



Association of fried food intake with prehypertension and hypertension: the Filipino women's diet and health study

Sherlyn Mae P. Provido¹, Grace P. Abris², Sangmo Hong³, Sung Hoon Yu⁴, Chang Beom Lee⁴ and Jung Eun Lee^{5,6*}

¹Department of Food and Nutrition, Sookmyung Women's University, Cheongpa-ro 47-gil 100, Yongsan-gu, Seoul 04310, Korea

²School of Public Health, Loma Linda University, Loma Linda, California 92354, USA

³Division of Endocrinology and Metabolism, Department of Internal Medicine, Hallym University Dongtan Sacred Heart Hospital, 7, Keunjaebong-gil, Hwaseong-si, Gyeonggi 18450, Korea

⁴Division of Endocrinology and Metabolism, Department of Internal Medicine, Hanyang University Guri Hospital, Hanyang University College of Medicine, 153 Gyeongchun-ro, Guri 11923, Korea

⁵Department of Food and Nutrition, College of Human Ecology, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Korea

⁶Research Institute of Human Ecology, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Korea

BACKGROUND/OBJECTIVES: Few epidemiological studies examined the association between fried food intake and hypertension. This study examined whether fried food intake was associated with higher prevalence of prehypertension and hypertension combined in a cross-sectional study of the Filipino Women's Diet and Health Study (FiLWHEL).

SUBJECTS/METHODS: This study included a total of 428 women aged 20-57 years who have ever been married to Korean men. Prehypertension was defined as 120 - < 140 mmHg of SBP or 80 - < 90 mmHg of DBP and hypertension as SBP \geq 140 mmHg or DBP \geq 90 mmHg. Fried food intake was assessed using one-day 24-hour recall. Fried foods were categorized into total, deep/shallow and pan/stir fried foods. The odds ratio (OR)s and 95% confidence interval (CI)s were calculated using multivariate logistic regression.

RESULTS: The prevalence of prehypertension and hypertension combined was 41.36% in this population. High fried food intake was associated with high prevalence of prehypertension and hypertension combined. The odds of having prehypertension and hypertension was higher in the 3rd tertile of fried food intake among fried food consumers compared to non-fried food consumers (OR = 2.46, 95% CI = 1.24, 4.87; *P* for trend = 0.004). Separate analysis for types of frying showed that deep and shallow fried food intake was associated with prevalence of prehypertension and hypertension combined for comparing the 3rd tertile vs. non-fried food consumers (OR = 2.93; 95% CI = 1.57-5.47; *P* for trend = < 0.001).

CONCLUSIONS: This study showed the evidence that high fried food intake was significantly associated with high prevalence of prehypertension and hypertension combined among Filipino women married to Korean men.

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INTRODUCTION

Hypertension is a worldwide public health challenge affecting approximately one billion individuals [1,2]. Globally, high blood pressure contributed to the 92 million or 6.0% of all disability-adjusted life years (DALYs) among adults aged \geq 45 years old [3]. The World Health Organization (WHO) reported 1.13 billion adults aged \geq 18 years old had raised blood pressure in 2015 and the prevalence of hypertension among adults aged \geq 20 years old was predicted to increase from 52.7% (972 million) in 2000 to approximately 60%, equating to 1.56 billion in 2025 [1,4,5].

The American Heart Association (AHA) documented aging,

being male, family history and genetics as non-modifiable risk factors for hypertension and high body mass index (BMI), physical inactivity, low income, smoking and tobacco use, excess intake of alcohol as modifiable risk factors [6,7]. A diet high in sodium, saturated fatty and trans-fatty acids, and added sugar was associated with an increase in blood pressure [8-10].

The US immigrant studies from national data found that Filipinos had the highest prevalence of hypertension and the highest hypertension mortality rate among Asian immigrants [11,12]. One study conducted among female marriage immigrants in Korea reported that Filipino women had the highest proportion of high blood pressure compared to Japanese, Chinese, Vietnamese, and Cambodians [13].

