** Disyllabic test in quiet get worse with face mask with a significant difference and stronger impact in noisy background. Age made no difference. Adding lipreading speech perception improved by 95.1 % for younger subjects (<50 years of age) and 91.2% for older subjects (>50 years of age). In the control sample, there was no differences in any condition.

**CONCLUSION:** Despite advantages of wearing mask in preventing coronavirus disease 2019 spread, we must consider that they have also drawbacks for some groups like hearing aid users. In this research, we have not observed high frequencies perception decrease with surgical masks worn, but there was reduction in speech perception, most notably in hearing aids wearers in noisy environment.

**KEYWORDS:** COVID-19, hearing loss, hearing aid, mask

## INTRODUCTION

Coronavirus disease 2019 (COVID-19) pandemic forced the world to wear face masks daily in an effort to prevent the spreading of the disease to the population.

Masks and social distance to prevent any physical contact made communication and understanding difficult. Communication is fundamental for human nature. It must be clear, comfortable, and fluent.

During this time, following conversations remains a challenge for hearing loss patients and can lead to isolation and a decrease in social competencies. Recent studies showed that mask wearing causes attenuation, decibel (dB) reduction, and speech understanding reduction in normal hearing individuals and hearing loss individuals compared to when no mask is worn. This attenuation appears to be reflected especially in high frequencies and changes with different types of masks.<sup>1-3</sup>

This fact and the absence of visual cues like lipreading or facial expressions make communication extremely difficult in hearing loss patients at the present time. Additionally, social distance reduced the sound intensity, thereby aggravating this situation, and this became a barrier to clear empathetic communication.

Furthermore, another paper has shown the impact of mask wearing by healthcare professionals with a detrimental effect on the patient's perceived empathy, difficulties in physician-patient relationship, and also affecting proper communication between

healthcare professionals themselves and caregivers. This issue might be more evident in hearing loss patients.<sup>4-6</sup>

Moreover, wearing masks made it difficult and cumbersome to wear hearing devices properly in some cases, thereby hampering communication even more and dropping the gain in hearing. Those circumstances increased the risk of condition of isolation for these population.

Our aim is to identify the influence of surgical masks in speech perception, in quiet as well as in noisy background, comparing normal hearing population with patients suffering with sensorineural hearing loss and hearing aid users. Gain from hearing devices and visual cues like lipreading have been also evaluated in all situations.

## METHODS

We conducted a prospective cohort study and enrolled consecutive patients in a tertiary care medical center between November 2020 and February 2021.

Fifty-five subjects were included, 10 without hearing troubles and 45 patients with hearing impairments fitted with a hearing aid for more than a year. The principal etiology was presbycusis for older than 50 years. In young people, different etiologies were included except chronic otitis media.

Hearing loss subjects of any case were included and those having incorrectly adapted hearing aid were excluded. Since referred sample patients over 18 years old were included, all of them underwent a pure tone audiometry to ensure proper hearing, which is defined as a pure tone average of less than 25 dB at 500, 1000, and 2000 Hz. In this group, Individuals with otologic disease were excluded.

For that reason, first of all, otoscopy was performed on all patients in order not to miss any otological disease or under-diagnosing health sample.

Both groups underwent pure tone audiometry and speech intelligibility in both quiet and noisy backgrounds plus 5 decibels making results more comparable to normal daily life circumstances. We evaluated the impact of wearing a surgical mask on acoustic output and speech perception, as well as changes in devices gain in all situations.

## MAIN POINTS

- Mask wearing causes misunderstandings and difficulties in human relations.
- In disyllabic test, when patients with and without wearing masks were compared in quiet background, differences were not found, however, in noisy environment, significant differences were obtained. This represents how listening and communication in a Normal noisy environment of daily life is totally different.
- Hearing aid users have disadvantages in speech perception, and facial masks increase those difficulties.

For audiometric testing and speech discrimination, the audiometer Equinox 2.0 AC 440 CD- OtoAccess™ database - Windows® 7 with a set of speakers Resolv Active Studio Monitor A5 45Hz to 27 KHz Biamped 50 watt at 45° was used.

For masking when was necessary, test was conducted in the modalities speakers in position 45°, the contralateral ear was masked by an auditory threshold of +10 dB with white noise plus complete plugging and noise canceling earphone.

