Predictors of Risk and Protection for Hypertension in Yup'ik People from Southwest Alaska

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Objective: Hypertension (HTN) contributes to vascular disease, and is increasingly common in non-western, rural contexts, such as the Yup'ik people of Southwestern Alaska. While much is known regarding HTN risk factors in western contexts, little is known about their relevance to non-western populations. We explore an American Heart Association risk factor model for HTN in predicting risk and protection from HTN among Yup'ik people.

Methods: Using data from 1015 Yup'ik individuals residing in remote Southwestern Alaska, we explore age, sex, education, waist circumference, physical activity, tobacco, social support, and cultural identification in multinomial logistic regressions comparing pre-hypertension (pre-HTN; systolic 120 to 129 mm Hg), and hypertension (HTN; systolic ≥130 mm Hg) to optimal blood pressure (opt-BP; systolic <120 mm Hg).

Results: We find positive associations between age (2%, 5% greater odds respectively), waist circumference (3%, 5% greater odds respectively) and hypertension medication usage (60%, 85% greater odds respectively) with both pre-HTN and HTN. We also find men have 86% greater odds of pre-HTN, people with fasting blood glucose ≥110 mg/dL have 52% increased odds of pre-HTN, and married persons have 19% lower odds of having pre-HTN compared to having opt-BP. Bicultural identification mitigates age related increases in BP and deleterious effects of low formal education.

Conclusions: While model continuities are noted in our Yup'ik study, important points of divergence are also noted. Future research on cultural identification and social support has promising implications for guiding responsive interventions. (*Ethn Dis.* 2013;23[4]:484–491)

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Key Words: Hypertension, Alaska Natives, American Indians, Blood Pressure

Introduction

Hypertension (HTN) continues to be an important risk factor for cardiovascular disease (CVD) despite improved awareness and treatments.[1,2] The American Heart Association (AHA) identifies significant factors associated with development of HTN in Western countries to include age, sex, high salt intake, increased alcohol intake and physical inactivity.[3] Hypertension has also emerged as a major global health problem where two-thirds of stroke and half of ischemic heart disease may be attributable to non-optimal blood pressure (BP).[4] Though 80% of CVD deaths occur in low and middle income countries, research on HTN in non-western and rural communities remains sparse.[4,5] The Institute of Medicine report, *Promoting Cardiovascular Health*, suggests that identifying mechanisms for the collection of local data, including BP measures, as well as elucidating social-contextual and community factors in HTN, are critical to meeting this global health challenge.[5]

In Alaska, approximately 50% of Alaska Native people live in small rural communities, and have varying degrees of reliance on subsistence foods; the Yup'ik have traditionally followed a subsistence lifestyle which includes following the seasonal shifts in the availability of different fish, sea mammals, game and plants such as berries. Prevalence of premature death from CVD among Alaska Native people has historically been low.[6] However, more recent data indicate that this pattern of lower CVD risk may be changing, aligning itself more closely with other Native American groups.[7]

Despite these trends, risk factors for HTN in Alaska Native people are understudied and there is a paucity of research on the applicability of Western risk models in native populations. Examining a model of HTN applicable to non-Western groups can contribute to our understanding of risk and protective factors for HTN, which may help guide interventions among Alaska Native people as well as other nonwestern, rural groups in a variety of global health settings. Our study aims to test the applicability of the AHA risk factor model of HTN, and explore other variables that may enhance the predictive power of a model of HTN.

Methods

Our analysis addresses one of the primary aims of the Center for Alaska Native Health Research (CANHR)

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study by elucidating risk factors associated with CVD in Alaska Natives. The aims and methods of CANHR are detailed elsewhere.[8] Briefly, CANHR is based in the Yukon-Kuskokwim (YK) Delta in Southwest Alaska, a large sparsely inhabited area of approximately 30,000 Yup'ik people. There are no roads in the region; communities are accessed by plane, snowmobile or boat. We conducted our research in 10 communities (five coastal and five inland). Study protocols were approved by the National and Alaska Area Indian Health Service Institutional Review Boards (IRB), the University of Alaska IRB, and the Yukon-Kuskokwim Health Corporation Human Studies Committee. Additionally, each tribal government passed a formal resolution to participate in the study. Recruitment and data collection occurred over 1–2 weeks in each community between 2003–2006. All residents of Alaska Native descent, non-pregnant and aged ≥14 years at the time of enrollment were invited to participate. There was a high level of community support for the study, with about 30% of community members enrolled.

