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Associations between food consumption/dietary habits and the risks of obesity, type 2 diabetes, and hypertension: a cross-sectional study in Jakarta, Indonesia

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ABSTRACT

BACKGROUND/OBJECTIVES: This study aimed to assess the current mean daily intake of 10 food groups, analyze the sociodemographic factors associated with food consumption, and determine the associations between food consumption/dietary intake and the prevalence rates of obesity, type 2 diabetes (T2D), and hypertension (HTN) in Jakarta, Indonesia.
SUBJECTS/METHODS: A total of 600 participants aged 20–85 yrs were included in this cross-sectional study. Food consumption and dietary habits were assessed using a food frequency questionnaire. To determine the association between food consumption/dietary habits and the abovementioned diseases, logistic regression analysis was performed.
RESULTS: The average vegetable and fruit intake was lower, while sugar and salt consumption were higher than that recommended by Indonesia's national dietary guidelines. A high intake of ultra-processed foods (UPFs) was associated with young age, men, "single" status, a high education level, and employment with a high monthly income. Obesity and T2D were positively correlated with high intakes of cereals and tubers, UPFs, sugars, fats, and oils. Conversely, an inverse association was found between legume, vegetable, and fruit consumption and obesity risk. An inverse correlation was also observed between vegetable consumption and T2D risk. Moreover, a high salt intake was inversely correlated with fruit consumption in terms of HTN risk. Non-indulgence in habitual late-night snacking and refrainment from consuming more than one dish at each meal were also negatively related to the prevalence of obesity, T2D, and HTN. Inverse correlations were also observed between the prevalence rates of T2D and HTN and abstaining from adding sugar to beverages.
CONCLUSION: Foods high in fat, sugar, and sodium were strongly associated with the risks of obesity, T2D, and HTN. Additionally, poor eating habits were also associated with disease development.

Keywords: Food intake; dietary habits; obesity; diabetes mellitus; hypertension

Conflict of Interest
The authors declare no potential conflicts of interests.

Author Contributions
Conceptualization: Noviana AIS, Lee BH; Formal analysis: Noviana AIS; Methodology: Noviana AIS, Hwang SB, Park HJ; Supervision: Lee BH; Writing - original draft: Noviana AIS, Hwang SB; Writing - review & editing: Lee BH.

INTRODUCTION

In Indonesia, as in several other countries worldwide, diet and dietary change currently lie at the heart of pressing public health challenges. Over the past decades, Indonesia, the world's fourth most populous and largest island country, has undergone dietary-pattern shifts and a rapid nutritional transition that have led to the increased prevalence of diet-related chronic diseases [1]. This nutritional transition, which entails unhealthy dietary choices and reduced physical activity, has played a major role in increasing the behavioral and metabolic risk factors for non-communicable and chronic diseases [2]. Poor dietary habits are also indicative of the growing risk of chronic diseases, such as obesity, diabetes, and hypertension (HTN) [3].

According to the Indonesian Health Ministry [4], the prevalence of obesity increased from 8.80% of the population in 2013 to 21.8% in 2018, such that as of 2018, more than 58 million people had been reported to have obesity. Regarding type 2 diabetes (T2D), more than 29 million patients had diabetes in 2018, and the prevalence of T2D increased from 6.9% of the population in 2013 to 10.9% in 2018 [4]. The overall number of people with HTN as well as the rate at which this figure is increasing is even more alarming than that of people with diabetes and obesity. Indeed, the prevalence of HTN increased dramatically from 25.8% of the population in 2013 to 34.1% in 2018 [4]. Thus, over a third of Indonesia's population, or approximately 90 million people, suffer from HTN, which co-occurs with the risk of decreasing health status.

Numerous studies conducted over the past few decades have underscored the important role current dietary-intake modification plays in the development of obesity, diabetes, and HTN. However, current data on the food consumption and dietary habits of Indonesians remains lacking, and these phenomena urgently need to be assessed. In particular, information on the associations of food consumption and eating habits with the risks of obesity, T2D, and HTN in the Indonesian population, especially in Jakarta, is limited. Therefore, conducting a study in this area is crucial. Additionally, the Indonesian government exclusively focuses on school-based nutritional intervention initiatives, such as nutrition education, school feeding, and vitamin and mineral supplementation for children and adolescents across all school levels. To aid in the development of future interventions that target people from various sociodemographic backgrounds, not just children, this study selected adults aged 20–85 yrs as its participants.

This study aimed to 1) examine the average daily dietary intakes of different food groups; 2) analyze the sociodemographic factors that influence food consumption; 3) determine the association between food intake and the prevalence of specific diseases (obesity, T2D, and HTN); and 4) assess dietary habits and their impact on the prevalence rates of obesity, T2D, and HTN. The overarching goal of this study was to improve diet quality, promote healthy eating habits, and increase nutritional knowledge in a bid to lower the risk of chronic diseases across various sociodemographic groups in Indonesia.

SUBJECTS AND METHODS

Study design and population

This study used a cross-sectional design to investigate the associations of food consumption and dietary habits with the incidence rates of obesity, T2D, and HTN. It was conducted from February to May 2022 and enrolled a total of 600 participants aged ≥ 20 yrs residing in Jakarta, Indonesia. This study's exclusion criteria were as follows: age < 20 yrs, pregnancy, and the presence of a mental illness. This study was approved by the Ethics Committee of Chung-Ang University (1041078-202203-HR-059). Written informed consent was obtained from all the participants included in this study prior to the investigation.

Outcome measurements

Obesity, T2D, and HTN were the key outcome variables. Direct measurements were performed during clinical examinations to collect participants' anthropometric measurements, namely body mass index (BMI), blood pressure, and blood sugar level. Physical examinations were conducted specifically for this study by trained personnel, such as nurses, using standardized protocols and calibrated equipment. A mechanical digital weight scale (Digital scale SMIC ZT-120; Gea Medical Inc., Jakarta, Indonesia) was used for weight measurements, with the resultant weight being recorded in kilograms (kg) to the nearest 0.1 kg. To measure height, this study employed a mechanical measuring tape (stature meter SH2A; Gea Medical Inc.) in a standing position, with the resultant height being recorded in centimeters (cm) to the nearest 0.5 cm.

BMI was calculated based on body weight in kg divided by height in meters squared (m^2). According to international standards, obesity was defined as a BMI ≥ 30 kg/m^2 and overweight (including obesity) as a BMI ≥ 25 kg/m^2 (World Health Organization, 2004). Blood pressure was measured using manual (Tensimeter AS041; ABN Medical Inc., Jakarta, Indonesia) and digital (Tensimeter Digital HEM-7130; OMRON Inc., Jakarta, Indonesia) sphygmomanometers. Blood pressure was classified into 4 categories: normal (< 120/80 mmHg), pre-HTN (120–139/80–89 mmHg), HTN level I (140–159/90–99 mmHg), and HTN level II (> 160/100 mmHg). The blood sugar level was measured using an MMS-Autocheck glucometer (Blood Lancet 286; Gea Medical Inc.), with the blood sugar level being classified as normal (< 100 mg/dL), pre-diabetes (100–125 mg/dL), and diabetes (> 125 mg/dL).

