Association of Food Intake with Metabolic Syndrome among Filipino Adults in the 8th Philippine National Nutrition and Health Survey (NNHeS)

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ABSTRACT

Background and Objectives. The prevalence of metabolic syndrome among Filipino adults was found to be 12-19%. Diet has been one risk factor targeted to prevent complications. The association of each macronutrient component with metabolic syndrome remains unclear. There is no Philippine data on macronutrient intake and metabolic syndrome, thus, the primary objective of this study is to determine the association of food intake with metabolic syndrome among Filipino adults.

Methods. This study utilized a cross-sectional design. Data were taken from the results of the 8th National Nutrition and Health Survey (NNHeS). Filipino adults from different regions who consented to participate and with complete anthropometric, biochemical and food recall data were included in this study.

Results. There were 8,056 adults included in the study. The prevalence of metabolic syndrome was 32%. Multivariate analysis showed that increased total protein intake (OR 1.391) and increased daily consumption of meat and poultry (OR 1.397) were associated with increased risk for metabolic syndrome. On the other hand, decreased vegetable intake was associated with increased risk for metabolic syndrome, as well as higher socioeconomic status, female sex, and old age.

Conclusion. Increased total protein intake and daily consumptions of meat, poultry, and decreased vegetable intake are associated with an increased risk for metabolic syndrome.

Keywords: metabolic syndrome, food intake, nutrition

INTRODUCTION

Cardiovascular and metabolic diseases such as diabetes mellitus remain as the top causes of morbidity and mortality worldwide, and in the Philippines. Metabolic syndrome is a clustered set of conditions which increase the risk for cardiovascular disease and morbidity. Its prevalence among Filipino adults was found to be 12-19%.[1] It is defined using the Harmonized IDF criteria[2] as fulfilling at least 3 out of 5 of the following: waist circumference for males: ≥90 cm, females: ≥80cm (WHO Asia-Pacific); triglycerides >150 mg/dl; HDL cholesterol <40 for males, <50 for females; fasting blood sugar >100 mg/dl; blood pressure for males: systolic ≥130 mm Hg and/or diastolic ≥85 mm Hg. Modifiable and non-modifiable risk factors have been identified and have been targeted for different levels of prevention.

The role of diet and food intake in metabolic syndrome remains unclear, but its association with each component criteria is better understood, which has led to recommendations such as the Dietary Approaches to Stop Hypertension (DASH)

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diet in hypertension, and a hypocaloric diet for patients with obesity. The association of glycemic index (GI) and glycemic load (GL) with the risk of diabetes has garnered varied data, although there is evidence suggesting that diets with high GI and GL may predispose to elevated blood glucose, which may eventually lead to glucose intolerance and an increased risk for diabetes.[3,4] Some evidence also suggests that high total and animal protein intake are associated with a higher risk for diabetes.[5] However, a 12-year community based prospective cohort study done in Korea found that a very-low-fat or very-high-carbohydrate intake may increase risk for diabetes.[6] The relationship between hypertension and dietary sodium intake is more clearly established and supported by various studies. There appears to be a dose-related effect but the threshold at which the amount of salt intake causes hypertension remains unclear across populations.

Filipinos are known to have diets rich in carbohydrates and salt. However in 2020, it was found that the macronutrient distribution among working Filipinos were within acceptable range, except for protein which was higher than recommended.[7]

Although there are studies showing the association of the different macronutrients and food content with metabolic syndrome and cardiovascular and metabolic risk factors in other countries, there is a lack of studies on the Philippine population.

OBJECTIVES

The primary objective of this study was to determine the association of food intake with metabolic syndrome among Filipino adults. The specific objectives were as follows:

1. To describe the distribution of total caloric intake (TCI) and macronutrient intake among adult Filipinos
2. To determine the association of TCI and macronutrient intake with obesity, diabetes, metabolic syndrome, dyslipidemia, hypertension
3. To determine the association of sociodemographic factors with obesity, diabetes, metabolic syndrome, dyslipidemia, hypertension

METHODS

This study utilized a cross-sectional analytic design. Data were taken from the results of the 8th National Nutrition and Health Survey (NNHeS) Clinical and Health Survey done in 2013 which were released through the Public Use Files. The NNHeS in 2013 serves as the latest NNHeS with complete biochemical testing.