Measures

Resting BP was measured using an automated BP cuff and after five minutes of quiet, three measurements were obtained. Hypertension medication history was retrieved from chart review. Fasting blood samples and anthropometric measurements were obtained by trained staff.[9] Blood was collected to assess genetic data, triglycerides, total cholesterol, HDL, LDL, blood glucose levels as well as several hormones, metabolites, cytokines, vitamins and minerals.[8]

Participants reported age, sex, education, lifetime smoking, marital status, and number of biological children. Physical activity was assessed by asking "How many times per week do you engage in simple/moderate/vigorous activity for at least 20 minutes?" Cultural identification was assessed using items adapted from the Orthogonal Cultural Identification Scale, which theorizes that level of identification with a culture can range from not at all to highly and is mutually exclusive from identification with another culture. It has been used to measure cultural affiliation of minority groups in comparison to White American culture. Oetting and colleagues report high reliability, as well as convergent and discriminate validity of the scale.[10,11] We asked participants on a 3-point scale (not at all, some, a lot), "How much do you follow the traditional Yup'ik way of life?" (enculturation), and "How much do you follow the White American (Kass'aq) way of life?" (acculturation). Alcohol is prohibited in these communities, therefore data were not collected. Dietary data were collected on a small subsample of CANHR participants and not included.

Statistical Analyses

Guided by the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC7), we categorized systolic blood pressure (SBP) into <120 mm Hg (optimal blood pressure: opt-BP), ≥120 mm Hg and <130 mm Hg (pre-hypertension: pre-HTN), and ≥130 mm Hg (HTN).[12] Any HTN medication was modeled dichotomously (user/nonuser). Blood glucose levels were dichotomized as ≤110 mg/dL (referent) and >110 mg/dL.[12] We dichotomized waist circumference at >88 cm for women; >102 cm for men.[13] Education was dichotomized as <9 years and ≥9 years (referent). Marital status was dichotomized as married vs not married (single-never married, separated, divorced or widowed persons; reference group). Number of biological children was categorized as those with 0 children, 1, 2 or 3 children and those with 4 or more children. Physical activity was assessed as meeting/not meeting AHA guidelines of 150 minutes a week of moderate-intensity or 75 minutes of vigorous-intensity aerobic physical activity for adults.[14] Smoking was modeled dichotomously as ever/never.

We combined the questions regarding level of ethnic identification based on models of biculturalism that suggest level of identification with Yup'ik and White culture may not be independent.[10,11] Few people reported not identifying with either Yup'ik or White culture so we combined those reporting not identifying with those reporting some level of identification. We then created four mutually exclusive categories representing individuals that identify strongly with Yup'ik culture (strong Yup'ik identification only), those that identify strongly with White culture (strong White identification only), those that identify strongly with both Yup'ik and White culture (bicultural identification), and those that do not identify strongly with either culture (diffuse identification).

We calculated the age-adjusted prevalence of definitive hypertension (systolic/diastolic blood pressure ≥140/90 mm Hg) using the direct method and the 1990 US non-institutionalized adult population for comparison. We calculated mean SBP across levels of cardiovascular risk factors stratified by age and sex. We constructed a series of multinomial logistic regression models using persons with opt-BP as the reference category. We present bivariate and fully adjusted models.

Based on prior observations that younger individuals and those with more education consumed less traditional food and had less nutritious dietary profiles,[15] we assessed whether age and education modified the association between cultural identification and HTN. We present predicted probabilities of pre-HTN or HTN from models including product terms between cultural identification and age or education. Probabilities are calculated for a male, with a waist circumference of 90cm, who meets the recommended levels of physical activity, has

never smoked, is married and has ≥4 kids. We used age 37 in the model assessing effect modification by education and <9th grade educational level in the model assessing effect modification by age.

RESULTS

The Center for Alaska Native Health Research (CANHR) study included 1015 persons and after deletion of missing data, our analytic sample contained 921 persons: 54% women; median age is 36 [IQR = 22–50]; and 98% identified as Yup'ik/Cup'ik. Distribution of study variables are presented in Table 1. We report an age-adjusted prevalence of definitive hypertension among those aged ≥20 years to be 17%. Prevalence of HTN increased with age such that approximately 15.5% of individual's aged 20–50 were hypertensive, compared to 34.6% of individuals 50–60, and 52.4% of individuals ≥60 years.