Assessment of food consumption and dietary habits

In this study, dietary consumption was assessed using an food frequency questionnaire (FFQ). The concept and rationale for major foods have been classified, and the FFQ comprised 54 food items so as to realistically capture food consumption among people living in Jakarta, Indonesia. The FFQ aims to assess dietary intake by requesting participants to indicate both the frequency of consumption and portion size of food items consumed over the preceding year. The FFQ in this study contained 54 food items arranged into 10 food categories, and they were selected based on the foods most frequently consumed by Indonesians, as set forth in the Indonesian Food Composition Data 2018 (**Supplementary Table 1**). Study participants reported their frequency of consumption of each food group based on six levels of frequency: never/hardly ever, 1 to 3 times per month, once a week, 2 to 4 times per week; once a day, and 2 to 4 times per day. Standard serving sizes were based on the recommendations for balanced nutrient intake published by the Indonesian Health Ministry (**Supplementary Table 2**). The serving size was provided as a reference to aid the participants in estimating each food item's portion size.

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The quantity of each food item consumed per day was calculated using the following formula: intake frequency (conversion factor) of food items × portion size (g). The following values or conversion factors were used for each frequency option: never/hardly ever = 0, 1 to 3 times a month = 0.07 (2/30), once a week = 0.14 (1/7), 2 to 4 times a week = 0.43 (3/7), once a day = 1 (1/1), and 2 to 4 times per day = 3 (3/1) [5]. For each portion size, the following values were used: small = 0.5, standard = 1, and large = 1.5. The value of each portion size was multiplied by the standard serving size recommended by the Indonesian Health Ministry. The resulting total daily intake was subsequently compared with Indonesia's national recommendation (**Supplementary Table 3**). This measurement was performed to determine whether the participant's total daily intake of each food group complied with the Indonesian government's recommendation or was lower or higher than the standard recommendation. Each item in the "dietary habits" section of the questionnaire was measured on a 5-point Likert scale ranging from 1 (very unlikely) to 5 (very likely). The "dietary habits" section comprised 10 questions that were considered appropriate for determining the association between eating habits and disease. These questions were related to their daily food-consumption frequency, average meal portions, tendency to add sugar and salt to meals, tendency to consume fast foods, water-drinking habits, supplementation regime (if any), and consumption of traditional healthy beverages.

Assessment of covariates

To collect information on sociodemographic characteristics (e.g., age, gender, marital status, education level, employment status, monthly income, and residential area) and lifestyle factors (e.g., dietary habits and physical activity), trained interviewers administered a detailed questionnaire. Based on age, participants were classified as young (20–35 yrs old), middle-aged (36–55 yrs old), or older (56–85 yrs old) adults. Gender was categorized into men and women and marital status into single (never married), married, and divorced/widowed. Education level was divided into low (primary school or lower), middle (middle or vocational school), and high (college, university, or higher). Regarding employment status, participants were classified as unemployed or employed. Monthly income categories were determined based on the classification established by BPS Statistics of DKI Jakarta Province [6]. The categories were as follows: Indonesian Rupiah (IDR) < 3,000,000 for low wages; 4,000,000–5,000,000 for average wages; and > 5,000,000 for high wages. In Unites States Dollars (USD), the categories were as follows: < 200, 200–400, and > 400, indicating that USD 200–400 was the average monthly income earned by Jakartans [6]. The average Jakartan family has four members [6]; therefore, family size was categorized into "zero-to-four member" and "more-than-four member" families. Moreover, residential area was divided into metropolitan and suburban areas. Physical activity was measured using a modified international physical activity questionnaire that comprised five questions and assessed the frequency, duration, and intensity of physical activity [7].

Statistical analysis

All analyses were performed using the Statistical Package for the Social Sciences (version 26.0;IBM Corp., Armonk, NY, USA). Statistical significance was set at $P < 0.05$. To evaluate the participants' general characteristics, continuous variables are presented as the mean ± SE and categorical variables as numbers and percentages. The 10 food groups were assessed according to their tertile ranges (low, medium, and high intake) based on their consumption values (frequency multiplied by serving size). Based on the participants' characteristics, food-group consumption was analyzed using the t-test and χ^2 test. The χ^2 test was also used to identify significant differences between participant characteristics and disease prevalence. To investigate the associations between each food group and selected diseases, a logistic regression model was used for multi-stage sampling. Adjustments were made for potential confounding variables, such as age, gender, BMI, marital status, education level, employment status, monthly income, family size, residential area, and physical activity. Logistic regression analysis was also used to examine the association between dietary habits and disease prevalence.

RESULTS

Study participants' general characteristics

Table 1 shows the general characteristics of this study's participants. Of the 600 participants, 46.2% were men, and 53.8% were women, while 50% were young adults, 34.7% were middle-

Table 1. General characteristics of the study participants

Characteristics	Men (n = 277)	Women (n = 323)	Total (n = 600)	*P*-value[1)]
Age (yrs)				0.876
20–35	136 (49.1)[1)]	164 (50.8)	300 (50)	
36–55	99 (35.7)	109 (33.7)	208 (34.7)	
> 55	42 (15.2)	50 (15.5)	92 (15.3)	
Marital status				0.931
Single	74 (26.7)	90 (27.9)	164 (27.3)	
Married	188 (67.9)	217 (67.2)	405 (67.5)	
Widowed/divorced	15 (5.4)	16 (4.9)	31 (5.2)	
Education level				0.056
Below high school	12 (4.3)	25 (7.7)	37 (6.2)	
High school	148 (53.4)	187 (57.9)	335 (55.8)	
College or higher	117 (42.2)	111 (34.4)	228 (38)	
Employment status				< 0.001***
Unemployed	59 (21.3)	236 (73.1)	295 (49.2)	
Employed	218 (78.7)	87 (26.9)	305 (50.8)	
Monthly income in USD				0.141
< 200	50 (18.1)	57 (17.6)	107 (17.8)	
200–400	100 (36.1)	94 (29.1)	194 (32.4)	
> 400	127 (45.8)	172 (53.3)	299 (49.8)	
Family size				0.945
0–4 members	168 (60.6)	195 (60.4)	363 (60.5)	
> 4 members	109 (39.4)	128 (39.6)	237 (39.5)	
Residential area				0.623
Metropolitan	274 (98.92)	318 (98.4)	592 (98.7)	
Suburban	3 (1.08)	5 (1.6)	8 (1.3)	
BMI (kg/m^2)				< 0.01**
< 18.5	0	14 (4.3)	14 (2.3)	
18.5–24.9	221 (79.8)	242 (74.9)	463 (77.2)	
25–29.9	53 (19.1)	65 (20.1)	118 (19.7)	
≥ 30	3 (1.1)	2 (0.6)	5 (0.8)	
Blood pressure (mmHg)				< 0.001***
< 120/80	9 (3.2)	70 (21.7)	79 (13.2)	
120–139/80–89	120 (43.3)	193 (59.8)	410 (68.3)	
140–159/90–99	44 (15.9)	54 (16.7)	98 (16.3)	
≥ 160/100	7 (2.5)	6 (1.9)	13 (2.2)	
Blood sugar (mg/dL)				< 0.001***
< 100	64 (23.1)	133 (41.2)	197 (32.8)	
100–125	180 (65)	142 (44)	322 (53.7)	
> 125	33 (11.9)	48 (14.8)	81 (13.5)	

Data are presented as numbers (%).
BMI, body mass index; USD, United States dollar.
[1)]*P*-values were obtained from the χ^2 test.
**P* < 0.05, ***P* < 0.01, ****P* < 0.001.

aged adults, and 15.3% were older adults. Most study participants were married (67.5%) and had completed high school (93.8%). Just over half of the participants (50.8%) were employed, and 49.8% had a monthly income exceeding IDR 6,000,000 (USD 400). Regarding family size, 60.5% of the participants were part of "zero-to-four member" families, with most them residing in the Jakarta metropolitan area. Furthermore, while most participants (77.2%) had a normal BMI, 86.8% had pre-HTN or HTN, and 67.2% had pre-diabetes or diabetes.