* Corresponding Author: Jung Eun Lee, Tel. 82-2-880-6834, Fax. 82-2-884-0305, Email. jungelee@snu.ac.kr

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Frying food is one of the most common and preferred cooking methods in the Philippines, probably because it is a convenient food preparation and fried food has a savory flavor favored by Filipinos [14,15]. During the frying process, the amount of oil absorbed into foods can reach up to 40% of the total weight of the food product [16,17]. Furthermore, during frying, the heated oil undergoes deterioration due to various chemical reactions like thermal oxidation, and thermally-oxidized oil induced oxidative stress [18]. Studies that examined the relationship of oxidative stress and endothelial dysfunction reported that oxidative stress was involved in the pathogenesis of endothelial dysfunction, one of the biological mechanisms responsible for the development of hypertension [19-22].

A cohort study in Spain reported that frequent intake of fried food was associated with a higher risk of hypertension and with the central adiposity and high blood pressure [23,24]. Also, a Spanish cross-sectional study found that high fried food intake was associated with high prevalence of hypertension when these foods were fried with re-used oils [25]. Another cross-sectional study in Korean adults suggested that frequent fried food intake was associated with high prevalence of hypertension among women [26].

Given the evidences that Filipino immigrants are at higher risk for hypertension and intake of fried food among Filipino women is common, this study aimed to examine the association of fried food intake and prehypertension and hypertension combined among Filipino women.

SUBJECTS AND METHODS

Study population

The present study is a cross-sectional study of fried food intake and the prevalence of elevated blood pressure among the Filipino Women’s Diet and Health Study (FiLWHEL) participants. Data were collected from 504 Filipino women aged 19 years or above using structured questionnaires, including demographic, health-related behavior, medical history, quality of life, acculturation, anthropometric examination and biospecimen. More information regarding the description of the

FiLWHEL study design and methods have previously been published elsewhere [27-29].

Out of 504 participants, 76 were excluded because of no 24-hour recalls (n = 7), unusual energy intake (3 standard deviations above or below the log-transformed mean energy intake; n = 7), and only one BP measurement (n = 24) or self-reported physician diagnosis of hypertension or use of antihypertensive medication (n = 38). As a result, 428 participants were included in the analysis. Prior to participation, all study participants gave written informed consent. The Sookmyung Women’s University Institutional Review Board (reference number SMWU-1311-BR-012) approved this study.

Dietary intake assessment

Fried food intake was determined using the one-day 24-hour recall method through an in-person or via telephone interview. Fried food was defined as deep fried, shallow fried, pan fried and stir fried. The list of fried foods is presented in Table 1. The total fried food intake per person was estimated by summing the amount of all fried foods consumed at home or away from home.

Fried food percent energy intake was calculated as total energy intakes from fried food (kcal/day) divided by total energy intakes from all food (kcal/day) multiplied by 100. Fried food (grams/day) per 1,000 kcal of total energy intake was also calculated. Collected data were coded using the Computer Aided Nutritional Analysis Program version 4.0 for professional (CAN-pro 4.0). The nutrition information of some food items that were not available in CAN-pro software were derived from the U.S. Department of Agriculture (USDA) [30], Rural Development Administration (RDA) of Korea [31], Food and Nutrition Research Institute (FNRI) of the Philippines (specifically for Filipino foods) [32] or the manufacturer’s product’s nutritional label.

Blood pressure measurements

In accordance with the standard principle of blood pressure measurement, mercury sphygmomanometer was used to measure blood pressure with at least 5-minute rest while the participant was seated calmly. Using the same arm, two blood

