Journal of the ASEAN Federation of Endocrine Societies

ORIGINAL ARTICLE

Cardiometabolic Risk Factors leading to Diabetes Mellitus among the Young (YOD) from the 8th Philippine National Nutrition Survey

Angelique Bea Uy[1] and Cecilia Jimeno[2]

[1]Division of Endocrinology, Diabetes and Metabolism, Department of Medicine, University of the Philippines College of Medicine-Philippine General Hospital
[2]Department of Pharmacology and Toxicology, University of the Philippines College of Medicine

Abstract

Objectives. This study looked into the prevalence of diabetes mellitus (DM) and risks for cardiovascular and metabolic diseases among young adults with diabetes (age 20-44 years old, YOD) and late-onset DM (≥45 years old, LOD) in Filipinos.

Methodology. Weighted data from 546,580 adults with DM from the 8th Philippine National Nutrition and Health Survey (NNHeS) were utilized. Differences in sociodemographic, anthropometric, clinical profiles and metabolic risks were compared between YOD and LOD.

Results. The aggregated prevalence of DM is 5.43% (95%CI, 5.10–5.79), YOD were 2.64% (95% CI, 2.32–3.00) and LOD 9.85% (95%CI, 9.18–10.56). Mean age of YOD was 37,6 years, LOD 59,9 years. The YOD were mostly males (56%), with higher BMI (26.24 kg/m^2 vs 25 kg/m^2, p=0.002), lower mean SBP (122.41±19.17 mmHg vs 135.45±22.47 mmHg, p<0.001), more daily smokers (23% vs 14%), and alcoholic beverage drinkers (39% vs 31%). Physical activity was similar between groups (44% vs 51%, p=0.078). However, average total caloric intake (1776.78±758.38 kcal vs 1596.88±639.16 kcal, p=0.023) and carbohydrate intake (306.13±142.16 grams vs 270.53±104.74 g, p=0.014) were higher in YOD. Dietary carbohydrate proportions were higher than recommended (69% vs 68%) for both groups. Young Filipinos had higher risk to develop diabetes when they are obese II (22% vs 12%), current drinker (56% vs 37%), and current smoker (28% vs 18%). Eighty percent of YOD and LOD had metabolic syndrome (MetS). With every unit increase in age and fat intake, the odds of having MetS were raised by 5.4% (95%CI 1%–10%, p=0.029) and 1.6% (95%CI 0.04%-3%, p=0.044), respectively.

Conclusion. Early-onset diabetes mellitus appears to be driven by obesity, MetS and social behaviors. Modifiable risk factors can be improved early to decrease hazards to develop cardiometabolic complications.

Key words: young-onset diabetes mellitus, Filipinos, metabolic syndrome, cardiovascular disease

INTRODUCTION

The growing burden of diabetes among adult populations worldwide cannot be overemphasized. In 2019, it was estimated that 463 million people worldwide have diabetes and this number is projected to reach 578 million by 2030, and 700 million by 2045.[1] This alarming increase in the number of people with diabetes does not only threaten individuals and their families, but has implications on economic and social outcomes in nations and the global population as a whole. The Philippines' data on diabetes mirrors this alarming rise worldwide with diabetes among the top causes of morbidity and mortality in the last two decades.[2]

One of the major aspects on addressing the global epidemic of diabetes is generating information on the pattern and burden of disease among different populations and age groups. In the recent decade, there is a particular concern and emphasis on young adults aged 18-44 with diabetes (YOD) for two compelling reasons: rising prevalence of diabetes in young adult age groups, and accompanying cardiometabolic risk factors early in life.[3,4] In the Philippines, there are no available data yet as to the prevalence of early-onset diabetes. However, as lifestyle and diet of Filipinos shift towards the demands of urbanization and globalization, we expect an increasing trend of emerging health problems brought about by the consumption of foods high in fat, sugar, and salt coupled with unhealthy lifestyle and stressful environments.

