Online Supplemental Material

Supplemental Methods: Intakes of Antioxidants and Magnesium

Dietary Intakes from Food Comsumption.

Dietary β-carotene, vitamin C, vitamin E, and magnesium intakes were estimated on a 24-hour dietary recall (24-h DR) interview. DR interview includes a list of all foods and beverages consumed by the respondent except plain drinking water during the 24-hour period prior to the interview, amounts of the reported foods, and detailed food descriptions (1-3). Individuals with unreliable or incomplete DR records were excluded as recommended by the National Center for Health Statistics (4). In NHANES 2001, dietary intake data were collected using the NHANES computer-assisted dietary interview system (CADI), an automated data collection form using Power Builder™, and several databases (i.e., quick List food list, brand name food list, and food amount unit list) are linked to this system (2). From NHANES 2002 to 2004, data were collected using the US Department of Agriculture (USDA) Automated Multiple Pass method (AMPM) (http://www.ars.usda.gov/ba/bhnrc/fsrg), a fully computerized recall method that uses a 5-step interview (quick list, forgotten foods , time and occasion, detail cycle, and final probe) (2, 3, 5).

NHANES food consumption data were then converted to USDA standard reference code, and food intakes data were linked to their matched nutrient composition database. Coding process for food intakes was conducted by the University of Texas Food Intake Analysis System (FIAS, version 3.99) with the USDA 1994-98 Survey Nutrient Database in the NHANES 2001 [2] and by USDA's Food and Nutrient Database for Dietary Studies, 2.0

(FNDDS 2.0) in the NHANS 2002 to 2004 (2, 3). Daily individual intakes from selected food item were determined by multiplying the content of each nutrient by its daily consumption. Data on participants' daily dietary intakes were estimated as the sum of those from all food sources and available in the NHANES 2001-2004. Each dietary intake reported was adjusted for total energy intake, using the residual method (6).

Nutrient Intakes from Food Consumption and Supplement Use.

Participants were interviewed about their supplement use in NHANES 2001-2004. β-carotene, vitamin C, vitamin E, and magnesium intakes from the supplement sources were estimated using the supplement counts file and supplement use file on dietary supplements questionnaire data and supplement product information file (7, 8) and supplement ingredient information file available on dietary supplement database (9). Ingredients corresponding to each nutrient were selected from the supplement ingredient information and converted to elemental nutrients unit. Next, nutrient composition of supplements was obtained from the supplement product information. Individual nutrient intakes from the supplements were calculated using the supplements counts and use and supplement product information, and participants' daily intakes were computed as the sum of all supplement sources intakes. Estimated total nutrient intake was sum of food- and supplement-sources intakes (10).

Supplemental Table 1. General characteristics of study participants and non-participants (n=3608[1])

Characteristic	Included Participants[2] (N=2592)	Excluded Non-Participants (N=1016)	*P-value*
Speech frequency PTA *(dB)*[3]	12.7 (± 0.35)[4]	16.2 (± 0.53)	*<0.001*
High frequency PTA *(dB)*[5]	18.8 (± 0.59)	23.1 (± 0.84)	*<0.001*
Age *(y)*	42.1 (± 0.33)	41.3 (± 0.46)	*0.210*
Body Mass Index *(kg/m^2)*	28.0 (± 0.14)	28.5 (± 0.39)[6]	*0.195*
Noise exposures			
Occupational noise[7] *(O*NET score)*	3.1 (± 0.02)	3.1 (± 0.03)[8]	*0.256*
Recreational noise *(Exposed %)*	27.5[9]	31.8[10]	*0.056*
Firearm noise *(Exposed %)*	7.8	8.5[11]	*0.646*
Sex *(Male %)*	47.8	49.5	*0.384*
Race ethnicity (%)			*<0.001*
Non-Hispanic White	73.0	66.4	
Non-Hispanic Black	11.2	10.4	
Mexican American	6.8	9.5	
Other	9.0	13.6	
Ototoxic medication *(Current use %)*	14.3	14.2[10]	*0.935*
Cumulative cigarette pack-years (%)			*0.440*
Never	54.4	53.8[12]	
<20	33.2	31.2	
≥20	12.4	15.0	
Current hypertension *(%)*	23.5	25.2[13]	*0.355*
Current diabetes mellitus *(%)*	4.5	6.3[11]	*0.049*

