

Association Between Dietary Total Antioxidant Capacity and Hypertension in Pre- and Postmenopausal Women; Finding From RaNCD Cohort Study

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Abstract

Background: Diet is one of the influential factors in developing hypertension. Moreover, the role of antioxidants in the prevention of cardiovascular diseases (CVDs) has been identified. Total antioxidant capacity (TAC) is a valid tool to assess intake antioxidants from diet. The aim of this study was to examine the association between TAC and hypertension in pre- and postmenopausal women.

Methods: In this cross-sectional study was used baseline data of the Ravansar Non-Communicable Disease (RaNCD) cohort study. The TAC was calculated using food items of the food frequency questionnaire. Univariable and multivariable logistic regression were applied to estimates odds ratio.

Results: A total of 5,067 women were included in the study. The mean daily intake of refined grains, legumes, white meat, nuts, omega-3, and omega-6, vitamins of B1, B2, B6 and D were significantly higher among women non-hypertensive compared to hypertensive ($P < 0.05$). Multivariate logistic regression showed the odds of hypertension in the third quartile of dietary TAC was 0.71 (95% CI: 0.52, 0.96) times and the fourth quartile of dietary TAC was 0.73 (95% CI: 0.53, 0.98) times lower compared to the first quartile, in pre/perimenopausal women. There was no association between TAC and hypertension in postmenopausal women.

Conclusion: A high dietary TAC was associated to a decreased risk of hypertension in pre/perimenopausal women. We suggest a diet rich in natural antioxidants as it may help prevent developing of hypertension before menopausal.

Introduction

Oxidative stress is a key factor in the pathogenesis of chronic diseases, through free radicals leading to biological damage (1). Oxidative stress, by creating an imbalance between peroxidants and antioxidants, leads to potential changes in endothelial cells and can act as an auxiliary mechanism in causing high blood pressure (2). Dietary total antioxidant capacity (TAC) can be reduces oxidative stress by inhibiting free radicals (3, 4). According to a review study, antioxidants have anti-inflammatory and anti-oxidant effects, although different types of antioxidants may have different effects because they are structurally and chemically different (2). Intervention studies on antioxidants, focusing on vitamins C and E, as well as pro-vitamins like beta-carotene have shown that can prevent cardiovascular disease (CVDs) (5, 6). Previous research has shown an inverse association between dietary antioxidants and the risk of CVDs, metabolic syndrome (MetS), cancers of lung, stomach, pancreatic and breast (2, 7, 8). Moreover, A study in French women has demonstrate a high antioxidant capacity was associated with a reduced risk of incident hypertension (9).

Menopause is a physiological process that occurs at an average age of 51 years and leads to hormonal changes in the body (10). Studies have demonstrated chronic diseases including diabetes, hypertension and CVDs increase after menopause (11-13). Generally, cessation of menstruation leads to iron accumulation and increased serum ferritin (14); excess iron in the body can be responsible for oxygen-

free radicals, which may oxidise low density lipoprotein (LDL) - particles and form fatty streaks and bone mineral density (15, 16). Moreover, BP is usually lower in pre/perimenopausal women compared to in men, but the prevalence of hypertension in post-menopausal women is higher compared to men (13). High blood pressure (BP) is one of the most common and preventable risk factors for CVDs (17). On the other hand, dietary pattern is one of the effective factors in blood pressure status. Previous research has demonstrated association between food groups and hypertension (18, 19). According to the mechanism of antioxidants in causing oxidative stress, particularly during menopause, there is a hypothesis that antioxidants are associated with hypertension in women. However, identifying potential risk factors for the prevention of hypertension is important. Therefore, the objective of current study was to assess the association between dietary TAC and hypertension in pre- and postmenopausal women.