The Filipino YOD has not yet been fully characterized using nationally representative local data. This study seeks to fill this gap in literature by using data from the 8th Philippine National Nutrition and Health Survey (NNHeS)[5] which covered 17 regions and 80 provinces of the Philippines. The

ISSN 0857-1074 (Print) | eISSN 2308-118x (Online)
Printed in the Philippines

Received: September 18, 2020. Accepted: February 16, 2021.
Published online first: April 14, 2021.
https://doi.org/10.15605/jafes.036.01.02

Corresponding author: Angelique Bea C. Uy, MD
Division of Endocrinology, Diabetes and Metabolism
Department of Medicine, University of the Philippines
College of Medicine-Philippine General Hospital
Taft Avenue, Ermita 1000 Manila, Philippines
Tel. No.: +632-55484000
E-mail: acuy2@up.edu.ph
ORCiD: https://orcid.org/0000-0002-9539-8239

objective of this study was to determine the prevalence of cardiovascular and metabolic diseases among the Filipino young adults with diabetes. Specifically, it aimed to determine the demographics and the clinical, behavioral and biochemical cardiometabolic risk factors among young adults aged 20–44 years and compare these with older adults aged 45 years and older with diabetes. This helps us understand the extent to which the risk factors and disease prevalence may differ among the young adult population with diabetes compared to older cohort.

METHODOLOGY

Design

This was a cross-sectional analytic study with data derived from the results of the NNHeS which is available from the public use files (PUF) of the Food and Nutrition Research Institute (FNRI) at the website, *http://enutrition.fnri.dost.gov.ph/site/puf-dataset.php/*. This survey had achieved sample size of 1104 respondents, with weighted count of 546,580.

Description of the Data Source

The 8th Philippine National Nutrition Clinical and Health Survey is a cross-sectional study approved by the FNRI Ethics Review Committee on January 22, 2013. It included a subsample of the Family Income and Expenditure Survey of the National Statistics Office. NNHeS utilized a stratified multi-stage sampling design covering the country's regions and provinces, except for Batanes. The primary sampling units were barangays, 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 80 provinces were covered between August 2013 and January 2014.

The study used the four-pronged approach of anthropometric, biochemical, clinical and dietary/food consumption assessments. Anthropometric measurements included height, weight, waist and hip circumference. Biochemical examinations were laboratory tests for lipid profile including total cholesterol, HDL-c, LDL-c and triglycerides, and fasting blood sugar. In the 8th NNHeS only one determination of FBS was done. Clinical evaluation included blood pressure monitoring. All forms were checked and rechecked during encoding using a CSPro program version 2.4. Data cleaning, checking for consistency and data processing were done by region. Weights were assigned and attached to the cleaned data so that the distributions in the households would reflect their actual distributions in the population as a whole.

Population

Filipino adults with diabetes who participated in the 2013 NNHeS.

Outcomes

1. Demographic variables – included age, sex, educational attainment, and socioeconomic status.
2. Cardiometabolic profile – This included measures of adiposity such as Body Mass Index (BMI), waist-to-hip ratio and waist circumference–to–height ratio (WHtR). Variables which were analyzed include:
   a. Serum total cholesterol, triglycerides, high-density lipoprotein cholesterol (HDL-c), low-density lipoprotein cholesterol (LDL-c), total cholesterol: HDL ratio
   b. Fasting Blood Sugar (FBS)
   c. Blood pressure (BP)
   d. Metabolic Syndrome (MetS)
   e. Smoking Status
   f. Alcoholic beverage intake
   g. Healthy eating habits/ Dietary profile
   h. Leisure-time physical activity (PA)