Continuous variables: survey t-test

Categorical variables: 2*2 table or 2*C table : survey X_square (Rao-Scott Chi-Square Test)

[1] Subjects (N=3608) are eligible for the audiometric data

[2] Participants (N=2592) are the individuals having all interest variables in this study: hearing thresholds, nutrient intake, age, BMI, sex, race/ethnicity, ototoxic medication, cumulative cigarette pack-years, hypertension, diabetes, occupation, recreation and firearm noise.

[3] PTA at speech frequencies (Pure tone means at 0.5, 1, 2, 4 KHz)

[4] Four-year weighted mean (± SE) (all such values)

[5] PTA at high frequencies (Pure tone means at 3, 4, 6 kHz)

Non-Participants (N=951[6], 790[8], 1013[10], 1015[11], 698[12], 843[13], and 1016 for the others) are the individuals having the variable to be compared

[7] Occupation noise (1 < O*NET noise scale< 5)

[9] Weighted percentages (all such values)

Supplemental Table 2. Multivariate-adjusted[1] percent change (95% CIs) of hearing thresholds (dB) by dietary (food) intake quartiles (Q).

	Q 1	Q 2		Q 3		Q 4		*p-Trend*
A. Speech frequencies (n=2543)								
β-Carotene[2]	0 (Ref)	-8.68	(-16.48, -0.16)	-12.94	(-19.78, -5.53)	-14.27	(-20.99, -6.98)	*<0.001*
Vitamin C[3]	0 (Ref)	-6.70	(-13.71, 0.89)	-7.19	(-15.85, 2.37)	-6.32	(-13.64, 1.62)	*0.165*
Vitamin E[4]	0 (Ref)	5.51	(-3.02, 14.80)	8.90	(-2.81, 22.01)	3.66	(-5.07, 13.19)	*0.399*
Magnesium[5]	0 (Ref)	-9.63	(-17.02, -1.59)	-9.89	(-19.07, 0.34)	-8.15	(-18.37, 3.34)	*0.208*
AC1[6]	0 (Ref)	-12.89	(-19.87, -5.30)	-14.88	(-21.80, -7.35)	-12.64	(-19.25, -5.48)	*0.002*
AC2[7]	0 (Ref)	-7.30	(-16.71, 3.18)	-6.72	(-13.73, 0.86)	-7.00	(-15.88, 2.80)	*0.166*
B. High frequencies (n=2535)								
β-Carotene[2]	0 (Ref)	-2.66	(-11.26, 6.77)	-9.70	(-16.23, -2.66)	-14.41	(-20.77, -7.53)	*<0.001*
Vitamin C[3]	0 (Ref)	-4.25	(-12.44, 4.71)	-3.34	(-12.34, 6.59)	-7.38	(-14.28, 0.08)	*0.096*
Vitamin E[4]	0 (Ref)	6.06	(-2.61, 15.49)	7.52	(-4.51, 21.06)	2.97	(-6.19, 13.04)	*0.533*
Magnesium[5]	0 (Ref)	-8.12	(-16.72, 1.37)	-11.46	(-20.59, -1.27)	-10.15	(-18.26, -1.24)	*0.036*
AC1[6]	0 (Ref)	-6.00	(-13.58, 2.24)	-11.23	(-19.32, -2.33)	-13.64	(-19.19, -7.71)	*<0.001*
AC2[7]	0 (Ref)	-8.82	(-16.49, -0.45)	-3.72	(-11.59, 4.85)	-10.55	(-18.06, -2.36)	*0.043*

Q, quartile (~25th%; ~median; ~75th %; ~100th %). Q1 is the reference.

