

Supplementary Information for:

Demographic factors impact the rate of hearing decline across the adult lifespan

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Supplementary Table 1: Baseline characteristics, including other factors to characterize the study population.

Characteristic	n or mean	% or SD
Age (years)	63.1	14.9
Female sex	828	57.7%
Race		
White	1180	82.2%
Black/African American	246	17.1%
Other	10	0.7%
Socioeconomic position proxy		
Low	242	27.1%
Mid	180	20.2%
High	471	52.7%
Noise exposure	646	47.8%
Diabetes	154	11.2%
Number of cardiovascular risk factors		
0	561	39.0%
1	420	29.2%
2	278	19.3%
3	109	7.6%
4+	70	4.9%
Body mass index (kg/m ²)	26.8	5.3

Note. Details for age, sex, and race are presented in Table 1 (main text) and are included here for ease of interpretation. Only race data are imputed. Citations numbers in definitions section (below) refer to references in the main text. SD: standard deviation.

Definitions:

Socioeconomic position (SEP) proxy: This proxy was determined from participants' number of years of education and baseline occupation.¹ SEP proxy classifications were determined for education and occupation, separately, by classifying education and occupation as low, mid, or high, then these classifications were combined to form a single SEP proxy. Educational classifications were low (high school degree or less; ≤12 years), mid (associate degree or some college; 12 to <16 years) or high (college graduate or more; 16+ years). Occupational classifications were derived from US annual salary data, which were used to classify occupations as low (operatives; labors and helpers; service workers), mid (technicians; sales workers; administrative support workers; craft workers), and high (executive/senior officials and managers; first/mid-level officials and managers; professionals).¹

Noise exposure: Positive history of occupational (including military) noise exposure and/or regular firearm use for at least one year, and/or acute acoustical trauma.²

Diabetes: Self-reported history of diabetes (type 1 or 2).

Number of cardiovascular risk factors: Total number (sum) of self-reported history of the following factors: high cholesterol, chest pain, heart problems, high blood pressure, shortness of breath, stroke.

Body mass index: Self-reported weight in kilograms (kg) divided by self-reported height in meters (m) squared.

Supplementary Table 2: Baseline thresholds and PTA (dB HL), by sex, race, and age group.

	Sex				Race [†]			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
18-39 years (n=154)								
	Female (n=91)		Male (n=63)		White (n=117)		Black/AA (n=31)	
Frequency (Hz)								
250	8.0	7.7	7.1	6.1	7.2	6.1	10.0	9.9
500	6.3	7.5	6.2	6.3	5.8	6.2	8.1	9.7
1000	5.6	8.6	5.5	7.6	5.0	7.9	7.9	9.5
2000	5.2	9.3	7.1	9.8	5.4	9.4	8.6	10.3
3000	3.3	7.3	13.6	18.4	7.7	15.5	7.6	8.3
4000	6.7	11.6	17.0	23.1	11.2	19.3	10.7	14.0
6000	12.4	11.9	21.7	23.6	17.4	19.7	13.3	11.8
8000	9.7	12.5	18.2	20.2	13.9	17.3	11.6	15.0
PTA	6.0	8.2	8.9	9.8	6.8	9.0	8.9	9.7
40-59 years (n=231)								
	Female (n=127)		Male (n=104)		White (n=148)		Black/AA (n=82)	
250	11.9	11.4	10.3	8.3	11.1	10.9	11.5	8.5
500	11.9	11.7	10.6	8.7	11.8	11.6	10.5	8.1
1000	12.8	12.3	13.1	11.1	13.1	12.9	12.7	9.5
2000	15.9	14.6	19.7	16.5	19.1	17.5	15.2	10.9
3000	16.9	16.4	29.7	21.1	25.8	22.1	17.3	12.6
4000	20.8	16.1	38.9	22.1	32.6	23.2	22.7	14.6
6000	27.2	18.4	40.2	22.5	37.4	23.3	25.5	14.4
8000	27.7	19.9	40.7	23.2	37.8	24.2	26.4	16.0
PTA	15.4	11.8	20.6	11.8	19.2	13.2	15.3	9.2
60-69 years (n=547)								
	Female (n=313)		Male (n=234)		White (n=472)		Black/AA (n=73)	
250	14.3	9.0	13.9	9.4	13.9	9.2	15.5	8.7
500	14.7	9.8	13.9	10.7	14.3	10.3	15.0	9.3
1000	15.4	11.5	17.9	13.4	16.4	12.7	17.2	10.9
2000	20.0	14.6	29.9	19.1	24.6	17.8	21.9	14.1
3000	23.8	15.8	44.9	20.3	34.1	20.9	25.2	17.2
4000	29.7	16.1	55.0	20.5	42.4	22.1	29.2	17.9
6000	38.1	18.6	60.5	21.7	49.7	22.7	35.7	19.8
8000	42.0	20.4	61.5	20.7	52.2	22.2	38.9	22.5
PTA	19.9	11.2	29.2	13.0	24.4	13.1	20.8	10.7
70+ years (n=504)								
	Female (n=297)		Male (n=207)		White (n=443)		Black/AA(n=60)	
250	20.6	11.4	18.7	11.7	19.6	11.6	21.5	10.7
500	21.8	12.7	20.1	13.0	20.9	12.8	22.3	12.4
1000	23.6	14.9	25.6	15.6	24.4	15.3	24.2	14.5
2000	30.6	16.1	40.4	20.0	35.1	18.7	31.0	16.6
3000	35.1	16.6	53.6	19.7	44.0	20.1	33.2	17.8
4000	42.4	17.8	64.4	19.0	53.2	20.8	37.8	19.4
6000	52.0	19.2	69.4	19.8	60.8	20.9	46.4	19.3
8000	59.9	19.8	73.1	17.5	66.6	19.5	55.9	20.7
PTA	29.6	13.6	37.6	14.5	33.4	14.4	28.8	14.3

