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Research Article

The Association Between Socioeconomic, Demographic, Serum Vitamin A, Serum Carotenoids and all-Cause Mortality of Adults

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Abstract

Background

This study investigated the association between socio-demographic factors, serum vitamin A, serum carotenoids and mortality in adults.

Patients and Methods

Public use National Health and Nutrition Examination Survey (NHANES III) data were used. NHANES III complex probabilistic household adult, laboratory and mortality data were merged. Only sample persons examined in the Mobile Examination Center were included in this study.

Results

There were 3400 sample persons had complete data and were used in this analysis. The mean age (S.E.) was 474 (465-484) months. The mean risk of death (S.E.) was 0.16 (0.14 – 0.18); the mean follow up from their MEC examination (S.E.) was 169 months (164 – 176). After multivariate analysis, the significant variables, odds ratios (95% confidence intervals) were: body mass index (BMI), 1.023 (0.993 - 1.053); age (MXPAXTMR) 1.0092 (1.0082 - 1.0101); poverty income ratio (DMPPIR), 0.824 (0.752 - 0.903); drinking hard liquors (HAN6JS), 1.011 (1.0014 - 1.020); and alpha carotene (ACPSI), 0.00045 (7.00e-06 - 0.02861).

Conclusion

Serum alpha carotenoid level was associated with decreased mortality in adults after adjustment for socio-demographic factors.

Introduction

Vitamin A is a group of micronutrients that has important physiologic functions and has been found to be deficient in south pacific [1]. Its deficiency has a significant effect on child mortality [1]. Carotenoids have been found to be associated with lower adult mortality. Mechanistically, blood vitamins and carotenoids are thought to be mediated by lowering inflammatory molecules [2]. In particular, carotenoids were found to interact with other micronutrients leading to their overall effects on mortality [3]. The interaction between socio-economic factors and serum carotenoid levels on mortality has not been investigated fully. This study used NHAENS III and NHANES III mortality linked data files to study the association between socio-demographic factors, serum vitamin A, serum carotenoid concentrations and all-cause mortality. This study, was a part of a series screening for potential chemicals with beneficial health effects, took advantage of the vastness of the public use NHANES III (National Health and Nutrition Examination Survey) data to adjust for various socio-economic covariates in assessing the health effects of nutrition.

Materials and Methods

NHANES and NHANES III

NHANES is a major program of National Center of Health Statistics (a part of Center of Disease Control (CDC) of United States of America) started in 1971. NHANES III is a national study based on a complex, multi-stage probability sampling design. For details of NHANES data and statistical guidance as well as their analysis examples see NHANES website [4]. In brief, NHANES studies were approved by CDC internal institutional review boards. The public use data are made available to the public and researchers. The NHANES sample weights were calculated to represent non-institutionalized general US population to account for non-coverage and non-response. These patients were interviewed at home and examined in mobile examination centers (MEC). This eliminated the cofounding effects of sample persons being too frail, too young or old to go to the MEC for examinations. In this study, NHANES III (conducted between1988 – 1994) household adult data file was merged with NHANES III laboratory data and the NHANES III linked cancer mortality data.

NHANES III linked mortality data

NHANES III participants were followed passively until December 31, 2006 for their mortality data. Detailed information about the data and analysis guidelines are available at their website [5]. In brief, probability matching was used to link NHANES III with National Death Index for vital status and mortality, age 90 years old was censored because they contribute little in person years. NHANES used multiple sources including the use of death certificates and with the National Death Index to ascertain vital status and cause of death.