Variables analyzed included anthropometric data, blood pressure, and biochemical test results including fasting blood sugar (FBS), total cholesterol, triglycerides, high density lipoprotein (HDL-c) and low-density cholesterol (LDL-c) levels.

Description of the Data Source

The Philippine NNHeS is a cross-sectional study approved by the Food and Nutrition Research Institute (FNRI) Institutional Ethics Review Committee on January 22, 2013.[8] NNHeS utilized a stratified multi-stage sampling design covering the country's regions and provinces (except for Batanes). The primary sampling units were barangay/s, from which various enumeration areas were randomly chosen. From these areas, different households were sampled. In all, a total of 2,636 households from 17 regions and 79 provinces were covered between August 2013 and January 2014. Of all Filipino adults included in the NNHeS, 8,056 adults were interviewed and have complete anthropometric measurements, blood tests, and 24-hour food recall.

Population

Filipino adult males and females in the NNHeS 2013 were interviewed about demographic data, and their blood pressure and weight were taken. Blood was also extracted from the participants for FBS, cholesterol, triglyceride, HDL, and LDL.

Socio-demographic and Lifestyle Variables

Information about sociodemographic and lifestyle characteristics were collected by the NNHeS including age, sex, and income. Food intake was collected through 24-hour recall and food weighing of actual consumption which were done by field researchers on separate days. Food items were classified by NNHeS into the following categories: energy-giving food such as cereals and cereal products, rice and rice products, corn and corn products, other cereal products; starchy roots and tubers; sugars and syrups; fats and oils; body-regulating food such as vegetables and fruits; body-building food such as fish, meat and poultry; eggs; milk and milk products; dried beans, nuts, seeds; miscellaneous including beverages, condiments and spices.

Cardiometabolic Profiles

Measures of adiposity were included such as BMI (calculated as body weight in kilograms divided by the square of height in meters), and central adiposity was defined by using waist circumference–to–height ratio (WHtR). Participants were categorized as having obesity if they had either a BMI of ≥25 kg/m2 or a WHtR of ≥0.5. Serum cholesterol-total cholesterol, triglyceride, HDL-c, LDL-c, blood pressure (BP), and blood glucose (FBS) were analyzed. Definition of component diseases of metabolic syndrome is in the Appendix.

Statistical Methods

Summary statistics were reported as median (interquartile range) for quantitative data with skewed distribution and as count (percent) for qualitative measures. Minimum and maximum values of quantitative data were also reported. Independent *t* test or analysis of variance was used to compare

Table 1. Distribution of Participants according to Socio-demographic Characteristics, N= 8056

Sociodemographic Characteristics	N (%)
Age in years	
19-29	1627 (20.2)
30-39	1521 (18.9)
40-49	1758 (21.8)
50-59	1614 (20.0)
60-69	916 (11.4)
≥70	620 (7.7)
Sex: Male	3855 (47.9)
Ethnicity	
Not an IP/without foreign blood	7476 (92.8)
Indigenous people	569 (7.1)
¾ Filipino	3 (0.0)
½ Foreign blood	8 (0.1)
Marital status	
Single	1465 (18.2)
Married	4962 (61.6)
Live-in	709 (8.8)
Widow/widower	739 (9.2)
Separated/annulled/divorced	181 (2.2)
Wealth quintile	
Poorest	1669 (20.7)
Poor	1753 (21.8)
Middle	1727 (21.4)
Rich	1480 (18.4)
Richest	1427 (17.7)
Smoking status	
Never	4644 (57.6)
Current smoker	2078 (25.8)
Former smoker	1334 (16.6)
Alcohol status	
Never	3051 (37.9)
Current alcohol beverage drinker	3935 (48.8)
Former alcohol beverage drinker	1070 (13.3)
General physical activity	
Low	3443 (42.7)
High	4613 (57.3)

transformed quantitative data between two groups and across more than two groups. Pearson's chi-square test was used to compare proportions. Significant pairwise comparisons were based on adjusted *p*-values. Binary logistic regression analysis was performed to determine association of socio-demographic characteristics and daily food consumption, total calorie and macronutrient intake with obesity, diabetes, metabolic syndrome, dyslipidemia, and hypertension. Daily food consumption, total calorie and macronutrient intake were classified into categories based on quartiles. Due to high multicollinearity of total calorie, total macronutrient intake, and daily food consumption, four best fit binary logistic regression models were generated and evaluated based on appropriate model diagnostics criteria. Odds-ratio and corresponding 95% confidence interval were estimated. Statistical significance was based on *p*-value ≤0.05. Data processing and analysis were performed using STATA v14.