[1]Adjusted for age, age[2], sex, race/ethnicity, BMI, ototoxic medication, pack-years of cigarette smoke, hypertension, diabetes, and occupation, recreation and firearm noise

[2] *β*-Carotene Quartiles cut-off points: 375.6, 770, 2024 µg/day

[3] Vitamin C Quartiles cut-off points: 33.65, 65.6, 136 mg/day

[4] Vitamin E Quartiles cut-off points: 0.238, 2.865, 6.3 mg/day

[5] Magnesium Quartiles cut-off points: 221.55, 270.8, 329.4mg/day

[6] Antioxidant composite 1: β-carotene + Vitamin C (0<nutritional score<200); quartiles cut-off points: 63.75, 101.9, 138.15

[7] Antioxidant composite 2: β-carotene + Vitamin C + Vitamin E (0< nutritional score<300); quartiles cut-off points: 106.30, 152.55, 193.5

Supplemental Table 3. Multivariate-adjusted[1] percent change (95% CIs) of hearing thresholds (dB) at differently defined frequencies by total nutrient intake quartiles (Q).

	Q 1		Q 2		Q 3		Q 4	*p-Trend*
A. Speech frequencies at 0.5, 1, 2 kHz (n=2472)								
β-Carotene[2]	0 (Ref)	-7.63	(-15.50, 0.97)	-9.97	(-17.14, -2.19)	-14.23	(-20.32, -7.67)	*<0.001*
Vitamin C[3]	0 (Ref)	-7.26	(-15.55, 1.84)	-11.04	(-17.36, -4.24)	-11.28	(-18.81, -3.06)	*0.007*
Vitamin E[4]	0 (Ref)	5.17	(-6.07, 17.75)	0.91	(-8.08, 10.79)	-6.37	(-14.00, 1.94)	*0.057*
Magnesium[5]	0 (Ref)	-10.10	(-18.26, -1.12)	-9.45	-(17.39, -0.76)	-13.43	(-20.81, -5.36)	*0.007*
AC1[6]	0 (Ref)	-6.37	(-12.78, 0.52)	-14.50	(-21.36, -7.05)	-13.90	(-19.83, -7.54)	*<0.001*
AC2[7]	0 (Ref)	-5.24	(-13.94, 4.34)	-12.90	(-20.43, -4.66)	-12.52	(-18.78, -5.79)	*<0.001*
B. High frequencies at 3, 4, 6, 8 kHz (n=2239)								
β-Carotene[2]	0 (Ref)	-5.53	(-14.00, 3.78)	-12.63	(-20.02, -4.56)	-16.48	(-22.78, -9.66)	*<0.001*
Vitamin C[3]	0 (Ref)	-3.17	(-12.39, 7.01)	-4.15	(-9.96, 2.03)	-10.01	(-17.42, -1.94)	*0.010*
Vitamin E[4]	0 (Ref)	10.31	(-2.46, 24.75)	7.25	(-1.33, 16.58)	-4.52	(-14.17, 6.23)	*0.330*
Magnesium[5]	0 (Ref)	-15.11	(-24.63, -4.39)	-10.50	(-16.38, -4.21)	-14.56	(-22.44, -5.89)	*0.007*
AC1[6]	0 (Ref)	-6.33	(-14.68, 2.83)	-9.77	(-17.62, -1.17)	-14.35	(-19.60, -8.76)	*<0.001*
AC2[7]	0 (Ref)	-5.82	(-13.90, 3.03)	-8.93	(-16.30, -0.91)	-13.48	(-20.10, -6.32)	*0.002*

Q, quartile (~25th%; ~median; ~75th %; ~100th %). Q1 is the reference.
Speech frequencies (speech-PTA at 0.5, 1, 2 kHz)
High frequencies (high-PTA at 3, 4, 6, 8 kHz)
[1] Adjusted for age, age^2, sex, race/ethnicity, BMI, ototoxic medication, pack-years of cigarette smoke, hypertension, diabetes, and occupation, recreation and firearm noise
[2] β-Carotene Quartiles cut-off points: 375.63, 771, 2034 µg/day
[3] Vitamin C Quartiles cut-off points: 44.623, 107, 213.5mg/day
[4] Vitamin E Quartiles cut-off points: 0.944, 6.444, 22.2 mg/day
[5] Magnesium Quartiles cut-off points: 233.49, 294.75, 374.45mg/day
[6] Antioxidant composite 1: β-carotene + Vitamin C (0<nutritional score<200); quartiles cut-off points: 66.3, 101, 137.2
[7] Antioxidant composite 2: *β*-carotene + Vitamin C + Vitamin E (0< nutritional score<300); ; quartile cut-off points: 101.2, 150.6, 200.3