Table 1 shows the mean SBP across levels of our cardiovascular risk factors stratified by age and sex. There are age related increases in BP in both men and women. Individuals with a larger waist circumference had a higher mean BP for all age groups except women >50. There is little variation in BP by physical activity within age and sex groups. There was no observed systematic patterning of blood pressure by chew or snuff use. In most age-sex groups a higher blood glucose level was associated with a higher mean BP. In nearly all age-sex groups the non-married group had higher mean BP levels than married persons. Overall, having children was associated with a lower mean BP than no children. Individuals prescribed medication for HTN had higher mean SBP than individuals not prescribed medication. Across levels of cultural identification mean SBP generally increased with age for both sexes although not always significantly. Biculturally identified persons in particular did not have large increases in mean systolic BP with age.

Table 2 displays results from our multinomial logistic regressions for outcomes of pre-HTN, and HTN (opt-BP is the referent). Age, waist circumference, ever smoking, and HTN medications are positively associated with HTN or pre-HTN compared to opt-BP. Men have 86% greater odds of pre-HTN, those with blood glucose >110 mg/dL have 52% increased odds of pre-HTN, and married persons have 19% lower odds of pre-HTN compared to opt-BP. We report marginally significant associations between strong Yup'ik identification only and having HTN (P=.08), diffuse identification and HTN (P=.11) or pre-HTN (P=.09) compared to strong White identification only.

Figures 1 and 2 graphically represent models of effect modification of the association between cultural identification, and pre-HTN and HTN, by age and education. Individuals who self-report as strong Yup'ik identity only, strong White identity only, or a diffuse identity have similar changes in the predicted probability of having pre-HTN as they age; in contrast persons reporting bicultural identification appear to be buffered from the effects of aging (Figure 1a). A similar graded relation exists between biculturalism and age for the probability of HTN. (Figure 1b). Biculturalism negates the effect of low formal education on pre-HTN (Figure 2a) but patterning of the association between cultural identity and HTN by education is less clear; it appears that education does not have as strong of an effect on HTN as with pre-HTN (Figure 2b).

DISCUSSION

In the CANHR survey of BP among Yup'ik peoples, we report an overall age-adjusted prevalence of definitive hypertension of 16.6%. We report a lower age-adjusted prevalence of HTN among this Yup'ik population than among non-Hispanic whites (23%), non-Hispanic blacks (32%) and Mexican Americans (23%) from NHANES.[16] Similar to NHANES, we find that among Yup'ik people approximately half (52%) of the adult participants had blood pressure within the optimal range (SBP <120 mm Hg). The Strong Heart Study of Native Americans reported a HTN prevalence similar to NHANES III despite a higher prevalence of diabetes and obesity.[17]

Despite the lower prevalence compared to non-Hispanic whites, HTN prevalence in this Yup'ik population is greater than previously reported among Alaska Native people. Indeed, data from samples collected between 1950–80 report very low prevalence of HTN (eg, <3% systolic BP >125mm Hg),[18–20] with exceptions among specific Aleut groups thought to be related to diet.[21] More recent studies report HTN prevalence between 10–15%.[22,23] The increasing prevalence of hypertension is parallel to the increasing prevalence of other cardiovascular disease risk factors.[6,24] Importantly, CHD and stroke mortality rates have remained relatively consistent for Alaska Native people between the 1980s and 2000s while rates for non-Native Alaskans have decreased.[6,25] The increasing levels of CVD risk factors may explain the lack of improvement in CVD mortality rates and their continued increase is suggestive of a rapid epidemiologic transition among Alaska Native people, which may portend increases in

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Table 1. Mean systolic blood pressure by cardiovascular risk factors stratified by age and sex of subjects in a rural Alaska Yup'ik community sample (*N*=1015) in the CANHR study 2003–2006