Note. PTA: pure-tone average, calculated from frequencies 500, 1000, 2000 and 4000 Hz averaged across right and left ears; SD: standard deviation; dB HL: decibel hearing level; AA: African American.

[†]Participants who were not white or Black/African American race (categorized as Other race) were excluded from these analyses given small sample size (n=10; see Table 1).

Supplementary Table 3: Adjusted estimates of rates of change of audiometric thresholds and PTA (dB), per year, stratified by sex.

	Females (n=828)			Males (n=608)			Difference by sex
	95% CI			95% CI			
	B	LL	UL	B	LL	UL	p-value
Frequency (Hz)							
250	0.41	0.36	0.46	0.42	0.37	0.48	0.5075
500	0.55	0.50	0.61	0.58	0.52	0.64	0.4960
1000	0.71	0.65	0.77	0.80	0.73	0.87	0.0769
2000	0.91	0.84	0.98	1.07	0.99	1.15	0.0035
3000	0.99	0.93	1.06	0.92	0.84	0.99	0.2014
4000	1.03	0.96	1.10	0.88	0.81	0.95	0.0110
6000	1.22	1.13	1.30	1.01	0.93	1.10	0.0034
8000	1.53	1.44	1.62	1.31	1.22	1.39	0.0007
PTA	0.81	0.76	0.86	0.85	0.80	0.90	0.2832

Note. Estimates (adjusted for race) correspond to those plotted in Figure 1 (main text). B: Beta coefficient; CI: Confidence Interval; LL: Lower limit; UL: Upper limit; PTA: pure-tone average, calculated from frequencies 500, 1000, 2000 and 4000 Hz averaged across right and left ears; dB: decibels.

Supplementary Table 4: Adjusted estimates of rates of change of audiometric thresholds and PTA (dB), per year, stratified by race.

	White (n=1180)			Black/AA [†] (n=246)			Difference by race
	95% CI			95% CI			
	B	LL	UL	B	LL	UL	p-value
Frequency (Hz)							
250	0.44	0.40	0.48	0.30	0.22	0.37	0.0350
500	0.58	0.54	0.63	0.45	0.37	0.54	0.0929
1000	0.79	0.74	0.84	0.57	0.47	0.67	0.0016
2000	1.02	0.96	1.08	0.74	0.63	0.87	0.0006
3000	1.00	0.94	1.06	0.77	0.66	0.89	0.0055
4000	1.00	0.95	1.06	0.83	0.72	0.95	0.0533
6000	1.17	1.11	1.24	0.91	0.76	1.05	0.0191
8000	1.46	1.40	1.53	1.28	1.12	1.44	0.1492
PTA	0.85	0.81	0.90	0.66	0.57	0.76	0.3131

Note. Estimates (adjusted for sex) correspond to those plotted in Figure 2 (main text). B: Beta coefficient; CI: Confidence Interval; LL: Lower limit; UL: Upper limit; PTA: pure-tone average, calculated from frequencies 500, 1000, 2000 and 4000 Hz averaged across right and left ears; dB: decibels; AA: African American.

