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The Association between C-Reactive Protein and Hypertension of Different United States Participants Categorized by Ethnicity: Applying the National Health and Nutrition Examination Survey from 1999-2010

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***Abstract*—Objectives:** The main objective of this study was to examine the association between the elevated level of C-reactive protein (CRP) and incidence of hypertension before and after adjustments for age, BMI, gender, SES, smoking, diabetes, cholesterol LDL and cholesterol HDL, and to determine whether the association differs by race. **Method:** Cross sectional data for participants from aged 17 years to 74 years, included in The National Health and Nutrition Examination Survey (NHANES) from 1999 to 2010 were analyzed. The CRP level was classified into three categories (> 3 mg/L, between 1 mg/L and 3 mg/L, and < 3 mg/L). Blood pressure categorization was done using JNC 7 indicator. Hypertension is defined as either systolic blood pressure (SBP) of 140 mmHg or more and diastolic blood pressure (DBP) of 90 mmHg or more, otherwise a self-reported prior diagnosis by a physician. Pre-hypertension was defined as 139 ≥ SBP > 120 or 89 ≥ DBP >80. Multinominal regression model was undertaken to measure the association between CRP level and hypertension. **Results:** In univariable models, CRP concentrations > 3 mg/L were associated with a 73% greater risk of incident hypertension compared with CRP concentrations < 1 mg/L (Hypertension: odds ratio [OR] = 1.73; 95% confidence interval [CI], 1.50-1.99). Ethnic comparisons showed that American Mexicans had the highest risk of incident hypertension (OR = 2.39; 95% CI, 2.21-2.58). This risk was statistically insignificant after controlling by other variables (Hypertension: OR = 0.75; 95% CI, 0.52-1.08), or categorized by race [American Mexican: OR= 1.58; 95% CI, 0.58-4.26, Other Hispanic: OR = 0.87; 95% CI, 0.19-4.42, Non-Hispanic white: OR = 0.90; 95% CI, 0.50-1.59, Non-Hispanic Black: OR = 0.44; 95% CI, 0.22-0.87. The same results were found for pre-hypertension, and the Non-Hispanic black segment showed the highest significant risk for Pre-Hypertension (OR = 1.60; 95% CI, 1.26-2.03). When CRP concentrations were between 1.0 and 3.0 mg/L in unadjusted models, prehypertension was associated with higher likelihood of elevated CRP (OR = 1.37; 95% CI, 1.15-1.62). The same relationship was maintained in Non-Hispanic white, Non-Hispanic black, and other race (Non-Hispanic white: OR = 1.24; 95% CI, 1.03-1.48, Non-Hispanic black: OR = 1.60; 95% CI, 1.27-2.03, other race: OR = 2.50; 95% CI, 1.32-4.74) while the association was insignificant with American Mexican and other Hispanic. In the adjusted model, the relationship between CRP and prehypertension were no longer available. Contrary, hypertension was not independently associated with elevated CRP, and the results were the same after being grouped by race or adjustments for the possible confounder variables. The same results were obtained when SBP or DBP were on a continuous measure. **Conclusions:** This study confirmed the existence of an association between hypertension, prehypertension and elevated level of CRP, however this association was no longer available after adjusting by other variables. Ethic group differences were statistically significant at the univariable models, while it disappeared after controlling by other variables.

***Keywords*—**CRP, hypertension, ethnicity, NHANES, blood pressure.

I. Introduction

CRP, a plasma protein collated by the liver, is a sensitive and active non-specific biomarker of inflammation that might be one of the causes of the development of stroke diseases. Hypertension is remarkable as a vital risk factor that raises the risk of myocardial infarction (MI). A few studies of clinical trials found that the elevated concentration levels of CRP are linked to poor patients' outcomes with unbalanced coronary disease [1]. In recent time, several researchers have remarked that hypertensive patients have high concentration level of CRP [2], [3]. This indicates that CRP is perhaps a mediator factor that increases the risk of MI in hypertensive patients. While a number of studies examined the relationship between hypertension and CRP, other studies examined if this association will vary across multiple ethnic groups [3], [4]. The first objective of this study was to determine whether there is a relationship between CRP and hypertensive patients among different ethnic groups of men and women aged from 17 years to 74 years, who were enrolled in the NHANES dataset undertaken from 1990 to 2010. NHANES is a program of studies designed to assess the health and diet of the non-institutionalized and civilians (children and adults) in the United States. The surveys were undertaken by the National Centre of Health Statistics (NCHS), at the Center for Disease Control and Prevention (CDC). The second objective was to ascertain whether the association between CRP and hypertension is modified after adjusting for gender, age, socioeconomic status (SES), body mass index (BMI), diabetes, smoking status, low-density lipoprotein (LDL) cholesterol level, and high-density lipoprotein (HDL) cholesterol level.