Table 1. A list of fried foods

No.	List of fried foods	Sub-group of fried foods
1	Cutlets	fried breaded fish cutlet, fried breaded pork cutlet, fried breaded cheese cutlet, and fried breaded chicken cutlet
2	Fried meat	fried pork, fried chicken, fried beef, fried chicken nuggets, fried meatball, fried patty and fried hotdog or sausage
3	Fried seafood	fried tempura, fried mussels or shellfish, fried squid, fried octopus, fried anchovy, fried laver, and fried fish
4	Fried dumplings	fried dumplings
5	Fried spring rolls	fried spring rolls
6	Fried tubers	fried sweet potato fritters, french fries, and fried potato
7	Fried bread	croquette (with meat or vegetable filling) and doughnuts
8	Fried banana	fried saba (ripe) and turon (banana roll)
9	Fried vegetables	fried chili (leaves or pepper), fried garlic stalk, fried mushroom, fried ampalaya, and fried chayote
10	Fried canned foods	fried corned beef, fried ham, fried canned fish, and fried luncheon meat
11	Fried noodles	ramyeon
12	Fried egg	sunny-side-up, scrambled, and rolled omelet
13	Fried pancake	hotcake, sugar-filled pancake, leek or chives pancake, napa kimchi pancake, and bean sprout pancake
14	Fried rice	fried rice
15	Other fried foods	fried cheese stick, popcorn, and fried tofu

pressure readings with a 5-minute interval after the first measurement were obtained and the average of the two readings was used for the analysis. Elevated blood pressure was categorized into prehypertension with systolic blood pressure (SBP) of 120 - < 140 mmHg or diastolic blood pressure (DBP) of 80 - < 90 mmHg and hypertension with SBP of \geq 140 or DBP of \geq 90 mmHg or the used of antihypertensive medication [7].

Anthropometric measurements

Height and waist circumference were measured to the nearest 0.1 cm using a stretch-resistant tape measure with the participant in standing position. Waist circumference was measured at midpoint between the lowest border of the rib cage and the upper most lateral border of the right iliac crest. To measure body weight, bioelectric impedance analysis machine (InBody 620, Biospace Co. Ltd, Seoul, Korea) was used. BMI was calculated as weight in kilograms (kg) divided by square of height in meters (m²). Details of anthropometric measurements have been published elsewhere [27].

Statistical analysis

Participants were classified into blood pressure categories: normotensive and pre-hypertensive and hypertensive combined. For fried food intake, participants were categorized into non-fried food consumers and tertile levels among fried food consumers. Deep and shallow fried food intake and pan and stir fried food intake were also analyzed separately. Non-fried food consumers were considered as the referent category. Analysis of variance (ANOVA) and chi-square test were used to compare the means and proportions of baseline characteristics of the study participants according to fried food intake. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated using multivariate logistic regression models. Tests for linear trend across increasing categories of fried food intake were

conducted by assigning medians of the intake of fried food within each category and treating this variable as a continuous variable. The multivariate analysis was adjusted for age (years, continuous), energy intake (kcal/day, continuous), education level (high school or below, college or above-category), length of stay in South Korea (years, continuous), smoking status (ever, never-category), and alcohol intake (ever, never-category). BMI (< 23 and \geq 23 kg/m²) was adjusted in the additional analysis using the WHO Asia-Pacific cut-off points for overweight [33]. When we further adjusted for vigorous physical activities (hours/day, continuous), sodium intake (grams/day, continuous) and sleeping hours (< 5 hours, 5-6 hours, 7-8 hours, > 8 hours-category), we did not observe appreciable change in the estimates and therefore we did not include those variables in the model. Interactions were examined using the Likelihood Ratio Test (LRT) by including a cross-product term in the model. All *P*-values presented were two-tailed and *P* < 0.05 was considered to be statistically significant. All analyses were performed using SAS version 9.4 software package (SAS Institute Inc., Cary, NC, USA).

RESULTS

Characteristics of participants according to fried food intake

A total of 428 women (mean \pm SD age: 33.77 \pm 7.78 yrs) were included in the analysis. The prevalence was 28.04% (n = 120) for prehypertension (120 - < 140 mmHg of SBP or 80 - < 90 mmHg of DBP) and 13.32% (n = 57) for hypertension (\geq 140 mmHg of SBP or \geq 90 mmHg of DBP). Among fried food consumers, their mean intake values were 199.72 g/d for total fried food, 165.92 g/d for deep and shallow fried food and 134.26 g/d for pan and stir fried food. Fried food consumers were younger and tended to consume more fast food compared to non-fried food consumers (Table 2). Intakes of total

Table 2. Characteristics of study participants according to fried food intake (n = 428)

