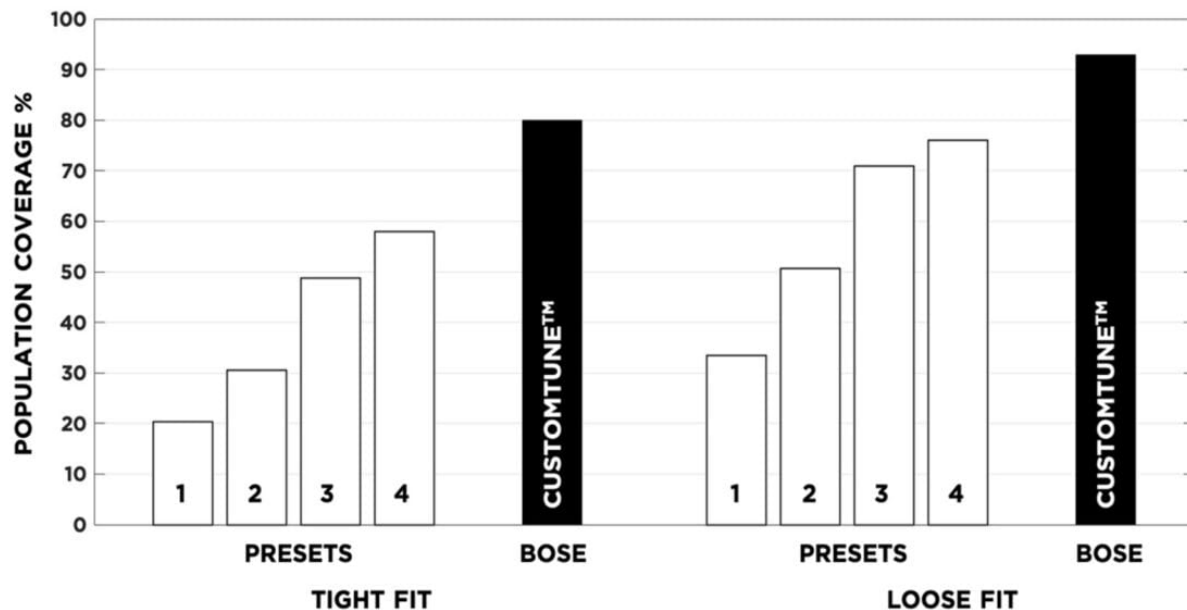


Comparing Population Coverage between Hearing Aids Using Presets vs Bose CustomTune



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The self-fitting Bose SoundControl™ hearing aid is the first of its kind to gain FDA clearance. In the self-fitting process, the Bose Hear app uses the Bose CustomTune™ interface for mapping to a wide range of target gain profiles, derived from a hearing loss database. This article compares the population coverage—or the percentage of people who would be able to find a frequency gain profile similar to a NAL-NL2 prescription fit—of SoundControl to other self-fitting

amplification devices which typically feature only 1 to 4 preset gain profiles.

Hearing aids sold directly to consumers must provide an interface that enables users to select their preferred gain profile. One fundamental trade-off when designing such an interface is finding the balance between:

- a) Making the controls simple enough for a layperson to use, while also
- b) Enabling as many individuals with hearing loss as possible to find a gain profile that meets their auditory needs.

In 2020, [Jensen et al](#)¹ published a study that attempted to quantify this trade-off by computing a value they called *population coverage*. At a high level, this value estimates the percentage of people with hearing loss that would be able to find a gain profile sufficiently similar to what would be prescribed for them. This value is computed for a given user interface with limited options.

Related Article: [Bose Announces First Self-fitting Hearing Aid: SoundControl](#)

In Jensen et al, coverage was estimated for interfaces with a wide range in the numbers of presets (ie, 1 to 20 preset frequency gain configurations designed to suit the individual's amplification needs). In this article, we use the same method to compute coverage for Bose CustomTune™—the primary user interface in the Bose Hear mobile app which is compatible with Bose SoundControl Hearing Aids. This app features two wheels—"World Volume" and "Treble/Bass"—to map to a wide range of target gain profiles that were derived from [hearing loss databases](#) (**Figure 1**).² Using these wheels, the wearer selects his/her own signal processing preferences using the two wheels which control the gain and compression in each frequency band. The

mapping of wheel position to gain is strictly monotonic (always increasing/decreasing) at each frequency band. This constraint simplifies the user interface and creates an experience that is similar to common controls like "volume" and "tone."