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II. Materials and Methods

A. Study Population

The NHANES is a program of studies designed to assess the health and diet of the non-institutionalized and civilians (children and adults) in the United States. The surveys were undertaken by NCHS, at the CDC. The NCHS approved the study protocol of NHANES; full details of the ethics approval, design of the survey and methodology study are available elsewhere [5]-[7]. The participants included in this study were those aged 17 years to 74 years. They were randomly selected by NHANES based on the availability of their blood pressure measurements and their CRP level. The focus was on the individuals with adult health conditions. The data for this study were derived from the NHANES conducted from six independent cross-sections studied for the years 1999-2000, 2001-2002, 2003-2004, 2005-2006, 2007–2008 and 2009–2010. This merge provided a sample of 63,620 participants (aged 17-74 years) for whom blood pressure values were available.

B. Measurements

1. Blood Pressure Measurements and Classification

Blood pressure (BP) was measured three times consecutively while the participants were seated. All BP measurements (systolic and diastolic) are taken in the mobile examination centre (MEC). The arithmetic mean was calculated for the second and third measurements of each systolic and DBP for all included participants. Missing values of BP measurements were excluded from the study. BP categorization was done using the Joint national committee 7 for hypertension (JNC 7) indicator [8]. Hypertension was defined as either SBP of 140 mmHg or more and DBP of 90mmHg or greater. Normal pressure was defined as SBP and DBP of less than or equal to 120 mmHg and 80mmHg, respectively.

2. CRP Level and Classification

The latex-enhanced nephelometry with high sensitivity by using a Dade Behring Nephelometer II Analyzer System (Dade Behring Diagnostics, Inc., Somerville, New Jersey) was used to measure CRP levels. The Dade Behring Diagnostics and standardized against the World Health Organization's International Reference Preparation of CRP serum prepared the standard of the assays [9]. The Immunology Division, Department of Laboratory Medicine, University of Washington Medical Centre performed the measurement. The CRP level was categorized into three groups; the elevated CRP level defined as greater than 3.0 mg/L [10], the moderate level of CRP was ($1.0 < CRP \geq 3.0$ mg/L), and the normal CRP level was less than or equal 1.0 mg/L.

3. Laboratory Variables

The laboratory components were obtained during the medical examination centre assessment. Serum cotinine level was used as a marker either for smoking status or Environmental Tobacco Smoke (ETS) exposure, it is categorized into three categories (no smoke: cotinine ≤ 10 ng/mL, light smoke: 300 >cotinine>10 ng/mL, heavy smoke: cotinine ≥ 300 ng/mL). "Serum cotinine was measured by an isotope dilution–high-performance liquid chromatography atmospheric pressure chemical ionization-tandem mass spectrometry. Briefly, the serum sample was spiked with methyl-D3 cutinise as an internal standard, and after an equilibration period, the sample was applied to a basified solid-phase extraction column. Cotinine was extracted off the column with methylene chloride, the organic extract was concentrated, and the residue was injected onto a short, C18 high-performance liquid chromatography column. The eluent from these injections was monitored by atmospheric pressure chemical ionization-tandem mass spectrometry, and the m/z 80 daughter ion from the m/z 177 quasimolecular ion was quantitated, along with additional ions for the internal standard, external standard, and for confirmation. Cotinine concentrations were derived from the ratio of native/labelled cotinine in the sample, by comparisons to a standard curve. Descriptions, in details, of serum cotinine measurement NHANES are available online" [12].

HDL cholesterol is the fraction of plasma lipoprotein with a hydrated density of 1.063 to 1.21 g/mL. It is contained of 50 per cent protein and 50 per cent lipids. The participants with low HDL cholesterol levels were more probably to develop coronary artery disease compared with high HDL cholesterol levels. LDL cholesterol is named as bad cholesterol because it contributes to plaque, a thick, hard deposit that may clog arteries, and this might cause a heart attack or stroke. In this paper, both of HDL and LDL were used on a continuous scale. The methodology of how to measuring HDL and LDL cholesterol are explained elsewhere [13].

