A Cross-Sectional Assessment of Dietary Patterns and Their Relationship to Hypertension and Obesity in Indonesia

by Martha Irene Kartasurya

A Cross-Sectional Assessment of Dietary Patterns and Their Relationship to Hypertension and Obesity in Indonesia

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ABSTRACT

Background: There is a marked increase in the intake of foods associated with higher risks for hypertension and obesity in Indonesia. However, studies assessing the relationship between dietary patterns and health outcomes are few.

Objective: The purpose of this study was to characterize dietary patterns and investigate their relationship with hypertension and obesity in Indonesia.

Methods: Exploratory factor analysis was used to derive dietary patterns from a brief food scanner filled by 31,160 respondents aged 15 y and older in the Indonesian Family Life Survey wave 5 (IFLS 5). Age- and gender-specific quintiles of consumption were created for each pattern and the association between quintiles of each dietary pattern and the odds for hypertension and obesity were assessed using multivariate logistic regression analyses.

Results: Two dietary patterns were identified: a modern dietary pattern characterized by fast foods, soft drinks, sweet snacks, and salty snacks and a traditional pattern characterized by fish, vegetables, and fruits. Younger age and being male were significantly correlated with higher consumption of the modern pattern ($P < 0.0001$ and $P = 0.03$, respectively). Analyses showed no association between hypertension and the modern pattern. However, the traditional pattern revealed lower odds for hypertension among those in the highest quintile compared with the lowest quintile (OR: 0.84; 95% CI: 0.74, 0.95; P-trend < 0.05). Individuals in the highest quintile of each dietary pattern had higher odds of obesity compared with those in the lowest quintile (modern pattern—OR: 1.31; 95% CI: 1.15, 1.49; P-trend < 0.00; traditional pattern—OR: 1.25; 95% CI: 1.10, 1.42; P-trend < 0.01).

Conclusions: More studies using gold-standard measures of dietary intake are needed to better understand the relationship between the modern dietary pattern and hypertension in Indonesia. Also, both modern and traditional dietary patterns in Indonesia may be energy dense, leading to higher risk for obesity. *Curr Dev Nutr* 2022;6:nzac091.

Introduction

Over the past 4 decades, diet-related noncommunicable diseases have soared in lower- to middle-income countries (LMICs), and now co-exist with infectious diseases and malnutrition (1–3). The sharp increase in chronic disease conditions in LMICs has been linked to demographic, economic, and epidemiological transitions (1, 4). LMICs are also experiencing nutritional transitions—substantial shifts in dietary patterns

(4, 5)—that are having a major public health impact. Consequently, diet-related cardiovascular disease (CVD) risk factors are increasing in LMICs to a level that the health systems are not fully equipped for, resulting in higher mortality rates than in higher-income countries (6, 7).

Dietary patterns rather than isolated nutrients provide a more realistic assessment of people's dietary intake behavior, and are likely to have interactive and synergistic effects that will be large enough to allow the detection of a relationship between diet and health outcomes,

where one exists (8). In recognition of this, the Scientific Committee for the 2020–2025 Dietary Guidelines for Americans made dietary patterns a major focus of its report and recommendations (9). In studies from high-income countries like the United States, findings have consistently linked higher prevalence of CVD events to consumption of dietary patterns that are high in saturated fat, sodium, and added sugars (10–12). However, for LMICs, individual-level data to help elucidate the relationship between dietary patterns and CVD risk factors are still lacking (3, 13).

Specifically for Indonesia, the world's fourth most populous and largest island country (14), the mortality rate due to CVD risk factors like hypertension and obesity has been on the rise in tandem with nutrition transition (15). Importantly, Indonesia presents an exception to the problem of data gaps highlighted for many LMICs to some extent, with the existence of ongoing, national-level survey data that capture dietary intake and health indicators at the individual level. Yet, relatively few studies have looked at the associations between individual-level dietary intake and CVD risk factors for the Indonesian population. The few studies that have assessed the links between diet and health outcomes in Indonesia have focused only on selected food groups rather than dietary patterns (16, 17). The aim of this study was to characterize the dietary patterns from a brief food screener and to assess the relationship between the dietary patterns and the odds for hypertension and obesity among survey respondents.

Methods

Study design and data source

This was a cross-sectional study design that used the fifth wave of the Indonesia Family Life Survey (IFLS). The IFLS is an ongoing, national survey that assesses dietary intake and health indicators of Indonesian adults and children. We followed the procedures of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) cross-sectional reporting guidelines in this study (18).

The IFLS was stratified by province and urban/rural location, and households were randomly selected from these strata based on a sampling frame derived from the Indonesian Bureau of Statistics (14). A total of 321 enumeration areas (EAs) were randomly selected from 13 provinces, and EAs in urban and smaller provinces were oversampled to facilitate urban-rural and Javanese–non-Javanese comparisons (14). The ethical approval for IFLS 5 was provided in the United States by the Institutional Review Board (IRB) of the Research and Development Corporation (RAND) and in Indonesia by the IRB of the University of Gadjah Mada (14). Prior to the start of the survey, each respondent provided a signed written consent to participate in the study (20). The IFLS data are publicly available upon request and creation of a free online account with RAND (https://www.rand.org/well-being/social-and-behavioral-policy/data/FLS/IFLS/ifls5.html).

The first wave (IFLS 1) was conducted in 1993 among individuals living in 7224 households. The fifth wave (IFLS 5), used for this study, was conducted in 2014 and administered to 16,204 households consisting of 50,148 individuals (**Figure 1**) (14). Only wave 5 included questions addressing the intake of fast foods, with fried and sweet snacks added, to capture the intake of some unhealthy food options (14). For this study, we limited our analyses to respondents aged 15 y and older

($n = 31,160$) who had sampling weights for all survey modules and health measurements and responded to the demographic and food consumption modules of the survey (**Figure 1**). Analyses accounted for sample attrition since IFLS 1 for the oversampling of urban areas and included survey weights that were matched to the Indonesian population in 2014 in the surveyed provinces for all age groups of respondents surveyed (14). To reduce reverse causality, respondents who reported currently taking medication for any chronic condition ($n = 2551$) were excluded from the regression analyses (**Figure 1**).