			Women									Men							
			<30 Years			30–50 Years			≥50 Years			<30 Years			30–50 Years			≥50 Years		
Variable	*n*	%	*n*	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*	Mean	SD
Unadjusted			194	109.7	9.7	209	116.4	13.5	141	130.3	18.3	190	121.2	9.9	152	121.5	10.6	117	128.0	17.2
Formal education																				
<9 yrs	213	21.3	32	107.1	10.1	5	109.3	12.2	86	132.1	18.4	31	116.7	9.1	3	120.8	6.0	55	131.0	20.0
≥9 years	785	78.7	160	110.2	9.6	202	116.6	13.5	50	127.7	18.2	154	122.4	9.7	148	121.6	10.6	60	125.7	13.8
Waist Circumference – ATP 3 metabolic syndrome cut points ≥88 cm women; ≥102 cm men																				
Meets threshold	374	37.6	16	124.9	9.5	31	124.4	8.6	38	126.9	15.3	54	112.5	11.2	138	119.1	13.3	97	132.7	19.1
Below threshold	621	62.4	173	120.9	9.8	121	120.7	10.9	75	128.3	18.5	140	108.4	8.8	70	110.7	11.9	42	123.9	14.7
Recommended physical activity level																				
Yes	481	47.9	97	109.8	10.3	86	115.2	12.8	45	128.9	20.9	117	120.9	10.4	80	122.3	11.4	56	125.1	20.0
No	524	52.1	98	109.5	9.2	123	117.2	13.9	96	130.9	17.0	73	121.7	9.1	72	120.6	9.6	62	130.7	13.7
Tobacco use – ever smoker																				
Ever	522	51.4	67	111.6	9.3	79	118.2	13.8	54	129.7	18.0	122	122.9	9.9	103	122.2	11.6	90	129.5	17.1
Never	493	48.6	128	108.7	9.8	130	115.2	13.2	87	130.6	18.5	68	118.1	9.2	49	120.0	8.0	28	123.5	17.1
Fasting blood glucose																				
≤110	947	94.3	194	109.7	9.7	200	115.8	13.2	123	130.2	18.8	187	121.0	9.7	141	121.7	10.4	102	127.3	17.8
>110	57	5.7	1	110.3	NA	8	131.0	11.6	18	130.5	14.8	3	136.2	12.9	11	118.6	12.3	16	133.0	11.6
Marital status																				
Married	461	45.6	33	109.6	10.6	152	116.1	13.4	98	129.4	17.2	18	120.6	7.2	78	121.7	9.0	79	127.2	16.8
Single/div/sep/wid	549	54.4	162	109.7	9.6	57	117.1	13.7	42	132.5	20.9	169	121.3	10.2	73	121.5	12.1	39	129.7	18.0
Number of biological children																				
0	341	35.1	113	110.0	9.9	20	117.9	16.6	15	133.5	17.1	126	120.9	9.7	42	121.9	11.9	23	129.2	18.7
1–3	266	27.4	56	110.5	9.5	64	116.4	12.6	23	133.2	24.3	40	124.8	9.0	53	121.6	9.8	28	126.7	11.0
≥4	364	37.5	14	107.6	10.7	122	115.8	13.3	101	129.3	16.9	6	119.7	6.8	51	121.9	10.4	64	128.5	19.3
Hypertension medication use																				
Yes	141	14.8	1	110.7	NA	23	129.9	15.6	71	135.8	17.9	2	132.5	9.7	6	127.0	9.1	38	129.2	21.7
No	810	85.2	184	109.2	9.2	175	114.5	12.1	69	124.3	16.9	171	121.1	9.5	137	121.3	10.5	74	127.4	14.6
Cultural identification (ID)																				
Strong Yup'ik ID only	293	38.1	35	109.6	9.8	64	114.3	13.2	65	131.0	19.3	42	119.5	9.5	41	123.5	9.6	45	129.5	20.3
Bicultural ID	57	7.4	13	107.5	13.3	9	118.3	18.0	10	124.5	14.3	6	122.2	13.5	11	125.7	15.6	8	120.0	11.3
Diffuse ID	347	45.1	86	109.8	9.1	79	116.3	12.2	30	134.6	18.2	77	121.8	9.5	48	122.2	10.8	26	129.4	16.6
Strong White ID only	72	9.36	19	110.1	9.3	20	121.1	14.5	2	127.7	9.0	15	125.1	11.2	10	115.1	7.4	6	129.6	7.8

Table 2. Multinomial logistic regression models comparing the odds of having hypertension or pre-hypertension compared to those with optimal blood pressure across American Heart Association cardiovascular risk factors in a rural Alaska Yup'ik community sample (*N*=1015) in the CANHR study 2003–2006