The protocol for this specific study was reviewed and approved by the UPMREB (UPMREB 2020-324-01).

RESULTS

Eight thousand fifty-six (8,056) adults were included in the study with complete anthropometric, biochemical profiles, and 24-hour food recall. The median age was 45 (IQR=23.8) years, majority belonging to the 40 to 49 age demographic (21.8%). There were 47.9% men. Higher proportion of adults were non-indigenous and without foreign blood (92.8%), married (61.6%) or belonged to poor households (21.8%). There were 25.8% current and 16.6% former smokers, 48.8% current alcohol beverage drinker and 42.7% with inadequate physical activity. (Table 1)

There were 32.8% adults with metabolic syndrome, with 73.7% of Filipinos with low HDL, 39% with elevated triglycerides, 36.2% with elevated blood pressure, 30.1% with elevated waist circumference, and 20.4% with fasting blood sugar ≥100 mg/dl. (Table 2)

Table 2. Metabolic Syndrome in Filipino Adults using the IDF Harmonized Criteria

Age in years	Elevated Waist Circumference (M: ≥90; F: ≥80 cm)	Triglycerides ≥150 mg/dl	Low HDL (M: <40; F: <50 mg/dl)	FBS ≥100 mg/dl	BP systolic ≥130 or diastolic ≥85 mmHg	Metabolic Syndrome ≥3 of 5
19-29	232 (9.6%)**	527 (16.8%)**	1083 (18.2%)**	118 (7.2%)**	244 (8.4%)**	220 (8.3%)**
30-39	436 (18.0%)	546 (17.4%)**	1129 (19.0%)	206 (12.6%)**	353 (12.1%)**	387 (14.6%)**
40-49	589 (24.3%)**	699 (22.3%)	1310 (22.1%)	380 (23.2%)	615 (21.1%)	614 (23.2%)**
50-59	618 (25.5%)**	753 (24.0%)**	1229 (20.7%)**	469 (28.6%)**	798 (27.4%)**	726 (27.5%)**
60-69	341 (14.1%)**	399 (12.7%)**	697 (11.7%)	299 (18.2%)**	527 (18.1%)**	439 (16.6%)**
≥70	207 (8.5%)	215 (6.8%)**	490 (8.3%)**	168 (10.2%)**	380 (13.0%)**	258 (9.8%)**
19-59	1875 (77.4%)**	2525 (80.4%)	4751 (80.0%)**	1173 (72%)**	2010 (69%)**	1947 (73.6%)**
≥60	548 (22.6%)**	614 (19.6%)	1187 (20.0%)**	467 (28.5%)**	907 (31.1%)**	697 (26.4%)**
Total	2423 (30.1%)	3139 (39.0%)	5938 (73.7%)	1640 (20.4%)	2917 (36.2%)	2644 (32.8%)

IDF – International Diabetes Federation, M – male, F – female, HDL – high-density lipoproteins, FBS – fasting blood sugar, BP – blood pressure

*Data presented as count (percent). ** Significant difference between those with and without metabolic syndrome, p<0.01*

Median total calorie intake in one day was 1,524.1 kcal (range: 148.3 to 7349.5) while median total carbohydrates, protein, and fat intake in one day were 273.3 grams (range: 33.8 to 1309.2), 49.4 grams (range: 2.8 to 273.3), and 19.8 g (range: 0.2 to 334.9), respectively. Comparisons across age showed decreasing total intake with increasing age.

