FISH CONSUMPTION AND HYPERTENSION INCIDENCE IN AFRICAN AMERICANS AND WHITES: THE NHANES I EPIDEMIOLOGIC FOLLOW-UP STUDY

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We sought to test the hypothesis that increased consumption of fish is associated with decreased incidence of essential hypertension. Data on fish consumption and incidence of hypertension from a national cohort of 5,394 blacks and whites normotensive at baseline and followed 10 years in the NHANES I Epidemiologic Follow-up Study (NHEFS) were analyzed.

Our results showed that whites aged 25–74 years had no significant association of fish consumption with incidence of hypertension. In black women, after adjusting for multiple risk factors, those who increased their fish intake from <1 time/week to ≥1 time/week had RR = 0.42, 95% CI 0.22–0.81, p = 0.009. However, those with high intake both times had adjusted RR = 0.75, 95% CI 0.45–1.26, p = 0.28.

No consistent significant associations of fish consumption with hypertension incidence were found, perhaps because fish consumption in this population was low. Further studies are needed in blacks. (*J Natl Med Assoc.* 2001;93:124–128.)

Key words: hypertension ◆ fatty acids ◆ omega-3 ◆ fish oils

INTRODUCTION

High fish consumption levels have been associated with reduced stroke and coronary heart disease mortality in several reports.[1,2] Possible mechanisms include the beneficial effects of n-3-polyunsaturated fatty acids (n-3-PUFA) from fish oil on blood pressure.[1,2] A recent meta-analysis of controlled trials of fish oil for blood pressure lowering concluded a dose-response effect of fish oil on blood pressure, with significant effects in hypertensive subjects and those with atherosclerotic disease or hypercholesterolemia.[3] The proposed mechanism is through stimulation of certain prostaglandins that affect sodium and water excretion, cause vasodilation, inhibit thromboxane, affect renin release, and decrease pressor response to hormones.[3] A few ecologic studies suggest an effect of dietary fish intake on blood pressure.[4] However, data are lacking on the effect of fish consumption on incidence of hypertension in prospectively studied cohorts. The epidemiologic follow-up to the first National Health and Nutrition Examination Survey (NHANES) provided an oppor-

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tunity to test the hypothesis that fish consumption once or more per week is associated with reduced hypertension incidence compared to no fish consumption in a large cohort of black and white women and men drawn from a sample of the U.S. population.

METHODS

The NHANES I Epidemiologic Follow-up Study (NHEFS) participants were those examined in NHANES I who were 25–74 years of age at the time of the survey in 1971–1975 (n = 14, 407).[5–8] This analysis was based on survivors at the initial phase of follow-up, which took place during 1982–1984 and included personal interviews in the home. At the end of the follow-up interview, the participant's pulse rate, and three consecutive blood pressure readings were attempted by the trained interviewer. Blood pressure was measured with the subject seated using a sphygmomanometer of the mercury type.[7,8] At baseline, a physician measured blood pressure once with the examinee seated using a standard sphygmomanometer of the mercury type or aneroid type.[9] Incident hypertension patients met the following criteria:

1. A follow-up blood pressure (first reading) ≥ 160 mmHg systolic and/or 95 mmHg diastolic.
2. A follow-up history of currently taking medication for high blood pressure.

The date of incidence onset was estimated as the date of the follow-up examination in 1982–1984, since interim blood pressure measurements were not available.

For assessment of fish consumption at baseline and at follow-up, a three-month food frequency questionnaire, which included "fish or shellfish" (baseline), or "fresh/frozen fish" and "canned fish" (follow-up) was administered by trained personnel, usually registered dietitians.[5,10] Based on these two assessments, subjects were categorized as follows: consumed fish <1 time/week at baseline and follow-up (reference group); consumed fish ≥1 time/week at baseline and < 1 time/week at follow-up; consumed fish <1 time/week at baseline and ≥1 time/week at follow-up; consumed fish ≥1 time/week at baseline and follow-up.

This analysis is limited to 11,214 white and black persons 25–74 years of age at baseline who received nutrition questionnaires. Of these persons, 823 (7.3%) were lost to follow-up and not included in the final analysis. To exclude participants with hypertension at baseline, 3,225 persons were eliminated who had baseline blood pressure ≥160 mmHg systolic and/or 95 mmHg diastolic or were regular or occasional users of medication for high blood pressure at baseline. Persons who had ever been told by a doctor that they had high blood pressure but who had blood pressure <160 mmHg systolic and 95 mmHg diastolic and were not users of medication for high blood pressure were considered at risk for development of hypertension and hence were included in this analysis. However, baseline blood pressure was considered as a possible confounder in the analysis. Persons were excluded who died, had no in-person interview, for whom blood pressure was not measured at follow-up and who had missing baseline data on fish consumption, or on the following confounding variables: systolic and diastolic blood pressure, pulse rate, body mass index, alcohol intake, recreational or nonrecreational physical activity, education, diabetes history, history of blood pressure medication use, smoking, or serum cholesterol concentration. Women pregnant at baseline or follow-up were also excluded. After all exclusions, there were 4,778 white and 616 black persons for analysis. The length of follow-up in the NHEFS for this analysis ranged from 8.0 to 12.6 years, average 10.4 years for white and 10.6 years for black survivors.