Operational definitions

1. Young-onset diabetes (YOD) or younger adults with diabetes are those aged 18-44 years old with diabetes. In the 8th NNHeS, FBS measurement started at 20 years and above.
2. UNITE for Diabetes Philippine Clinical Practice Guidelines (CPG) adapted from the American Diabetes Association (ADA) criteria for diabetes and dysglycemia are as follows:
   a. Normal FBS is <100 mg/dL
   b. Impaired fasting glucose is FBS 100-125 mg/dL, and
   c. Diabetes is FBS ≥126 mg/dL
3. Asia-Pacific Classification of BMI was adopted for this study:
   a. Underweight: <18.5 kg/m^2
   b. Normal weight: 18.5-22.9 kg/m^2
   c. Overweight: 23-24.9 kg/m^2
   d. Obese I: 25-29.9 kg/m^2
   e. Obese II: ≥30 kg/m^2
4. WHO-Asia Pacific Classification of waist circumference:
   a. Males: normal (<90 cm), borderline (90-101 cm), and high (>101)
   b. Females: normal (<80 cm), borderline (80-87 cm), and high (>87 cm)
5. Other Obesity indices:
   a. Waist–hip ratio values of greater than 0.90 and 0.80 for men and women, respectively, OR
   b. Waist to Height Ratio (WHtR) of ≥0.5
6. Blood pressure categories in this study are based on the American College of Cardiology/American Heart Association (ACC/AHA) 2017 guidelines on Hypertension
   a. Normal (systolic BP <120 and diastolic BP <80 mmHg)
   b. Elevated (systolic BP 120-129 and diastolic <80 mmHg)
   c. Stage 1 hypertension (systolic BP 130-139 or diastolic 80-89 mmHg)
   d. Stage 2 hypertension (systolic BP ≥140 or diastolic ≥90 mmHg)
7. The 2001 National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III) guidelines on serum lipid level categories were used in this study as follows:
   a. Total cholesterol (in mg/dL) desirable (<200), borderline high (200-239), high (>240);
   b. LDL-c (in mg/dL) optimal (<100), near optimal/ above optimal (100-129), borderline high (130-159), high (160-189), very high (>190);
   c. HDL-c (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. Alcohol consumption was classified according to these WHO categories (2014):
   a. Lifetime abstainers are people who have never consumed alcohol
   b. Former drinkers are people who have previously consumed alcohol but have not done so in the previous 12-month period, and
   c. Current drinkers are people who were currently consuming alcohol during the survey period.
   d. Binge drinking status for males is defined as drinking five or more standard drinks in a row, while for females it is drinking four or more standard drinks in a row.
   e. Standard drink is equal to 14.0 grams (0.6 ounces) of pure alcohol, with moderate alcohol consumption defined as having up to 1 drink per day for women and up to 2 drinks per day for men
9. Cigarette smoking status was categorized according to the WHO STEPS Surveillance Manual:
   a. Current smokers are those who smoke during the time of survey either on a daily basis (at least 1 cigarette a day), or on a regular/occasional smoking, or those who do not smoke daily but who smoke at least weekly, or those who smoke less often than weekly,
   b. Former smokers are those who have ever smoked in the past year prior to the survey whether in a daily basis or an aggregate lifetime consumption of at least 100 cigarettes but not daily; and
   c. Never smokers are those individuals who have never smoked at all.
10. A person not meeting any of the following criteria is considered physically inactive or insufficiently physically active and therefore at risk for chronic disease based on the WHO STEPS Surveillance Manual:
    a. 3 or more days of vigorous-intensity activity of at least 20 minutes per day or
    b. 5 or more days of moderate intensity activity or walking of at least 30 minutes per day
11. Unhealthy diet is the failure to meet the WHO recommended intake of 400 g of fruits and vegetables per day based on the 24-hour food recall.
12. Metabolic Syndrome defined by the NCEP-ATP III as fulfilling at least 3 out of 5 of the following criteria:
    a. Waist circumference for males: ≥90 cm, females: ≥80 cm;
    b. Triglycerides ≥150 mg/dl;
    c. HDL cholesterol for males: <40 mg/dl, females <50 mg/dl;
    d. Fasting blood sugar ≥100 mg/dl;
    e. Blood pressure: ≥130 mmHg systolic or ≥80 mmHg on antihypertensive drug treatment in a patient with hypertension

Statistical Methods

The study utilized the 8th NNHeS data requested from the FNRI. A single sampling using the dataset weights from the socio-demographic profile was implemented to generate the results. Descriptive statistics were used to summarize the general and clinical characteristics of the participants. Frequency and proportion were used for nominal variables, median and range for ordinal variables, and mean and standard deviation for interval/ ratio variables. Adjusted Wald test was used to determine the difference of mean between the two age groups. Pearson's Chi-square test and logistic regression were used to determine differences in the frequency and risk between groups.

All valid data were included in the analysis. Missing variables were neither replaced nor estimated. Null hypothesis was rejected at 0.05 α-level of significance. STATA 15.0 was used for data analysis.

Ethical Issues

The study was conducted in compliance with the ethical principles set forth in the Declaration of Helsinki and the (Philippine) National Ethical Guidelines for Health and Health-Related Research of 2017. The study protocol and subsequent amendments underwent review and approval by the UP Manila Research Ethics Board (UPM REB) prior to study initiation.

RESULTS

A total of 100,021 adults aged 20 years or older were identified from the NNHeS dataset, of whom 18,484 individuals had fasting blood sugar levels tested. Elevated blood sugar was found among 1,104 of the 18,484 tested. The estimated weighted prevalence of DM in the adult population is 5.43% (95% CI, 5.10–5.79). Disaggregated, DM prevalence in the young adult (20–44 years) and ≥45 years age brackets were 2.64% (95% CI, 2.32–3.00) and 9.85% (95% CI, 9.18–10.56), respectively.