Methods

Study design and population

This cross-sectional study was performed using the baseline phase data of the Ravansar Non-Communicable disease (RaNCD) prospective cohort study. The RaNCD study is one of the prospective epidemiological research studies in Iran (PERSIAN). Ravansar is a district with urban and rural areas which is located in the west of Iran and in Kermanshah province with a population of about 50,000. The initial phase of the RaNCD study began in 2014 with the enrolment of 10,047 adults aged 35 to 65 and continues to now. The complete methodology of the RaNCD study has already been published (20). For current study, the exclusion criteria were as follows: men, pregnancy and subjects with cancer. Finally, 5,067 women were examined this study.

Data collection

Questionnaire information was collected in the form of face-to-face interviews by trained experts. Demographic information included age, marital status, and socioeconomic status. Lifestyle included smoking status and physical activity that the level of physical activity was assessed using the PERSIAN cohort questionnaire, which consists of 22 questions, and the results were reported in terms of Met hour/ per week. To evaluate the biochemical markers including fasting blood sugar (FBS), total cholesterol (T-C), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and triglyceride (TG), a blood sample was taken from the participants after 12 hours of fasting. Height was measured using a BSM 370 (Biospace Co, Seoul, Korea). Body weight was measured were measured using a Bio Impedance Analyzer BIA (InBody 770 Biospace, Korea), waist-to-hip ratio (WHR) was calculated by dividing the waist circumference by hip circumference. Blood pressure was measured using a manometer (Reister) cuff and stethoscope (Reister) in the seated position after had rested for at least 10 min.

Assessment of dietary total antioxidant capacity

Dietary information was collected using a Food Frequency Questionnaire (FFQ) by face-to-face. Participants responded questions about the frequency and amount of food consumed, to help estimate portion size was used a booklet with standard values.

The TAC was calculated by multiplying the amount received from each food item (in grams) by the amount of antioxidants per gram of food (mol / 100g μ). The method used to estimate dietary TAC was ORCA and its unit was reported in mmol. The amount of antioxidant capacity for each food item was calculated separately and then TAC was obtained from the sum of the amount of antioxidant capacity received from all food items. The TAC content of each food item is calculated in the second version of the TAC content of food parameters published by the USDA and study of Wu et al (21, 22).

Definition

Hypertension was defined as having a systolic blood pressure (SBP) \geq 140 mmHg and/or diastolic blood pressure (DBP) \geq 90 mmHg, or taking antihypertensive medication (23). Menopause status was defined as having no menstrual for the last 12 months. women of having menstruated for the past 12 consecutive months were defined as pre/perimenopausal, and those no menstruated for the past 12 months were defined as menopausal.

Statistical analysis

To the descriptive section of this study; quantitative variables by mean \pm standard deviation indices are presented and quantitative variables are reported in frequency (percentage). We categorized participants into quartiles according to TAC intake, and considered the lowest group as a reference. In addition, mean \pm standard deviation of anthropometric and biochemical characteristics was compared by one-way ANOVA among four studied groups. The mean \pm standard deviation of food parameters was compared by t-test between hypertensive and non- hypertensive groups. Univariate and multivariate logistic regression model was used to determine the association between risk factors and hypertension. The estimates were reported with 95% confidence interval. All analyses were done with STATA software version 14.2 (Stata Corp, College Station, Tex).

Results

A total of 5,067 women aged 35 to 65 years were analysed in this study. Table 1 presented the basic characteristics of the participants based on TAC quartiles. Women included in the highest quartile of TAC were significantly younger than those in the lowest quartile ($P < 0.001$). According to TAC quartiles, women with the most intake antioxidant had significantly higher HDL-C ($p = 0.003$), and lower LDL-C ($P < 0.001$) and T-C ($P = 0.001$).

Women with the highest SES had a significantly higher dietary TAC intake compared to those in the lowest SES ($P < 0.001$). The prevalence of hypertension was significantly lower in women with higher dietary TAC intake ($P = 0.018$).

Table 2 presented the daily intake of macro- and micronutrients according to TAC quartiles. Daily intake of dairy, fruit, legumes, vegetables, poultry, sea food, egg, omega-3, omega-6 and vitamins were significantly higher in the highest quartile of TAC ($P < 0.001$).