	Non-fried food consumer	Fried food consumer (% energy intake)			<i>P</i> -value ^{1,2)}
		Tertile 1	Tertile 2	Tertile 3	
Age (yrs)	35.04 \pm 8.40	34.65 \pm 7.90	33.22 \pm 7.21	32.13 \pm 7.52	0.03
BMI (kg/m ²) ³⁾ *	23.41 \pm 3.23	23.44 \pm 4.02	23.32 \pm 3.57	23.75 \pm 3.88	0.84
Waist circumference (cm) ³⁾ *	79.45 \pm 8.60	79.28 \pm 9.96	78.58 \pm 8.51	79.96 \pm 10.01	0.74
Smoking status (n, %)*					0.74
Never	74 (89.16)	107 (93.04)	99 (90.00)	105 (92.11)	
Ever	9 (10.84)	8 (6.96)	11 (10.00)	9 (7.89)	
Alcohol intake (n, %)*					0.14
Never	18 (21.69)	34 (29.57)	38 (34.23)	26 (22.81)	
Ever	65 (78.31)	81 (70.43)	73 (65.77)	88 (77.19)	
Education (n, %)*					0.18
High school or below	28 (33.73)	30 (26.09)	41 (36.28)	45 (39.13)	
College or above	55 (66.27)	85 (73.91)	72 (63.72)	70 (60.87)	
Length of stay in Korea (yrs)*	8.29 \pm 5.66	8.55 \pm 5.42	7.55 \pm 4.78	6.96 \pm 4.61	0.09
Fast Food (n, %)					< 0.001
No	70 (84.34)	80 (69.57)	62 (53.91)	61 (53.04)	
Yes	13 (15.66)	35 (30.43)	53 (46.09)	54 (49.96)	
Energy intake from fried food (%)	-	7.32 \pm 3.80	20.34 \pm 4.53	44.57 \pm 13.50	< 0.001
Fried food intake (g/d)	-	84.92 \pm 61.58	183.82 \pm 105.09	330.43 \pm 177.04	< 0.001
Total caloric intake (kcal/d)	1,473.93 \pm 615.67	1,936.47 \pm 693.93	1,918.38 \pm 752.11	1,808.82 \pm 704.95	< 0.001

Table 2. continued

	Non-fried food consumer	Fried food consumer (% energy intake)			P-value ^{1,2)}
		Tertile 1	Tertile 2	Tertile 3	
Carbohydrate intake (% energy intake)	58.51 ± 14.21	58.81 ± 12.35	57.65 ± 10.56	51.93 ± 9.29	< 0.001
Protein intake (% energy intake)	15.80 ± 4.89	15.45 ± 4.21	16.20 ± 4.72	16.47 ± 4.48	0.36
Fat intake (% energy intake)	25.24 ± 11.86	25.16 ± 9.56	26.39 ± 8.14	31.10 ± 7.68	< 0.001
Sodium intake (mg/d)	2,367.42 ± 2,067.52	3,328.42 ± 2,244.17	3,143.34 ± 1,865.62	3,274.37 ± 2,188.69	0.007
Potassium intake (mg/d)	1,893.19 ± 966.49	2,443.33 ± 1,101.59	2,440.67 ± 1,343.57	2,059.58 ± 1,043.04	< 0.001
Cholesterol intake (mg/d)	263.54 ± 404.40	341.12 ± 289.90	319.35 ± 241.78	382.98 ± 300.18	0.06

¹⁾ P-value for continuous was determined by ANOVA: mean ± SD (Standard deviation)

²⁾ P-value for categorical was determined by Chi-square test

³⁾ BMI: Body Mass Index

* Due to missing data, number of participants may not sum up to 428.