Characteristics of Young Adults with Diabetes

Mean, SD ages of the young adult and older adult age groups were 37, 6 years and 59, 9 years, respectively. Males comprised a greater proportion of young adults (56%) compared to older adults (45%). Most of YOD were high school graduates, while LOD finished elementary education. Majority in both groups were married and employed. Those belonging to the two highest socioeconomic quintiles (Q4-Q5) comprised 51% and 57% of young and older adults, respectively (Table 1).

The young adults had significantly greater weight (66.36±14.24 kg vs. 61.35±11.81 kg, $p<0.001$), higher BMI (26.24 kg/m^2 vs 25 kg/m^2, $p=0.002$), and had more obese II proportions than older adults (22.38% vs. 12.14%, $p=0.002$). Distributions of waist ($p>0.999$) and hip ($p=0.273$) circumferences among the young and older adults were not found to be significantly different. While the mean SBP of younger adults was significantly lower compared to that of older adults (122.41±19.17 mmHg vs 135.45±22.47 mmHg, p<0.001), their diastolic BP was not statistically significantly different ($p=0.188$). A greater proportion among the YOD, as compared to LOD, were presently daily smokers (23% vs 14%). Although significantly more of the older adults, in comparison with the younger group, had never consumed alcoholic beverage (48% vs 31%), there was no statistically significant difference in proportions of binge drinkers between the two groups (11% vs 16%, respectively). Physical activity was likewise determined to be not significantly different between the two groups ($p=0.078$). However, despite having a greater proportion who were physically active among the YOD compared to LOD (55.55% versus 48.38%), there are more obese persons among the young (56% vs 49%) (Table 2).

Table 1. Socio-demographic profile of NNHeS adult respondents with diabetes ($n_{weighted}$=546580)

	All (n_w=546580)	Young Adults (n_w=162675)	Older Adults (n_w=383905)	*p*
	Frequency (%); Mean ± SD			
Age, years	52.18 ± 13.06	36.79 ± 6.40	58.71 ± 9.08	-
Sex				.004*
Male	262715 (48.07)	91027 (55.96)	171688 (44.72)	
Female	283864 (51.93)	71648 (44.04)	212217 (55.28)	
Civil status				<.001*
Single	67889 (12.42)	39844 (24.49)	28046 (7.31)	
Married	371373 (67.94)	106697 (65.59)	264676 (68.94)	
Live-in	26181 (4.79)	12459 (7.66)	13722 (3.57)	
Widowed	68070 (12.45)	1285 (0.79)	66784 (17.4)	
Separated	13067 (2.39)	2390 (1.47)	10677 (2.78)	
Highest educational attainment				<.001*
No grade completed	11430 (2.09)	1688 (1.04)	9742 (2.54)	
Nursery/Kinder/Preparatory	571 (0.1)	0	571 (0.15)	
Some Elementary	76178 (13.94)	11790 (7.25)	64387 (16.77)	
Elementary Graduate	97800 (17.89)	19040 (11.7)	78760 (20.52)	
Some High School	65283 (11.54)	22762 (13.99)	42521 (11.07)	
High School Graduate	121143 (22.16)	46601 (28.65)	74543 (19.42)	
Some Voc/Tech	5566 (1.02)	2084 (1.28)	3482 (0.91)	
Graduate (Voc/Tech)	26877 (4.92)	9050 (5.56)	17826 (4.64)	
Some College	52343 (9.58)	18702 (11.5)	33641 (8.76)	
College graduate	85168 (15.58)	30148 (18.53)	55020 (14.33)	
Master's graduate	3158 (0.58)	406 (0.25)	2752 (0.72)	
PhD graduate	347 (0.06)	0	347 (0.09)	
Others	403 (0.07)	403 (0.25)	0	
Missing	313 (0.06)	0	313 (0.08)	
Occupational status				<.001*
No occupation	97921 (17.92)	28046 (17.24)	69875 (18.2)	
Housekeeper	97726 (17.88)	22883 (14.07)	74843 (19.5)	
Student	4012 (0.73)	3385 (2.08)	627 (0.16)	
Pensioner	34339 (6.28)	0	34339 (8.94)	
With job or business	311430 (56.98)	108361 (66.61)	203069 (52.9)	
With job or business and Student	1152 (0.21)	0	1152 (0.3)	
Wealth quintile				.155*
Poorest	62858 (11.78)	24791 (15.51)	38067 (10.18)	
Poor	83375 (15.62)	23003 (14.39)	60372 (16.15)	
Middle	93619 (17.54)	31221 (19.53)	62398 (16.69)	
Rich	129118 (24.2)	36838 (23.05)	92280 (24.69)	
Richest	164659 (30.86)	43993 (27.52)	120666 (32.28)	