Dietary patterns

The food-consumption module of IFLS 5 asked about the consumption of 17 food items (**Figure 2** and **Supplemental Table 1**). Most of the items included were iron- and vitamin A–rich foods, which are two micronutrients of public health importance for Indonesia (14). Respondents were asked if they consumed each food item in the past week and how many days in the week they consumed it (14).

We used factor analysis to aggregate the 17 food items in the food screener into dietary patterns with orthogonal rotation using the procedure "proc factor" steps in SAS version 9.4 (SAS Institute). The number of factors retained was determined by considering the scree plot, eigenvalues (>1), magnitude of factor loadings ($\geq$0.3), and the interpretability of the factors (8). The factor score of each dietary pattern for each respondent was derived by multiplying the mean frequency of consumption of each food item by their derived factor loadings (8).

Outcomes

The main outcome of interest was hypertension, and the secondary outcome of interest was obesity. For hypertension, 3 measures of each respondent's blood pressure were taken, following study protocol (14). The average of the 3 measurements was used in our analyses. Hypertension was defined as a combination of measured mean systolic blood pressure $\geq$140 mm Hg and/or mean diastolic blood pressure $\geq$90 mm Hg (21, 22) and categorized as a binary variable. To assess obesity status, each respondent's weight (kg) and height (cm) were taken based on the study protocol (14). Height was recalculated into meters by dividing the centimeter values by 100, and BMI values were calculated based on the formula: kg/m^2. Obesity was then assessed as a binary variable of BMI values $\geq$ 27.50, based on the Asian population cutoffs (23).

Covariates

Sociodemographic information collected during the survey included age, gender, urban-rural location, employment status, and educational level. Behavioral factors included the following: smoking status, physical activity (PA), and sleep quality. Respondents were asked if they ever smoked or were former smokers and if they are currently smoking or using tobacco products. Respondents were asked about the amount of time they spent engaged in different forms of physical activities and their intensity in the past 7 d. The PA module was based on the International Physical Activity Questionnaire (IPAQ). PA was coded to capture intensity by estimating metabolic equivalent (MET) values (24). We further categorized the PA scores into 3 levels: low, medium, and high (21). The sleep scale had 10 items drawn from the Patient-Reported Outcome Measurement Information System (PROMIS), which is a validated instrument used internationally in clinical settings with diverse populations (14, 25). Eight items on the scale asked respondents to describe
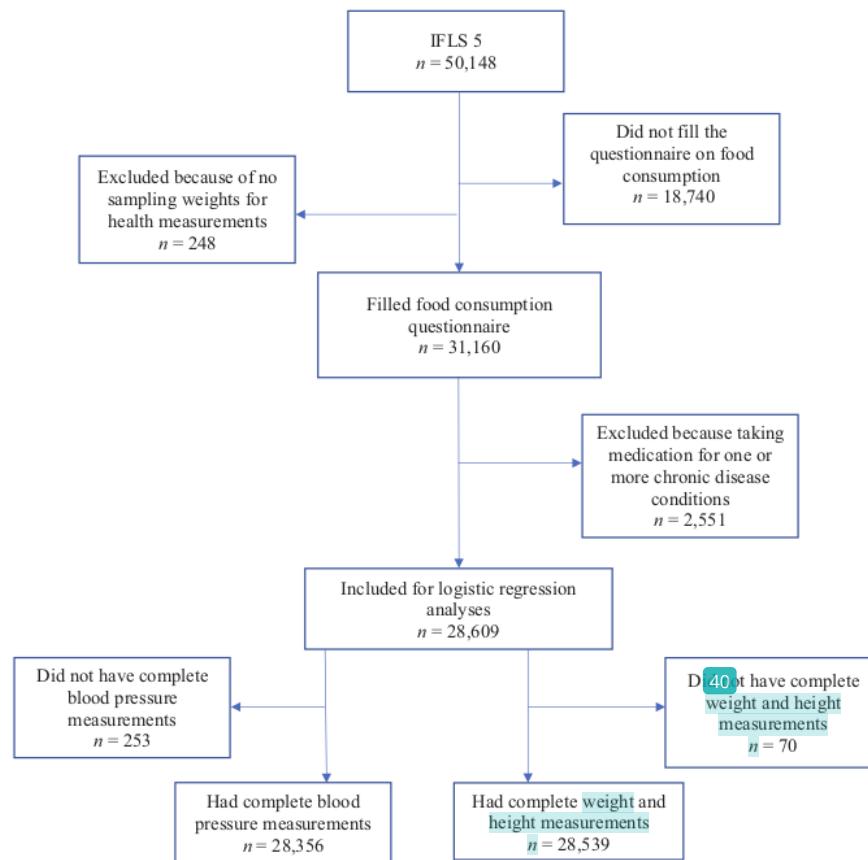
IFLS 5
$n = 50,148$

Did not fill the
questionnaire on food
consumption
$n = 18,740$

Excluded because of no
sampling weights for
health measurements
$n = 248$

Filled food consumption
questionnaire
$n = 31,160$

Excluded because taking
medication for one or
more chronic disease
conditions
$n = 2,551$

Included for logistic regression
analyses
$n = 28,609$

Did not have complete
blood pressure
measurements
$n = 253$

Did not have complete
weight and height
measurements
$n = 70$

Had complete blood
pressure measurements
$n = 28,356$

Had complete weight and
height measurements
$n = 28,539$

FIGURE 1   Study flowchart of the IFLS 5 (2014). IFLS 5, Indonesian Family Life Survey Wave 5.

their sleep patterns using different statements like, "My sleep was refreshing," "I had difficulty falling asleep," and "I had problems during the day because of poor sleep." Responses were measured on a 5-point scale: 1 = not at all, 5 = very much. One item directly addressed sleep quality: "my quality of sleep was…" and was scored on a 5-point scale: 1 = very poor, 5 = very good. Finally, 1 item assessed ease of falling asleep: "I had trouble sleeping" and was scored on a 5-point scale: 1 = never, 5 = always. Following the methodology used by PROMIS, we reversed the score for negative statements such as "I had difficulty falling asleep" and then combined the scores of each statement to derive an overall sleep score of 50 (25). We then categorized the sleep score into 3 levels: <30 = poor, 30–39 = fair, and 40 and above = good.