[†]Participants who were not white or Black/African American race (categorized as Other race) were excluded from these analyses given small sample size (n=10; see Table 1).

Supplementary Table 5: Adjusted estimates of rates of change of audiometric thresholds and PTA (dB), per year, stratified by baseline age group.

	18-40 years (n=154)			41-60 years (n=231)			61-70 years (n=547)			71+ years (n=504)			Difference by baseline age
	95% CI			95% CI			95% CI			95% CI			
	B	LL	UL	B	LL	UL	B	LL	UL	B	LL	UL	p-value
Frequency (Hz)													
250	0.04	-0.13	0.21	0.25	0.09	0.40	0.41	0.34	0.48	0.68	0.57	0.78	0.0002
500	0.15	-0.02	0.31	0.43	0.28	0.58	0.62	0.55	0.69	0.83	0.73	0.93	5.0 x 10 ⁻⁹
1000	0.23	0.04	0.43	0.63	0.47	0.79	0.77	0.69	0.85	1.11	1.10	1.21	1.7 x 10 ⁻⁹
2000	0.25	0.08	0.41	0.67	0.51	0.84	1.05	0.96	1.14	1.29	1.17	1.41	0.0992
3000	0.28	0.02	0.53	0.72	0.56	0.89	0.99	0.90	1.08	1.16	1.05	1.28	0.7793
4000	0.32	0.12	0.52	0.76	0.58	0.93	1.03	0.94	1.12	1.04	0.93	1.15	0.5740
6000	0.31	0.18	0.44	0.84	0.60	1.07	1.17	1.06	1.28	1.30	1.17	1.43	0.8469
8000	0.53	0.26	0.79	1.39	1.12	1.66	1.56	1.46	1.67	1.46	1.32	1.60	0.4207
PTA	0.27	0.12	0.43	0.64	0.51	0.77	0.87	0.81	0.93	1.07	0.98	1.15	0.0005

Note. Estimates (adjusted for sex and race) correspond to those plotted in Figure 3 (main text).
 B: Beta coefficient; CI: Confidence Interval; LL: Lower limit; UL: Upper limit; PTA: pure-tone average, calculated from frequencies 500, 1000, 2000 and 4000 Hz averaged across right and left ears; dB: decibels.

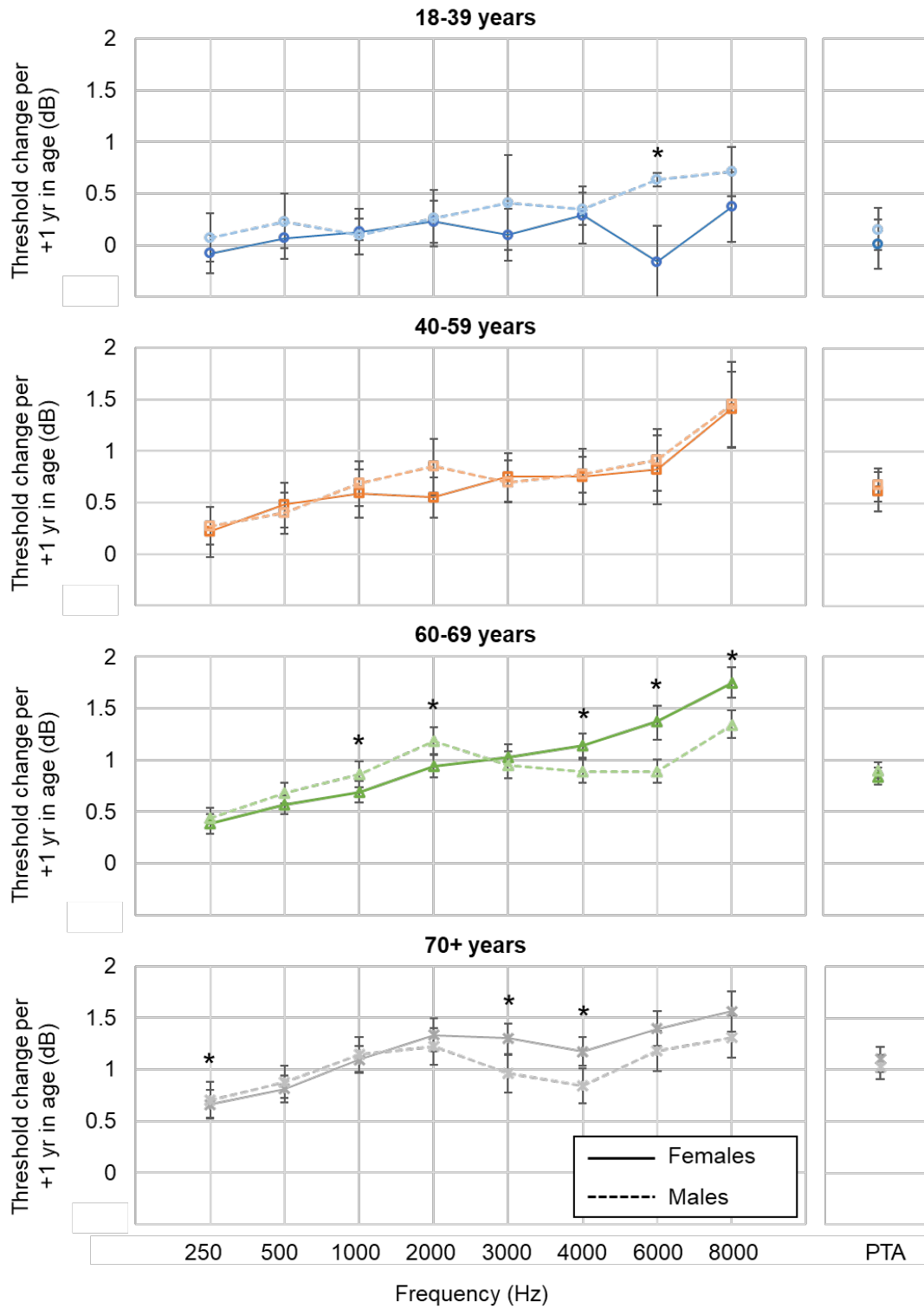
Supplementary Table 6: Unadjusted estimates of rates of change of audiometric thresholds and PTA (dB) per year, stratified by baseline age group, then sex and race.