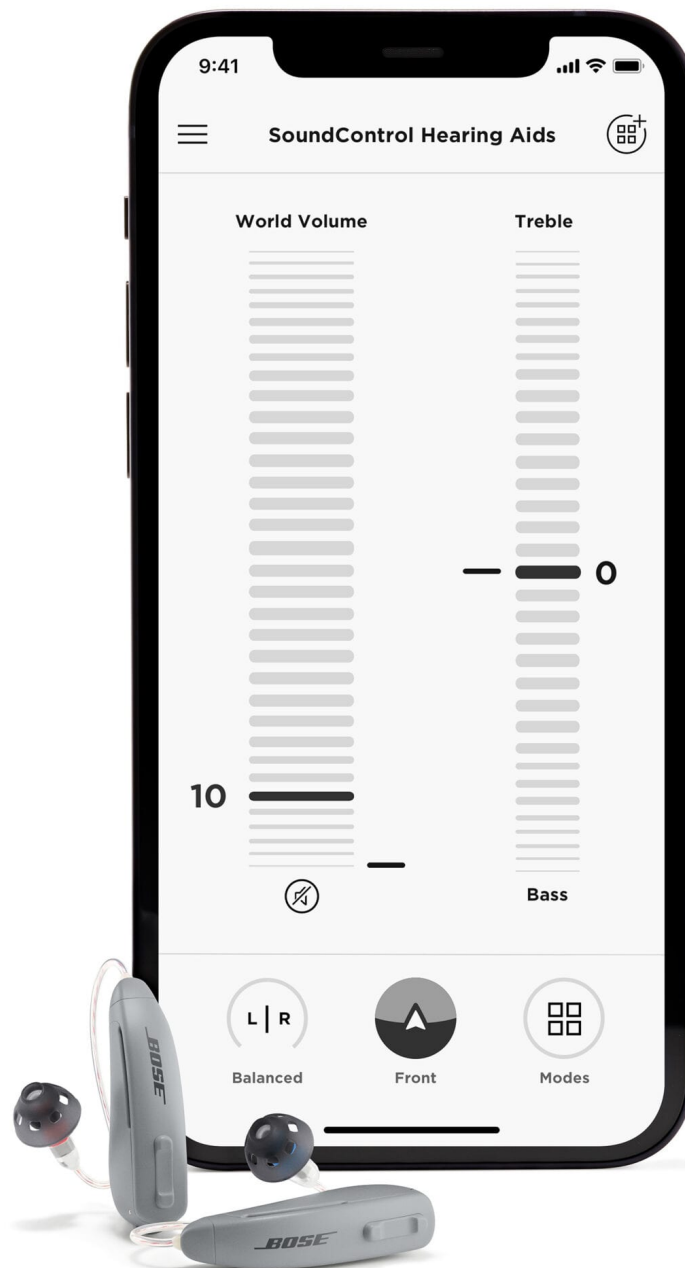


Figure 1. Bose CustomTune features two user-adjusted wheels: World Volume and Treble/Bass.²

Computing coverage begins with the selection of a representative population of individuals with hearing loss. For this study, we used the same 934 audiograms as in Jensen et al.¹ That population was intended to be a representative subset of individuals with mild-to-moderate sensorineural hearing loss from the [NHANES database](#).³ Specifically, they included individuals aged 55-85 years who had normal tympanograms, had three frequency average (0.5, 1, and 2 kHz) air conduction thresholds ≥ 25 dB HL and ≤ 55 dB HL, and had no threshold poorer than 75 dB HL from 0.5-6 kHz. In this study, for each individual in that dataset, we computed their "prescribed" gain settings using [NAL-NL2](#)⁴ software (dll v 2.15) with applied corrections for experienced users, unspecified gender, non-tonal language, and ["dual" compression speed](#).⁵

As in Jensen et al,¹ fits were evaluated via a "Tight" and a "Loose" criterion. A Tight fit occurred when an interface provided a gain profile option within ± 5 dB of a given individual's prescribed NAL-NL2 targets at 3 input levels (55, 65, 75 dB SPL) for 8 frequencies (0.25, 0.5, 1, 2, 3, 4, 6, 8 kHz). (The lowest threshold frequency in the NHANES database is 500 Hz; as in the previous study,¹ here we reused the threshold at 500 Hz in the 250 Hz position.) A Loose fit used the same frequencies but only focused on targets for the 65 dB SPL input.

Finally, the percent coverage (population coverage) is the sum of all of the sample weights of the individuals who satisfied the "fit" criterion divided by the sum of the sample weights across all of the individuals in the data set. (Sample weights are provided in the NHANES database and are used to correct for any demographic mismatch between the sample set and the broader population of the United States.)