The mean daily intake of refined grains, legumes, white meat, nuts, omega-3, and omega-6, vitamins of B1, B2, B6 and D were significantly higher among women non-hypertensive compared to hypertensive (Table 3).

Univariate logistic regression analysis has demonstrated odds of hypertension in the fourth quartile of TAC was 0.81 (95% CI: 0.60, 1.10) times lower compared to the first quartile among pre/perimenopausal women. Among pre/perimenopausal women, the odds of hypertension are 1.70 (95% CI: 1.21, 2.40) times higher in the overweight and 2.53 (95% CI: 1.81, 3.52) times higher in obese group compared to the normal-weight group. Postmenopausal women also have a higher odd of hypertension in the overweight 1.21 ($P = 0.178$) and obese groups 1.62 ($P = 0.001$) compared to normal-weight. Moreover, Multivariate logistic regression analysis showed the risk of hypertension in the second quartile was 80% ($p = 0.140$), third quartile 71% ($P = 0.028$), and in fourth quartile 73% ($P = 0.040$) lower compared to first quartile of TAC, among pre/perimenopausal women. However, there was no association between high TAC and hypertension among postmenopausal women. A significant positive association was observed between dyslipidaemia and risk of hypertension among pre/perimenopausal 1.67 (95% CI: 1.34, 2.10) and postmenopausal women 1.17 (95% CI: 0.94, 1.45) (Table 4). Figure 1 presented association between dietary TAC and risk of hypertension in pre/perimenopausal and postmenopausal women.

Discussion

In the present study, we found a significantly associated between a high dietary TAC and reduced risk of hypertension - independent of other risk factors for hypertension including overweight, obesity, physical inactivity and dyslipidaemia- in pre/perimenopausal women; however, this association was not significant in postmenopausal women.

We found that women with the most intake antioxidant had significantly higher HDL-C, and lower LDL-C and T-C. Dyslipidaemia is one of the most important risk factors for hypertension (24). A study by Kashyap et al. has showed that blood lipid levels were higher in subjects with high blood pressure compared to subjects of with normal blood pressure (25). The plasma malonaldehyde (MDA) increases in subjects with hypertension, MDA is the end product of non-enzymatic degradation of polyunsaturated fatty acids (PUFA). Actually, higher levels of MDA in hypertensive individuals indicate an increase in lipid peroxidation, and an increase in the production of peroxides in the cell membrane leads to the production of free radicals. Free radicals also cause dyslipidaemia and increase uric acid and plasma homocysteine, that is why subjects with hypertension have dyslipidaemia (25). Therefore, a diet rich in antioxidants may have a double role in the prevention of hypertension.

According to the evidence, oxidative stress is caused by the overproduction of oxygen free radicals or a decrease in the concentration of antioxidants in the body (2). On the other hand, Hypertension is indirectly

the result of an imbalance of antioxidants to inhibit free radicals (2, 26). Meta-analysis studies have shown that increased intake of fruits, vegetables and vitamins is associated with a reduced risk of developing hypertension (18, 19). Our findings also show that the intake of legumes, nuts, tea & coffee, fruit juiced and omega 3, omega 3, vitamin B1, vitamin B2, vitamin B6 and vitamin D were significantly lower in women with hypertension. A just one study on French women has shown a significant association between dietary TAC and hypertension (9). Ahmad et al. (2017) have suggested that the antioxidant therapy to reduce oxidative stress is a promising strategy for prevention and treatment of cardiovascular events involving hypertension (28). However, In a clinical trial study, no association was found between antioxidant supplementation and a reduction in hypertension (27). On the other hand, it is important to note that many antihypertensive drugs currently used in clinical practice, including calcium channel blockers, and β -blockers, angiotensin-converting enzyme inhibitors and angiotensin receptor blockers; in addition to reducing BP, adrenergics can also reduce the antioxidant effects and activity of several vascular matrix metalloproteinases (29). Similarly, in hypertensive rats have been shown that antihypertensive drugs such as osartan, nifedipine, metoprolol, nebivolol and nimodipine to reduce vascular oxidative stress and matrix metalloproteinases expression, and thus have an antioxidant effect (30, 31). Overall, these findings support the theory that hypertension can be treated with dietary / natural antioxidants. However, clinical trial studies are clearly needed to determine the responsibility of oxidative stress on hypertension and the possible therapy of high blood pressure with antioxidants.