Table 3. Odds ratio and 95% confidence interval of prehypertension and hypertension combined according to fried food intake

	Non-fried food consumer	Fried food intake			P for trend
		Tertile 1	Tertile 2	Tertile 3	
Percent energy intake					
No. of cases/Total N	33/83	45/115	43/115	56/115	
Median intake	0	7.88	19.41	41.02	
Age-adjusted	1.00	1.03 (0.55-1.93)	1.11 (0.59-2.08)	2.17 (1.15-4.09)	0.005
Multivariate-adjusted ¹⁾	1.00	1.03 (0.54-1.96)	1.17 (0.62-2.22)	2.24 (1.17-4.26)	0.004
Multivariate-adjusted ²⁾	1.00	1.18 (0.61-2.31)	1.28 (0.65-2.51)	2.46 (1.24-4.87)	0.004
Grams per day					
No. of cases/Total N	33/83	40/115	53/115	51/115	
Median intake	0	62.90	156.00	335.00	
Age-adjusted	1.00	0.89 (0.47-1.68)	1.52 (0.82-2.84)	1.75 (0.93-3.27)	0.02
Multivariate-adjusted ¹⁾	1.00	0.94 (0.49-1.80)	1.50 (0.80-2.84)	1.84 (0.97-3.47)	0.02
Multivariate-adjusted ²⁾	1.00	1.07 (0.54-2.11)	1.58 (0.81-3.07)	2.13 (1.09-4.18)	0.01
Grams per 1000 kcal of total energy intakes					
No. of cases/Total N	33/83	47/115	49/115	48/115	
Median intake	0	40.18	89.56	185.29	
Age-adjusted	1.00	1.05 (0.56-1.96)	1.37 (0.74-2.57)	1.69 (0.90-3.19)	0.06
Multivariate-adjusted ¹⁾	1.00	1.10 (0.58-2.08)	1.39 (0.74-2.62)	1.76 (0.92-3.37)	0.05
Multivariate-adjusted ²⁾	1.00	1.26 (0.64-2.46)	1.50 (0.77-2.92)	1.95 (0.99-3.84)	0.05

¹⁾ Adjusted for age (years, continuous), education (high school or below, college or above), length of stay in Korea (years, continuous), smoking status (ever, never), and alcohol intake (ever, never)

²⁾ Adjusted for age (years, continuous), education (high school or below, college or above), length of stay in Korea (years, continuous), smoking status (ever, never), alcohol intake (ever, never), and BMI (<23, ≥ 23 kg/m²)

Table 4. Odds ratio and 95% confidence interval of hypertension according to fried food intake

	Non-fried food consumer	Fried food consumer (% energy intake)			P for trend
		Tertile 1	Tertile 2	Tertile 3	
No. of cases/Total N	11/83	14/155	16/115	16/155	
Median	0	7.88	19.41	41.02	
Age-adjusted	1.00	0.97 (0.39-2.41)	1.48 (0.61-3.61)	1.63 (0.66-4.02)	0.18
Multivariate-adjusted ¹⁾	1.00	1.03 (0.41-2.57)	1.62 (0.66-4.02)	1.63 (0.65-4.10)	0.21
Multivariate-adjusted ²⁾	1.00	1.28 (0.50-3.28)	1.85 (0.72-4.72)	1.75 (0.68-4.50)	0.23

¹⁾ Adjusted for age (years, continuous), education (high school or below, college or above), length of stay in Korea (years, continuous), smoking status (ever, never), and alcohol intake (ever, never)

²⁾ Adjusted for age (years, continuous), education (high school or below, college or above), length of stay in Korea (years, continuous), smoking status (ever, never), alcohol intake (ever, never), and BMI (<23, ≥ 23 kg/m²)

energy, fat, sodium, potassium, and cholesterol were higher among high fried food consumers but lower in carbohydrate intake as compared to non-fried food consumers.

Association between fried food intake and prehypertension and hypertension combined

High fried food intake was associated with high prevalence of prehypertension and hypertension combined (Table 3).