	Sex						Race†					
	95% CI			95% CI			95% CI			95% CI		
	B	LL	UL	B	LL	UL	B	LL	UL	B	LL	UL
18-39 years (n=154)												
	Female (n=91)			Male (n=63)			White (n=117)			Black/AA (n=31)		
Frequency (Hz)												
250	-0.08	-0.27	0.10	0.07	-0.16	0.31	0.11	-0.06	0.27	-0.08	-0.42	0.27
500	0.07	-0.13	0.26	0.23	-0.03	0.50	0.20	0.04	0.35	-0.28	-0.78	0.22
1000	0.13	-0.09	0.35	0.10	0.05	0.26	0.30	0.12	0.49	-0.04	-0.50	0.42
2000	0.23	0.02	0.43	0.26	-0.01	0.53	0.26	0.07	0.45	0.21	-0.24	0.65
3000	0.10	-0.15	0.35	0.41	-0.05	0.87	0.31	-0.01	0.64	0.49	0.27	0.70
4000	0.29	0.01	0.57	0.35	0.20	0.51	0.25	-0.02	0.53	0.34	-0.26	0.94
6000	-0.16	-0.51	0.19	0.63	0.57	0.70	0.55	0.38	0.72	-0.04	-0.73	0.64
8000	0.37	0.03	0.71	0.71	0.47	0.95	0.76	0.44	1.08	0.02	-0.69	0.74
PTA	0.15	-0.05	0.36	0.25	0.01	0.49	0.28	0.10	0.45	0.06	-0.40	0.51
40-59 years (n=231)												
	Female (n=127)			Male (n=104)			White (n=148)			Black/AA (n=82)		
250	0.22	-0.03	0.46	0.27	0.09	0.46	0.24	0.04	0.44	0.19	-0.05	0.44
500	0.48	0.26	0.69	0.40	0.20	0.60	0.36	0.18	0.54	0.52	0.26	0.77
1000	0.59	0.35	0.82	0.69	0.47	0.90	0.69	0.50	0.89	0.41	0.12	0.70
2000	0.55	0.35	0.74	0.85	0.57	1.12	0.67	0.47	0.87	0.62	0.36	0.88
3000	0.75	0.51	0.98	0.70	0.50	0.91	0.73	0.54	0.92	0.70	0.37	1.03
4000	0.75	0.48	1.02	0.77	0.60	0.94	0.78	0.58	0.98	0.70	0.34	1.07
6000	0.82	0.48	1.15	0.91	0.61	1.21	1.02	0.75	1.29	0.36	-0.01	0.73
8000	1.41	1.04	1.77	1.45	1.03	1.86	1.50	1.18	1.83	1.00	0.57	1.43
PTA	0.61	0.42	0.80	0.67	0.51	0.83	0.62	0.47	0.78	0.63	0.41	0.85
60-69 years (n=547)												
	Female (n=313)			Male (n=234)			White (n=472)			Black/AA (n=73)		
250	0.39	0.29	0.48	0.44	0.34	0.54	0.43	0.36	0.50	0.25	0.02	0.47
500	0.57	0.48	0.66	0.68	0.58	0.78	0.63	0.56	0.70	0.57	0.33	0.81
1000	0.69	0.59	0.80	0.86	0.74	0.99	0.79	0.71	0.88	0.60	0.39	0.82
2000	0.94	0.83	1.06	1.18	1.05	1.32	1.09	1.00	1.18	0.74	0.43	1.04
3000	1.03	0.91	1.15	0.95	0.82	1.08	1.04	0.94	1.13	0.67	0.43	0.91
4000	1.14	1.02	1.26	0.89	0.78	1.01	1.05	0.96	1.14	0.89	0.63	1.15
6000	1.37	1.20	1.53	0.89	0.78	1.01	1.20	1.08	1.32	1.03	0.69	1.38
8000	1.75	1.60	1.90	1.34	1.21	1.48	1.60	1.49	1.71	1.33	1.02	1.65
PTA	0.84	0.76	0.93	0.90	0.82	0.98	0.89	0.83	0.95	0.75	0.55	0.95
70+ years (n=504)												
	Female (n=297)			Male (n=207)			White (n=443)			Black/AA (n=60)		
250	0.66	0.53	0.80	0.70	0.52	0.88	0.70	0.59	0.82	0.50	0.21	0.79
500	0.81	0.68	0.94	0.87	0.72	1.03	0.87	0.76	0.98	0.63	0.43	0.84
1000	1.09	0.96	1.22	1.14	0.97	1.31	1.14	1.03	1.25	0.95	0.68	1.22
2000	1.33	1.17	1.49	1.22	1.04	1.40	1.32	1.19	1.45	1.00	0.67	1.33
3000	1.30	1.15	1.44	0.96	0.77	1.14	1.18	1.05	1.31	0.97	0.69	1.26
4000	1.17	1.03	1.31	0.84	0.67	1.01	1.05	0.93	1.17	0.86	0.57	1.14
6000	1.39	1.22	1.56	1.18	0.98	1.37	1.30	1.16	1.44	1.24	0.81	1.67
8000	1.56	1.36	1.75	1.31	1.11	1.52	1.43	1.28	1.58	1.65	1.09	2.21
PTA	1.10	0.98	1.22	1.03	0.91	1.14	1.10	1.01	1.19	0.81	0.56	1.05