The findings of this study showed, dietary TAC has a protective effect for hypertension in pre/perimenopausal women and no protective effect was observed in postmenopausal women. One of the reasons for this difference is that postmenopausal women are older and so other risk factors are stronger and the role of antioxidants is less. Therefore, following a diet rich in antioxidants from adolescence and young adults can have a preventive effect.

The strengths of this study include the following: large sample size, using of RaNCD prospective study data and using a valid questionnaire with 137 food items to calculate dietary TAC. This research is the first study in Iran on a large population of women of Kurdish ethnicity. One of the limitations of this study is its cross-sectional nature. There is a measurement error that we always encounter in collecting nutritional information. In addition, in the food frequency questionnaire used in this study, local foods were also included, therefore to prove the generalizability of the results, it is necessary to conduct more studies in different regions and with different dietary patterns.

Conclusion

The findings of this study demonstrated a significantly associated between a high dietary TAC and reduced risk of hypertension among pre/perimenopausal women; however, this association was not significant in postmenopausal women. We suggest a diet rich in natural antioxidants as it may help prevent developing of hypertension from younger ages. However, these results need to be interpreted with caution. To definitively accept the results of this study, further studies are needed on different demographic and ethnic subgroups.

Abbreviations

CVDs, cardiovascular diseases; TAC, Total antioxidant capacity; RaNCD, Ravansar Non-Communicable Disease; MetS, metabolic syndrome; BP, blood pressure; FBS, fasting blood sugar; T-C, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglyceride; WHR, waist-to-hip ratio; FFQ, food frequent questioner.

Declarations

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Author contribution

HL, YP and FN designed the study. NM and MD prepared the manuscript. HL, YP and MG review the article and give the final accept. All of authors edited the manuscript.

Ethics approval and consent to participate

The Research and Technology Deputy and the Ethical Committee of Kermanshah University of Medical Sciences have approved the study protocol (Ethical Number: KUMS.REC.1394.318). Participants were provided with oral and written informed consent. Written informed consent was obtained from all subjects prior to enrolment in the study. All methods were carried out in accordance with relevant guidelines and regulations or the Declaration of Helsinki in the methods section of the manuscript.

Consent for publication

Not applicable

Availability of data and materials

The data analysed in the study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Tables

Table1- Baseline characteristics of the study population according to total antioxidant capacity quartiles (RaNCD cohort data, N=5067)