Table 5. Odds ratio and 95% confidence interval of prehypertension and hypertension combined according to deep/shallow and pan/stir fried food

	Mean (g/d)	Non-fried food consumer	Fried food (% energy intake)			P for trend
			Tertile 1	Tertile 2	Tertile 3	
Deep and shallow fry						
	165.62					
No. of cases/Total N		70/183	32/81	32/82	43/82	
Median		0	8.03	18.69	36.28	
Age-adjusted		1.00	1.15 (0.64-2.05)	1.22 (0.69-2.18)	2.33 (1.32-4.14)	0.005
Multivariate-adjusted ¹		1.00	1.19 (0.66-2.15)	1.33 (0.74-2.39)	2.48 (1.38-4.46)	0.003
Multivariate-adjusted ²		1.00	1.38 (0.75-2.54)	1.61 (0.87-2.98)	2.93 (1.57-5.47)	< 0.001
Pan and stir fry						
	134.26					
No. of cases/Total N		92/217	28/70	35/71	22/70	
Median		0	3.24	10.54	23.82	
Age-adjusted		1.00	0.74 (0.41-1.33)	1.51 (0.85-2.69)	0.74 (0.40-1.36)	0.67
Multivariate-adjusted ¹		1.00	0.80 (0.44-1.45)	1.52 (0.84-2.75)	0.74 (0.39-1.38)	0.66
Multivariate-adjusted ²		1.00	0.86 (0.46-1.61)	1.28 (0.70-2.36)	0.60 (0.31-1.17)	0.25

¹ Adjusted for age (years, continuous), education (high school or below, college or above), length of stay in Korea (years, continuous), smoking status (ever, never), and alcohol intake (ever, never)

² Adjusted for age (years, continuous), education (high school or below, college or above), length of stay in Korea (years, continuous), smoking status (ever, never), alcohol intake (ever, never), and BMI (< 23, ≥ 23 kg/m²)

Table 6. Odds ratio and 95% confidence interval of prehypertension and hypertension combined according to fried food intake by age, waist circumference, BMI, education, and length of stay in Korea

		Non-fried food consumer	Fried food (% energy)			P for trend	P for heterogeneity
			Tertile 1	Tertile 2	Tertile 3		
Age							
0.46							
< 40 yrs	No. of cases/Total N	17/59	27/86	24/92	43/98		
	OR (95% CI)	1.00	1.04 (0.49-2.21)	0.88 (0.41-1.87)	2.08 (1.01-4.27)	0.01	
≥ 40 yrs	No. of cases/Total N	16/24	18/29	19/23	13/17		
	OR (95% CI)	1.00	0.90 (0.28-2.90)	3.34 (0.77-14.49)	1.79 (0.40-8.06)	0.20	
WC							
0.53							
< 85 cm	No. of cases/Total N	23/65	27/86	28/87	33/82		
	OR (95% CI)	1.00	0.71 (0.33-1.51)	0.96 (0.45-2.02)	1.67 (0.79-3.54)	0.04	
≥ 85 cm	No. of cases/Total N	18-10	18/29	15/28	23/33		
	OR (95% CI)	1.00	2.23 (0.56-8.87)	1.89 (0.49-7.33)	3.31 (0.81-13.43)	0.16	
BMI							
0.10							
< 23 kg/m ²	No. of cases/Total N	8/35	18/60	16/57	12/55		
	OR (95% CI)	1.00	1.15 (0.40-3.28)	1.52 (0.53-4.37)	1.27 (0.42-3.81)	0.66	
≥ 23 kg/m ²	No. of cases/Total N	25/48	27/55	27/58	44/60		
	OR (95% CI)	1.00	1.16 (0.48-2.79)	1.14 (0.48-2.73)	4.09 (1.62-10.31)	< 0.001	
Education							
0.07							
High school or below	No. of cases/Total N	13/28	30-12	12/41	18/45		
	OR (95% CI)	1.00	0.77 (0.24-2.44)	0.69 (0.23-2.13)	0.98 (0.33-2.92)	0.83	
College or above	No. of cases/Total N	20/55	33/85	31/72	38/70		
	OR (95% CI)	1.00	1.20 (0.55-2.61)	1.50 (0.68-3.34)	3.30 (1.46-7.47)	0.001	
Length of stay in Korea							
0.66							
< 10 yrs	No. of cases/Total N	15/53	16/71	23/73	31/80		
	OR (95% CI)	1.00	0.66 (0.28-1.58)	1.26 (0.55-2.89)	1.98 (0.89-4.42)	0.01	
≥ 10 yrs	No. of cases/Total N	18/30	28/41	20/38	24/32		
	OR (95% CI)	1.00	1.65 (0.59-4.60)	0.89 (0.32-2.45)	2.24 (0.72-7.02)	0.30	