Average daily food intake according to sociodemographic factors

Table 2 shows the average daily consumption of various food groups by sociodemographic factors. Overall, participants consumed 285.77 g/day of cereals and tubers; 56.99 g/day of meat, poultry, and seafood; 30.46 g/day of legumes; 111.29 g/day of vegetables; and 45.90 g/day of fruits. They also consumed 51.58 g/day of ultra-processed foods (UPFs), 54.58 g/day of fats and oils, 40.58 g/day of sugars, 144.54 g/day of beverages, and 30.00 g/day of seasonings. Men intakes of cereals and tubers ($P < 0.001$), UPFs ($P < 0.001$), sugars ($P < 0.05$), and beverages ($P < 0.001$) were significantly higher than women intakes. Middle-aged adults consumed more cereals and tubers, vegetables, fats, and oils than young and older adults ($P < 0.001$). Married participants consumed more cereals and tubers ($P < 0.001$), legumes ($P < 0.05$), vegetables ($P < 0.01$), and fats and oils ($P < 0.01$) than single and divorced/widowed participants. Higher education levels led to higher intakes of cereals and tubers ($P < 0.001$); meat, poultry, and seafood ($P < 0.01$); vegetables ($P < 0.01$); fruits ($P < 0.001$); UPFs ($P < 0.001$); fats and oils ($P < 0.001$); and beverages ($P < 0.05$). Employment status also affected consumption, with a higher monthly income resulting in higher intakes of cereals and tubers, UPFs, fats and oils, and seasonings ($P < 0.001$, $P < 0.001$, $P < 0.01$, and $P < 0.001$, respectively).

Associations between food-group consumption and the prevalence rates of obesity, T2D, and HTN

Table 3 reveals that participants with obesity were more likely to be older, be married, have lower educational attainment, and have fewer than four family members ($P < 0.001$). They also tended to be unemployed or wealthy ($P < 0.01$). No significant differences were noted in gender ($P = 0.998$) and residential area ($P = 0.615$) with regard to obesity. Participants with T2D were more likely to be older, overweight, and married ($P < 0.001$), with a relatively high proportion evidencing low educational attainment and unemployment status. However, no significant differences in gender, monthly income, and residential area were identified between participants with and without T2D. Those with HTN tended to be older, married, of lower educational attainment, unemployed, and in a family with more than four family members ($P < 0.001$). They were also more likely to be wealthy ($P < 0.05$) and overweight ($P < 0.001$). No significant differences in gender ($P = 0.959$) and residential area ($P = 0.175$) were observed according to the prevalence of HTN.

Table 4 shows the associations between various food groups and diseases, including obesity, T2D, and HTN. Under the fully adjusted model (model 3), participants in the highest consumption tertiles for cereals and tubers ($P < 0.05$), UPFs ($P < 0.01$), fats and oils ($P < 0.01$), and sugars ($P < 0.05$) tended to be obese compared with those in the lowest tertiles. However, participants in the highest consumption tertiles for legumes ($P < 0.05$), vegetables ($P < 0.05$), and fruits ($P < 0.01$) were less likely to be obese than those in the lowest tertiles. In model 3, compared with those in the lowest tertiles, participants in the highest consumption tertiles for cereals and tubers, UPFs, fats and oils, and sugars tended to develop T2D ($P < 0.05$, $P < 0.05$, $P < 0.01$, and $P < 0.05$, respectively). However, those in the highest tertile of the vegetable group were less likely to develop T2D ($P < 0.05$). As regards HTN, seasoning

Table 2. Daily intake of food groups (g/day) according to sociodemographic characteristics

Variables	Cereals and tubers	Meat, poultry, and seafood	Legumes	Vegetables	Fruits	UPFs	Fats and oils	Sugars	Beverages	Seasonings
Average intake	285.77 ± 0.12	56.99 ± 0.02	30.46 ± 0.02	111.29 ± 0.06	45.90 ± 0.05	51.86 ± 0.01	54.58 ± 0.06	40.58 ± 0.03	144.54 ± 0.14	30.00 ± 0.03
Gender										
Men	304.77 ± 3.41	57.08 ± 0.79	30.58 ± 0.58	105.78 ± 1.84	43.63 ± 1.93	54.95 ± 1.15	55.14 ± 0.73	40.79 ± 0.55	169.64 ± 4.97	30.06 ± 0.22
Women	269.47 ± 4.29	56.92 ± 0.46	30.36 ± 0.74	116.01 ± 2.28	47.85 ± 1.11	49.22 ± 0.96	54.11 ± 0.75	40.40 ± 0.14	122.99 ± 4.62	29.95 ± 0.03
P-value[1)]	< 0.001***	0.852	0.823	< 0.05*	0.067	< 0.001***	0.339	0.051	< 0.001***	0.588
Age (yrs)										
20–35	290.95 ± 3.51	57.34 ± 0.72	30.03 ± 0.68	109.98 ± 1.65	45.77 ± 1.30	56.10 ± 0.93	54.67 ± 0.34	40.05 ± 0.66	143.48 ± 4.99	30.18 ± 0.18
36–55	307.09 ± 3.65	57.20 ± 0.62	29.90 ± 0.50	119.75 ± 3.24	48.32 ± 2.33	55.61 ± 1.33	57.20 ± 1.35	39.70 ± 0.47	149.47 ± 6.03	29.82 ± 0.14
56–85	221.01 ± 9.84	55.37 ± 0.95	33.14 ± 1.89	96.12 ± 3.14	40.51 ± 2.67	39.39 ± 1.88	48.38 ± 0.93	39.33 ± 0.33	136.79 ± 8.63	29.82 ± 0.12
P-value	< 0.001***	0.300	0.061	< 0.001***	0.075	< 0.001***	< 0.001***	0.782	0.480	0.245
Marital status										
Single	287.06 ± 5.07	57.73 ± 1.15	28.60 ± 0.99	107.08 ± 2.09	45.78 ± 1.73	52.82 ± 1.25	53.26 ± 0.46	40.14 ± 0.23	138.94 ± 7.10	30.00 ± 0.00
Married	292.47 ± 3.27	56.84 ± 0.44	31.26 ± 0.57	114.31 ± 1.97	46.26 ± 1.41	52.79 ± 0.93	55.61 ± 0.74	40.42 ± 0.38	147.80 ± 4.17	30.01 ± 0.15
Divorced/widowed	192.30 ± 6.68	55.13 ± 1.96	29.84 ± 1.79	93.78 ± 6.85	40.77 ± 6.46	34.84 ± 3.19	48.27 ± 1.94	39.53 ± 0.75	131.43 ± 5.44	29.80 ± 0.19
P-value	< 0.001***	0.421	< 0.05*	< 0.01**	0.561	<0.05*	< 0.01**	0.617	0.370	0.907
Education level										
Middle school or lower	190.47 ± 5.31	54.20 ± 1.50	29.57 ± 0.48	95.17 ± 6.58	35.06 ± 3.01	36.26 ± 3.69	44.70 ± 1.83	39.32 ± 0.48	133.65 ± 3.19	29.56 ± 0.31
High school	286.99 ± 3.68	56.17 ± 0.67	30.95 ± 0.71	110.01 ± 2.15	42.06 ± 1.18	52.78 ± 0.87	54.29 ± 0.60	39.45 ± 0.54	137.80 ± 4.38	30.07 ± 0.18
College or higher	299.56 ± 3.88	58.66 ± 0.56	29.89 ± 0.66	115.69 ± 2.10	53.06 ± 2.23	53.07 ± 1.32	56.62 ± 1.00	40.44 ± 0.55	156.19 ± 6.22	29.97 ± 0.02
P-value	< 0.001***	< 0.01**	0.520	< 0.01**	< 0.001***	< 0.001***	< 0.001***	0.425	< 0.05*	0.518
Employment status										
Unemployed	266.30 ± 4.71	56.46 ± 0.45	30.36 ± 0.73	109.31 ± 2.42	44.93 ± 1.27	47.80 ± 0.97	53.14 ± 0.66	40.33 ± 0.14	125.53 ± 4.64	29.94 ± 0.03
Employed	304.71 ± 3.01	57.51 ± 0.75	30.56 ± 0.63	113.18 ± 1.81	46.74 ± 1.82	55.80 ± 1.10	55.98 ± 0.81	40.28 ± 0.50	162.91 ± 5.04	30.05 ± 0.20
P-value	< 0.001***	0.243	0.840	0.200	0.419	< 0.001***	< 0.01**	0.734	< 0.001***	0.591
Monthly income										
Low	244.84 ± 8.48	56.53 ± 0.83	29.34 ± 1.31	99.95 ± 2.59	43.92 ± 2.36	45.09 ± 1.56	51.03 ± 0.78	38.52 ± 0.47	130.74 ± 7.89	29.94 ± 0.05
Middle	289.43 ± 4.65	54.96 ± 1.05	29.87 ± 0.63	113.40 ± 3.35	37.36 ± 1.39	55.17 ± 1.34	54.80 ± 0.97	39.86 ± 0.34	137.07 ± 6.17	29.79 ± 0.16
High	298.14 ± 3.55	58.48 ± 0.48	31.24 ± 0.74	113.96 ± 1.86	52.04 ± 1.79	56.15 ± 1.06	55.72 ± 0.80	40.25 ± 0.69	154.30 ± 5.02	30.16 ± 0.18
P-value	< 0.001***	< 0.01**	0.255	< 0.01**	< 0.001***	< 0.001***	< 0.01**	0.242	< 0.05*	0.295