Multivariate analysis showed that increased total protein intake OR 1.391 (1.150-1.684) and increased daily consumption of meat and poultry OR 1.397 (1.163-1.677) were associated with increased risk for metabolic syndrome. On the other hand, decreased vegetable intake OR 1.3 (1.080-1.565) was associated with increased risk for metabolic syndrome. The following were also associated with increased risk for metabolic syndrome: a higher socioeconomic status, female sex, and old age. (Table 3)

Hypertension

There were 59.5% Filipinos with elevated blood pressure based on the 2017 guidelines of the American College of Cardiology and American Heart Association,[9] 26.7% with Stage I hypertension, and 25% with Stage II hypertension. Based on the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC 7),[10] there were 15.6% (95% CI: 14.8% to 16.4%) adults with pre-hypertension while 16.9% (95% CI: 16.1% to 17.8%) and 8.1% (95% CI: 7.5% to 8.7%) with stage I and II hypertension, respectively. After adjusting for confounders and multicollinearity, results of the multivariate analysis on association with elevated blood pressure based on ACC/AHA guidelines showed insufficient evidence of significant association of total calorie and macronutrient intake with elevated blood pressure.

Diabetes

After adjusting for confounders and multicollinearity, results of multivariate analysis on association with FBS ≥100 mg/dl showed insufficient evidence of significant association of total calorie intake, total macronutrient intake, and daily food consumption with impaired fasting glucose and diabetes.

Among the socio-demographic characteristics, age, gender, household wealth, and alcohol status were associated with FBS ≥100 mg/dl. Older adults had higher likelihood of impaired fasting glucose and diabetes. The odds of FBS ≥100 mg/dl for an adult male was 1.234 times the odds of FBS ≥100 mg/dl for an adult female, holding other factors constant. Adults from households with more wealth had increased likelihood of impaired fasting glucose and diabetes than those from poorest households. Current or former alcohol beverage drinkers were less likely to have FBS ≥100 mg/dl than those who reported they never drank alcohol beverages.

Obesity

The median total calorie intake of overweight, obese I, and II adults were 1595 grams (range: 148.3 to 5456 grams), 1582.9 grams (range: 288.6 to 7349.5), and 1534.5 grams (range: 478.4 to 5294.6), respectively. After adjusting for confounders and multicollinearity, results of multivariate analysis showed that total calorie intake OR 1.608 (1.337-

Table 3. Multivariate Association with Metabolic Syndrome

Factor	Model 1, Adjusted OR (95% CI)	*p*-value	Model 2, Adjusted OR (95% CI)	*p*-value
Total protein intake in g				**0.008***
Below P_{25}			1	
P_{25} to P_{50}			1.177 (0.989, 1.400)	0.067
P_{50} to P_{75}			1.232 (1.030, 1.474)	0.023*
Above P_{75}			1.391 (1.150, 1.684)	0.001*
Age				
19-29	1		1	
30-39	2.111 (1.680, 2.654)	<0.001*	2.130 (1.694, 2.678)	<0.001*
40-49	3.471 (2.798, 4.307)	<0.001*	3.544 (2.855, 4.400)	<0.001*
50-59	4.951 (3.990, 6.144)	<0.001*	5.139 (4.135, 6.387)	<0.001*
60-69	5.915 (4.646, 7.531)	<0.001*	6.302 (4.933, 8.052)	<0.001*
≥70	4.664 (3.570, 6.093)	<0.001*	5.096 (3.880, 6.692)	<0.001*
Sex				
Female	1		1	
Male	0.622 (0.536, 0.722)	<0.001*	0.578 (0.495, 0.675)	<0.001*
Household wealth		**<0.001***		**<0.001***
Poorest	1		1	
Poor	1.526 (1.254, 1.858)	<0.001*	1.512 (1.242, 1.841)	<0.001*
Middle	1.883 (1.548, 2.290)	<0.001*	1.844 (1.515, 2.245)	<0.001*
Rich	2.160 (1.765, 2.643)	<0.001*	2.062 (1.682, 2.527)	<0.001*
Richest	2.671 (2.182, 3.271)	<0.001*	2.517 (2.050, 3.092)	<0.001*