Speech tests and sentences in quiet and noise (SNR+5) was evaluated using disyllabic lists and sentences from The assessment of hearing in Spanish Language Protocol.<sup>7</sup>

Disyllabic word test in Spanish was presented at 65 dB SPL in the sound field with the subject seated 1 m from the speaker facing 0° azimuth. A live voice was used. The variable to be recorded for speech in silence was the “% correct words” at 65 dB SPL for 2 lists of 25 words. The same live voice was used in all cases.

Researchers informed patients about the risks and benefits of participating in this study. After that, they gave their informed consent prior to the study initiation.

All of test were made without surgical masks for all individuals in quiet and noisy conditions and were then repeated with the audiologist wearing a surgical mask. Both the results were compared subsequently.

Lipreading was also evaluated as frontal testing by the same clinician, without mask and 1 m away from patient.

Data analysis was done by using Statistical Package for the Social Sciences software 25.0 (IBM SPSS Corp.; Armonk, NY, USA).<sup>8</sup> Within the different groups, the categorical variables were represented in percentages and absolute frequencies and the numerical variables were represented in means. The percentage values were compared by using the chi-square test. Analysis of variance or the Kruskal-Wallis non-parametric test for independent samples was used to compare means or medians for more than 2 groups. The level of statistical significance established in this study was  $P < .05$ .

This study was approved by the Ethics Committee Universidad de Las Palmas de Gran Canaria University (HUGCDN: 2020-449-1). Written informed consent was obtained from all participants who participated in this study.

## RESULTS

Overall, 55 individuals were recruited, 10 of them were referred to as healthy samples with a mean age of 52 years old (ranging between 31 and 60). Among the 45 individuals recruited as the study population, the youngest subject was 19 years old, while the oldest was 83 years old. They were divided in 2 subgroups speech discrimination begins to decrease in older than younger than 50 years old (15 patients) with a mean age of 37.4 years and older than 50 years old (30 patients) with a mean age of 65.2 years. The study group includes 51% men and 48% woman, for referral group Five woman and 5 men were included.

**Table 1.** Results With and Without Mask and Adding Lipreading (N = 55)

	Age Mean (Range)	Gender	Speech Perception				
			Without Mask	With Mask	Without Mask +5 SNR	With Mask +5 SNR	Adding Lipreading
Healthy population (n = 10)	52 (31-60)	5 male, 5 female	100	98 (92-100)	96 (92-100)	96 (88-100)	100
Sample with hearing loss <50 years old (n = 15)	37.4 (19-48)	8 male, 7 female	87.5 (80-100)	78.8 (56-100)	82.5 (36-100)	59.8 (48-88)	95.1 (92-100)
Sample with hearing loss >50 years old (n = 30)	65.2 (51-83)	15 male, 15 female	82 (56-100)	74.2 (68-96)	72.8 (40-96)	61.2 (44-88)	91.2 (72-100)

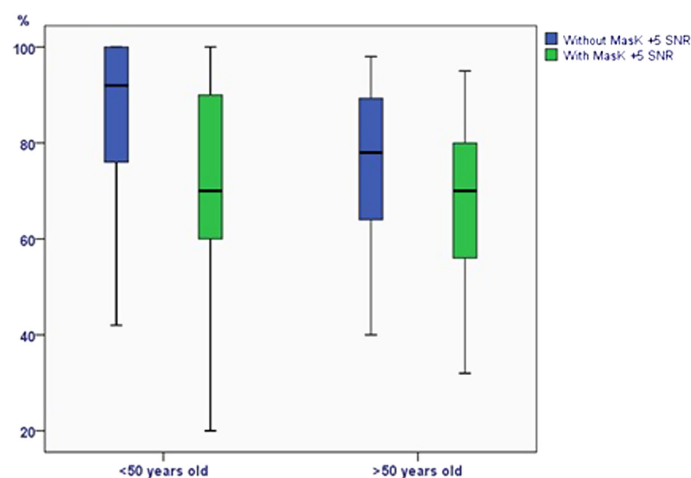
Speech discrimination score without masks in quiet background was 100% and 96% in noisy +5 SNR background (range: 92%-100%) for all individuals in normal hearing group. On the other hand, studied sample obtained in younger than 50 years group had a mean value of 87.5% (range from 80% to 100 %) and 82.5% (range from 36% to 100 %) in quiet and noisy background, respectively. For older than 50, the mean value was 82 (range from 56% to 100%) in quiet and 72.8% (range from 40% to 96%) in noisy +5 SNR background.