Statistical analyses
We estimated means and SDs for continuous variables and percentages for categorical variables. We conducted ANOVA tests (for continuous variables) and chi-square tests (for categorical variables) to assess associations between each quintile of the derived dietary patterns and sociodemographic (age, gender, urban-rural location, employment status, and educational level) and behavioral factors (smoking status, PA, and sleep quality). Factor scores for each derived dietary pattern were

categorized into age- and gender-specific quintiles. Logistic regression models were used to estimate ORs for dietary patterns in association with hypertension and obesity, with simultaneous adjustments of both dietary patterns in the model. A few models were developed, and the final model retained was adjusted for age, gender, BMI, smoking, PA, sleep quality, employment status, and educational level. We included employment status and educational level in separate models in order to avoid model overfit, since both variables are proxies for socioeconomic status. We could not adjust for energy intake in any of the models because the food-consumption module did not provide details in terms of the composition or quantity of each food item. We evaluated the statistical significance of the different models by performing the log-likelihood ratio test. We assessed effect modification by age and gender and plotted the log odds of having hypertension by gender and by different iterations of age in years (5, 25, 50, 75, and 95 percentiles, which correspond to ages 16, 25, 34, 45, and 64 y, respectively). Based on the results, we then conducted subanalyses with stratification by gender and age group. A P value of 0.05 or lower was considered statistically significant for all analyses. The factor analysis was carried out using SAS statistical software, version 9.4 (SAS Institute, Inc.). All other statistical analyses were performed using the "svyset" procedure for Stata SE

Factor Loadings of the Derived Dietary Patterns
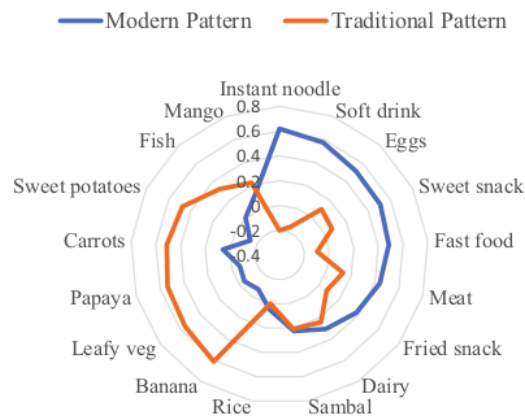
— Modern Pattern   — Traditional Pattern

FIGURE 2 Factor loadings of the derived dietary patterns. Factor loadings >.3 were retained for each factor. The orange line corresponds to the factor loadings of each food group in the traditional dietary pattern; the blue line corresponds to the factor loadings of each food group for the modern dietary pattern. The numbers in the middle are the numerical values of the factor loadings. The further the dot in a line from the center of the circle, the larger the factor loading for a particular food group.

version 17 (StataCorp LP), to account for the complex survey procedure and attrition.

Results

Table 1 shows the sociodemographic and health characteristics of survey respondents. Overall, the weight-adjusted mean ± SD age of study participants was 42.4 15.8 y, women constituted 53.7% of the respondents, and urban versus rural breakdown was approximately 50:50. The prevalence of hypertension was 29.4% in the study population. Among those who have hypertension, 6.3% were 15–19 y, 18.9% were 20–49 y, and 51.3% were 50 y and older. Average BMI (in kg/m^2) for the whole sample was 23.4 ± 4.57. Based on the Asian population cutoffs, the prevalence of overweight and obesity among the study population was 30.9% and 17.4%, respectively.

Figure 2 and **Supplemental Table 2** show the results of the exploratory factor analysis. Factor 1 loaded highly on instant noodle, soft drink, eggs, sweet snacks, fast food, meat, fried snacks, and dairy and was labeled as "modern." Factor 2 loaded on banana, leafy vegetables, papaya, carrots, sweet potatoes, and fish and was labeled "traditional." **Table 2** shows the distribution of quintiles of consumption of both dietary patterns based on respondents' sociodemographic and behavioral factors. Respondents who reported higher adherence to the modern pattern were younger, and more likely to be male, and have higher levels of education (secondary educational level or higher) and moderate-to-high-level PA. They were also more likely to report poor or fair sleep quality. Individuals who reported higher adherence to the traditional pattern were older and more likely to be female and

nonsmokers. Overall, more rural dwellers, and people with primary educational level or lower, reported low adherence to both types of diet.

Table 3 shows the association between dietary patterns and hypertension from multivariable logistic regression. Compared with individuals in the lowest quintiles, those in the highest quintiles of the traditional pattern had a 16% lower odds for hypertension (Q5 vs. Q1: OR = 0.84; 95% CI: 0.74, 0.95; *P*-trend < 0.05). Further adjustments of other health-related and psychosocial variables (e.g., self-rated health and mental health) did not change the results (**Supplemental Table 3**). When we substituted educational level for employment status in the model, the pattern of relationship between the traditional pattern and hypertension remained unchanged, but the trend was no longer significant (**Supplemental Table 4**).