	Bivariate		Fully Adjusted	
	HTN vs opt BP	Pre HTN vs opt BP	HTN vs opt BP	Pre HTN vs opt BP
Variable	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Demographics				
Age, years	1.07 (1.05, 1.08)	1.03 (1.02, 1.04)	1.05 (1.03, 1.07)	1.02 (1, 1.03)
Sex - female referent	1.21 (.99, 1.47)	1.66 (1.45, 1.91)	1.23 (.94, 1.6)	1.88 (1.58, 2.23)
Education - ≥9th grade referent	1.67 (1.35, 2.07)	1.13 (.95, 1.34)	1.06 (.76, 1.47)	1.05 (.84, 1.3)
Body composition measure				
Waist circumference, cm	1.05 (1.04, 1.07)	1.03 (1.02, 1.04)	1.05 (1.03, 1.06)	1.03 (1.02, 1.04)
Physical activity				
Meets recommended minutes of PA per week	.88 (.73, 1.08)	.88 (.77, 1.01)	1.13 (.89, 1.45)	.91 (.78, 1.07)
Tobacco use				
Ever smoker	1.61 (1.31, 1.98)	1.33 (1.16, 1.53)	1.56 (1.2, 2.02)	1.07 (.91, 1.26)
Blood glucose ≤ 110 mg/dL				
> 110 mg/dL	2.4 (1.6, 3.62)	2.11 (1.49, 2.99)	1.28 (.79, 2.07)	1.52 (1.04, 2.23)
Marital status - single/separated/div/widowed referent				
Married	1.32 (1.08, 1.61)	1.07 (.93, 1.22)	.81 (.61, 1.07)	.82 (.67, 1.01)
Number of alive biological children - none referent				
1–3	1.22 (.94, 1.6)	1.13 (.95, 1.33)	.93 (.66, 1.32)	1.09 (.87, 1.37)
≥4	1.61 (1.27, 2.03)	1.19 (1.02, 1.4)	.86 (.6, 1.23)	1.08 (.83, 1.39)
Hypertension medication use - none referent				
Yes	3.29 (2.53, 4.28)	1.92 (1.52, 2.42)	1.85 (1.33, 2.56)	1.6 (1.21, 2.11)
Ethnic Identification (ID) - Strong White ID only referent				
Strong Yup'ik ID only	1.31 (1.02, 1.68)	1.00 (.84, 1.2)	1.32 (.97, 1.79)	1.05 (.85, 1.29)
Bicultural ID	1.06 (.67, 1.66)	.90 (.66, 1.23)	1.18 (.7, 1.99)	.98 (.68, 1.42)
Diffuse ID	1.04 (.81, 1.35)	1.02 (.86, 1.2)	1.3 (.94, 1.78)	1.18 (.97, 1.43)

HTN, hypertension - systolic blood pressure >130 mm Hg; Pre HTN, pre-hypertension - systolic blood pressure 120–129 mm Hg; opt-BP, optimal blood pressure - systolic blood pressure <120 mm Hg.

coming years. The rapid epidemiologic transition for Alaska Natives may be characterized by the introduction of processed foods, sugar-sweetened beverages, and a shift away from dependence on hunting and gathering toward sedentary lifestyles.

We report important similarities and differences between our model of hypertension risk with the AHA model. In agreement with the AHA model, we report positive associations with increasing age, male sex, smoking, larger waist circumference, and elevated FBG. In contrast with the AHA model, we found a low prevalence of self-reported diabetes (<3%) with no significant relationship to HTN; however, we report a significant relationship between having a FBG >110 mg/dL and HTN. In a sensitivity analysis, we found 78% of persons with FBG >110 mg/dL reported no diabetes suggesting that undiagnosed diabetes may be a significant concern. Being married was protective against pre-HTN and HTN. Marital status has been associated with protective effects for vascular mortality as well as vascular risk in urban cohorts,[26,27] but to our knowledge this effect has not been demonstrated in Alaska Native people. While numerous categorizations of physical activity were explored, we find no relationship with HTN in this Yup'ik sample. One explanation is that our baseline measures of activity may not adequately capture the type and quantity of activity in rural Yup'ik communities. In particular, hunting, fishing, gathering and processing subsistence foods may be protective despite being low intensity activities because of their duration.[28]

We report borderline statistically significant increased odds of HTN among those with strong Yup'ik identification and diffuse identification. Moreover we find bicultural identification buffered the age related increases in hypertension as well as the deleterious effects of low formal education. Yup'ik people have high exposure to salt through many traditional foods,[29] which may partially explain the increased risk