Variable	Dietary total antioxidant capacity (TAC)				P value
	Q1 n= 1,569	Q2 n= 1,295	Q3 n= 1,121	Q4 n= 1,082	
Age , mean± SD	49.07± 8.68	47.38± 8.28	46.99± 8.35	46.52± 8.06	<0.001
BMI (kg/m ²), mean± SD	27.69± 4.83	28.71± 4.94	28.88± 4.90	29.17± 4.69	<0.001
WHR, mean± SD	0.94±0.05	0.94± 0.06	0.95±0.06	0.95± 0.06	<0.001
FBS (mg/dl), mean± SD	97.53± 29.26	96.92± 27.19	96.98± 30.66	96.69± 30.52	0.896
TG (mg/dl), mean± SD	129.15± 80.88	129.84± 74.51	127.58± 68.07	130.95± 72.83	0.757
HDL-C (mg/dl), mean± SD	50.39± 10.99	49.16± 11.37	49.66± 11.70	48.90± 11.74	0.003
LDL-C (mg/dl), mean± SD	105.19± 27.44	102.72± 25.78	101.24± 25.38	101.20± 24.85	<0.001
T-C (mg/dl), mean± SD	191.46± 40.35	188.96± 39.24	186.85± 37.31	185.99± 37.07	0.001
Marital status, n (%)					
Married	1237 (29.09)	1101 (25.89)	974 (22.91)	940 (22.11)	<0.001
Single	139 (43.03)	67 (20.74)	66 (20.43)	51 (15.79)	
Widowed/Divorced	199 (39.25)	131 (25.84)	83 (16.37)	94 (18.54)	
Socio-economic status, n (%)					
1(lowest)	688 (47.16)	369 (25.29)	250 (17.14)	152 (10.42)	<0.001
2	448 (36.57)	343 (28.00)	227 (18.53)	207 (16.90)	
3	270 (25.74)	285 (27.17)	257 (24.50)	237 (22.59)	
4	134 (15.82)	212 (25.03)	250 (29.52)	251 (29.63)	
5 (highest)	35 (7.01)	90 (18.04)	137 (27.45)	237 (47.49)	
Physical activity (Met-h/week), n (%)					
Light	414 (31.20)	358 (26.98)	272 (20.50)	283 (21.33)	<0.001
Moderate	975 (30.45)	769 (24.02)	743 (23.20)	715 (22.33)	
High	186 (33.63)	172 (31.10)	108 (19.53)	87 (15.73)	
Menopausal status, n (%)					
Pre/perimenopausal	986 (28.12)	914 (26.06)	809 (23.07)	798 (22.75)	<0.001

Post-menopausal	589 (37.40)	385 (24.44)	314 (19.94)	287 (18.22)	
Smoking status, n (%)	39 (39.00)	21 (21.00)	25 (25.00)	15 (15.00)	0.007
Hypertension, n (%)	299 (35.14)	218 (25.62)	174 (20.45)	160 (18.80)	0.018

Table 2- Nutrients intake according to the dietary antioxidant capacity of participants (RaNCD cohort data, N=5067)

Food parameters	Dietary total antioxidant capacity (TAC)				P value
	Mean± SD				
	Q1 n= 1,575	Q2 n= 1,299	Q3 n= 1,123	Q4 n= 1,085	
Energy intake (kcal/d)	1597.85± 584.24	1892.16± 601.00	2047.03± 667.45	2277.61± 773.14	<0.001
Carbohydrate (%E)	68.60± 7.26	65.49± 7.24	63.32± 7.46	61.17± 8.01	<0.001
Protein (%E)	15.38± 1.91	15.75± 2.13	15.81± 2.07	15.95± 2.17	<0.001
Lipid (%E)	15.62± 6.54	18.56± 6.66	20.81± 7.08	23.00± 7.73	<0.001
Whole grains (gr/d)	20.41± 32.93	31.73± 45.98	40.25± 55.86	54.51± 84.51	<0.001
Refined grains (gr/d)	488.69± 231.28	528.45± 233.67	538.72± 257.34	547.27± 270.57	<0.001
Legumes (gr/d)	21.01± 17.02	33.65± 24.79	44.31± 31.91	59.26± 42.25	<0.001
Dairy (gr/d)	293.10± 331.89	416.95± 385.46	477.10± 404.61	568.46± 467.10	<0.001
Fruit (gr/d)	87.93± 68.33	182.83± 121.37	269.24± 174.70	409.80± 261.60	<0.001
Vegetables (gr/d)	329.73± 200.47	474.16± 240.10	579.31± 292.13	713.10± 377.74	<0.001
Red meat (gr/d)	25.12± 23.86	33.76± 30.03	37.62± 31.76	44.53± 39.24	<0.001
Poultry (gr/d)	2.98± 5.86	3.95± 7.50	4.41± 8.90	3.49± 8.26	<0.001
Sea food (gr/d)	0.71±1.81	1.40± 3.63	1.85± 4.27	2.25± 4.82	<0.001
Egg (gr/d)	1.65±4.91	2.81± 5.13	4.19± 7.37	6.63± 10.56	<0.001
Salt (gr/d)	4.00± 2.47	4.24± 2.76	4.28± 4.88	4.45± 3.15	0.001
Nuts (gr/d)	26.30± 23.67	32.85± 32.52	33.80± 35.41	34.16± 36.01	<0.001
Tea & coffee (gr/d)	1.43± 2.78	2.67± 4.45	3.76± 6.82	4.95± 9.30	<0.001
Olive oil (gr/d)	0.50± 1.22	1.40± 2.06	2.74± 4.10	5.95± 10.23	<0.001
Dried fruits (gr/d)	20.75± 17.21	25.37± 22.60	28.10± 25.32	32.60± 31.00	<0.001
Juices fruits (gr/d)	0.24± 0.01	0.47± 1.68	0.67± 1.94	0.89± 3.12	<0.001
Omega-3 (mcg)	0.71±0.05	0.10± 0.06	0.13± 0.08	0.16± 0.11	<0.001