Data are presented as the mean ± SE.
UPF, ultra-processed food.[1)]*P*-values were obtained from the χ^2 test.
$^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

consumption was positively associated with HTN prevalence in all models ($P < 0.01$), while fruit consumption was inversely associated with HTN prevalence ($P < 0.05$).

Associations between dietary habits and disease

Table 5 displays the participants' dietary habits based on gender, with women being more likely to abstain from late-night snacking ($P < 0.05$), adding sugar to beverages ($P < 0.01$), and

Table 3. General characteristics of the participants according to obesity, T2D, and HTN

Variables	Obesity (n = 117)	Non-obesity (n = 483)	*P*-value[1)]	T2D (n = 80)	Non-T2D (n = 520)	*P*-value	HTN (n = 111)	Non-HTN (n = 489)	*P*-value
Gender			0.998			0.343			0.959
Men	54 (46.17)	223 (46.17)		33 (41.25)	244 (46.92)		51 (45.95)	226 (46.22)	
Women	63 (53.85)	260 (53.83)		47 (58.75)	276 (53.08)		60 (54.05)	263 (53.78)	
Age (yrs)			$< 0.001^{***}$			$< 0.001^{***}$			$< 0.001^{***}$
20–35	25 (21.37)	275 (56.94)		11 (13.75)	289 (55.58)		6 (5.40)	294 (60.12)	
36–55	54 (46.15)	154 (31.89)		33 (41.25)	175 (33.65)		44 (39.64)	164 (33.54)	
> 55	38 (32.48)	54 (11.18)		36 (45)	56 (10.77)		61 (54.96)	31 (6.34)	
BMI (kg/m^2)	30.75 ± 2.17	20.84 ± 2.01	$< 0.001^{***}$	26.79 ± 2.57	22.15 ± 2.05	$< 0.001^{***}$	25.45 ± 3.17	22.17 ± 2.08	$< 0.001^{***}$
Marital status			$< 0.001^{***}$			$< 0.001^{***}$			$< 0.001^{***}$
Single	7 (5.98)	157 (32.51)		0 (0)	164 (31.54)		1 (0.90)	163 (33.33)	
Married	102 (87.2)	303 (62.73)		70 (87.5)	335 (64.42)		91 (81.98)	314 (64.21)	
Divorced/widowed	8 (6.84)	23 (4.76)		10 (12.5)	21 (4.04)		19 (17.12)	12 (2.45)	
Education level			$< 0.001^{***}$			$< 0.001^{***}$			$< 0.001^{***}$
Below high school	12 (10.26)	25 (5.18)		17 (21.25)	20 (3.85)		26 (23.42)	11 (2.25)	
High school	76 (64.96)	259 (53.62)		50 (62.5)	285 (54.80)		72 (64.86)	263 (53.78)	
College or above	29 (24.79)	199 (41.20)		13 (16.25)	215 (41.35)		13 (11.71)	215 (43.97)	
Employment status			$< 0.01^{**}$			$< 0.001^{***}$			$< 0.001^{***}$
Unemployed	74 (63.25)	221 (45.76)		58 (72.5)	237 (45.58)		78 (70.27)	217 (44.38)	
Employed	43 (36.75)	262 (54.24)		22 (27.5)	283 (54.42)		33 (29.73)	272 (55.62)	
Monthly income in USD			$< 0.01^{**}$			0.096			$< 0.05^{*}$
< 200	14 (11.97)	93 (19.25)		14 (17.5)	93 (17.88)		27 (24.32)	80 (16.36)	
200–400	27 (23.08)	167 (34.58)		18 (22.5)	176 (33.84)		24 (21.62)	170 (34.76)	
> 400	76 (64.96)	223 (46.17)		48 (60)	251 (48.27)		60 (50.05)	239 (48.88)	
Family size			$< 0.01^{**}$			$< 0.001^{***}$			$< 0.001^{***}$
0–4 members	52 (44.44)	311 (64.39)		33 (41.25)	330 (63.46)		43 (38.74)	320 (65.44)	
> 4 members	65 (55.56)	172 (35.61)		47 (58.75)	190 (36.54)		68 (61.26)	169 (34.56)	
Residence area			0.615			0.264			0.175
Metropolitan	116 (99.2)	476 (98.55)		80 (100)	512 (98.46)		111 (100)	481 (98.36)	
Suburban	1 (0.85)	7 (1.45)		0 (0)	8 (1.54)		0 (0)	8 (1.64)	