Statistical analysis

NHANES III employed a complex sampling strategy and analysis [6]. Matlab programs (posted on Matlab File Exchange) were developed to convert SAS files provided by NAHNES to STATA programs to download NHANES III data files for further analysis. Specialized survey software is needed for NHANES complex data analysis [7]. STATA 12 (College Station, TX) was among those recommended by CDC to analyze the complex NHANES data and was used in this study. The sampling weight used was WTPFEX6 because only the sample persons had examinations in the MEC were included in this study, SDPPSU6 was used for the probability sampling unit (PSU) and SDPSTRA6 was used to designate the strata for the STATA survey commands. STATA scripts were written for this analysis, and will be submitted for publication separately. Univariate and multivariate logistic regressions were used to study the relationship between serum retinyl ester (REPSI, umol/L), vitamin A (VAPSI, umol/L), alpha carotenoid (ACPSI, umol/L) and beta carotenoid (BCPSI, nmol/L) concentrations and all cause in adults (17 years or older). The status of mortality was coded as a binary outcome (1= death, 0 = otherwise). Linearized Taylor Standard Error estimation was used. The covariates and the corresponding NHANES III codes used were: MXPAXTMR (age at the MEC final examination in months), HSSEX (sex, _IHSSEX_1 = male, female as the reference group when applicable), HAM6S (weight in lbs without clothes), DMPMETRO (urban rural residence status), _IDMPMETRO_2 (rural residence, urban residence was used as the reference group), DMARETHN (race and ethnicity, _IDMARETHN_2 = non-Hispanic black, _IDMARETHN_3 = Mexican Americans, _IDMARETHN_4 = others, non-Hispanic white was used as the reference group), DMPPIR (poverty index ratio), HAN6JS (alcohol consumption, number of hard liquor drinks per month), and HAR4S (smoking, number cigarettes per day). For STATA analyses, only the patients without missing values for all of WTPFEX6, SDPPSU6, SDPSTRA6, REPSI , VAPSI, ACPSI, BCPSI, MXPAXTMR, HSSEX, DMPMETRO, DMARETHN, DMPPIR, HAR4S, and HAN6JS were included in this study. Further, these additional NHANES III codes considered not eligible: DMPPIR (888888), the numerator of DMPPIR was the midpoint of the observed family income category in the Family Questionnaire variable:HFF19R, and the denominator was the poverty threshold, the age of the family reference person, and the calender year in which the family was interviewed, HAR4S (666), HAR4S (777), HAR4S (888), HAR4S (999), HAN6JS (888), HAN6JS (999), not in BMI > 15 & BMI < 50, REPSI (8888), VAPSI (888), ACPSI (8888), BCPSI (88888), youth sample persons and incomplete mortality data. A total of 3400 sample persons were eligible for this study.

Results

The general characteristics of the NHANES III linked mortality data were as follows. In brief, there were 20024 cases in NHANES III linked mortality data file. 13944 cases were not available in the public use file to protect the privacy of youth subjects. 26 cases in the NHANES III linked dataset did not have mortality data. All cause mortality (5291 deaths out of 33994 subjects, only deaths with a known ucod_113 code for the underlying cause of death were included) was used as the binary outcomes for this analysis. The NHANES III adult data file and the NHANES III linked mortality file were merged according to the SEQN number provided by NHANES III to uniquely identify the cases. All the results were obtained by using survey command taking into account the primary sampling unit and stratification variables and the weights assigned to the sample persons examined in the MEC. Thus these results are representative of the US population.

There were 3400 sample persons (Table 1) had complete data and were used in this analysis. The mean age (S.E.) was 474 (465-484) months. The mean risk of death (S.E.) was 0.16 (0.14 – 0.18); the mean follow up from their MEC examination (S.E.) was 169 months (164 – 176); the mean serum retinyl ester concentration (umol/L) was 0.176 (0.169-0.183); the mean serum Vitamin A concentration (umol/L) was 1.993 (1.959-2.027), the mean serum alpha carotene concentration (nmol/L) was 0.055 (0.052-0.058), and the mean serum alpha carotene concentration (nmol/L) was 0.244 (0.231-0.258). The mean BMI (S.E.) was 25.22 (24.93 – 25.52).

	Linearized		
	Mean	Std. Err.	[95% Conf. Interval]
Indicator Death	.1560986	.0086575	.1387006 .1734965
BMI	25.2253	.1451987	24.93351 25.51708
MXPAXTMR	474.5718	4.661745	465.2036 483.9399
HSSEX	1.454068	.0081235	1.437743 1.470392
DMPMETRO	1.570341	.0527762	1.464283 1.676399
DMARETHN	1.354327	.0334284	1.28715 1.421504
DMPPIR	2.677877	.0691747	2.538866 2.816889
HAR4S	19.81768	.4478975	18.9176 20.71777
HAN6JS	2.779617	.2804729	2.215986 3.343249
permth_exm	169.963	2.924377	164.0862 175.8397
REPSI	.1760991	.0033379	.1693914 .1828068
VAPSI	1.993047	.0166964	1.959495 2.0266
ACPSI	.0545333	.0014991	.0515207 .0575459
BCPSI	.2443912	.0067528	.2308209 .2579614

Table 1. Baseline demographic, socioeconomic and health status univariables. Indicator Death: 0=alive, 1=dead. Linearized Taylor Standard Error estimation was used. The NHANES III codes used were: BMI (body mass index), HSSEX (sex), MXPAXTMR (age at the MEC final examination), DMPMETRO (urbanicity), DMARETHN (race and ethnicity), DMPPIR (poverty index ratio), HAN6JS (alcohol consumption), and HAR4S (smoking)), REPSI (serum retinyl ester concentration in S.I. units), VAPSI (serum Vitamin A concentration in S.I. units), ACPSI (serum carotene concentration in S.I. units), BCPSI (serum beta carotene concentration in S.I. units). n = 3400 samples.