Table 3. Multivariate Association with Metabolic Syndrome *(continued)*

Factor	Model 3, Adjusted OR (95% CI)	*p*-value	Model 4, Adjusted OR (95% CI)	*p*-value
Corn and corn products				**0.030***
Below P_{25}			1	
P_{25} to P_{50}			0.630 (0.448, 0.885)	0.008*
P_{50} to P_{75}			0.767 (0.538, 1.091)	0.140
Above P_{75}			0.974 (0.694, 1.367)	0.879
Vegetables in g/day		**0.044***		
Below P_{25}	1.141 (0.960, 1.355)	0.134		
P_{25} to P_{50}	1.200 (0.995, 1.447)	0.056		
P_{50} to P_{75}	1.300 (1.080, 1.565)	0.006*		
Above P_{75}	1			
Meat and poultry		**0.002***		
Below P_{25}	1			
P_{25} to P_{50}	1.125 (0.947, 1.338)	0.181		
P_{50} to P_{75}	1.080 (0.904, 1.291)	0.395		
Above P_{75}	1.397 (1.163, 1.677)	<0.001*		
Age in years		**<0.001***		**<0.001***
≤29	1		1	
30-39	2.146 (1.705, 2.700)	<0.001*	2.102 (1.671, 2.643)	<0.001*
40-49	3.557 (2.862, 4.420)	<0.001*	3.509 (2.826, 4.358)	<0.001*
50-59	5.158 (4.148, 6.415)	<0.001*	5.045 (4.060, 6.269)	<0.001*
60-69	6.113 (4.789, 7.804)	<0.001*	5.996 (4.702, 7.645)	<0.001*
≥70	4.971 (3.790, 6.520)	<0.001*	4.759 (3.635, 6.229)	<0.001*
Sex				
Female	1		1	
Male	0.601 (0.516, 0.699)	<0.001*	0.614 (0.529, 0.713)	<0.001*
Household wealth		**<0.001***		**<0.001***
Poorest	1		1	
Poor	1.510 (1.240, 1.840)	<0.001*	1.530 (1.255, 1.864)	<0.001*
Middle	1.852 (1.519, 2.257)	<0.001*	1.891 (1.551, 2.306)	<0.001*
Rich	2.071 (1.686, 2.544)	<0.001*	2.144 (1.747, 2.632)	<0.001*
Richest	2.489 (2.020, 3.066)	<0.001*	2.643 (2.151, 3.248)	<0.001*

OR – odds-ratio, CI – confidence interval

Model 1 derived from multivariate binary logistic regression of total calorie intake and socio-demographic characteristics.
Model 2 derived from multivariate binary logistic regression of total carbohydrates, protein, and fat intake and socio-demographic characteristics.
Model 3 derived from multivariate binary logistic regression of daily consumption of food groups and socio-demographic characteristics.
Model 4 derived from multivariate binary logistic regression of daily consumption of food sub-groups and socio-demographic characteristics.

Significant multivariate association, p≤0.05

1.935) and total protein intake OR 1.794 (1.491-2.159) were associated with overweight and obesity. Adults with higher total calorie and protein intake had increased risk of overweight and obesity based on Asia-Pacific classification.

Adults with higher daily consumption of meat and poultry had increased likelihood of overweight and obesity OR 1.749 (1.465-2.089). In particular, adults with high daily consumption of fish and fish products 1.333 (1.127-1.577) and meat and meat products OR 1.521 (1.253-1.847) had higher risk of overweight and obesity than those with low daily consumption.

Significant socio-demographic factors associated with BMI ≥23 kg/m^2 were old age, female sex, marital status, and higher socioeconomic status. Adults who were either married, living with common-law partner or widowed had higher likelihood of overweight and obesity than single adults. Adults belonging to households with more wealth had increased risk of overweight and obesity than those belonging to poorest households.

Dyslipidemia

Elevated LDL is the most prevalent dyslipidemia among Filipinos, followed by low HDL, high total cholesterol, and triglycerides. (Table 2)

After adjusting for confounders and multicollinearity, results of multivariate analysis on association with triglyce-

ride ≥150 mg/dl showed insufficient evidence of significant association of total calorie and macronutrient intake with high triglyceride. Among the socio-demographic characteristics, age, gender, and household wealth had significant association with triglyceride ≥150 mg/dl. After adjusting for confounders and multicollinearity, results of multivariate analysis on association with LDL ≥100 mg/dl showed that total carbohydrate intake above 75th percentile was associated with high LDL OR 1.345 (1.093-1.655). Among the socio-demographic characteristics, old age, female sex, marital status, and higher socioeconomic status were associated with high LDL.