Note. There is uncertainty in stratified analyses in the age group 18-39 years, likely due to small sample sizes; several p-values are >0.05 (see CI). B: Beta coefficient; CI: Confidence Interval; LL: Lower limit; UL: Upper limit; PTA: pure-tone average, calculated from frequencies 500, 1000, 2000 and 4000 Hz averaged across right and left ears; dB: decibel; AA: African American.

†Participants who were not white or Black/African American race (categorized as Other race) were excluded from these analyses given small sample size (n=10; see Table 1).

Supplementary Figure 1: Average rates of audiometric threshold and PTA change (dB) per year, stratified by baseline age group (years), then sex.



Note. There is uncertainty in stratified analyses in the age group 18-39 years; several p-values are >0.05 (see confidence intervals [error bars] and Supplementary Table 4). dB: decibel.

Supplementary Table 7: Unadjusted estimates of rates of change of audiometric thresholds and PTA (dB), per year.

	95% CI		
	B	LL	UL
Frequency (Hz)			
250	0.41	0.37	0.45
500	0.56	0.52	0.60
1000	0.74	0.70	0.79
2000	0.98	0.93	1.03
3000	0.98	0.93	1.03
4000	0.99	0.94	1.04
6000	1.16	1.10	1.23
8000	1.46	1.40	1.53
PTA	0.83	0.79	0.87

Note. B: Beta coefficient; CI: Confidence Interval; LL: Lower limit; UL: Upper limit; PTA: pure-tone average, calculated from frequencies 500, 1000, 2000 and 4000 Hz averaged across right and left ears; dB: decibel.

Supplementary Table 8: Unadjusted estimates of rates of change of audiometric thresholds and PTA (dB), per year, stratified by sex.