Data are presented as numbers (%).
T2D, type 2 diabetes; HTN, hypertension; BMI, body mass index.
[1)]*P*-values were obtained from the χ^2 test for categorical variables and *t*-test for continuous variables.
$^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

Table 4. Logistic regression analysis of food group intake and the prevalence of obesity, T2D, and HTN

Food group intake (g/day)	Obesity			T2D			HTN		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Cereals and tubers									
T1 (50–183)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
T2 (184–317)	1.60^{***} (0.60–2.03)	2.19^{***} (1.34–3.56)	1.97^{**} (1.18–3.28)	1.88^{***} (1.12–3.15)	3.07^{***} (1.66–5.66)	3.47^{*} (1.32–9.17)	1.03^{*} (0.65–1.64)	1.79^{*} (0.98–3.25)	1.63^{NS} (0.78–3.41)
T3 (318–450)	3.31^{***} (1.75–6.26)	3.39^{***} (1.69–6.81)	2.95^{**} (1.43–6.09)	3.61^{***} (1.77–7.36)	3.89^{***} (1.73–8.73)	2.09^{*} (0.62–7.10)	2.45^{*} (1.28–4.67)	2.59^{*} (1.16–5.77)	1.41^{NS} (0.51–3.92)
Meat, poultry, and seafoods									
T1 (26–100)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
T2 (101–175)	1.20^{**} (0.76–1.96)	1.35^{NS} (0.82–2.20)	1.31^{*} (0.78–2.21)	0.97^{NS} (0.56–1.66)	1.09^{NS} (0.61–1.96)	1.47^{NS} (0.60–3.58)	0.71^{*} (0.44–1.15)	0.73^{NS} (0.39–1.32)	0.72^{NS} (0.34–1.51)
T3 (176–250)	2.96^{**} (1.95–3.54)	1.88^{NS} (1.29–2.82)	1.76^{NS} (1.12–2.58)	0.55^{NS} (0.29–1.02)	0.69^{NS} (0.34–1.39)	2.25^{NS} (0.78–6.53)	0.49^{*} (0.29–0.83)	0.58^{NS} (0.29–1.13)	1.38^{NS} (0.61–3.11)

(continued to the next page)

Table 4. (Continued) Logistic regression analysis of food group intake and the prevalence of obesity, T2D, and HTN

Food group intake (g/day)	Obesity			T2D			HTN		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Legumes									
T1 (0–56)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
T2 (57–113)	1.85^{NS} (1.16–2.97)	2.19^{NS} (1.31–3.65)	1.86* (1.09–3.17)	1.20^{NS} (0.71–2.03)	1.52^{NS} (0.85–2.72)	0.73^{NS} (0.29–1.86)	0.77^{NS} (0.49–1.21)	0.98^{NS} (0.57–1.73)	0.57^{NS} (0.27–1.19)
T3 (114–170)	1.12^{NS} (0.51–2.46)	1.03^{NS} (0.44–2.44)	0.88* (0.36–2.14)	1.04^{NS} (0.44–2.44)	0.68^{NS} (0.27–1.71)	0.29^{NS} (0.06–1.35)	1.32^{NS} (0.68–2.56)	0.68^{NS} (0.29–1.56)	0.79^{NS} (0.28–2.26)
Vegetables									
T1 (0–184)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
T2 (185–368)	0.48** (0.29–0.79)	0.49** (0.29–0.85)	0.46* (0.26–0.79)	0.45* (0.25–0.82)	0.55* (0.29–1.05)	0.83* (0.32–2.14)	0.51* (0.31–0.85)	0.72^{NS} (0.38–1.35)	1.11^{NS} (0.51–2.41)
T3 (369–552)	0.49** (0.30–0.86)	0.58** (0.34–0.99)	0.55* (0.31–0.96)	0.54* (0.31–0.94)	0.66* (0.35–1.23)	0.81* (0.29–2.23)	0.59* (0.36–0.96)	0.82^{NS} (0.44–1.53)	1.37^{NS} (0.59–3.14)
Fruits									
T1 (0–38)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
T2 (39–76)	0.75** (0.47–1.19)	0.97** (0.57–1.65)	0.85** (0.49–1.48)	0.69^{NS} (0.39–1.22)	0.86^{NS} (0.45–1.63)	0.69^{NS} (0.39–1.22)	0.66** (0.40–1.07)	0.96** (0.51–1.81)	1.19* (0.55–2.64)
T3 (77–114)	0.41** (0.25–0.70)	0.43** (0.25–0.75)	0.35** (0.19–0.64)	0.61^{NS} (0.35–1.08)	0.61^{NS} (0.33–1.14)	0.61^{NS} (0.35–1.08)	0.45** (0.27–0.76)	0.38** (0.20–0.73)	0.45* (0.18–0.82)
UPFs									
T1 (0–40)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
T2 (41–80)	0.81^{NS} (0.48–1.36)	1.28** (0.71–2.32)	1.26** (0.68–2.33)	0.64** (0.33–1.24)	1.56*** (0.71–3.43)	1.32* (0.43–4.05)	0.35** (0.20–0.62)	0.88** (0.43–1.83)	0.52^{NS} (0.21–1.26)
T3 (81–120)	1.26^{NS} (0.78–2.04)	2.55** (1.43–4.55)	2.55** (1.39–4.69)	1.77** (1.02–3.06)	5.74*** (2.72–12.09)	3.71* (1.22–11.2)	0.84** (0.52–1.33)	3.02** (1.51–6.06)	1.23^{NS} (0.51–2.99)
Fats and oils									
T1 (0–68)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
T2 (69–137)	1.69* (1.12–2.57)	2.80*** (1.71–4.56)	3.45** (2.03–5.85)	2.19*** (1.32–3.63)	5.35*** (2.76–10.4)	2.05** (1.27–3.31)	0.84^{NS} (0.55–1.29)	1.85^{NS} (1.04–3.30)	0.94^{NS} (0.44–2.03)
T3 (138–205)	1.70** (0.69–4.19)	5.83*** (1.74–9.5)	6.00** (4.05–7.83)	4.67*** (4.67–1.95)	12.3*** (3.52–41.1)	5.74** (2.00–16.5)	2.06^{NS} (0.18–23.1)	2.97^{NS} (0.24–36.8)	1.65^{NS} (0.07–37.1)
Sugars									
T1 (0–38)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
T2 (39–77)	1.93** (1.27–2.93)	1.76* (1.11–2.77)	1.74* (1.09–2.78)	1.42* (0.87–2.32)	1.44* (0.83–2.48)	1.37* (0.61–3.06)	1.10* (0.72–1.69)	1.04^{NS} (0.60–1.80)	0.85^{NS} (0.43–1.68)
T3 (76–116)	1.91** (0.67–5.49)	1.75* (0.56–5.48)	2.19* (0.69–7.02)	4.39* (1.65–11.7)	4.06* (1.33–12.4)	6.79* (0.93–49.4)	4.00* (1.59–10.1)	4.35^{NS} (1.24–15.3)	3.24^{NS} (0.46–22.8)
Beverages									
T1 (0–50)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
T2 (51–100)	1.20^{NS} (0.74–1.95)	1.24^{NS} (0.69–2.21)	1.19^{NS} (0.65–2.18)	1.38^{NS} (0.77–2.46)	1.57^{NS} (0.77–3.19)	2.01^{NS} (0.72–5.59)	1.09^{NS} (0.65–1.82)	1.12^{NS} (0.56–2.25)	1.01^{NS} (0.42–2.46)
T3 (101–150)	0.82^{NS} (0.50–1.35)	0.93^{NS} (0.51–1.69)	0.85^{NS} (0.45–1.59)	1.21^{NS} (0.68–2.15)	1.50^{NS} (0.73–3.11)	3.27^{NS} (1.10–9.77)	1.29^{NS} (0.79–2.10)	1.41^{NS} (0.71–2.82)	1.91^{NS} (0.79–4.62)
Seasonings									
T1 (0–18)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
T2 (19–36)	1.67^{NS} (1.04–2.66)	1.52^{NS} (0.93–2.50)	1.65^{NS} (0.98–2.75)	4.60** (3.87–6.35)	6.82** (4.21–7.46)	1.13^{NS} (0.78–1.64)	4.11** (2.27–7.41)	4.91** (2.49–9.93)	4.36** (1.90–9.99)
T3 (37–54)	1.92^{NS} (1.20–2.56)	1.30^{NS} (0.73–1.86)	1.24^{NS} (0.68–1.52)	5.93** (4.82–8.86)	8.55** (3.44–9.51)	1.37^{NS} (0.81–1.90)	53.1** (5.56–58.1)	23.8** (14.4–38.5)	23.5** (1.33–28.3)