DISCUSSION

This study found a higher prevalence of metabolic syndrome among Filipinos at 32.8%, compared to the study done with data from 6th NNHeS with a prevalence of 19% using the same criteria.[1] Similar to the study done by Morales[1], the most prevalent component was also low HDL at 73.7%.

Our study found that older age[11,12] and higher socio-economic status[13] were associated with increased risk for metabolic syndrome which were consistent with some studies worldwide. This is in contrast with other studies[14-16] which described the association of metabolic syndrome with lower socioeconomic status and educational attainment. Conflicting data on metabolic syndrome and socioeconomic status may be explained by heterogeneity of included studies, and variability of definitions of socioeconomic status. Female sex was also found to be associated with increased risk for metabolic syndrome in this study, which is not a consistent finding in current evidence.[17-19] While metabolic syndrome has no established sex predisposition, its individual components do show sex-specific patterns.

This study found insufficient evidence of significant association of total calorie intake, total macronutrient intake, and daily food consumption with metabolic syndrome, impaired fasting glucose and diabetes, elevated triglyceride, and hypertension. It has however found that total protein intake was associated with metabolic syndrome, overweight, and obesity. This is consistent with the Atherosclerosis Risk in Communities (ARIC) study which found greater consumption of meat was associated with higher incidence of metabolic syndrome.[20] The Dose Responses to Exercise Training (DR's EXTRA) study[21] found that the consumption of protein, sausages in particular, had direct association with the risk of having metabolic syndrome. Ruidavets et al.[22] and Kim[23] also showed that as meat intake increases, the risk for metabolic syndrome also increases. This may be due to an increase in saturated fat and salt content with increased total protein intake, which includes processed meat. An original study published by Mennen et al.[24] found no association between the intake of meat and fish with metabolic syndrome, but it is important to note that the definition of metabolic syndrome has been updated since then.

Decreased vegetable intake was found to be associated with an increased risk for metabolic syndrome. A meta-analysis in 2017[25] revealed that increased vegetable intake was inversely associated with risk of metabolic syndrome. Contrary to priori hypotheses, high daily consumption of green, leafy and yellow vegetables were found to be associated with elevated triglyceride levels, although with no consistent trend as consumption increases. A meta-analysis on the relationship between fruit and vegetable intake and triglycerides showed no significant association between vegetable intake and triglyceride levels.[26]

Total calorie, particularly contribution from total carbohydrate intake, was found to be associated with elevated LDL. This is, however, in contrast with the findings of a longitudinal study done by Ma et al. in 2006[27] which interestingly found that higher total carbohydrate intake was related to lower total cholesterol and LDL levels.

Description of the association between macronutrient intake and metabolic syndrome and other cardiovascular diseases can lead to policy recommendations on nutrition for the prevention of non-communicable diseases which continue to increase.

Further future researches on food intake, food choices, food security, quality of macronutrients, and the occurrence of cardiovascular outcomes, and cardiovascular and metabolic diseases are recommended.

Limitations of this study include: 1) failure to account for those who are already taking maintenance medications for hypertension, diabetes, dyslipidemia; 2) lack of data regarding quality of macronutrient, such as type of protein or meat consumed. These are limitations of using secondary data.

CONCLUSION

Increased age, higher socioeconomic status, female sex, increased total protein intake and daily consumption of meat and poultry, and decreased vegetable intake are associated with an increased risk for metabolic syndrome.

Statement of Authorship

Both authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

Both authors declared no conflicts of interest.