4. Other Variables

Information on race/ethnicity, gender, age, diabetes was obtained from self-reported questionnaires at baseline [12]. Race was available in five groups (Mexican American, Non-Hispanic white, non-Hispanic black, and other Hispanic, and other race). All participants, both male and female, are older than 17 and less than or equal to 74 years of age. BMI was calculated from the equation weight (kg)/ height (m2); obesity was considered for a BMI >30. The ratio of income/poverty was used as a measure of SES.

III. Data Analysis

Descriptive data and US adult population estimates were linked using NHANES dataset from 1999 to 2010 based on the availability of CRP and BP data for the participants. Weighting variables and a jacknife design were undertaken to account for the complex sample design of the NHANES. The focus was on the participants without a diagnosis of hypertension to determine the association between the elevated level of CRP and BP in a naïve population (participants whose BP did not alter by treatment). The relationship between BP and CRP was examined in individuals without a diagnosis of hypertension. The elevated level of CRP (dependent variable) was categorized as (> 3.0, $1.0 - 3.$, ≤ 1.0 mg/L). The three categories of BP (independent

variable) was defined as normal: SBP ≤120 mm Hg and DBP ≤ 80 mm Hg; prehypertension: 139 ≥ SBP > 120 or 89 ≥ DPB > 80; and hypertension: SBP ≥ 40 or DPB > 90, using JNC 7 categories. Multinominal logistic regression model was undertaken to measure the association between BP and an elevated level of CRP. The adjusted models were considered to examine whether the association remained after adjusting for other possible confounders. The possible confounder variables included gender, age, race, smoking status, BMI, diabetes status, LDL cholesterol level, and HDL Cholesterol level. In further analysis, the statistical analyses were repeated for each ethnicity separately (American Mexican, Other Hispanic, Non-Hispanic white, Non-Hispanic black, and other race), to examine whether the association between BP and elevated level of CRP was modified. Odds ratio and 95% confidence intervals were obtained from the multinominal logistic regression model. Statistical significance was defined as $p - value < 0.05$. STATA version 12 statistical software package was used in the statistical analysis.

IV. Results

Descriptive data and demographics of the NHANES dataset are shown in Table I. The total sample size was 63,620 pooled from six continuous studies (1999 to 2010). Among participants without a previous diagnosis of prehypertension or hypertension; 3.6% and 17.8% had CRP greater than 3.0 mg/L, respectively. Race, gender, smoking status and diabetes were measured on the categorical scale, while age, SES, BMI, LDL cholesterol, and HDL cholesterol were measured on a continuous scale (mean ± sd) [Table I]. Table II shows the results obtained from the multinominal logistic regression models for clinically elevated levels of CRP among participants, without previously diagnosed prehypertension or hypertension. The model was controlled by age, gender, race, smoking status, BMI, diabetes status, cholesterol LDL, and cholesterol HDL.

In univariable models, CRP concentrations > 3 mg/L were associated with a 73% greater risk of incident hypertension compared with CRP concentrations < 1 mg/L (Hypertension: odds ratio [OR] = 1.73; 95% confidence interval [CI], 1.50-1.99). Ethnic comparisons showed that the group American Mexican had the highest risk of incident hypertension (OR= 2.39; 95% CI, 2.21-2.58). Contrary, the findings were insignificant after adjusting by other possible confounders (Hypertension: OR = 0.75; 95% CI, 0.52-1.08,), or categorized by race, see Table II. However, the participants who had prehypertension, with CRP>3.0 mg/L, had significantly less likely risk of the elevated level of CRP compared with participants with normal BP (OR, 0.81; 95% CI, 0.71–0.91). The same results were found after grouped by race (American Mexican: OR=0.70; 95% CI, 0.61–0.80; Other Hispanic: OR=0.68; 95% CI, 0.50–0.91; Non-Hispanic white: OR=0.76; 95% CI, 0.69–0.85; Non-Hispanic black: OR=0.75; 95% CI, 0.65–0.86); while the other race showed insignificant results (OR=1.03; 95% CI, 0.76–1.40). In contrast, this risk was no longer available after controlling by the possible confounders variables [Table II]. The same findings were obtained when SBP or DBP were on a continuous measure.

When CRP concentrations were between 1.0 − 3.0 mg/L, in an unadjusted models, prehypertension was associated with a higher likelihood of elevated CRP (OR = 1.37; 95% CI, 1.15-1.62). The same relationship was maintained in Non-Hispanic white, Non-Hispanic black, and other race (Non-Hispanic white: OR = 1.24; 95% CI, 1.03-1.48, Non-Hispanic black: OR = 1.60; 95% CI, 1.27-2.03, other race: OR = 2.50; 95% CI, 1.32-4.74). On the contrary, the association was insignificant with American Mexican and other Hispanic. In the adjusted model, the relationship between CRP and prehypertension were no longer available. Hypertension was not independently associated with elevated CRP. The findings were still insignificant after adjusting by the possible confounders and grouped by race [Table III]. The same results were obtained when SBP or DBP were on a continuous scale.