Adjusted for age (years, continuous), education (high school or below, college or above), length of stay in Korea (years, continuous), smoking status (ever, never), and alcohol intake (ever, never), and BMI (< 23, ≥ 23 kg/m²)

Compared to non-fried food consumers, the multivariate-adjusted ORs and 95% CIs for having elevated blood pressure among fried food consumers were 1.03 (95% CI: 0.54-1.96) in the 1st tertile, 1.17 (95% CI: 0.62-2.22) in the 2nd tertile, and

2.24 (95% CI: 1.17-4.26) in the 3rd tertile of fried food intake (% energy intake) (*P* for trend = 0.004). When adjusted for BMI, compared to non-fried food consumers, the ORs and 95% CIs for the 1st, 2nd, and 3rd tertiles were 1.18 (0.61-2.31), 1.28 (0.65-

2.51) and 2.46 (1.24-4.87), respectively, (P for trend = 0.004). A similar pattern was observed when fried food intake as grams per day or grams per 1,000 kcal of total energy intake was analyzed. When only hypertension was considered as an endpoint, the prevalence was still higher, albeit not statistically significant (Table 4), comparing the 3rd tertile of fried food consumers with non-fried food consumers.

For the separate analyses of deep and shallow fried food intake or pan and stir fried food intake, there was a high prevalence of prehypertension and hypertension combined limited to deep and shallow fried food (Table 5); ORs (95% CIs) for the 1st, 2nd, and 3rd tertiles of fried food intake were 1.19 (0.66-2.15), 1.33 (0.74-2.39) and 2.48 (1.38-4.46), respectively, (P for trend = 0.003). When BMI was added to the multivariate model, compared to non-fried food consumers, the ORs and 95% CIs for the 1st, 2nd, and 3rd tertiles were 1.38 (0.75-2.54), 1.61 (0.87-2.98), and 2.93 (1.57-5.47), respectively, (P for trend = <0.001). However, the tertiles of pan and stir fried food consumers were compared to non-fried food consumers, there was no significant association.

Interaction by age, obesity, education and length of stay

Examination of whether the association of fried food intakes and prehypertension and hypertension combined was modified by age, anthropometric measures, education, and length of stay in South Korea, revealed that there was only a borderline significant interaction with education (P for heterogeneity = 0.07) (Table 6). The association was more pronounced among those who graduated from college or above than those who graduated from high school or below. In addition, those with higher BMI tended to have high prevalence of prehypertension and hypertension combined with high fried food intake, but this pattern was not clear for those with lower BMI.

DISCUSSION

This study found that high fried food intake was associated with high prevalence of prehypertension and hypertension combined among Filipino women married to Korean men. Compared to non-fried food consumers, Filipino women in the highest tertile of fried food intake had a 2-fold higher prevalence of prehypertension and hypertension combined. The association was observed for deep and shallow fried food intake but not for pan and stir fried food intake. In addition, the association between fried food intake and prehypertension and hypertension combined was more apparent for Filipino women with a higher BMI or with higher education compared to those with a lower BMI or lower education, respectively.

Only a few epidemiologic studies examined the association between fried food intake and hypertension. The Seguimiento Universidad de Navarra (SUN) project, a prospective cohort from Spain, previously reported that frequent consumption of fried foods was associated with higher risk of developing hypertension among young adults after 6.3 years of follow-up. In that study, comparing those who consumed fried foods <2 times/week with those who consumed fried food >2-4 and >4 times/week, the relative risk (RR) were 1.18 (95% CI: 1.03, 1.36) and 1.21 (95% CI: 1.04, 1.41), respectively, (P for trend =

0.009) [23]. Furthermore, another SUN study reported that, in comparison to those who consumed fried foods >4 times/week with ≤ 2 times/week, after 8.3 years of follow-up, the RR for developing high blood pressure was 1.16 (95% CI: 1.02, 1.32; P for trend = 0.011) [24].