For univariate analysis, the significant univariates, odds ratios (95% confidence intervals) were: body mass index (BMI), 1.029 (1.0023 - 1.057); age (MXPAXTMR), 1.0086 (1.0076 - 1.0097); poverty income ratio (DMPPIR), 0 .918 (0 .855 - 0 .985); drinking hard liquors (HAN6JS), 1.017 (1.00043 - 1.033674); retiny ester (REPSI), 3.563 (1.1794 - 10.764); vitamin A (VAPSI), 1.450 (1.065 - 1.973); and beta carotene (BCPSI), 2.092 (1.308 - 3.346).

For multivariate analysis, the significant variables (Table 2) were body mass index (BMI), 1.023 (0.993 - 1.053); age (MXPAXTMR) 1.0092 (1.0082 - 1.0101); poverty income ratio (DMPPIR), 0.824 (0.752 - 0.903); drinking hard liquors (HAN6JS), 1.011 (1.0014 - 1.020); and alpha carotene (ACPSI), 0.00045 (7.00e-06 - 0.02861).

	Linearized				
IndicatorDeath	Odds Ratio	Std. Err.	t	P>|t|	[95% Conf. Interval]
BMI	1.022975	.0149091	1.56	0.126	.9934491 1.053379
MXPAXTMR	1.009177	.0004797	19.22	0.000	1.008214 1.010142
_IHSSEX_2	.7602913	.1566076	-1.33	0.190	.5025835 1.150143
_IDMPMETRO_2	1.007627	.1298549	0.06	0.953	.7777269 1.305487
_IDMARETHN_2	1.327688	.2223734	1.69	0.097	.9482444 1.858967
_IDMARETHN_3	.7667569	.1909206	-1.07	0.291	.4648851 1.264648
_IDMARETHN_4	.8531367	.2708044	-0.50	0.619	.4508056 1.614537
DMPPIR	.8240518	.0374848	-4.25	0.000	.7520637 .9029306
HAN6JS	1.010543	.004595	2.31	0.025	1.001351 1.019819
HAR4S	.9992633	.0081926	-0.09	0.929	.9829346 1.015863
REPSI	2.784153	1.624606	1.75	0.086	.8618432 8.994104
VAPSI	1.132916	.2069269	0.68	0.498	.7848565 1.635328
ACPSI	.0004474	.0009257	-3.73	0.001	7.00e-06 .0286059
BCPSI	1.151076	.2484066	0.65	0.517	.7460397 1.776014
_cons	.0011399	.0006963	-11.09	0.000	.000334 .00389

Table 2. Multivariate analysis of covariates of all cause mortality. IndicatorDeath: 0=alive, 1=dead. Linearized Taylor Standard Error estimation was used. The NHANES III codes used were: BMI (body mass index), HSSEX (_IHSSEX2 = female, using male as the reference group), MXPAXTMR (age at the MEC final examination), DMPMETRO (urban rural residence status, _IDMPMETRO_2 = rural residence, urban residence used as the reference group), DMARETHN (race and ethnicity, _IDMARETHN_2 = non-Hispanic black, _IDMARETHN_3 = Mexicans, _IDMARETHN_4 = others, non-Hispanic white used as the reference group), DMPPIR (poverty index ratio), HAN6JS (alcohol consumption), and HAR4S (smoking)), REPSI (serum retinyl ester concentration in S.I. units), VAPSI (serum Vitamin A concentration in S.I. units), ACPSI (serum carotene concentration in S.I. units), BCPSI (serum beta carotene concentration in S.I. units). n = 3400 samples.

Discussion

This study analyzed the NHANES III data and HNAHES III linked mortality data that represented US non-institutionalized population as designed by NHANES. There were 3400 sample persons (Table 1) had complete data and were used in this analysis. The mean age was 39 years and 6 months old. The mean follow up was 14.1 years. They have a mean serum retinyl ester concentration (S.E.) (umol/L) of 0.176 (0.169-0.183), a mean serum Vitamin A concentration (umol/L) of 1.993 (1.959-2.027), a mean serum alpha carotene concentration (nmol/L) of 0.055 (0.052-0.058), and a mean serum beta carotene concentration (nmol/L) of 0.244 (0.231-0.258). On average, their income was 2.7 times higher than the poverty level.

For univariate analysis, the significant univariates, odds ratios (95% confidence intervals) were: body mass index , age, poverty income ratio, drinking hard liquors, retiny ester, vitamin A and beta carotene, 2.092 (1.308-3.346). To ensure a more conservative analysis for not missing any potential covariates, all of the univariates were included in the multivariate analysis. For multivariate analysis, the significant variables (Table 2) were body mass index, age, poverty income ratio, drinking hard liquors, and alpha carotene. The effects of racial disparities [8] and the adverse effects of smoking, obesity and drinking [9] on mortality have been reported and were supported by this study.

After adjustment for these socio-demographic factors, only alpha carotenoids remained a significant predicator of adult mortality.

Conflict of Interest

No conflict of interest.

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