TABLE I
Demographic and Descriptive Characteristics of The US Population Without a Previous Diagnosis of Hypertension (NHANES Dataset from 1999 to 2010)

	Non-Hypertensive (<=120/80 MM HG)	Prehypertensive (120–139 MM HG SBP OR 80–89 MM HG DBP)	Undiagnosed Hypertensive (>140/90 MM HG)
Elevated CRP (>3.0 Mg/L)	8.7%	3.6%	17.8%
Race (Total)			
American Mexican	3.3%	1.2%	49.5%
Other Hispanic	2.1%	0.7%	2.8%
Non-Hispanic White	23.6%	12.3%	30.9%
Non-Hispanic Black	3.7%	1.8%	6.5%
Other Race	1.8%	0.9%	3.4%
Male	15.1%	10.1%	24.1%
Age (Yrs, Mean ±SD)	38.3±0.29	46.14± 0.30	44.8±0.28
SES (Mean ±SD)	2.63± 0.05	2.75± 0.05	2.62±0.03
BMI (Mean ±SD)	25.63±0.09	29±0.13	25.2±0.10
Serum Cotinine (Mean ±SD)	53±2.25	63.3±2.64	43.8±1.98
Insulin Level (Mean ±SD)	10.70±0.16	13.70±0.38	14.16±0.24
LDL Cholesterol (Mg/Dl), (Mean ±SD)	110.4± ± 0.61	119.1±0.76	111.4±0.69
HDL Cholesterol (Mg/Dl), (Mean ±SD)	54.1± 0.33	52±0.47	54.03±0.33

TABLE II
MULTINOMIAL REGRESSION ANALYSES AMONG NHANES DATASET FROM 1999 TO 2010 WITHOUT A DIAGNOSIS OF HYPERTENSION, ODDS RATIO (OR) AND 95% CONFIDENCE INTERVAL (95% CI) OF HAVING ELEVATED CRP >3.0 MG/L

Variable	All People		American Mexican		Other Hispanic		Non-Hispanic White		Non-Hispanic Black		Other Race	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Hypertension												
Non-Hypertensive	1	1	1	1	1	1	1	1	1	1	1	1
Pre-Hypertensive	0.80	0.52-1.25	1.58	0.58-4.26	0.41	0.36-4.42	1.12	0.58-2.12	0.36	0.14-0.92	0.23	0.12-1.92
Undiagnosed Hypertensive	0.75	0.52-1.08	1..17	0.49-2.77	0.87	0.19-4.13	0.90	0.50-1.59	0.44	0.22-0.87	0.41	0.06-2.92
Age	1.02	1.01-1.03	1.02	0.99-1.03	1.04	0.99-1.08	1.02	1.01-1.03	1.02	0.99-1/04	1.02	0.96-1.08
Gender												
Male	1	1	1	1	1	1	1	1	1	1	1	1
Female	1.62	1.15-2.28	1.06	0.49-2.29	3.09	0.53-7.89	1.91	1.13-3.23	1.77	1.61-3.41	0.44	0.40-2.01
BMI												
<30	1	1	1	1	1	1	1	1	1	1	1	1
≥30	1.69	1.21-2.36	0.82	0.36-1.86	2.46	0.62-2.79	1.61	0.97-2.67	1.55	0.81-2.96	1.84	1.78-1.90
Income Poverty (SES)	0.90	0.81-1.02	0.90	0.67-1.19	1.06	0.67-1.66	0.92	0.79-1.07	0.85	0.68-1.07	1.19	0.67-2.11
Diabetes												
No	1	1	1	1	1	1	1	1	1	1	1	1
Yes	1.18	0.80-1.73	1.19	0.61-2.34	0.59	0.18-2.68	1.95	1.20-3.19	0.38	0.17-0.83	1.38	0.32-3.89
Smoke												
No Smoke	1	1	1	1	1	1	1	1	1	1	1	1
Light Smoking	1.54	1.05-2.21	0.96	0.34-1.84	0.71	0.08-6.20	1.54	0.85-2.78	1.58	0.78-3.19	1.12	0.10-1.05
Heavy Smoker	1.58	0.91-2.75	2.01	1.89-4.79	0.51	0.45-4.05	1.50	0.68-3.34	1.30	0.48-3.53		
LDL Cholesterol	0.99	0.98-1.01	0.99	0.98-1.02	0.98	0.95-1.01	1.01	0.99-1.02	0.99	0.98-1.01	0.99	0.97-1.02
HDL	0.98	0.97-0.99	1.02	0.98-1.04	1.01	0.95-1.06	0.97	0.94-0.99	0.97	0.95-0.99	1.01	0.92-1.09