The present study showed similar findings to two cross-sectional studies carried out in Spain and in Korea. The Spanish study found that fried food intake was associated with prevalence of hypertension, especially when degraded vegetable oils, such as sunflower oil, were re-used [25]. Also, prolonged intakes of the repeated heated oil has been reported to increase blood pressure [34]. However, in the present study, it was not possible to differentiate between the different type of oils or fats used to fry or if they ever use used oils in frying. In the 5th Korean National Health and Nutrition Survey (KNHANES) 2010-2011 of Korean adults, the prevalence of hypertension increased by 2.4-fold in women with >2 times/week fried food intake compared with those who rarely consumed it [26].

There are various possible mechanisms behind the blood pressure raising effect of heated oil. During frying, heated oil undergoes deterioration due to the exposure of oil to high temperatures in the presence of air and moisture [35,36]. Thermally-oxidized oil generates free radicals which in turn react with nitric oxide (NO), causing activation of peroxynitrite, which propagates the chain of lipid peroxidation [18,21,37]. Also, it has been reported that hypertensive individuals have high levels of malondialdehyde (MDA), a breakdown product of lipid peroxidation and a known marker of oxidative stress [18,38]. Several narrative reviews reported that oxidative stress instigates vascular inflammation by activating the nuclear factor kappa-light-chain-enhancer of activated B cells (NF- κ B), promoting endothelial dysfunction which impairs the production of NO, increases vascular reactivity and resistance, as well as raises angiotensin II (Ang II) levels in vascular smooth muscle cells (VSMC), which may predispose risk of hypertension [18,22, 34,37,39].

In this study, we found high prevalence of hypertension with deep and shallow fried food, but not with pan and stir fried food. When oil is exposed to deep-frying temperature, it leads to a series of physicochemical changes such as production of volatile and non-volatile compounds, which affect the properties of oil and fried food [21,35,40]. Also, deep-frying generates toxic compounds such as hydroperoxides, aldehydes, and other free radicals. These toxic products are absorbed into the food, ingested into the gastrointestinal tract, eventually entering the circulatory system [21,41,42]. The frying method might have different effects on the absorption of fats depending on the food, food surface area, moisture content of food, the type of oil used, frying condition (time, temperature, fryer, etc.) and the degree of degradation [25,43,44]. However, we could not assess whether the oil used was fresh or re-used.

This, to our knowledge, is the first study to examine the association of fried food intake and hypertension among Filipino women. Another strength of our study is that we defined prehypertension or hypertension based on blood pressure levels measured by trained physicians. Nonetheless, the study has several limitations. First, the cross-sectional design cannot infer any causal relationship between fried food and elevated

blood pressure or hypertension. Although the current evidence is from a cross-sectional study, it is still reasonable within the context of achieving optimum health to recommend reducing or eliminating frying foods as well as avoidance of consuming fried foods among Filipino women. Secondly, the relatively small sample size based on convenience sampling does not represent the general population. Thirdly, the data on fried foods were collected from a one-day 24-hour recall, which does not represent the usual daily intake and might have some non-differential measurement errors. Lastly, we did not investigate in detail the type of fat or oil used for frying from a take away restaurant or away from home.

In conclusion, this study showed the evidence that high fried food intake, especially deep and shallow fried food was significantly associated with high prevalence of prehypertension and hypertension combined among Filipino women. Further prospective studies are warranted on the association of fried food intake and cardiovascular risk factors among Filipino women.

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CONFLICT OF INTEREST

The authors declare no potential conflicts of interest.

ORCID

Sherlyn Mae P. Provido: <https://orcid.org/0000-0001-5894-247X>
 Grace P. Abris: <https://orcid.org/0000-0002-0483-7137>
 Sangmo Hong: <https://orcid.org/0000-0002-8535-0565>
 Sung Hoon Yu: <https://orcid.org/0000-0003-4391-4526>
 Chang Beom Lee: <https://orcid.org/0000-0003-4891-834X>
 Jung Eun Lee: <https://orcid.org/0000-0003-1141-878X>

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