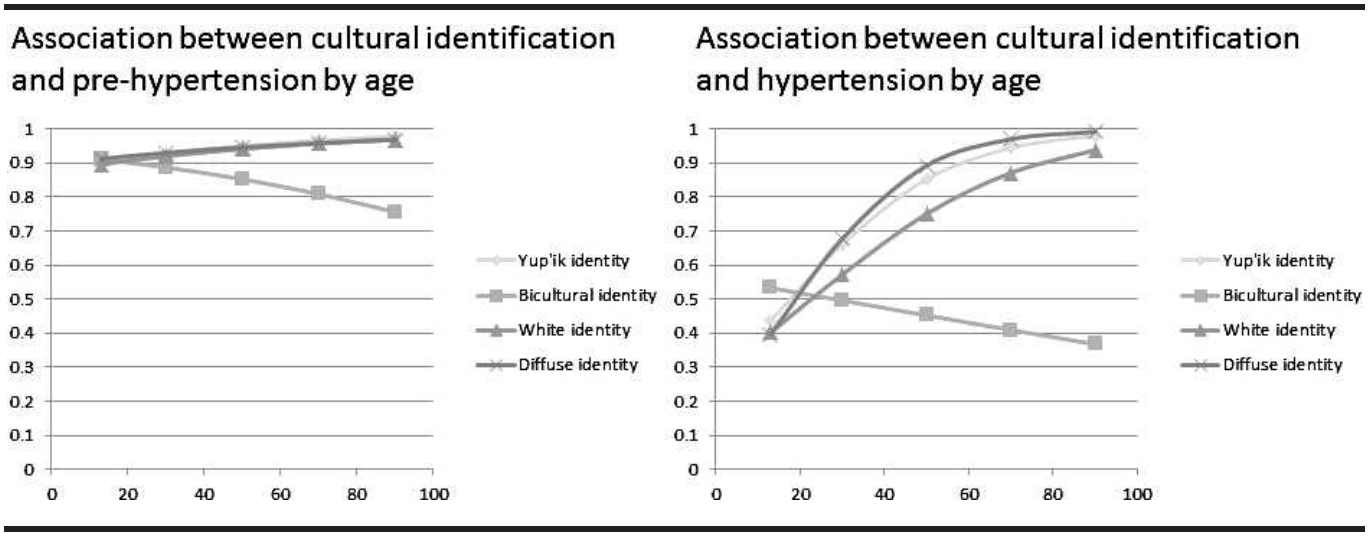

Fig 1. Predicted probabilities of having pre-hypertension (pre-HTN; systolic blood pressure 120–129 mm Hg) (Figure 1a), or hypertension (HTN; systolic blood pressure 130+ mm Hg) (Figure 1b) compared to optimal blood pressure (opt-BP; systolic blood pressure <120 mm Hg) from multinomial logistic regression models that include product terms between cultural identification and age, controlling for other CVD risk factors. Data come from the CANHR study in a rural Alaska Yup'ik community sample (*N*=1015) collected between 2003–2006

among those that strongly identify as Yup'ik only. However, further research is necessary to understand optimal dietary balance as other aspects of their diet are salubrious.[30,31] A meta-analytic review found positive associations between acculturation and BP generally; importantly they find that migration to a Western society was associated with the largest effect size that diminished over time.[32] Similarly, persons with a diffuse cultural identity in our study do not identify with the two dominate cultures in the region and may experience distress related to feelings of alienation which may partially