Omega- 6 (mcg)	0.19± 0.22	0.29± 0.32	0.36± 0.37	0.40± 0.41	<0.001
Vitamin A (mcg)	364.43± 294.40	575.28± 384.34	735.03± 524.51	947.75± 689.17	<0.001
Vitamin B1 (mg)	0.41± 0.22	0.58± 0.28	0.71± 0.35	0.89± 0.52	<0.001
Vitamin B2(mg)	0.54± 0.27	0.76± 0.31	0.93± 0.42	1.13± 0.52	<0.001
Vitamin B6 (mg)	0.74± 0.31	1.01± 0.35	1.20± 0.44	1.44± 0.57	<0.001
Vitamin B12 (mcg)	1.69± 1.84	2.60± 2.45	3.32± 3.52	4.12± 4.29	<0.001
Vitamin C (mg)	40.33± 27.44	56.87± 30.10	69.72± 38.73	87.98± 55.55	<0.001
Vitamin D (mcg)	0.59± 0.50	0.84± 0.55	1.06± 0.73	1.30± 0.91	<0.001
Vitamin E (mg)	1.53± 0.92	2.13± 1.03	2.61± 1.35	3.25± 1.86	<0.001

Table3- Comparison of dietary pattern in participants with and without hypertension (RaNCD cohort data, N=5067)

Food parameters	Non-Hypertension	Hypertension	P value
	Mean± SD		
Whole grains (gr/d)	33.61 ± 46.87	35.45± 52.56	0.309
Refined grains (gr/d)	533.40± 248.06	467.70± 238.14	<0.001
Legumes (gr/d)	38.60± 33.08	32.40± 28.45	<0.001
Dairy (gr/d)	427.33± 407.44	410.21± 399.37	0.263
Fruit (gr/d)	220.71± 200.00	222.64± 208.10	0.798
White meat (gr/d)	19.41± 18.34	15.52± 16.87	<0.001
Red meat (gr/d)	35.85± 30.52	33.56± 29.01	0.045
Sea food (gr/d)	1.45± 3.35	1.22± 3.49	0.062
Egg (gr/d)	3.47± 6.49	3.05± 5.93	0.081
Drink (gr/d)	3.04± 5.82	2.07± 4.14	<0.001
Leafy vegetables (gr/d)	364.80± 247.63	350.58± 246.92	0.127
Carotene rich vegetables (gr/d)	89.42± 90.06	88.36± 89.94	0.753
Starchy vegetables (gr/d)	43.46± 49.19	41.39± 43.12	0.555
Nuts (gr/d)	31.77± 31.99	29.02± 30.53	0.021
Tea & coffee (gr/d)	3.20± 6.31	2.11± 5.19	<0.001
Olive oil (gr/d)	2.35± 4.80	2.12± 4.70	0.196
Dried fruits (gr/d)	26.35± 24.25	24.72± 24.21	0.073
Juices fruits (gr/d)	0.53± 1.84	0.34± 1.27	0.002
Omega-3 (mcg)	0.11± 0.08	0.10± 0.07	<0.001
Omega- 6 (mcg)	0.31± 0.34	0.26± 0.31	<0.001
Vitamin A (mcg)	630.10± 527.65	598.89± 497.34	0.113
Vitamin B1(mg)	0.63 ± 0.39	0.59± 0.38	0.001
Vitamin B2(mg)	0.82± 0.44	0.76± 0.43	<0.001
Vitamin B6 (mg)	1.10± 0.50	0.98± 0.46	<0.001
Vitamin B12 (mcg)	2.83± 3.10	2.67± 3.58	0.153
Vitamin C (mg)	61.46± 42.10	60.10± 41.50	0.389
Vitamin D (mcg)	0.93± 0.73	0.78± 0.63	<0.001