TABLE III
MULTINOMIAL REGRESSION ANALYSES AMONG NHANES DATASET FROM 1999 TO 2010 WITHOUT A DIAGNOSIS OF HYPERTENSION, ODDS RATIO (OR) AND 95% CONFIDENCE INTERVAL (95% CI) OF HAVING ELEVATED (3 ≥CRP>1.0 MG/L)

Variable	All people		American Mexican		Other Hispanic		Non-Hispanic white		Non-Hispanic Black		Other race	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Hypertension												
Non-hypertensive	1	1	1	1	1	1	1	1	1	1	1	1
Pre-hypertensive	0.94	0.77-1.15	1.23	0.82-1.85	1.09	0.43-2.77	1.12	0.87-1.44	0.95	0.62-1.46	0.60	0.14-2.57
Undiagnosed hypertensive	1.09	0.93-1.29	0.93	0.67-1.30	1.56	0.75-3.23	0.87	0.64-1.19	1.21	0.86-1.70	0.62	0.21-2.78
Age	1.01	0.99-1.02	1.01	0.99-1.02	1.01	0.98-1.02	1.01	0.99-1.02	1.01	0.99-1.02	1.02	0.99-1.05
Gender												
Male	1	1	1	1	1	1	1	1	1	1	1	1
Female	2.65	2.25-3.11	3.22	2.29-4.54	1.73	0.90-3.31	2.35	1.84-3.00	3.49	2.48-4.93	1.41	0.48-3.04
BMI												
<30	1	1	1	1	1	1	1	1	1	1	1	1
≥30	3.70	3.18-4.30	2.46	1.82-3.31	3.87	3.99-5.49	3.82	3.03-4.82	4.06	2.91-4.64	2.49	0.94-3.61
Income poverty (SES)	0.90	0.86-0.94	0.95	0.85-1.06	0.94	0.77-1.15	0.92	0.86-0.98	0.89	0.80-0.98	0.69	0.48-0.97
Diabetes												
No	1	1	1	1	1	1	1	1	1	1	1	1
Yes	0.88	0.78-1.08	1.16	0.77-1.73	0.98	0.49-2.01	0.86	0.62-1.20	0.75	0.50-1.14	0.92	0.32-2.70
Smoke												
No smoke	1	1	1	1	1	1	1	1	1	1	1	1
Light smoking	1.10	0.92-1.31	0.73	0.45-1.20	1.02	0.48-2.16	1.30	1.01-1.72	1.15	0.79-1.67	0.99	0.29-3.30
Heavy smoker	1.16	0.87-1.54	1.35	1.25-6.29	0.64	0.70-2.42	1.28	0.86-1.91	1.13	0.68-1.86	0.91	0.11-2.91
LDL Cholesterol	0.99	0.98-1.01	0.99	0.98-1.01	1.01	0.99-1.02	0.98	0.97-1.01	0.99	0.98-1.01	0.99	0.98-1.01
HDL	0.98	0.97-0.99	0.98	0.97-0.99	0.99	0.97-1.03	0.99	0.98-1.01	0.98	0.97-0.99	1.01	0.96-1.04

V. DISCUSSION

In the NHANES dataset from 1999 to 2010, the association between BP and elevated levels of CRP (>3.0 mg/L) appeared significant. In particular, participants with hypertension were significantly more likely to have elevated CRP than normative participants. While this relationship was no longer available after adjusting for the possible confounders including sex, age, smoking status, BMI, diabetes status, LDL cholesterol and HDL cholesterol. In an unadjusted model, the analysis was repeated after grouped by ethnicity. The association between hypertension and elevated level of CRP remained significant. In the adjusted model, the findings were insignificant after controlling for the possible confounders. The findings were not modified when the analysis was repeated for SBP or DBP as a continuous scale. The participants with prehypertension had statistically less likely risk of an elevated level of CRP compared to normative participants. The results alternated to be insignificant after controlling by the possible confounders. The ethnicity difference also yielded insignificant results for the adjusted models.