When mask was worn by younger than 50 years old sample, mean of 78.8% of discrimination was obtained and mean of 74.2% in older sample (>50 years old). If we added +5 SNR, the obtained mean was 59.8% (range: 48%-88%) in younger sample and 61.2% (range: 44%-88%) in older sample as reported in Table 1.

In healthy sample, a mean value of 98% (range: 92%-100%) and 96% (range: 88%-100%) was obtained with mask in quiet and noisy environment, respectively.

No level of significance was obtained in sample using face mask comparing between both subgroups of ages (Figures 1 and 2). But if we compare with normal hearing sample, a significant difference was obtained ( $P < .001$ ) (Figure 3).

Adding lipreading provided a mean speech discrimination score of 95.1% (92%-100%) for younger than 50 years old and 91.2% (76%-100%) for older than 50 without differences comparing all the groups.

**Figure 1.** Disyllabic test results in noise for hearing loss patients with and without mask ( $P < .001$ ).

Comparing the disyllabic test in both groups of ages using a mask and after it in the quiet background, we did not obtain any differences ( $P > .05$ ), but if we compared both situations in the noisy environment, a significant difference was achieved, as represented in Figure 4.

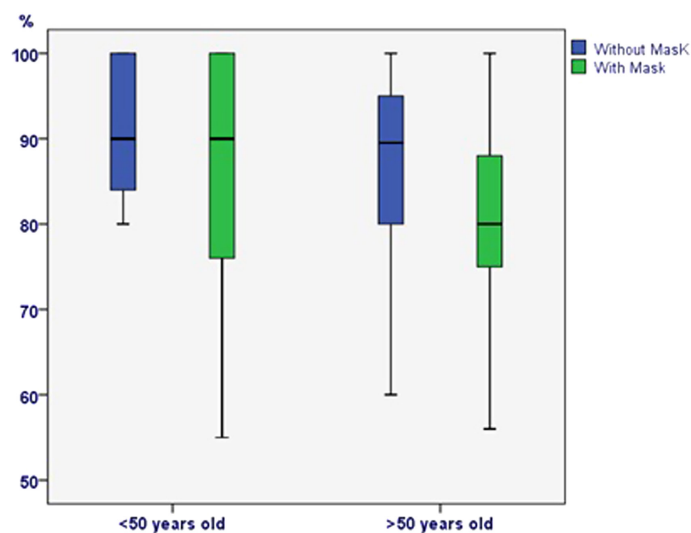
Hearing aid users younger than 50 years old used the hearing aid for more than 8 hours a day, while older than 50 years old 50 used it between 6 and 8 hours a day.

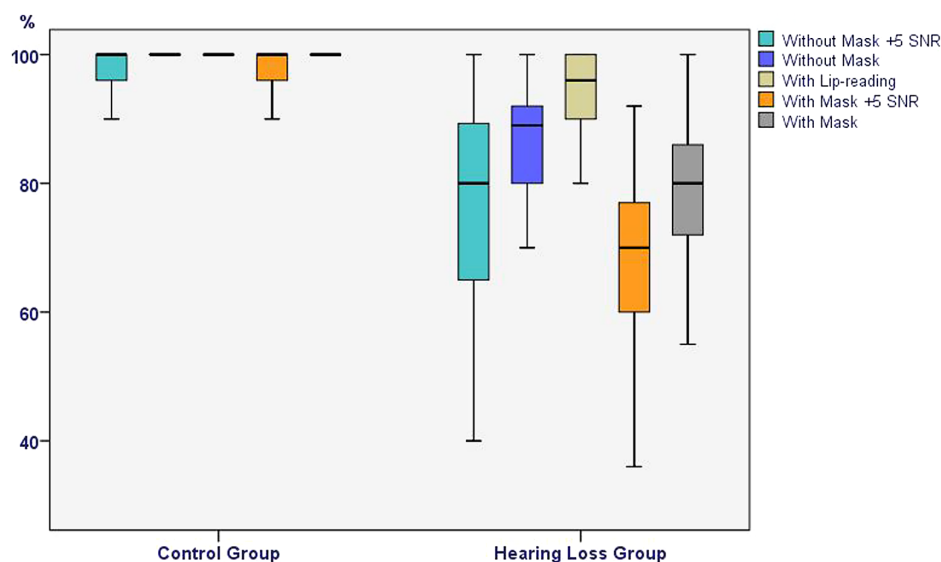
## DISCUSSION

Coronavirus disease 2019 pandemic forced the world to restrict personal and family relations in a different manner for each country. Different ways of communication have evolved and improved, but direct relationships have worsened.