Table 3 shows the results of the unadjusted and adjusted logistic regression analyses to assess the relationship between the odds of obesity and levels of consumption of the derived dietary patterns. Both patterns were associated with a higher odds for obesity. Compared with individuals in the highest quintile, those in the highest quintile of the modern dietary pattern and traditional dietary pattern had a 31% (OR = 1.31; 95% CI: 1.15, 1.49; *P*-trend <0.001) and 25% (OR = 1.25; 95% CI: 1.10, 1.42; *P*-trend < 0.01) higher odds for obesity, respectively.

Figure 3 shows the margins plot for the log odds of hypertension by gender. In the adjusted model, among males, the highest level of consumption of the modern pattern relative to the lowest is associated with higher log odds of hypertension while, for women, consuming at the highest level relative to the lowest is associated with lower log odds of hypertension (*P*-interaction = 0.01). We found no significant gender effect for the traditional pattern. **Figure 4** shows the margins plot for the log odds of hypertension by age. Irrespective of the level of consumption of the modern pattern, the log odds for hypertension increase with age (*P*-interaction = 0.01). Similar to gender, age effects were not significant in assessing the role of high versus low adherence of the traditional pattern. In stratified analyses by gender, the highest level of consumption of the modern pattern relative to the lowest was associated with 17% reduced odds for hypertension (OR: 0.83; 95% CI: 0.69, 0.99; *P*-trend = 0.036) among women, while we found no significant association for men (**Supplemental Table 5**). When stratified by age group, older age was associated with lower odds for hypertension only among respondents 50 y and older with the highest level of adherence to the modern pattern relative to the lowest (OR: 0.76; 95% CI: 0.62, 0.94; *P*-trend = 0.015), while no significant effect was observed for other age groups (**Supplemental Table 6**).

Discussion

Diet-related health risk factors like hypertension and obesity have been on the rise in Indonesia, parallel to nutrition transitions. Using dietary data collected from national surveys, we characterized 2 dietary patterns—modern and traditional—and their sociodemographic and behavioral correlates. We also examined the association between these patterns and 2 major CVD risk factors among respondents 15 y and older in the IFLS wave 5 data (2014). Our analyses revealed a significant variation in food-consumption patterns by population subgroups. We also found some indications that the traditional pattern

TABLE 1 Characteristics of study respondents in the Indonesian Family Life Survey Wave 5, stratified by age group[1]

Characteristics	Total (n = 31,160)	15–19 y (n = 3562)	20–49 y (n = 20,943)	≥50 y (n = 6655)
Gender, n (%)				
Female	16,619 (53.7)	1857 (45.6)	11,221 (54.0)	3541 (54.9)
Male	14,541 (46.3)	1705 (54.4)	9722 (46.0)	3114 (45.1)
Age, mean ± SD, y	42.6 ± 15.8	16.8 ± 1.8	35.1 ± 9.4	59.6 ± 6.2
Place of residence, n (%)				
Rural	12,797 (50.3)	1374 (48.3)	8473 (49.3)	2950 (52.3)
Urban	18,363 (49.7)	2188 (51.7)	12,470 (50.7)	3705 (47.7)
Marital status, n (%)				
Single	6159 (15.0)	3232 (91.6)	2856 (13.6)	71 (0.9)
Married	22,602 (74.0)	319 (8.2)	17,309 (82.0)	4974 (75.0)
Divorced	797 (2.9)	11 (0.2)	537 (2.8)	249 (3.7)
Widowed	1602 (8.1)	0 (0.0)	241 (1.6)	1361 (20.3)
Educational level, n (%)				
Primary or less	10,413 (44.6)	222 (6.7)	5640 (32.7)	4551 (71.9)
Secondary	16,019 (43.2)	3017 (85.5)	11,463 (51.5)	1539 (20.8)
Beyond secondary	4708 (12.2)	323 (7.8)	3832 (15.8)	553 (7.3)
Employment status, n (%)				
Employed	18,326 (59.9)	668 (19.1)	13,637 (64.9)	4021 (60.5)
Student	2576 (5.6)	2216 (61.6)	359 (1.6)	1 (0.0)
Housekeeping	8406 (27.6)	408 (11.0)	6228 (29.8)	1770 (27.5)
Retired	566 (2.6)	0 (0.0)	4 (0.0)	562 (7.3)
Unemployed[2]	671 (2.4)	96 (2.9)	389 (2.0)	186 (2.8)
Other[3]	613 (2.0)	174 (5.5)	324 (1.6)	115 (1.8)
BMI, mean ± SD, kg/m^2	23.4 ± 4.6	20.4 ± 4.6	23.88 ± 4.9	23.4 ± 3.5
Weight status,[4] n (%)				
Underweight	3838 (12.2)	1127 (32.8)	1894 (9.0)	817 (12.8)
Normal	12,612 (39.6)	1779 (49.9)	8340 (38.9)	2493 (38.4)
Overweight	9440 (30.9)	472 (12.6)	6841 (33.0)	2127 (31.4)
Obese	1185 (17.4)	176 (4.7)	3822 (19.1)	1185 (17.3)
Blood pressure, mean ± SD, mmHg				
Systolic	131.5 ± 22.2	118.2 ± 14.4	125.1 ± 18.3	144.6 ± 19.5
Diastolic	80.1 ± 12.0	72.7 ± 10.5	78.9 ± 12.1	83.6 ± 9.9
Hypertension, n (%)				
No	23,851 (70.6)	3347 (93.7)	17,330 (81.2)	3174 (48.7)
Yes	6995 (29.4)	201 (6.3)	3412 (18.8)	3382 (51.3)

[1]Percentages are weighted to account for sampling design and attrition factor.
[2]Unemployed category includes respondents that are not currently employed or disabled.
[3]Other: unspecified employment category.
[4]Weight status derived from BMI categories based on Asian population cutoffs.

might be protective of hypertension and that both the modern and traditional dietary patterns were associated with higher odds for obesity.