Data are presented as odds ratio (95% confidence interval).

T2D, type 2 diabetes; HTN, hypertension; T1, tertile 1 (range of low intake); T2, tertile 2 (range of medium intake); T3, tertile 3 (range of high intake); UPF, ultra-processed food.

Model 1 = unadjusted, crude odds ratios calculated from logistic regression models; Model 2 = multivariable-adjusted odds ratios calculated from logistic regression models adjusted for gender, age, and physical activity; Model 3 = fully adjusted model, multivariable-adjusted odds ratios calculated from logistic regression models adjusted for gender, age, physical activity, marital status, education level, employment status, monthly income, family size, residential area, and body mass index.

$^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$, NS, not significant.

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Nutrition Research and Practice

Table 5. Dietary habits of the study participants according to gender

Variables	Men (n = 277)	Women (n = 323)	Total (n = 600)	P-value[1)]
I have three meals a day				0.842
Unlikely	48 (17.33)	57 (17.65)	105 (17.5)	
Likely	229 (82.67)	266 (82.35)	495 (82.5)	
I have breakfast regularly				0.434
Unlikely	62 (22.38)	63 (19.50)	125 (20.83)	
Likely	215 (77.62)	260 (80.50)	475 (79.17)	
I don't eat late-night snacks everyday				< 0.05*
Unlikely	49 (17.69)	38 (11.76)	87 (14.5)	
Likely	228 (82.31)	285 (88.24)	513 (85.5)	
I don't add sugar to my beverages				< 0.01**
Unlikely	10 (3.61)	2 (0.62)	12 (2)	
Likely	267 (96.39)	321 (99.38)	588 (98)	
I don't add salt to my food				0.473
Unlikely	3 (1.08)	1 (0.31)	4 (0.67)	
Likely	274 (98.92)	322 (99.69)	596 (99.33)	
I don't eat more than one serving of food every meal time				< 0.05*
Unlikely	34 (12.27)	20 (6.19)	54 (9)	
Likely	243 (87.73)	303 (93.81)	546 (91)	
I don't eat fast food everyday				0.911
Unlikely	2 (0.72)	1 (0.36)	3 (0.5)	
Likely	275 (99.28)	322 (99.69)	597 (99.5)	
I take some nutrient supplements everyday				< 0.05*
Unlikely	2 (0.72)	9 (2.79)	11 (1.83)	
Likely	275 (99.28)	314 (97.21)	589 (98.17)	
I drink at least eight cups of water everyday				0.285
Unlikely	176 (63.54)	191 (59.13)	367 (61.17)	
Likely	101 (36.46)	132 (40.87)	233 (38.83)	
I consume healthy drinks to improve my health				0.867
Unlikely	252 (90.97)	295 (91.33)	547 (91.17)	
Likely	25 (9.03)	28 (8.67)	53 (8.83)	

Data are presented as numbers (%).
[1)]*P*-values were obtained from the χ^2 test.
**P* < 0.05, ***P* < 0.01, ****P* < 0.001.

eating more than one serving of a food every meal time (P < 0.05). Men tended to take daily nutrient supplements more than women (P < 0.05). Furthermore, no significant associations were observed between other dietary habits and gender.

As shown in **Table 6**, significant differences were noted between dietary habits and obesity, T2D, and HTN. Participants in the overweight, T2D, and HTN groups were more likely to consume three meals a day (all P < 0.001); skip breakfast on a daily basis (P < 0.01, P < 0.001, and P < 0.001, respectively); consume late-night snacks, such as chips, crackers, sweet cakes, and fritters (all P < 0.001); add sugar to beverages (P = 0.223, P < 0.01, and P < 0.05, respectively), and add table salt to their food (P < 0.05, P < 0.01, and P < 0.05, respectively). Furthermore, among those with T2D and HTN, a greater percentage consumed more than one serving of food every meal time (P < 0.001). Those who were overweight were less likely to drink at least eight glasses of water per day (P < 0.05). However, no differences in fast-food consumption, nutrient supplementation, and consumption of healthy drinks were observed between participants with and without obesity, T2D, or HTN.

The associations between dietary habits and health outcomes were further investigated using multivariate logistic regression (**Table 7**). Participants who did not consume late-night snacks were less likely to be obese (odds ratio [OR], 0.04; 95% confidence interval [CI], 0.02–0.08), be diagnosed with T2D (OR, 0.06; 95% CI, 0.03–0.12), or suffer from HTN (OR, 0.10; 95%

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Table 6. Prevalence of obesity, T2D, and HTN according to dietary habits

Dietary habits	Prevalence								
	Obesity	Non-obesity	*P*-value[1)]	T2D	Non-T2D	*P*-value	HTN	Non-HTN	*P*-value
I have three meals a day			< 0.001***			< 0.001***			< 0.001***
Unlikely	30.51	14.11		37.5	14.23		51.35	9.61	
Likely	69.49	85.89		62.5	85.77		48.65	90.39	
I have breakfast regularly			< 0.01**			< 0.001***			< 0.001***
Unlikely	32.20	18.05		40.0	17.69		51.35	13.70	
Likely	67.80	81.95		60.0	82.31		48.65	86.30	
I don't eat late-night snacks everyday			< 0.001***			< 0.001***			< 0.001***
Unlikely	47.46	6.64		48.75	9.23		34.23	10.02	
Likely	52.54	93.36		51.25	90.77		65.77	89.98	
I don't add sugar to my beverages			0.223			< 0.01**			< 0.05*
Unlikely	4.24	1.66		6.25	1.35		4.50	1.43	
Likely	95.76	98.34		93.75	98.65		95.50	98.36	
I don't add salt to my food			< 0.05*			< 0.01**			< 0.05*
Unlikely	2.54	0.21		2.5	0.19		1.80	0.40	
Likely	97.46	99.79		97.5	99.81		98.20	99.60	
I don't eat more than one serving of food every meal time			< 0.001***			< 0.001***			< 0.001***
Unlikely	36.44	2.28		36.25	4.62		24.32	5.32	
Likely	63.56	97.72		63.75	95.19		75.68	94.68	
I don't eat fast food everyday			0.485			0.127			0.499
Unlikely	0.85	0.41		1.25	0.19		0.0	0.41	
Likely	99.15	99.59		98.75	99.81		100	99.59	
I take some nutrient supplements everyday			0.443			0.533			0.347
Unlikely	1.69	1.87		2.5	1.54		2.70	1.43	
Likely	98.31	98.13		97.5	98.46		97.30	98.57	
I drink at least eight cups of water everyday			< 0.05*			0.783			0.543
Unlikely	71.19	58.71		62.5	60.77		58.56	61.55	
Likely	28.81	41.29		37.5	39.23		41.44	38.45	
I consume healthy drinks to improve my health			0.198			0.587			0.095
Unlikely	82.20	93.36		70.0	94.23		71.17	96.89	
Likely	17.80	6.64		30.0	5.77		28.82	3.11	