Vitamin E (mg)	2.31± 1.45	2.20± 1.38	0.074
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Table 4- Logistic regression analysis of risk factors related to hypertension in Pre/perimenopausal and postmenopausal women (RaNCD cohort data, N=5067)

Risk factors of hypertension		Pre/perimenopausal		Post-menopausal	
		OR (95% CI)	P value	OR (95% CI)	P value
Univariate analysis	TAC (mmol/day)				
	Q1	1.00 (Reference)		1.00 (Reference)	
	Q2	0.86 (0.65, 1.14)	0.300	1.05 (0.79, 1.39)	0.737
	Q3	0.76 (0.56, 1.02)	0.068	1.04 (0.77, 1.40)	0.785
	Q4	0.81 (0.60, 1.10)	0.170	0.87 (0.63, 1.20)	0.380
	BMI (kg/m²)				
	Normal	1.00 (Reference)		1.00 (Reference)	
	Overweight	1.70 (1.21, 2.40)	0.002	1.21 (0.91, 1.61)	0.178
	Obese	2.53 (1.81, 3.52)	<0.001	1.62 (1.21, 2.16)	0.001
	Physical Activity (Met)				
	Light	1.00 (Reference)		1.00 (Reference)	
	Moderate	0.86 (0.67, 1.03)	0.242	0.84 (0.66, 1.01)	0.157
	High	0.76 (0.51, 1.14)	0.191	0.54 (0.35, 0.81)	0.003
	Dyslipidaemia				
	No	1.00 (Reference)		1.00 (Reference)	
	Yes	1.71 (1.42, 2.20)	<0.001	1.21 (0.97, 1.50)	0.080
Multivariate analysis	TAC (mmol/day)				
	Q1	1.00 (Reference)		1.00 (Reference)	
	Q2	0.80 (0.60, 1.10)	0.140	1.05 (0.79, 1.40)	0.709

Q3	0.71 (0.52, 0.96)	0.028	1.04 (0.77, 1.42)	0.771
Q4	0.73 (0.53, 0.98)	0.040	0.84 (0.61, 1.15)	0.284
BMI (kg/m²)				
Normal	1.00 (Reference)		1.00 (Reference)	
Overweight	1.62 (1.15, 2.28)	0.006	1.17 (0.88, 1.55)	0.286
Obese	2.41 (1.72, 3.37)	<0.001	1.54 (1.15, 2.10)	0.004
Physical Activity (Met)				
Light	1.00 (Reference)		1.00 (Reference)	
Moderate	0.89 (0.69, 1.15)	0.394	0.89 (0.70, 1.13)	0.353
High	0.88 (0.59, 1.33)	0.555	0.59 (0.39, 0.90)	0.014
Dyslipidaemia				
No	1.00 (Reference)		1.00 (Reference)	
Yes	1.67 (1.34, 2.10)	<0.001	1.17 (0.94, 1.45)	<0.001