Supplemental Table 4. Percent change (95% CIs) of hearing thresholds (dB) by contribution of different variables (n=2535)

A. Combined effect of β-carotene and Magnesium

Variables	No.	Regression model[1]	
β-carotene and Mg intake			
Low β-carotene, Low Mg	805	0	(Reference)
Low β-carotene, High Mg	464	-7.87	(-14.94, -0.21)
High β-carotene, Low Mg	503	-9.32	(-16.74, -1.23)
High β-carotene, High Mg	763	-14.21	(-20.26, -7.71)
O*NET Noise at longest job *(unit score change)*		19.74	(12.69, 27.23)
Age *(unit year change)*		3.38	(1.56, 5.22)
Age^2 *(unit year change)*		0.00	(-0.01,0.02)
Body mass index *(unit kg/m^2 change)*		0.77	(0.26, 1.27)
Sex			
Male	1186	0	(Reference)
Female	1349	-25.92	(-30.75, -20.76)
Race ethnicity			
Non-Hispanic White	1284	0	(Reference)
Non-Hispanic Black	549	-15.35	(-22.18, -7.91)
Mexican American	510	1.87	(-7.57, 12.27)
Other	192	3.51	(-6.93, 15.13)
Ototoxic medication			
No	2163	0	(Reference)
Yes	372	0.59	(-9.57, 11.89)
Cumulative cigarette packyears			
Never	1431	0	(Reference)
<20	812	12.46	(5.08, 20.36)
≥20	292	17.85	(7.50, 29.21)
Current diagnosis of hypertension			
No	1830	0	(Reference)
Yes	705	4.79	(-0.72, 10.61)
Current diagnosis of diabetes mellitus			
No	2376	0	(Reference)
Yes	159	10.65	(-3.27, 26.56)
Noise Exposure at firearm			
No	2367	0	(Reference)
Yes	168	21.16	(9.70, 33.83)
Noise Exposure at recreation			
No	1910	0	(Reference)
Yes	625	5.43	(-2.84, 14.40)

Supplemental Table 4 (Continued)

A. Combined effect of vitamin C and Magnesium

Variables	No.	Regression model[1]	
Vitamin C and Mg intake			
Low Vitamin C, Low Mg	692	0	(Reference)
Low Vitamin C, High Mg	228	2.13	(-8.49, 13.97)
High Vitamin C, Low Mg	616	-1.33	(-9.37, 7.42)
High Vitamin C, High Mg	999	-10.72	(-16.57, -4.45)
O*NET Noise at longest job *(unit score change)*		20.50	(13.33, 28.11)
Age *(unit year change)*		3.36	(1.57, 5.18)
Age^2 *(unit year change)*		0.00	(-0.01,0.02)
Body mass index *(unit kg/m^2 change)*		0.75	(0.24, 1.26)
Sex			
Male	1186	0	(Reference)
Female	1349	-25.74	(-30.72, -20.39)
Race ethnicity			
Non-Hispanic White	1284	0	(Reference)
Non-Hispanic Black	549	-15.46	(-22.38, -7.93)
Mexican American	510	0.96	(-8.53, 11.43)
Other	192	2.75	(-7.43, 14.04)
Ototoxic medication			
No	2163	0	(Reference)
Yes	372	0.38	(-9.75, 11.66)
Cumulative cigarette packyears			
Never	1431	0	(Reference)
<20	812	12.20	(4.62, 20.33)
≥20	292	18.04	(7.21, 29.95)
Current diagnosis of hypertension			
No	1830	0	(Reference)
Yes	705	5.25	(-0.43, 11.25)
Current diagnosis of diabetes mellitus			
No	2376	0	(Reference)
Yes	159	11.00	(-2.51, 26.37)
Noise Exposure at firearm			
No	2367	0	(Reference)
Yes	168	20.91	(9.33, 33.72)
Noise Exposure at recreation			
No	1910	0	(Reference)
Yes	625	5.71	(-2.55, 14.66)

[1] Multivariate models defined in Table 5 were used.

Supplemental References

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