When the CRP level was between 1.0 to 3.0, the participants with incident prehypertension showed a higher risk of elevated levels of CRP compared to the normative (unadjusted model); while the participation with incident hypertension showed less likely risk compared to normative.

At the adjusted model, both participants with incidence prehypertension or hypertension were not independently associated with elevated CRP level. The same results were obtained after grouped by race. The results again did not change, when the analysis is repeated using SBP or DBP as a continuous scale.

Apparently, since the association between the hypertension and the elevated level of CRP disappeared after controlling by the confounders factors. This indicated that there are other variables that might be the independent cause for elevated CRP levels, such as obesity. In more depth, the link between the inflammation and obesity may be lead to the development of hypertension and then elevated CRP; this might be supported by the connection between the renin-angiotensin system and adiposity and obesity-related hypertension via insulin-mediated sympathetic stimulation, which both have an inflammatory component [14]. Age is possibly one of the most independent factors that play a vital role in understanding the obesity inflammation mechanism that might be related to hypertension or elevated CRP level. Diabetes perhaps also plays a role as one of the major factors due to elevated the levels of CRP in middle age.

In prior studies, for example at [16], the authors showed an association between elevated CRP and BP. In particular, the participants with prehypertension had more likely elevated CRP level compared to normative at NHANES III. The association remained after controlling by confounders variables. Bautista et al. [17] also found an independent association between the elevated CRP level and essential hypertension. In [18], the authors found that increases in pulse pressure are associated with elevated CRP levels among apparently healthy US adults, independent of SBP and DBP. In [19], the authors confirm "the existence of an independent association between hypertension and inflammation in both men and women. Ethnic group differences were evident, with the strongest association observed in Chinese participants and no difference in CRP levels by hypertension status in Hispanics". While in [20], the author found that there was an association between the CRP level and hypertension, but this relationship was no longer available after adjustment by BMI; the same findings were similar within each of the race-and sex –specific groups [21].

The limitations of this study were: (i) the data on this study is based on cross-sectional data, which lead to impossible determination of the temporal ordering of the relationship that was observed between BP and CRP. However, this study proved that the increased level of BP based on three levels (normative, prehypertensive, and hypertensive) possibly increased the risk of elevated the concentration of CRP level. (ii) The measure of CRP was classified into three groups, which might result in some lost information and biased findings. (iii) The focus in this paper was only related to CRP, other inflammation variables such as soluble intercellular adhesion molecule-1, and interleukin-6 possibly related to BP measurements are not included.

The strengths of this study were: (i) The finding of this study based on an immense dataset; in particular it is based on the NHANES dataset from 1999 to 2010, which collated 63,620 participants. (ii) This study accounted for the complex sample design of the NHANES dataset by using weighting variables and a jacknife design. (iii) The independent variable of the PB grouped into three stages (normal BP, prehypertension, and hypertension) using JNC 7 categories, and the analysis was repeated again based on the continuous scale for SBP and DBP, and the same findings were obtained. (iv) Several studies have proved that the increased levels of BP possibly predict CVD; however, this study was aimed to examine the increase level of BP might predict increase the risk of elevated CRP level.

In conclusion, at the unadjusted models, this study proved that there is a significant association between the increase level of BP (classified as prehypertension and hypertension) and elevated CRP levels. The same findings were obtained after grouped by ethnicity. However, in the adjusted models, this significant association was no longer available after adjustment by the possible confounding variables, and after being grouped by ethnicity. Future studies need to be undertaken with a prospective cohort design to clarify whether the increase in BP will increase the inflammation, and whether this effect still remains in certain subgroups such as age, gender, obesity; and the effect of more inflammsation variables need to be studies such as soluble intercellular adhesion molecule-1, and interleukin-6.

ABBREVIATIONS

- **MI:** Myocardial infarction
- **CRP:** C-reactive protein
- **NHANES:** National Health and Nutrition Examination Survey
- **NCHS:** National Centre of Health Statistics
- **CDC:** The Centres for Disease Control and Prevention
- **SES:** Socioeconomic status
- **BMI:** Body Mass Index
- **LDL:** Low-density lipoprotein cholesterol
- **HDL:** High-density lipoprotein cholesterol
- **BP:** Blood pressure
- **MEC:** Mobile examination centre
- **DBP:** Diastolic blood pressure
- **SBP:** Systolic blood pressure
- **JNC 7:** Joint national committee 7 for hypertension

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