Statistical tests used: * - Pearson's chi-square test

In terms of patterns of dietary intake (Table 3), there was notably greater consumption of cereals (*p*=0.002) and rice (*p*=0.028) among young adults as compared to older ones, but the latter consumed more starchy roots and tubers (*p*=0.008), as well as milk and its derivatives (*p*=0.004). On the other hand, significant differences in intake or consumption of corn, sugars and syrups, dried beans and nuts, vegetables, fruits, fats and oils, fish, meats, poultry, eggs, beverages, condiments, vitamins, minerals, total protein, and total fat, were not detected. Though the total amounts of food consumed were comparable (*p*=0.690), the average total caloric (1776.78±758.38 kcal vs 1596.88±639.16 kcal, *p*=0.023) and carbohydrate (306.13±142.16 grams vs 270.53±104.74 grams, *p*=0.014) intakes were higher in the young adult group than in the older adult group. Carbohydrate intake for both groups comprised 69% and 68%, respectively. Levels of UIE (139.3±131.7 μg/dl vs 105.96±108.65 μg/dl) and hemoglobin (14.5±1.6 g/dL vs 13.9±1.5 g/dL) were significantly greater in the young adult bracket than in the older age group. In contrast, levels of vitamin A were comparable between the two.

Cardiometabolic Risk Factors

Metabolic syndrome was found in 83.76% (81.28-85.97) of the overall population. MetS in the YOD comprised 81.13% (75.59-85.66), and in LOD 84.88% (82.13-87.27). Among the YOD, the diagnostic criteria that were met are as follows: waist circumference more than cutoff among 55%; hypertriglyceridemia was found in 66%; low HDL-C in 84%; elevated fasting glucose 100%; and elevated BP 38% (Table 4).

Lipid profile for both the young and adult age groups had high TC (63% vs 70%, *p*=0.051), high LDL (94% vs 96%, *p*=0.119), high Tg (>150 mg/dl) (65% vs 65%, *p*=0.305), and low HDL (84% vs 82%, *p*=0.667). Mean values for TC is 215 mg/dl vs 228 mg/dl (*p*=0.002), LDL 136 vs 150 mg/dl (*p*<0.001), Tg 228 mg/dl vs 213 mg/dl (*p*=0.174); and HDL 34 mg/dl vs 35 mg/dl (*p*=0.316), among the young and older adults with diabetes, respectively. The LOD had significantly higher TC and LDL.

In addition, the young adult group had significantly higher proportions who were in the obese II category (22% vs 12%) using BMI, current drinkers (56% vs 37%), and

Table 2. Anthropometric and Clinical profile of NNHeS adult respondents with diabetes