Studies looking into dietary patterns and their sociodemographic correlates in Indonesia are few but reveal converging trends. In a series of focus group discussions on food culture among Indonesian adults in West Sumatra, Lipoeto et al. found low consumption of Western-type food relative to traditional food (26). Our findings corroborate this: overall, the study population reported very low consumption of fast foods and soft drinks (Figure 2 and Supplemental Table 2). This, however, does not mean that Indonesia is not undergoing nutrition transition. According to Lipoeto et al. (15), there is an increase in the expenditure for oil and fat, as well as ready-to-eat foods, especially in the urban areas; urban dwellers and people of higher socioeconomic status (SES) are at higher risk for the adverse health effects of nutrition transition. Treloar et al. (27) also found that younger people and people of higher SES were more likely to buy "snack" food or eat out.

Overall, our analyses revealed that there is a marked difference in adherence to each type of dietary pattern by population subgroups in the study population. This has important public health implications, especially with respect to considering which subpopulations are most vulnerable to the adverse health impacts of nutrition transitions. It may also provide useful information to guide the design of targeted nutrition interventions to address disparities in dietary intake by population subgroups.

Evidence from high-income countries suggests that a dietary pattern characterized by higher intake of processed foods with high saturated fat, sodium, and sugar contents significantly increases the risk for CVDs (28–30). Hypertension is the leading risk factor for CVD in Indonesia (21, 31, 32), with current prevalence figures at about 48% among adults 40 y and older, and about 70% of cases undiagnosed (21).

We found no association between the modern dietary pattern and hypertension, while the traditional dietary pattern was inversely

TABLE 2 Characteristics by dietary patterns among respondents of the Indonesian Family Life Survey Wave 5 (2014)[1]

Characteristics	Modern dietary pattern						Traditional dietary pattern					
	Quintile 1 (n = 6231)	Quintile 2 (n = 6249)	Quintile 3 (n = 6226)	Quintile 4 (n = 6232)	Quintile 5 (n = 6222)	P²	Quintile 1 (n = 6233)	Quintile 2 (n = 6225)	Quintile 3 (n = 6246)	Quintile 4 (n = 6233)	Quintile 5 (n = 6223)	P²
Age, mean ± SD, y	43.9 ± 15.9	43.0 ± 15.8	42.1 ± 15.7	41.8 ± 15.6	41.1 ± 15.9	<0.0001	42.1 ± 16.1	41.9 ± 15.7	42.2 ± 15.7	42.6 ± 15.7	43.3 ± 15.6	<0.0001
Age group, n (%)												
15–19 y	710 (7.8)	712 (7.5)	714 (7.4)	713 (7.6)	713 (7.4)	0.69	710 (7.4)	714 (7.8)	716 (7.6)	713 (7.5)	709 (7.5)	0.91
20–49 y	4192 (57.5)	4202 (57.9)	4185 (56.8)	4188 (56.6)	4176 (56.2)		4188 (56.5)	4187 (57.3)	4195 (57.0)	4189 (56.7)	4184 (57.7)	
≥50 y	1329 (34.7)	1335 (34.6)	1327 (35.8)	1331 (35.8)	1333 (36.4)		1335 (36.1)	1324 (34.9)	1335 (35.4)	1331 (35.9)	1330 (34.9)	
Sex, n (%)												
Female	3325 (55.5)	3327 (54.1)	3323 (53.7)	3328 (53.1)	3316 (52.2)	0.03	3325 (52.8)	3327 (53.7)	3327 (54.5)	3319 (53.4)	3321 (54.3)	0.55
Male	2906 (44.5)	2922 (45.9)	2903 (46.3)	2904 (46.9)	2906 (47.8)		2908 (47.2)	2898 (46.3)	2919 (45.5)	2914 (46.6)	2902 (45.7)	
Place of residence, n (%)												
Rural	3402 (62.7)	2787 (53.6)	2426 (48.4)	2139 (44.1)	2043 (42.2)	<0.0001	2639 (53.3)	2718 (52.0)	2767 (52.8)	2541 (49.4)	2132 (43.6)	<0.0001
Urban	2829 (37.3)	3462 (46.4)	3800 (51.6)	4093 (55.9)	4179 (57.8)		3594 (46.7)	3507 (48.0)	3479 (47.2)	3692 (50.6)	4091 (56.4)	
Marital status, n (%)												
Single	1006 (12.4)	1113 (13.5)	1238 (15.1)	1293 (16.2)	1509 (1.0)	<0.0001	1355 (16.6)	1260 (15.6)	1222 (14.9)	1182 (14.5)	1140 (13.2)	<0.0001
Married	4695 (75.6)	4632 (74.9)	4531 (73.9)	4475 (73.2)	4269 (72.3)		4303 (70.2)	4502 (73.8)	4576 (74.5)	4587 (74.9)	4634 (76.9)	
Divorced	166 (3.1)	164 (3.1)	144 (2.6)	164 (2.9)	159 (2.7)		210 (3.9)	152 (2.7)	141 (2.8)	146 (2.4)	148 (2.7)	
Widowed	364 (8.9)	340 (8.5)	313 (8.4)	300 (7.8)	285 (7.0)		365 (9.3)	311 (7.9)	307 (7.8)	318 (8.2)	301 (7.2)	
Educational level, n (%)												
Primary school or less	2875 (57.5)	2281 (47.6)	1914 (42.0)	1775 (39.1)	1568 (36.4)	<0.0001	2548 (52.8)	2296 (48.3)	2069 (43.8)	1867 (40.8)	1633 (36.5)	<0.0001
Secondary school	2795 (35.6)	3191 (42.5)	3302 (44.6)	3284 (45.8)	3447 (47.9)		3140 (40.3)	3186 (42.1)	3286 (44.7)	3223 (44.3)	3184 (44.8)	
Beyond secondary school	560 (6.9)	774 (10.0)	1006 (13.4)	1167 (15.1)	1201 (15.7)		541 (6.9)	738 (9.6)	887 (11.5)	1141 (14.9)	1401 (18.7)	
Employment status, n (%)												
Employed	3587 (57.9)	3599 (59.1)	3611 (59.7)	3749 (61.1)	3780 (62.0)	<0.0001	3501 (57.7)	3610 (59.5)	3665 (59.1)	3754 (61.7)	3796 (61.8)	<0.001