	Female (n=828)			Male (n=608)		
	95% CI			95% CI		
	B	LL	UL	B	LL	UL
Frequency (Hz)						
250	0.41	0.36	0.46	0.42	0.36	0.47
500	0.55	0.50	0.60	0.57	0.51	0.63
1000	0.71	0.65	0.77	0.79	0.72	0.86
2000	0.91	0.84	0.98	1.07	0.99	1.15
3000	1.00	0.93	1.06	0.94	0.86	1.02
4000	1.04	0.97	1.10	0.91	0.84	0.98
6000	1.23	1.15	1.31	1.06	0.98	1.14
8000	1.55	1.46	1.63	1.34	1.26	1.43
PTA	0.81	0.75	0.86	0.85	0.80	0.90

Note. B: Beta coefficient; CI: Confidence Interval; LL: Lower limit; UL: Upper limit; PTA: pure-tone average, calculated from frequencies 500, 1000, 2000 and 4000 Hz averaged across right and left ears.

Supplementary Table 9: Unadjusted estimates of rates of change of audiometric thresholds and PTA (dB) per year, stratified by race.

	White (n=1180)			Black/AA [†] (n=246)		
	95% CI			95% CI		
	B	LL	UL	B	LL	UL
Frequency (Hz)						
250	0.44	0.40	0.48	0.31	0.23	0.39
500	0.58	0.54	0.63	0.46	0.37	0.54
1000	0.79	0.74	0.84	0.56	0.46	0.66
2000	1.03	0.97	1.09	0.72	0.60	0.84
3000	1.01	0.95	1.07	0.74	0.63	0.86
4000	1.01	0.95	1.06	0.80	0.68	0.92
6000	1.18	1.11	1.25	0.88	0.74	1.02
8000	1.47	1.40	1.54	1.25	1.09	1.40
PTA	0.86	0.82	0.90	0.65	0.56	0.74

Note. B: Beta coefficient; CI: Confidence Interval; LL: Lower limit; UL: Upper limit; PTA: pure-tone average, calculated from frequencies 500, 1000, 2000 and 4000 Hz averaged across right and left ears. AA: African American.

[†]Participants who were not white or Black/African American race (categorized as Other race) were excluded from these analyses given small sample size (n=10; see Table 1).

Supplementary Table 10: Unadjusted estimates of rates of change of audiometric thresholds and PTA (dB) per year, stratified by baseline age group.

	18-39 years (n=154)			40-59 years (n=231)			60-69 years (n=547)			70+ years (n=504)		
	95% CI			95% CI			95% CI			95% CI		
	B	LL	UL	B	LL	UL	B	LL	UL	B	LL	UL
Frequency (Hz)												
250	0.03	-0.13	0.19	0.24	0.08	0.40	0.41	0.34	0.48	0.67	0.57	0.78
500	0.15	-0.01	0.31	0.43	0.28	0.58	0.62	0.55	0.69	0.83	0.73	0.93
1000	0.25	0.06	0.44	0.63	0.47	0.79	0.77	0.69	0.85	1.11	1.01	1.21
2000	0.27	0.11	0.43	0.67	0.51	0.84	1.05	0.96	1.14	1.28	1.16	1.41
3000	0.34	0.09	0.59	0.73	0.57	0.90	1.00	0.91	1.09	1.16	1.04	1.28
4000	0.37	0.17	0.57	0.77	0.59	0.95	1.04	0.95	1.12	1.04	0.93	1.15
6000	0.30	0.22	0.38	0.87	0.63	1.10	1.19	1.08	1.30	1.30	1.17	1.43
8000	0.58	0.32	0.85	1.42	1.14	1.69	1.58	1.47	1.68	1.46	1.31	1.60
PTA	0.30	0.14	0.46	0.64	0.50	0.77	0.87	0.81	0.93	1.07	0.98	1.15

Note. B: Beta coefficient; CI: Confidence Interval; LL: Lower limit; UL: Upper limit; PTA: pure-tone average, calculated from frequencies 500, 1000, 2000 and 4000 Hz averaged across right and left ears.

Supplementary References

1. Simpson, A. N., Matthews, L. J., Cassarly, C., & Dubno, J. R. Time from hearing-aid candidacy to hearing-aid adoption: A longitudinal cohort study. *Ear Hear.* 40,468-76 (2019).
2. Lee, F. S., Matthews, L. J., Dubno, J. R., & Mills, J. H. Longitudinal study of pure-tone thresholds in older persons. *Ear Hear.* 26,1-1 (2005).