Wearing masks hinders human relations, and it is more pronounced for people with hearing disability. It also affected physician–patient relationship, especially in certain circumstances like going to the emergency room, during procedures, or when one needed to go to the operating theatre for any need.<sup>5</sup>

In normal conditions, it is difficult to understand each other when masks are worn. Recently many papers described this situation in an attempt to prevent collateral damage by clear effective communication and avoiding people isolation.<sup>1-3</sup>

**Figure 2.** Disyllabic test results in quiet for hearing loss patients with and without mask ( $P < .001$ ).



**Figure 3.** Comparison between control group and hearing loss group disyllabic test with and without mask in quiet, with +5 SNR ( $P < .001$ ).

Solid understanding is a decisive element in high performing communication among patients and healthcare workers. The influence of using masks in this context is very important, because misunderstanding generates uncertainty, anxiety, and influence in decision-making in healthcare.

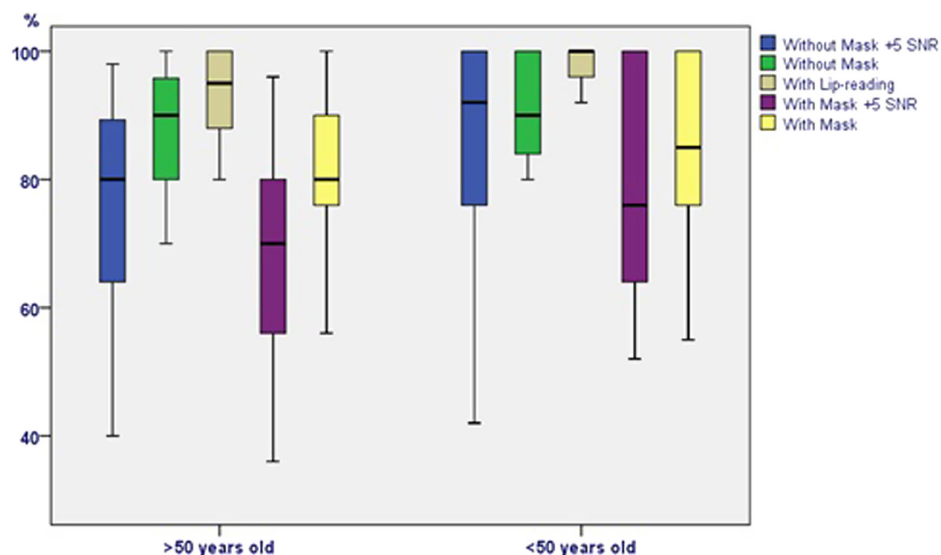
Corey et al<sup>1</sup> describes the attenuation of sound in front of the talker by comparing different types of masks like cloth masks, surgical masks, KN95, and N95 masks. Surgical mask and KN95 respirator revealed an attenuation of around 4 dB in high frequencies and N95 about 6 dB in high frequencies. Cloth masks differ depending on the number of layers and type of materials. They observed how multilayer masks made of loosely woven cotton were more efficient against viral droplets with a reasonable acoustic performance compared to multilayer masks made of loosely woven cotton. They concluded that surgical masks provided best acoustic performance compared to the others.<sup>1</sup>

In the study by Goldin et al.<sup>3</sup> sound attenuation in high frequencies by mask ranged from 3 to 4 dB for surgical masks and close to 12 dB for N95 masks.

All these papers revealed how masks are a barrier and reduce sound perception, especially in high frequencies but what we want to clarify what happened with speech perception.<sup>1,3,6</sup>

We have divided the study sample into younger and older than 50 years old group. The reason for this division is because it is known that age-related hearing loss begins around 50 years, affecting more than 40% of people over 50.<sup>9,10</sup> Speech perception also differs depending on age. Hence, results in older people could be poor due to age-related decrease.

Our results reveal how hearing-impaired community with hearing aid fitted had statistically significant decrease in speech



**Figure 4.** Disyllabic test with and without mask in quiet, with +5 SNR in hearing loss group by age group ( $P > .05$ ).

discrimination scores with the use of surgical mask in noisy environment (+5 SNR). In both subgroups of hearing aid users, the *P*-values obtained was less than .001 compared to same sample without using surgical mask. In contrast to Mendel et al.<sup>11</sup> they did not observe differences in noisy background with surgical masks for both groups in speech discrimination (normal hearing and hearing impairment).<sup>11</sup>

However, this difference has not been achieved in quiet background. This represents once again how listening and communication in a normal environment of daily life is totally different to results in some audiologic test. For that reason, it is important to check out audio-logical situations of patients in noise or in similar environments to real life.