(Continued)

TABLE 2 (Continued)

Characteristics	Modern dietary pattern						Traditional dietary pattern					
	Quintile 1 (n = 6231)	Quintile 2 (n = 6249)	Quintile 3 (n = 6226)	Quintile 4 (n = 6232)	Quintile 5 (n = 6222)	P[2]	Quintile 1 (n = 6233)	Quintile 2 (n = 6225)	Quintile 3 (n = 6246)	Quintile 4 (n = 6233)	Quintile 5 (n = 6223)	P[2]
Student	406 (4.6)	485 (5.2)	527 (5.5)	579 (6.3)	579 (6.3)		518 (5.5)	514 (5.7)	555 (6.1)	494 (5.3)	495 (5.2)	
Housekeeping	1812 (29.7)	1750 (27.7)	1719 (28.0)	1590 (26.6)	1535 (25.7)		1793 (29.0)	1709 (27.4)	1674 (27.9)	1655 (27.0)	1575 (26.3)	
Retired	131 (2.9)	127 (2.9)	111 (2.6)	100 (2.3)	97 (2.3)		98 (2.4)	106 (2.5)	111 (2.6)	108 (2.5)	143 (3.0)	
Unemployed	166 (2.7)	146 (2.8)	130 (2.2)	107 (2.0)	122 (2.0)		173 (3.1)	149 (2.4)	128 (2.4)	110 (1.8)	111 (2.0)	
Other (unspecified)	129 (2.2)	141 (2.3)	128 (1.9)	107 (1.8)	108 (1.6)		149 (2.4)	137 (2.2)	113 (2.9)	112 (1.8)	102 (1.7)	
Smoking status, n (%)												
Nonsmoker	3961 (64.3)	4005 (62.8)	4048 (64.0)	4046 (63.6)	3958 (61.7)	0.26	3832 (59.5)	3966 (63.2)	4009 (64.1)	4060 (63.9)	4151 (66.1)	<0.0001
Former smoker	271 (4.6)	273 (4.8)	290 (4.8)	304 (5.9)	278 (4.8)		245 (4.5)	247 (4.2)	272 (4.5)	288 (4.8)	364 (6.3)	
Current smoker	1999 (31.1)	1971 (32.4)	1888 (31.2)	1882 (31.2)	1986 (33.5)		2156 (36.0)	2012 (32.6)	1965 (31.4)	1885 (31.3)	1708 (27.6)	
Level of physical activity,[3] n (%)												
Low	2159 (33.0)	2083 (30.6)	2068 (30.4)	2095 (31.5)	1974 (29.0)	<0.01	2329 (34.6)	2180 (32.6)	2063 (30.8)	1931 (28.3)	1876 (27.9)	<0.0001
Moderate	1912 (30.9)	2097 (33.7)	2112 (33.9)	2123 (33.5)	2140 (34.5)		1979 (31.3)	2016 (31.3)	2063 (33.2)	2171 (35.0)	2155 (34.7)	
High	2160 (36.1)	2069 (35.8)	2046 (35.7)	2014 (35.0)	2108 (36.5)		1925 (34.1)	2029 (35.1)	2120 (36.0)	2131 (36.7)	2192 (37.4)	
Sleep quality, n (%)												
Poor	631 (10.0)	632 (9.6)	714 (11.2)	701 (11.1)	894 (13.4)	<0.0001	864 (13.4)	730 (11.0)	672 (10.2)	642 (9.8)	664 (10.4)	<0.0001
Fair	1978 (29.6)	2120 (31.5)	2177 (31.6)	2302 (34.3)	2364 (35.4)		2193 (31.9)	2194 (32.4)	2257 (33.7)	2186 (32.8)	2111 (31.4)	
Good	3622 (60.5)	3497 (58.8)	3335 (57.2)	3229 (54.6)	2964 (51.3)		3176 (54.7)	3301 (56.6)	3317 (56.1)	3405 (57.3)	3448 (58.2)	

[1] Percentages are weighted to account for sampling design and attrition factor.
[2] P values based on Pearson's chi-square tests for categorical variables and ANOVA for continuous variables.
[3] Level of physical activity was categorized based on tertiles of total minutes per day of metabolic equivalents (METs) of physical activity: low if <540, moderate if 540–2887, and high if >2888.

TABLE 3 Logistic regression analyses to assess the relationship between dietary patterns, hypertension, and obesity[1]