	All (n_w=546580)	Young Adults (n_w=162675)	Older Adults (n_w=383905)	*p*
		Mean ± SD		
Weight, kg	[n_w=534262] 62.86 ± 12.79	[n_w=160675] 66.36 ± 14.24	[n_w=373587] 61.35 ± 11.81	<.001*
Height, cm	[n_w=532651] 157.32 ± 8.44	[n_w=160675] 158.95 ± 8.61	[n_w=371976] 156.61 ± 8.27	.001*
BMI, kg/m^2	[n_w=532210] 25.38 ± 4.57	[n_w=160675] 26.24 ± 5.05	[n_w=371535] 25 ± 4.29	.002*
BMI classification	[n_w=532210]	[n_w=160675]	[n_w=371535]	.010†
Underweight (<18.5)	28848 (5.42)	7982 (4.97)	20866 (5.62)	
Normal (<23)	143652 (26.99)	39560 (24.62)	104093 (28.02)	
Overweight + Obese	359710 (67.59)	113133 (70.41)	246577 (66.37)	
Overweight(<25)	86408 (16.24)	23219 (14.45)	63189 (17.01)	
Obese I (<30)	192223 (36.12)	53953 (33.58)	138270 (37.22)	
Obese II (≥30)	81079 (15.23)	35961 (22.38)	45118 (12.14)	
Waist circumference, cm	[n_w=526942] 87.22 ± 11.61	[n_w=155759] 87.26 ± 12.78	[n_w=371183] 87.2 ± 11.09	.952*
Hip circumference, cm	[n_w=531380] 93.55 ± 8.93	[n_w=156434] 93.94 ± 9.62	[n_w=374946] 93.39 ± 8.68	.480*
Systolic BP, mm Hg	[n_w=542807] 131.56 ± 22.34	[n_w=162061] 122.41 ± 19.17	[n_w=380746] 135.45 ± 22.47	<.001*
Diastolic BP, mm Hg	[n_w=542807] 82.31 ± 12.08	[n_w=162061] 81.42 ± 12.23	[n_w=380746] 82.69 ± 12.01	.188*
Present smoker	[n_w=511436]			.007†
No	405867 (79.36)	106245 (71.73)	299622 (82.47)	
Once a week	5813 (1.14)	2460 (1.66)	3353 (0.92)	
2-6 times a week	13127 (2.57)	4625 (3.12)	8501 (2.34)	
Every day	86630 (16.94)	34784 (23.48)	51846 (14.27)	
Ever smoked tobacco product	[n_w=511436]			<.001†
Not at all	415539 (81.25)	124187 (83.85)	291352 (80.19)	
Once a week	3118 (0.61)	584 (0.39)	2534 (0.7)	
2-6 times a week	6045 (1.18)	3719 (2.51)	2326 (0.64)	
Every day	57376 (11.22)	7135 (4.82)	50242 (13.83)	
Tried once	22156 (4.33)	9112 (6.15)	13044 (3.59)	
Occasionally	7202 (1.41)	3377 (2.28)	3825 (1.05)	
Ever consumed alcoholic beverage	[n_w=511436]			<.001†
No	219210 (42.86)	46397 (31.33)	172814 (47.56)	
Yes	172435 (33.72)	58747 (39.66)	113688 (31.29)	
Occasionally (during socials)	119791 (23.42)	42969 (29.01)	76821 (21.14)	
Binge drinker	[n_w=511436] 64246 (12.56)	23116 (15.61)	41130 (11.32)	.052†
General physical activity	[n_w=501646]			.078†
Low	248377 (49.51)	65458 (44.45)	182919 (51.62)	
High	253269 (50.49)	81819 (55.55)	171451 (48.38)	

Statistical tests used: * - Adjusted Wald test; † - Pearson's chi-squared test

Table 3. Dietary and biochemical profile of NNHeS adult respondents with diabetes

	All (n_w=546580)	Young Adults (n_w=162675)	Older Adults (n_w=383905)	*p*
		Mean ± SD		
Cereals and derivatives, g	[n_w=277580] 300.32 ± 148.29	[n_w=78697] 339.2 ± 169.04	[n_w=198883] 284.94 ± 136.5	.002
Rice and derivatives, g	[n_w=277580] 256.1 ± 151.51	[n_w=78697] 284.32 ± 177.1	[n_w=198883] 244.93 ± 138.85	.028
Corn and derivatives, g	[n_w=277580] 12.5 ± 48.33	[n_w=78697] 17.54 ± 64.86	[n_w=198883] 10.5 ± 39.91	.242
Other cereal products, g	[n_w=277580] 31.73 ± 37.02	[n_w=78697] 37.34 ± 46.18	[n_w=198883] 29.51 ± 32.51	.134
Starchy roots and tubers, g	[n_w=277580] 11.46 ± 39.39	[n_w=78697] 6.14 ± 24.55	[n_w=198883] 13.57 ± 43.74	.008
Sugar and syrups, g	[n_w=277580] 10.84 ± 18.68	[n_w=78697] 11.46 ± 17.88	[n_w=198883] 10.59 ± 19	.642
Dried beans/nuts/seeds, g	[n_w=277580] 7.8 ± 26.93	[n_w=78697] 8.24 ± 24.14	[n_w=198883] 7.63 ± 27.99	.821
Vegetables, g	[n_w=277580] 74.13 ± 82.16	[n_w=78697] 66.75 ± 68.81	[n_w=198883] 77.04 ± 86.8	.165

Table 3. Dietary and biochemical profile of NNHeS adult respondents with diabetes *(continued)*