Data are presented as percentages (%).
T2D, type 2 diabetes; HTN, hypertension.
[1)]*P*-values were obtained from the χ^2 test.
*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

CI, 0.05–0.21). Furthermore, those who did not add white sugar to beverages were also less likely to develop T2D and HTN (OR, 0.08; 95% CI, 0.02–0.38 and OR, 0.11; 95% CI, 0.02–0.53, respectively). Additionally, non-consumption of more than one serving of food every meal time was associated with reduced risks of obesity, T2D, and HTN (OR, 0.02; 95% CI, 0.00–0.04, OR, 0.03; 95% CI, 0.01–0.08, and OR, 0.05; 95% CI, 0.02–0.12, respectively).

DISCUSSION

This study revealed that Jakartans generally consume less than the recommended daily intakes of cereals and tubers (285 g/day against 300 g/day), vegetables (111 g/day against 250 g/day), and fruits (46 g/day against 100–150 g/day). The average amount of protein consumed from meat, poultry, seafood, and legumes was within the recommended range (87.46 g/day against 70–140 g/day). However, sugar and salt intakes exceeded the recommended guidelines (sugar: 40.58 g/day against 40 g/day; salt: 10 g/day against 6 g/day), indicating poor diet quality and increased disease risk.

The prevalence of being overweight and obese was found to be significantly associated with the consumption of cereals and tubers (≥ 318 g/day), UPFs (≥ 81 g/day), and sugars (≥ 39 g/

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Table 7. Logistic regression analysis of dietary habits and the prevalence of obesity, T2D, and HTN

Dietary habits	Obesity	T2D	HTN
I have three meals a day			
Unlikely	1.00 (ref)	1.00 (ref)	1.00 (ref)
Likely[1)]	0.76[NS] (0.36–1.59)	1.44[NS] (0.61–3.40)	0.56[NS] (0.27–1.19)
I have breakfast regularly			
Unlikely	1.00 (ref)	1.00 (ref)	1.00 (ref)
Likely[1)]	0.79[NS] (0.41–1.55)	1.12[NS] (0.53–2.38)	0.68[NS] (0.34–1.38)
I don't eat late-night snacks everyday			
Unlikely	1.00 (ref)	1.00 (ref)	1.00 (ref)
Likely[1)]	0.04*** (0.02–0.08)	0.06*** (0.03–0.12)	0.10*** (0.05–0.21)
I don't add sugar to my beverages			
Unlikely	1.00 (ref)	1.00 (ref)	1.00 (ref)
Likely[1)]	0.29[NS] (0.07–1.17)	0.08** (0.02–0.38)	0.11** (0.02–0.53)
I don't add salt to my food			
Unlikely	1.00 (ref)	1.00 (ref)	1.00 (ref)
Likely[1)]	0.07[NS] (0.00–1.08)	0.14[NS] (0.06–1.24)	0.01[NS] (0.00–0.97)
I don't eat more than one serving of food every meal time			
Unlikely	1.00 (ref)	1.00 (ref)	1.00 (ref)
Likely[1)]	0.01*** (0.00–1.01)	0.03*** (0.01–0.08)	0.05*** (0.02–0.12)
I don't eat fast food everyday			
Unlikely	1.00 (ref)	1.00 (ref)	1.00 (ref)
Likely[1)]	0.10[NS] (0.05–0.94)	0.54[NS] (0.18–1.26)	2.43[NS] (1.75–2.99)
I take some nutrient supplements everyday			
Unlikely	1.00 (ref)	1.00 (ref)	1.00 (ref)
Likely[1)]	1.58[NS] (0.17–14.41)	0.41[NS] (0.07–2.55)	0.39[NS] (0.05–3.09)
I drink at least eight cups of water everyday			
Unlikely	1.00 (ref)	1.00 (ref)	1.00 (ref)
Likely[1)]	0.66[NS] (0.39–1.09)	0.95[NS] (0.53–1.71)	1.27[NS] (0.71–2.28)
I consume healthy drinks to improve my health			
Unlikely	1.00 (ref)	1.00 (ref)	1.00 (ref)
Likely[1)]	2.02[NS] (0.96–4.24)	3.17[NS] (1.50–6.69)	2.69[NS] (1.23–5.88)

Data are presented as odds ratio (95% confidence interval).
T2D, type 2 diabetes.
[1)]All values are multivariable-adjusted odds ratios calculated from a logistic regression model adjusted for age, gender, body mass index, physical activity, marital status, educational attainment, employment status, monthly income, number of family members, and residential area.
*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$, NS, not significant.

day). In this study, the major component in the cereal and tuber food group was polished or white rice, a staple food of Indonesians. Previous studies have investigated the association between cereal and grain intake, particularly that of white rice, and the risk of weight gain. One study by Sawada *et al.* [8] found that Japanese workers who consumed ≥ 188.8 g of white rice per day experienced a one-year body-weight gain of ≥ 3 kg. In addition, Radhika *et al.* [9] reported that those in the highest quartile of refined grain/white rice intake (488.8 g/day) exhibited a higher body-weight gain of 12.1% than those in the lowest quartile (218.1 g/day). Regarding UPF consumption, a cross-sectional study in the US found that consuming ≥ 74.2% *vs.* ≥ 36.5% of total energy from UPFs was linked to 48%, 53%, and 62% higher probabilities of becoming overweight, obese, and abdominally obese, respectively [10]. Consistent with this study, a 12-y follow-up study demonstrated that those who consumed ≥ 1.9 servings/day of fruits and 3.2 servings/day of vegetables had a 24% of lower risk of becoming obese [11]. The protective effects of fruits and vegetables against obesity are presumably related to their soluble-fiber content, which promotes feelings of satiety and delays gastric emptying while enhancing insulin sensitivity [12].