	Hypertension, n (%)			Obesity, n (%)		
Factor scores	Yes (n = 5868)	No (n = 22,488)	OR (95% CI)[2]	Yes (n = 4527)	No (n = 24,012)	OR (95% CI)[3]
Modern dietary pattern[4]						
Q1 (≤ −0.51)	1276 (22.1)	4430 (20.1)	Ref.	795 (17.7)	4949 (21.1)	Ref.
Q2 (−0.50, 0.02)	1221 (21.1)	4454 (19.8)	1.00 (0.89–1.13)	884 (19.1)	4829 (20.3)	1.11 (0.98–1.27)
Q3 (0.03, 0.56)	1169 (19.6)	4535 (20.3)	0.94 (0.83–1.06)	957 (20.7)	4784 (20.0)	1.19 (1.05–1.36)
Q4 (0.57, 1.26)	1144 (19.5)	4510 (20.0)	0.98 (0.86–1.10)	965 (21.3)	4718 (19.5)	1.25 (1.10–1.43)
Q5 (≥ 1.27)	1058 (17.8)	4559 (19.9)	0.90 (0.79–1.02)	926 (21.1)	4732 (19.0)	1.31 (1.15–1.49)
P-trend			0.41			< 0.001
Traditional dietary pattern[4]						
Q1 (≤ −0.65)	1230 (22.4)	4552 (21.6)	Ref.	853 (19.2)	4975 (22.4)	Ref.
Q2 (−0.64, 0.15)	1198 (20.6)	4497 (20.3)	0.99 (0.87–1.11)	862 (19.8)	4871 (20.5)	1.08 (0.95–1.23)
Q3 (0.16, 0.42)	1161 (19.3)	4574 (20.2)	0.90 (0.80–1.01)	857 (18.9)	4917 (20.2)	1.03 (0.90–1.17)
Q4 (0.43 − 1.22)	1177 (19.7)	4483 (19.5)	0.93 (0.83–1.05)	951 (20.4)	4746 (19.3)	1.13 (0.99–1.28)
Q5 (≥ 1.23)	1102 (18.0)	4382 (18.5)	0.84 (0.74–0.95)	1004 (21.7)	4503 (17.7)	1.25 (1.10–1.42)
P-trend			0.047			<0.01

[1]Percentages were weighted to account for complex sampling design and attrition factor. Q, quintile; Ref., reference.
[2]ORs and 95% CIs were adjusted for age, gender, BMI, physical activity, sleep quality, smoking status, urban/rural location, and employment status.
[3]ORs and 95% CIs were additionally adjusted for marital status.
[4]The 2 dietary patterns were simultaneously included in the same model.

associated with the odds of having hypertension in this population (Table 3). The null findings for the association between the modern pattern and hypertension may be due to residual confounding by gender and age. For instance, a greater proportion of participants who have hypertension were women and older (≥50 y), and both subgroups had lower consumption of the modern dietary pattern (Table 2). Conversely, a greater proportion of the younger participants (15–49 y), who had a lower prevalence of hypertension, also had a higher intake of the modern pattern. As has been established in the literature, gender and older age are causal factors for hypertension and this is also

true for Indonesia (16, 21). Our analyses showed a significant association between higher adherence to the traditional pattern and hypertension based on a model that included employment status as an indicator for SES, while in another model that retained educational level as a proxy for SES, this significant association was attenuated. It may be that the significant association that we found could be an indication of the "healthy worker effect," rather than a real association (33, 34). The available data did not provide enough granularity on the types of employment for us to further assess the true influence of employment status on the observed relationship. Thus, more studies with robust
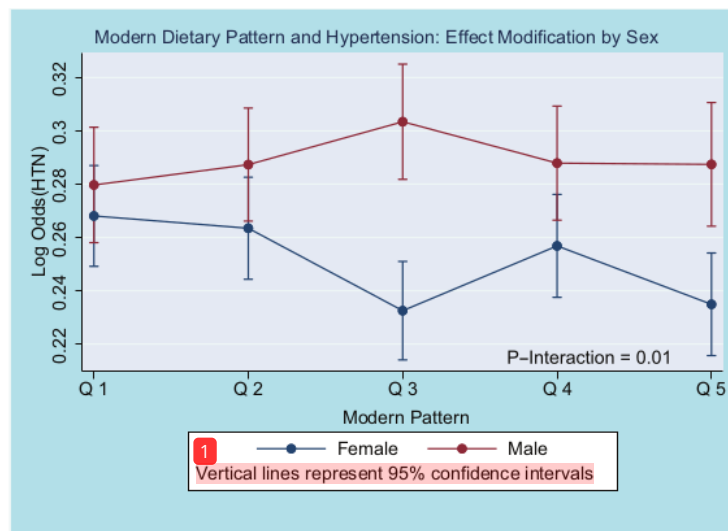

FIGURE 3 Modern dietary pattern and hypertension by sex. Results were adjusted for age, BMI, physical activity, sleep quality, smoking status, urban/rural location, and employment status. HTN, hypertension; Q, quintile.
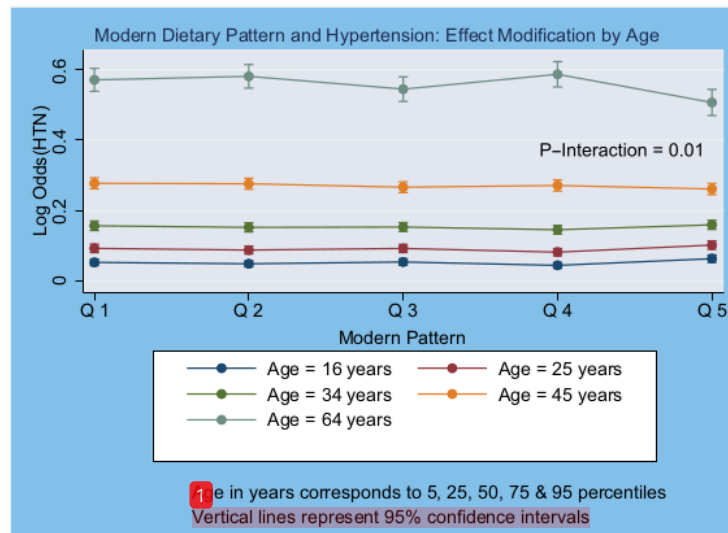
FIGURE 4 Modern dietary pattern and hypertension by age. Results were adjusted for gender, BMI, physical activity, sleep quality, smoking status, urban/rural location, and employment status. HTN, hypertension; Q, quintile.

measures of SES are needed to better elucidate the relationship between the levels of adherence to the traditional pattern and hypertension in Indonesia.