	All (n_w=546580)	**Young Adults (n_w=162675)**	**Older Adults (n_w=383905)**	***p***
		Mean ± SD		
Green leafy and yellow, g	[n_w=277580] 29.45 ± 49	[n_w=78697] 26.23 ± 46.16	[n_w=198883] 30.72 ± 50.09	.314
Other vegetables, g	[n_w=277580] 44.68 ± 59.19	[n_w=78697] 40.52 ± 52.13	[n_w=198883] 46.32 ± 61.76	.319
Fruits, g	[n_w=277580] 41.92 ± 119.94	[n_w=78697] 32.18 ± 100.63	[n_w=198883] 45.78 ± 126.7	.193
Vitamin C rich fruits, g	[n_w=277580] 5.56 ± 30.41	[n_w=78697] 3.43 ± 20.83	[n_w=198883] 6.4 ± 33.43	.217
Other fruits, g	[n_w=277580] 36.36 ± 114.19	[n_w=78697] 28.75 ± 94.17	[n_w=198883] 39.38 ± 121.2	.282
Fish, meat, and poultry, g	[n_w=277580] 209.62 ± 147.03	[n_w=78697] 202.35 ± 139.85	[n_w=198883] 212.49 ± 149.89	.492
Fish and derivatives, g	[n_w=277580] 111.89 ± 112.83	[n_w=78697] 104.59 ± 91.22	[n_w=198883] 114.78 ± 120.31	.331
Meat and derivatives, g	[n_w=277580] 63.73 ± 87.88	[n_w=78697] 68.02 ± 89.65	[n_w=198883] 62.04 ± 87.26	.524
Poultry, g	[n_w=277580] 33.99 ± 57.46	[n_w=78697] 29.74 ± 52.95	[n_w=198883] 35.67 ± 59.15	.338
Eggs, g	[n_w=277580] 11.28 ± 19.71	[n_w=78697] 9.74 ± 16.63	[n_w=198883] 11.89 ± 20.79	.255
Milk and derivatives, g	[n_w=277580] 28.66 ± 84.57	[n_w=78697] 16.27 ± 41.66	[n_w=198883] 33.57 ± 96.02	.004
Whole milk, g	[n_w=277580] 16.89 ± 60.92	[n_w=78697] 8.71 ± 33.48	[n_w=198883] 20.12 ± 68.59	.008
Milk products, g	[n_w=277580] 11.78 ± 58.15	[n_w=78697] 7.56 ± 26.41	[n_w=198883] 13.45 ± 66.62	.159
Fats and oils, g	[n_w=277580] 5.81 ± 9.93	[n_w=78697] 5.34 ± 6.34	[n_w=198883] 5.99 ± 11.03	.436
Miscellaneous, g	[n_w=277580] 48.41 ± 134.49	[n_w=78697] 42.59 ± 103.49	[n_w=198883] 50.71 ± 145	.508
Beverages, g	[n_w=277580] 42.36 ± 129.89	[n_w=78697] 37.42 ± 103.17	[n_w=198883] 44.32 ± 139.13	.569
Condiments and spices, g	[n_w=277580] 1.7 ± 4.16	[n_w=78697] 1.48 ± 3.26	[n_w=198883] 1.8 ± 4.47	.406
Other miscellaneous, g	[n_w=277580] 4.34 ± 38.17	[n_w=78697] 3.7 ± 17.3	[n_w=198883] 4.6 ± 43.78	.740
Total calcium, g	[n_w=277580] 329.9 ± 250.39	[n_w=78697] 315.83 ± 224.42	[n_w=198883] 335.47 ± 260.06	.372
Total carbohydrates, g	[n_w=277580] 280.62 ± 117.5	[n_w=78697] 306.13 ± 142.16	[n_w=198883] 270.53 ± 104.74	.014
Total energy, kcal	[n_w=277580] 1647.88 ± 679.08	[n_w=78697] 1776.78 ± 758.38	[n_w=198883] 1596.88 ± 639.16	.023
Total fats, g	[n_w=277580] 31.49 ± 25.78	[n_w=78697] 34.27 ± 26.9	[n_w=198883] 30.39 ± 25.28	.175
Total iron, mg	[n_w=277580] 8.35 ± 4.06	[n_w=78697] 8.65 ± 4.02	[n_w=198883] 8.23 ± 4.08	.338
Total vitamin C, mg	[n_w=277580] 18.39 ± 8.27	[n_w=78697] 18.92 ± 9.07	[n_w=198883] 18.18 ± 7.93	.423*
Total protein, g	[n_w=277580] 55.78 ± 24.3	[n_w=78697] 58.35 ± 26.34	[n_w=198883] 54.77 ± 23.41	.185
Total niacin, mg	[n_w=277580] 0.74 ± 0.66	[n_w=78697] 0.73 ± 0.56	[n_w=198883] 0.74 ± 0.69	.794
Total riboflavin, mg	[n_w=277580] 0.95 ± 3.53	[n_w=78697] 0.89 ± 0.55	[n_w=198883] 0.97 ± 4.16	.694
Total vitamin A, mcg RE	[n_w=277580] 524.05 ± 1403.39	[n_w=78697] 434.43 ± 923.12	[n_w=198883] 559.52 ± 1552.61	.326
Total thiamine, mg	[n_w=277580] 524.05 ± 1403.39	[n_w=78697] 434.43 ± 923.12	[n_w=198883] 559.52 ± 1552.61	.319
UIE, μg/dL	[n_w=512745] 115.48 ± 116.6	[n_w=146345] 139.32 ± 131.71	[n_w=366400] 105.96 ± 108.65	.001
Vitamin A, μg/dL	[n_w=543068] 48.48 ± 17.94	[n_w=161535] 48 ± 16.89	[n_w=381533] 48.68 ± 18.37	.608
Hemoglobin, g/dL	[n_w=545606] 14.04 ± 1.54	[n_w=162229] 14.47 ± 1.58	[n_w=383377] 13.86 ± 1.48	<.001