Additionally, significant differences in speech discrimination score between normal hearing sample and hearing loss sample from both subgroups of ages have been outlined with and without masks and with and without noise. Except when lipreading has been incorporated, differences subside between normal hearing and hearing impairment groups, explaining how important non-verbal cues are in this community.

On the other hand, in relation to both subgroups in hearing impairment population (older and younger than 50 years old), there was not any statistically significant difference (*P*-values > .05) in speech discrimination score values between each other, with and without surgical masks, neither for gender.

This results suggest that gender and age has no relation with speech perception in these group.

For no hearing impairments population, it is outlined that speech discrimination score declines slightly with surgical masks.

An important issue for this population is their healthcare, many research has been published accordingly, like Bandaru et al<sup>5</sup> studied the effect among speech reception thresholds and speech discrimination in normal hearing and healthy people.<sup>5</sup> Healthcare workers with n95 masks and face shield worn by themselves. In this research 20 patients were recruited and observed frequent misunderstandings between healthcare workers and significant impairment of speech perception when healthcare workers worn n95 masks and face shield by themselves.

Realizing that hearing aid wearers have those disadvantages in speech perception, especially in noisy environment, it is important help them to improve and trying to avoid miscommunication between healthcare workers and patients and is interesting develop new communication tools. In this context, Goldin et al<sup>3</sup> describes some tips for talking to patients in hospital settings, like speaks slowly, consider using a portable hearing amplifier, or do not speak to the patient while walking, among other things.<sup>3</sup>

Considering the gain obtained from hearing aids, we get a decrease in perception when surgical masks are worn, so this leads into loss in devices performance. Blocking the benefits that patients could obtain from their devices.

Different options have been proposed like mobile applications, plastic panel masks, face masks programs for hearing aids, etc.<sup>12,13</sup>

Atcherson et al<sup>2</sup> compared speech perception between a surgical face mask and a transparent prototype surgical face mask in normal hearing, moderate, and severe-to-profound hearing loss patients. Thirty patients were included in this study which showed how transparent masks are an option for better intelligibility for patients with severe-to-profound hearing loss compared to surgical masks in a noisy background.<sup>2</sup>

Transparent prototype could support and important contribution to these patients providing non-verbal cues. As we have outlined in our results, lipreading substantially improves speech discrimination in both groups of ages. Like it provides more facial expression allowing a more empathic and clear conversation. This benefits in communication could be obtained easily with these transparent prototype.

As we described previously, age or gender had no statistically significant correlations with changes in speech discrimination in normal hearing and hearing loss sample, suggesting that these results could be applicable to general population.

Another option for those patients could be arranging for visits by video conference when it is necessary to explain something important and thus no physical exploration is needed.

Paper support with different type of diagrams, graphics, drawings, and information may help in different daily life situations or medical visits and contribute to improve communication and understanding.

## CONCLUSION

Disclosure strategies must be adapted to bolster patient communication in the COVID-19 era. These new conditions in hearing loss patients with masks and social distancing must be considered.

Regardless of decibel reduction especially in high frequencies, as we have shown wearing masks results in speech understanding reduction and it is more evident in hearing aids wearers than in normal hearing sample, independent of age.

These challenges are due to sound barrier effect, distortion of speech discrimination, and lack of nonverbal clues as facial expressions and lipreading.

## Strengths and Limitations

Our study reveals weakness of hearing aid users in the COVID-19 era with the use of surgical masks and how communication breakdowns with the decline in speech discrimination score especially in the noisy background. This has not been described before. This information has a crucial role to find out new communication strategies and improve audiologic evaluations.

In age-related hearing loss, patients' cognitive deterioration and dementia may be involved. These circumstances could add difficulties in speech discrimination and lipreading, and it has not been evaluated in this work.



More researches are needed in this sense to reinforce these results and to obtain solid conclusions.

**Ethics Committee Approval:** Ethical committee approval was received from the Ethics Committee of Universidad de Las Palmas de Gran Canaria University (HUGCDN: 2020-449-1).

**Informed Consent:** Written informed consent was obtained from all participants who participated in this study.

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**Declaration of Interests:** The authors declare that they have no conflict of interest.

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