Statistical Analysis

Estimates of the risk of hypertension for persons with greater fish consumption relative to those with lowest fish consumption derive from Cox proportional hazards models and the SAS procedure PHREG.[11] All models included age at baseline in single years as a covariate. A time-dependent covariate, and inspection of $-\log(-\log)$ survival curves for parallelism were used to assess proportional hazards assumptions.[11] To assess the effect of the sample weights on the results, regression analyses were done using sample weights and taking the complex survey design into account using the SUDAAN procedure.[12,13] The results were consistent with minimal effects of weighting on the main conclusions derived from the unweighted estimates, which have

Table 1. Incident Cases of Hypertension at Follow-up by Sex, Age, Race at Baseline

Gender	Race	Age (yr)	Total cases	Treated cases	Noncases	Number at risk
Men		25–44 yr	110	69	774	884
	White		92	58	715	807
	Black		18	11	59	77
		45–64 yr	159	112	479	638
	White		132	95	437	569
	Black		27	17	42	69
		65–74 yr	102	60	279	381
	White		90	53	256	346
	Black		12	7	23	35
Women		25–44 yr	264	222	2030	2294
	White		190	156	1782	1972
	Black		74	66	248	322
		45–64 yr	194	158	577	771
	White		169	137	523	692
	Black		25	21	54	79
		65–74 yr	152	108	274	426
	White		134	93	258	392
	Black		18	15	16	34
Total			981	729	4413	5394

smaller variances. Therefore, only the data from the unweighted Cox regression models are presented.

RESULTS

Table 1 shows the number of incident cases of hypertension by sex, race, and age at baseline by hypertension status at follow-up. Compared to nonhypertensive subjects, patients with hypertension detected at follow-up tended to have higher BMI, age, systolic blood pressure, and a greater frequency of baseline history of diabetes (not shown).

In whites aged 25–74 years, no association of fish consumption with incidence of hypertension could be demonstrated (Table 2). Nor were consistent associations seen in blacks aged 25–74. No interaction of fish consumption with age was noted. In black women, after adjusting for multiple risk factors, those increasing intake had RR = 0.42, 95% CI 0.22–0.81, p = 0.009. However, those with high intake both times had adjusted RR = 0.75, 95% CI 0.45–1.26, p = 0.28. No significant associations were seen in black men aged 25–74. In a subgroup of 2540 black and white subjects with baseline history of hypertension, heart disease or stroke, or serum cholesterol >240 mg/dl, fish consumption was not associated with hypertension incidence.

DISCUSSION

No previous cohort studies of dietary fish intake and hypertension incidence were found. Many placebo-controlled trials of fish oil supplements have been conducted.[3,14–16] A recent meta-analysis of 31 trials concluded there was no detectable effect in healthy subjects, and a small but statistically significant effect most consistent in hypercholesterolemic and less so in hypertensive subjects.[3] Larger though nonsignificant effects were seen in a few trials in patients with cardiovascular disease. A dose-response effect was noted with significant blood pressure lowering seen only at doses in excess of 3 g per day. Most trials used fish oil supplements; only two small studies in male volunteers used fatty fish supplements, reporting no effect on blood pressure.[14,15] The Lugalawa study compared Tanzanians in a fishing village with those in a nearby farming village.[4] People in the fishing village consumed 300–600 g of lake fish daily (three or four fish meals per day) and had lower blood pressure (123/72 vs. 133/76) and prevalence of definite hypertension (2.8% vs. 16.4%) than the vegetarian farmers. The fish intake of the lake villagers was among the highest observed in the world and likely contained 3–5 g daily of n-3 PUFA, which explains the large blood

Table 2. Relative Risks for Incidence of Hypertension Associated with Fish Consumption at Ages 25–74 Years: NHANES I Epidemiologic Follow-up Study 1971–1984

Fish consumption frequency, times/week		Age-adjusted RR (95% CL)	Risk-adjusted* RR (95% CL)
Baseline	Follow-up		
		White men	
<1	<1	1.00	1.00
≥1	<1	0.82 (0.59–1.12)	0.86 (0.62–1.18)
<1	≥1	0.84 (0.60–1.18)	0.87 (0.62–1.23)
≥1	≥1	0.91 (0.69–1.19)	0.86 (0.65–1.14)
		Black men	
<1	<1	1.00	1.00
≥1	<1	1.06 (0.47–2.39)	0.96 (0.40–2.28)
<1	≥1	1.51 (0.70–3.26)	1.46 (0.62–3.44)
≥1	≥1	1.01 (0.52–1.98)	0.87 (0.43–1.77)
		White women	
<1	<1	1.00	1.00
≥1	<1	0.87 (0.66–1.14)	0.96 (0.73–1.26)
<1	≥1	1.03 (0.79–1.34)	1.00 (0.77–1.30)
≥1	≥1	1.08 (0.86–1.36)	1.04 (0.83–1.32)
		Black women	
<1	<1	1.00	1.00
≥1	<1	0.78 (0.42–1.46)	0.70 (0.36–1.36)
<1	≥1	0.56 (0.30–1.03)	0.42 (0.22–0.81)†
≥1	≥1	0.90 (0.56–1.44)	0.75 (0.45–1.26)

*Adjusted for baseline age, smoking, history of diabetes, education < high school graduate, systolic blood pressure, serum cholesterol concentration, body mass index, pulse rate, alcohol intake, and physical activity.
†$p \geq 0.01$.
RR = relative risk; 95% CL, 95% confidence limits.

pressure effect. NHEFS findings of no effect of fish intake on hypertension incidence are consistent with these findings that very high intakes of fish or fish oil supplements are required before any blood pressure effect can be observed, even in hypertensive or hypercholesterolemic persons. The amount of fish consumed by persons in NHEFS was likely too low to have a measurable acute effect on blood pressure.

CONCLUSION

NHEFS failed to provide any evidence that eating fish once per week over long periods is sufficient to reduce the incidence of hypertension, although it was shown to be associated with reduced incidence of stroke in women.[1] Because of the present findings in black women regarding increasing fish consumption (see above), the previously reported striking association of fish consumption with reduced stroke risk in blacks,[1] and the striking blood pressure findings from Tanzania,[4] further research on fish consumption and hypertension and stroke prevention in blacks are urgently needed.

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