The significantly positive association that this study established between the cereal and tuber food group and T2D corroborates the findings of previous studies [13-15]. A 9.5-yrs follow-up study found that a greater consumption of white rice (≥ 450 *vs.* < 150 g/day) was significantly associated with an increased risk of diabetic incidents [13]. White rice, a valuable source of available carbohydrates, increases blood glucose rapidly due to its high glycemic response [14,15]. Moreover, UPF consumption was also significantly linked to the risk of T2D. A study by Srour *et al.* [16] revealed that consuming 100 g/day of UPFs was consistently associated with T2D risk, even after adjusting for the absolute quantity of unprocessed food consumed. Research has demonstrated that UPFs elicit a higher glycemic response but lower satiety potential than their less-processed alternatives, therefore increasing the risk of T2D [17]. In the fat and oil group, palm oil was the most widely used cooking oil in Jakarta. Although a link was discovered between palm oil consumption and T2D incidence, insufficient evidence was available to support this finding. An earlier review was unable to collate compelling evidence to either support or refute the association between palm oil consumption and cardiovascular disease risk, including T2D. However, the major factor potentially underlying the association between fat and oil consumption and T2D risk is the presence of elevated triglyceride levels. This major component of fats and oils can decrease insulin sensitivity, thus increasing the risk of developing T2D [18]. The "added sugar" group in this study was characterized by a high intake of granulated white sugar. An earlier study suggested that it is the fructose contained in white sugar, more than the glucose, that potentially increases the levels of total cholesterol, uric acid, and postprandial triglycerides, which can trigger T2D onset [19]. High fructose doses (≥ 50 g/day) in humans have been implicated in insulin resistance and intra-abdominal fat accumulation [20].

A significantly inverse connection persisted between vegetable consumption and T2D, even when the study participants' daily vegetable consumption was less than the recommended amount (400 g/day). This finding is consistent with that of a prior prospective analysis of 54,793 participants with 7,695 cases of incident T2D wherein those who consumed more vegetables (≥ 319 g/day) were found to have a 21% lower risk of T2D than those who consumed less vegetables (67 g/day) [21]. The biological mechanism underlying the inverse association between vegetable consumption and T2D has not yet been fully elucidated [21]. Nevertheless, the bioactive compounds in vegetables have been suggested to possess the potential to reduce body weight, plasma glucose, and insulin resistance, thereby regulating glucose–insulin homeostasis and preventing T2D owing to their antioxidant, anti-inflammatory, and immune-protective properties [22].

This study found that a greater consumption of seasonings increased the OR of HTN among participants. Meanwhile, increased fruit intake exhibited an inverse relationship with the risk of HTN. Table salt and mono sodium glutamate (MSG) were the two major types of seasonings consumed by participants. The use of condiments, such as table salt, MSG, and soy sauce, contributed to the significantly high intake of dietary sodium [23]. Existing literature reveals similar findings regarding the association between sodium intake and HTN risk. A study by Erdem *et al.* [24] reported that a salt consumption of approximately 15 g/day resulted in a 5.8-mmHg increase in systolic BP and 3.8-mmHg increase in diastolic BP. The mechanisms by which salt raises blood pressure remain unclear. However, growing evidence suggests that the increased plasma sodium concentration may be directly related to elevated blood pressure [25]. Consistent with this study's findings, an inverse association between fruit consumption and HTN has also been demonstrated by earlier studies [26,27]. In this study, even a relatively low fruit intake (≥ 39 g/day) was found to be inversely associated with HTN. A meta-analysis revealed that increasing daily fruit servings (106 g/day) decreased the risk of HTN by 1.9% [26]. In addition, three prospective cohort studies in the US found long-term fruit intake to be associated with a decreased risk of developing HTN, whereas

Nutrition Research and Practice

vegetable intake was not associated with HTN risk [28]. The anti-hypertensive effect of fruits may emanate from their antioxidant vitamins, dietary fiber, flavonoids, polyphenols, anthocyanins, and procyanidins [28].

Furthermore, our findings revealed significantly inverse associations of late-night eating with obesity, T2D, and HTN. Late-night eating, especially after 8 PM, has been identified as a risk factor for obesity [29], T2D [30], and HTN [31]. Late-night eating potentially leads to circadian misalignment, reduced energy expenditure (reduced leptin levels), increased appetite sensations, and weight gain [32]. Food intake at night may also induce visceral fat accumulation [29]. Additionally, once obesity develops, insulin resistance and metabolic inflammation due to adipocytokine-secretion dysfunction are triggered, resulting in metabolic dysfunction [33]. Finally, postprandial glucose, insulin, and triglyceride levels are significantly elevated when food is consumed at night compared with that during the day, and this phenomenon decreases insulin sensitivity [34]. The mechanism underlying the association between late-night snacking and blood pressure may be related to increases in other risk factors for HTN, such as increased total and low-density lipoprotein cholesterol levels, as well as the reduction of fat oxidation resulting from snacking at night.

A range of observational studies have associated increased portion sizes with overweight and obesity [35]. People with obesity report significantly larger food-portion sizes than those without obesity, and this potentially leads to a higher energy intake, overconsumption, and body-weight gain [36]. Similarly, the habitual addition of sugar to beverages was also positively associated with T2D and HTN owing to the high glucose content in granulated white sugar. Indonesian meals, which are rich in macronutrients, especially carbohydrates, in every meal serving, tend to have a high glycemic index and glycemic load. Therefore, consuming a large portion of a meal rich in carbohydrates or habitually adding extra sugar may have a harmful effect on glucose metabolism and insulin resistance, thereby increasing the risk of developing obesity, T2D, and HTN [37,38].

To the best of our knowledge, this study is the first in Indonesia to investigate food group consumption based on sociodemographic factors in participants aged 20–85 yrs. It is also the first to investigate the associations between food group consumption and the risks of obesity, T2D, and HTN in Jakarta, Indonesia. However, this study has certain limitations. First, the sample size was relatively small (600 individuals out of Jakarta's population of 10.56 million). Second, the study was limited to one province, Jakarta, out of the 34 provinces in Indonesia. Hence, the findings cannot be generalized to the whole population of Indonesia. Third, the "genetic history" variable was not included as one of the confounding variables, and this might have affected the results. Fourth, our study followed a single cross-sectional design, thus imposing a limit on examining causality. Fifth, despite conducting a feasibility test with a modified FFQ from a validated semi-quantitative FFQ developed in the previous study [39], we did not validate the modified FFQ that we created. As a result, we recommend that future research validate the modified FFQ that we developed in this study. Sixth, the CI presented in the table was quite wide, which could be related to the study's small sample size. Further investigation and more in-depth research into the associations between food group consumption and the risks of obesity, T2D, and HTN are necessary to establish causality, especially regarding the Indonesian population at large.

Finally, to prevent chronic diseases, such as obesity, T2D, and HTN, strategies that will instill healthy eating habits in Indonesians from various sociodemographic backgrounds are warranted. These strategies must aim to improve dietary intake and knowledge, promote healthy eating habits, and establish a healthy lifestyle via a complementary increase in physical activity and exercise. The Indonesian government should also consider advocating and promoting healthier lifestyles. Such campaigns should persuasively convey messages regarding the adoption of healthy eating habits, for example, reducing the consumption of sugar, salt, and UPFs. Furthermore, the government should also establish means of supporting adequate nutritional intake and physical activity as strategies of preventing these avoidable diseases. To assess the health and nutritional statuses of people from different sociodemographic backgrounds in Indonesia, annual comprehensive surveys must be conducted in all the country's provinces. This will culminate in the establishment of an Indonesian equivalent of the National Health and Examination Survey database. Finally, the Indonesian government must collaborate with decision-makers and healthcare professionals in updating the dietary recommendations for its citizens every 5 yrs. This will assist Indonesians in becoming and remaining healthy for life.

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SUPPLEMENTARY MATERIALS

Supplementary Table 1
Food groups

Supplementary Table 2
Standard serving size for each food item

Supplementary Table 3
Indonesia's national dietary guidelines

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