We further examined whether the association between dietary patterns and hypertension differs among population with different gender and age. In these subanalyses, the modern pattern was significantly associated with lower odds for hypertension among females and older adults (Supplemental Tables 5 and 6). This was an unexpected finding that warrants further investigation. One possible explanation could be that the modern pattern could be a proxy for higher protein intake, since it is characterized by meat, including beef, pork, and chicken, as well as eggs. Previous studies have shown the beneficial effect of protein on blood pressure, although evidence is mixed concerning whether it is animal-source or plant-based protein that confers this protection (35–37). Another explanation may be the menopausal status of the women. Previous studies have shown that premenopausal women have lower systolic blood pressure compared with menopausal women (38, 39). A greater proportion of survey respondents are less than 50 y and predominantly female (Table 1). More and better designed studies (experimental and/or cohort) and better dietary assessment instruments like 24-h recalls are needed to better elucidate the relationship between higher intake of proteins and hypertension by gender and age group.

Overweight and obesity rates in Indonesia have also been on the rise across all population subgroups, with changing diets and sedentary lifestyle likely the major drivers (7, 40). Prevalence rates for overweight are particularly high for women (26–31%) compared to men (16–21%) (7, 40). More importantly, change in diets means that even poor households are not immune from obesity due to higher intake of low-nutrient energy-dense foods (6, 17). We found that both types of patterns are associated with higher odds for obesity. The higher odds for obesity observed for both types of dietary patterns can be better

understood in the light of other relevant literature from Indonesia. Lipoeto, Lin, and Angeles-Agdeppa (26) concluded that the nutrition transition being experienced in Indonesia and other countries of South East Asia was not all due to consuming more Western food, since the populations in the region have largely preserved their traditional eating patterns. Rather, they postulated that it might be better explained by the changing composition of the traditional diets (26). This provides a good context for our findings and is a crucial point to consider, especially in categorizing dietary patterns as healthy versus unhealthy. In our study, although the traditional pattern was characterized by higher intakes of fish, leafy green vegetables, and fruits (foods typically considered to be healthier options), the odds for obesity on this type of diet was only slightly lower than with the modern pattern (Table 3). This is an indication that how food is prepared is equally as important as the type of food being consumed. Preliminary results from an ongoing qualitative study on diet quality and health outcomes in Indonesia reveal that frying, using the same oil multiple times, and the use of coconut milk are the most common methods for cooking many Indonesian dishes, including fish and vegetables (O Anyanwu[1], E Naumova[1], V Chomitz[2], F Zhang[1], K Chui[2], M Kartasurya[3], S Folta[1], 2022; [1]Tufts University Friedman School of Nutrition and Policy, [2]School of Medicine, Tufts University, [3]Diponegoro University, Semarang, Indonesia; unpublished data). Healthcare providers interviewed during the study concluded that these practices are key drivers for the high number of CVD-related cases they treat in their practices (O Anyanwu[1], E Naumova[1], V Chomitz[2], F Zhang[1], K Chui[2], M Kartasurya[3], S Folta[1], 2022; [1]Tufts University Friedman School of Nutrition and Policy, [2]School of Medicine, Tufts University, [3]Diponegoro University, Semarang, Indonesia; unpublished data). More studies addressing the sociodemographic factors related to changes in the composition of traditional diets, cooking practices, and their effects on CVD risk factors are warranted for Indonesia.

Challenges and limitations

This study has several limitations. First, our study uses a cross-sectional design and thus it may not indicate a strong causal argument between the exposures and outcomes of interest. Second, it is only the fifth wave of the IFLS that captured the intake of potentially unhealthy foods, and it was the only wave used in this study, so we were not able to investigate any longitudinal changes in the associations. Third, the instrument for assessing food intake in the survey was a brief food screener that was designed to capture specific micronutrients of public health importance for Indonesia and provided no details in quantities of consumption or methods of preparation. Thus, we could not estimate and adjust for total energy intake in our analyses, leaving room for measurement errors and confounding by total energy intake. Based on these limitations, we recommend caution about making any causal inference on any of our findings.

Strengths of the study

The sparseness of information available from the brief food screener used in our study notwithstanding, it is still comparatively a valid instrument for assessing food consumption at the individual level (41, 42), especially for an LMIC like Indonesia, where nationally representative dietary data at the individual level are scarce. Other available options such as per-capita expenditure estimates do not capture differences in food-consumption patterns at the individual and population subgroup levels as the brief screener was able to do (3). Brief food screeners have been shown in the literature to have adequate reproducibility and validity when compared with a longer food-frequency questionnaire and biomarkers (41, 43). Additionally, brief food screeners have low cost, low respondent burden and are appropriate for studies testing a limited set of hypotheses (41, 42). Further, conducting factor analysis afforded us a more rigorous and valid approach to quantifying the food-consumption patterns of study participants. By aggregating the food items into patterns rather than individual food items, we were able to detect a significant association that another study using the same dataset missed (16). Also, the large sample size allowed us to have more precise and robust estimates of the relationship between diet and CVD risk factors of respondents than a less-powered study would have done.

Conclusions

Our findings provided some initial evidence for the associations between dietary intake patterns, hypertension, and obesity in Indonesia. Future studies using a longitudinal design are warranted to further evaluate the role of dietary intake patterns in noncommunicable diseases in Indonesians, who have been experiencing a transition in dietary intake patterns in the past few decades. Further, our findings may be informative for public health and nutrition researchers in Indonesia to help identify vulnerable subgroups at higher risk of the adverse health effects of nutrition transitions and to tailor nutrition interventions to meet the needs of the different subpopulations in Indonesia.

Data Availability

Data described in the manuscript, code book, and analytic code will be made available upon request pending application and approval.

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