Using this calculation, CustomTune is able to fit substantially more of the population than a small number of presets. In a recent study of 28 direct-to-

consumer (DTC) hearing devices, all but one had [4 or fewer presets](#), and the most common number was 1 preset.⁶ For reference, the coverage values associated with 1-4 presets are replotted from Jensen et al¹ in **Figure 2**. As would be expected, the coverage increases with number of presets (20-58% for “Tight” fits and 33-76% for “Loose” fits). The coverage values for Bose CustomTune are higher than all preset conditions (80% for “Tight” and 93% for “Loose” fits).

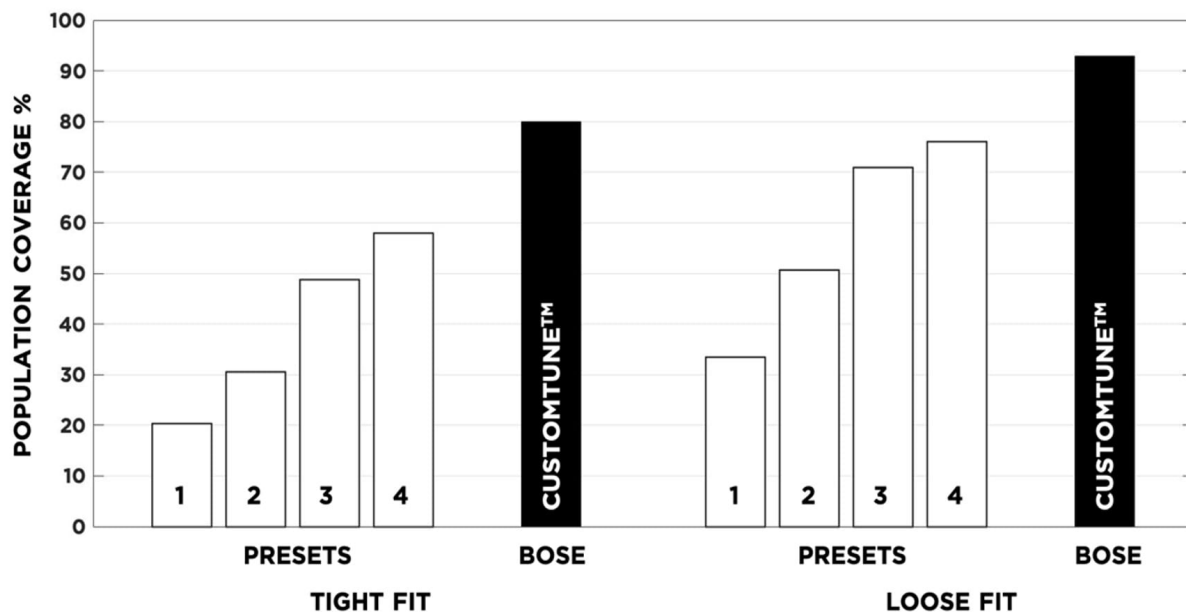


Figure 2. Population coverage values for 1-4 presets (white bars) and Bose CustomTune (black bars) interface. Values are reported for Tight fits (left bars; within ± 5 dB across 8 frequencies at 55, 65, and 75 dB SPL input levels) and Loose fits (right bars; within ± 5 dB across frequencies at only 65 dB SPL input level). Values for “Presets” are replotted from Jensen et al, 2020¹ (REAR clustering).

Further, it is worth noting that this calculation likely overestimates the coverage associated with the preset interface. This is because the presets used in the analysis were derived, via cluster analysis, from the identical 785 hearing losses that were used to evaluate coverage, and therefore can be considered somewhat “overfit.” In contrast, CustomTune was derived from

multiple different datasets than the one used in evaluation coverage and can therefore be considered a test of “generalization” of that interface. It is also worth noting that these calculations do not consider any acoustic limitations of a device, variation in head/ear acoustics, or volume controls.

Overall, these data show that Bose CustomTune can cover substantially more of the population of individuals with mild-to-moderate hearing loss than a device with 1-4 presets. [Goman and Lin](#)⁷ estimated there are 36.4 million individuals in the United States with mild-to-moderate hearing loss. Given this figure, the increased coverage could mean that 6.2-8 million more individuals could satisfy the “fit” criterion with Bose CustomTune than a device with 1-4 presets.

Finally, it is also important to acknowledge that coverage is just one of several criteria that should be used to evaluate a DTC hearing aid. For example, the analysis of coverage does not consider whether each interface can accommodate the sound quality preferences of each user, performance in noise and/or specific listening situations, or many other factors known to influence benefit and satisfaction with amplification devices.



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