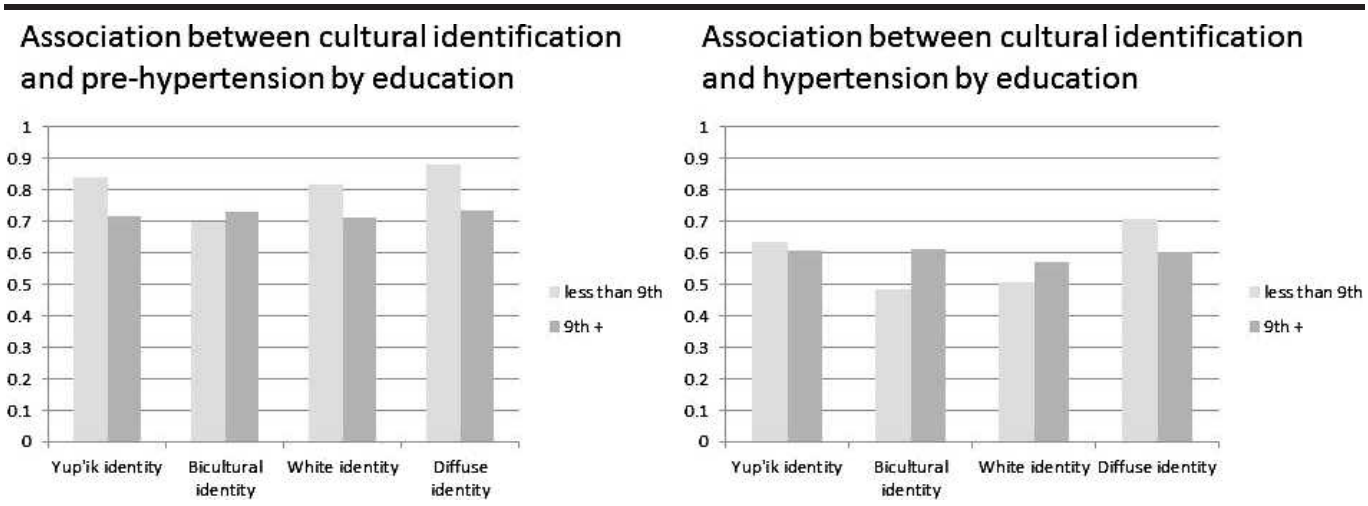

Fig 2. Predicted probabilities of having pre-hypertension (pre-HTN; systolic blood pressure 120–129 mm Hg) (Figure 2a), or hypertension (HTN; systolic blood pressure 130+ mm Hg) (Figure 2b) compared to those with optimal blood pressure (opt-BP; systolic blood pressure <120 mm Hg) from multinomial logistic regression models that include product terms between cultural identification and education, controlling for other CVD risk factors. Data come from the CANHR study in a rural Alaska Yup'ik community sample (*N*=1015) collected between 2003–2006

Probabilities are calculated for a male, with a waist circumference of 90cm, who meets the recommended levels of physical activity, has never smoked, is married and has 4+ kids. We used age 37 in the model assessing effect modification by education and a less than 9th grade level of education in the model assessing effect modification by age

explain their increased risk. Finally, biculturalism may be an adaptive response to the pressures of rapid epidemiologic transition.[33] Indeed Yup'ik conceptions of health view competence in both cultures as having a positive effect on health.[34] Some approaches to promoting health in Yup'ik communities have focused on the protective effects of strengthening ties to Yup'ik culture (ie, observing a traditional lifestyle and diet).[35]

LIMITATIONS AND CONCLUSION

Although this is one of the first surveys of blood pressure and hypertension among Alaska Native people in Southwestern Alaska, our results may be limited by the cross sectional nature of the data. Random sampling methods were not acceptable to the communities in this study and the capture of participants in a non-randomized manner may have introduced bias in the sample. We were unable to collect data on alcohol use, an important risk factor for hypertension. Alaska has one of the highest rates of per capita alcohol consumption in the United States and health complications have been documented in Alaska Native populations,[36] however there is no data specifically from the YK Delta. As Segal points out there are important differences in patterns of use between Alaska Natives and Western populations that make it difficult to predict how this unmeasured confounding may be biasing our results.[37] Similarly we only have limited dietary data; the nature of population-based research (ie, flying into remote villages for 1–2 week stays) makes it difficult to systematically collect data on all participants. Moreover, the seasonal nature of hunting and gathering introduces measurement error into traditional food frequency questionnaires. However, we believe some of this effect is reflected in the associations between cultural identity and hypertension. Our study considers only acculturative strategies adopted by the individual, and does not consider larger changes within the society. Finally, each community and tribal affiliation is unique, and generalizations of these results to other Alaska Native and Native American populations may be limited.

While our findings suggest that HTN and associated risk factors in these culturally distinct, geographically dispersed tribal communities share some epidemiological commonality with Western populations, we also report important differences from a Western model of HTN. These differences suggest important avenues for culturally responsive and effective intervention for HTN. Understanding the impact of rapid epidemiologic transition on HTN, and appreciating its burden within cultural and geographic contexts are critical next steps to designing global solutions to this health problem.

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