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APPENDIX

Operational Definitions

1. Diabetes was defined using the Philippine UNITE for Diabetes Philippine Clinical Practice Guidelines (CPG) adapted from the American Diabetes Association (ADA) as follows:
   a. Normal <100 mg/dL
   b. Impaired fasting glucose 100-125 mg/dL, and
   c. Diabetes ≥126 mg/dL
   However, in the NNS, only one determination of FBS was done and symptoms of diabetes were not elicited. Hence, the thresholds above only gave an estimate of diabetes prevalence since no repeat blood sugar determination was done.
2. Body Mass Index (BMI) was defined using the Asia-Pacific classification as follows:
   a. Underweight (<18.5)
   b. Normal weight (18.5-22.9)
   c. Overweight (23-24.9)
   d. Obese I (25-29.9)
   e. Obese II (≥30)
3. The categories of the Body Mass Index (BMI) by WHO Classification were as follows:
   a. Underweight (<18.5)
   b. Normal weight (18.5-22.9)
   c. Overweight (23-24.9)
   d. Obese I (25-29.9)
   e. Obese II (30-39.9)
   f. Obese III (≥40)
4. The categories of visceral adiposity were determined using the waist circumference according to the WHO-Asia Pacific cut-offs:
   a. For males: normal (<90 cm), borderline (90-101 cm), and high (>101 cm)
   b. For females: normal (<80 cm), borderline (80-87 cm), and high (>87 cm)
5. The categories of blood pressure were defined according to ACC/AHA guidelines (2017):
   a. Normal (<120/<80 mm Hg)
   b. Elevated (systolic 120-129 mm Hg and diastolic <80 mm Hg)
   c. Stage I hypertension (systolic 130-139 mm Hg or diastolic 80-89 mm Hg)
   d. Stage II hypertension (systolic >140 mm Hg or diastolic >90 mm Hg)
6. Blood pressure was also defined according to JNC 7 guidelines:
   a. Normal (<120/<80 mm Hg)
   b. Pre-hypertension (systolic 120-139 mm Hg and diastolic 80-89 mm Hg)
   c. Stage I hypertension (systolic 140-159 mm Hg or diastolic 90-99 mm Hg)
   d. Stage II hypertension (systolic ≥160 mm Hg or diastolic ≥100 mm Hg)
7. The categories of dyslipidemia were determined by the categories of the lipid profile according to the NCEP-ATP III in 2001:
   a. Total cholesterol (in mg/dl) desirable (<200), borderline high (200-239), high (>240);
   b. LDL-cholesterol (in mg/dl) optimal (<100), near optimal/ above optimal (100-129), borderline high (130-159), high (160-189), very high (>190);
   c. HDL-cholesterol (in mg/dl) low (<40), borderline (50-59), desirable (>60);
   d. Triglyceride (in mg/dl) desirable (<150), borderline (150-199), high (200-399), very high (>400).
8. Metabolic Syndrome was defined using the Harmonized IDF criteria as fulfilling at least 3 out of 5 of the following:
   a. Waist circumference for males: ≥90 cm, females: ≥80 cm (WHO Asia-Pacific);
   b. Triglycerides >150 mg/dl;
   c. HDL cholesterol <40 for males, <50 for females
   d. Fasting blood sugar ≥100 mg/dl;
   e. Blood pressure: systolic ≥130 mm Hg and/or diastolic ≥85 mm Hg
9. Total caloric (in kcal) and macronutrient (in grams) intake per day were estimated through 24-hour food recall. The Philippine Dietary Reference Intakes served as a guide for interpretation of individual energy adequacy (Table 1).

Table 1. Philippine Dietary Reference Intakes

Age Group (years)	Weight (kg)		Energy (kcal)		Carbohydrate (g) 55-75%		Protein (g) 10-15%		Total Fat (g) 15-30%	
	M	F	M	F	M	F	M	F	M	F
19-29	60.5	52.5	2530	1930	347.88 g – 474.38 g	265.38 g – 361.88 g	63.25 – 94.88 g	48.25 – 72.38 g	42.17 – 84.33 g	32.17 – 64.33 g
30-49			2420	1870	332.75 – 453.75 g	257.13 – 350.63 g	60.5 – 90.75 g	46.75 – 70.13 g	40.33 – 80.67 g	31.17 – 62.33 g
50-59										
60-69			2140	1610	294.25 – 401.25 g	221.38 – 301.88 g	53.5 – 80.25 g	40.25 – 60.38 g	35.67 – 71.33 g	26.83 – 53.67 g
≥70			1960	1540	269.5 – 367.5 g	211.75 – 288.75 g	49 – 73.5 g	38.5 – 57.75 g	32.67 – 65.33 g	25.67 – 51.33 g

Data presented as count (percent).