Figures

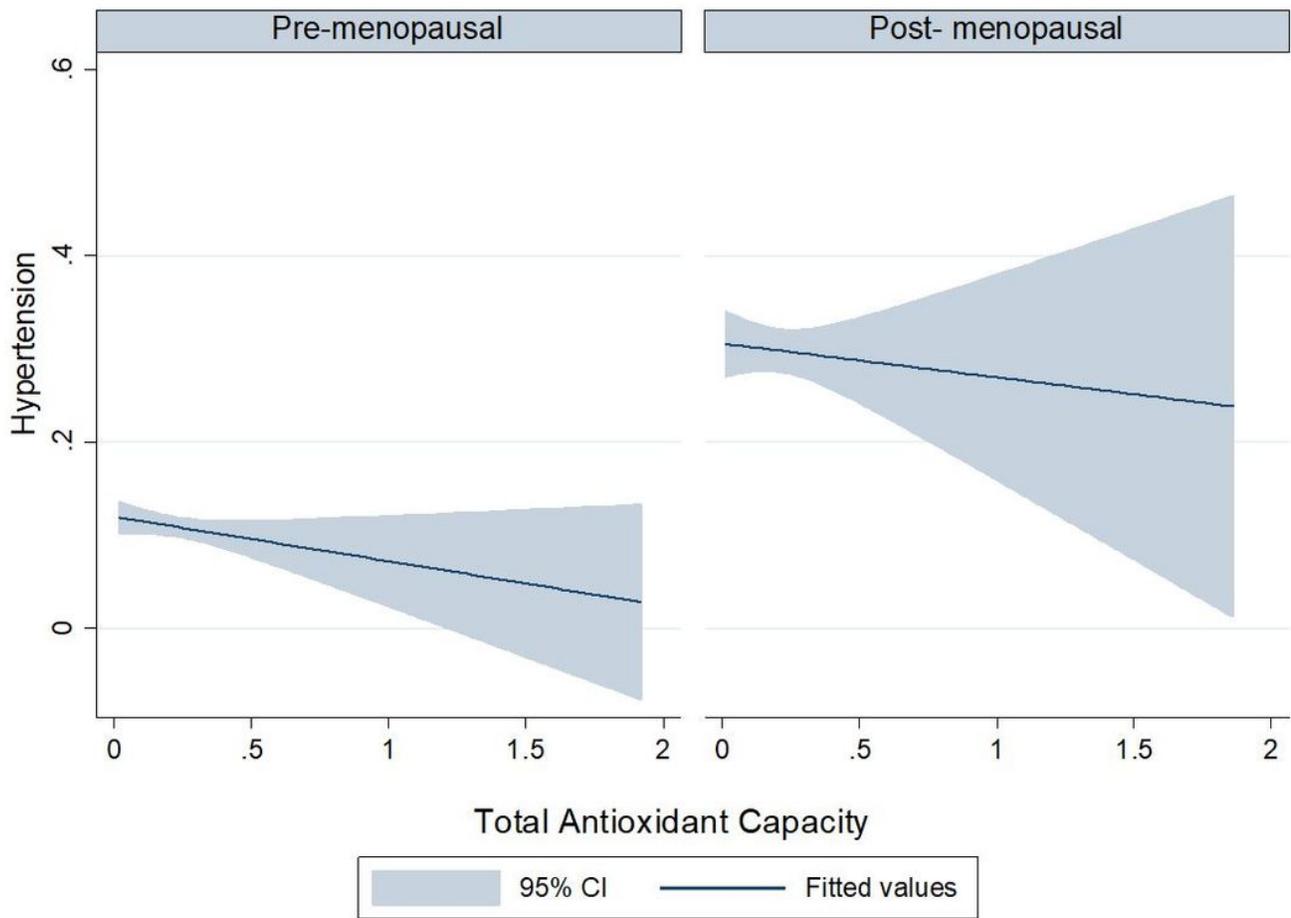


Figure 1

Association between total antioxidant capacity and hypertension in in pre/perimenopausal and postmenopausal women