Means were compared by adjusted Wald test

Table 4. Cardiometabolic risk factors among Young and Older Adults with diabetes

	Total (n_w=546580)	Young Adults (n_w=162675)	Older Adults (n_w=383905)	*p*
	Frequency (%); Mean ± SD			
Metabolic syndrome				
High waist circumference [n_w=526942]	310582 (58.94)	85428 (54.85)	225153 (60.66)	.135
Male (≥90cm) [n_w=256605]	101765 (39.66)	33052 (36.64)	68713 (41.3)	.362
Female (≥80cm) [n_w=270338]	208817 (77.24)	52376 (79.92)	156441 (76.39)	.444
TG ≥150 mg/dL [n_w=545353]	356040 (65.29)	106515 (65.73)	249524 (65.1)	.305
Low HDL-C [n_w=545353]	451071 (82.71)	135401 (83.56)	315670 (82.35)	.667
Male (<40 mg/dL) [n_w = 261488]	192816 (73.74)	68665 (75.96)	124152 (72.56)	.447
Female (<50 mg/dL) [n_w = 283864]	258255 (90.98)	66736 (93.15)	191518 (90.25)	.328
BP ≥130/85 mmHg [n_w = 542807]	302461 (55.72)	61263 (37.8)	241198 (63.35)	<.001
Metabolic syndrome [n_w = 546580]	457841 (83.76)	131983 (81.13)	325859 (84.88)	.194
Lipid profile				
TC to HDL-C ratio	[n_w= 545353]	[n_w=162041]	[n_w=383311]	
	7.62 ± 4.86	7.76 ± 6.03	7.56 ± 4.28	.651
Total cholesterol-to-HDL cholesterol ratio ≥ 5.9	308712 (56.61)	86107 (53.14)	222605 (58.07)	.201
Total cholesterol, mg/dL	[n_w= 545353]	[n_w=162041]	[n_w=383311]	
	224.82 ± 54.14	215.46 ± 51.15	228.77 ± 54.91	.002
TC ≥200 mg/dL	373490 (68.49)	102872 (63.48)	270618 (70.6)	.051
LDL-C, mg/dL	[n_w= 544790]	[n_w=161479]	[n_w=383311]	
	146.57 ± 46.9	136.24 ± 44.89	150.92 ± 47.08	<.001
LDL-C above cutoff	[n_w= 544790]	[n_w=161479]	[n_w=383311]	
≥100 (vs <100)	462729 (84.94)	133308 (82.55)	329421 (85.94)	.227
≥ 70 (vs <70)	521547 (95.73)	151585 (93.87)	369962 (96.52)	.119
≥55 (vs <55)	536321 (98.45)	157226 (97.37)	379095 (98.9)	.193
HDL	[n_w= 545353]	[n_w=162041]	[n_w=383311]	
	34.84 ± 12.52	34.19 ± 12.07	35.12 ± 12.71	.316
VLDL ≥130 [nw=545353]	11636 (2.13)	6392 (3.94)	5243 (1.37)	.052
Triglycerides	[n_w= 545353]	[n_w=162041]	[n_w=383311]	
	217.52 ± 134.6	227.99 ± 157.58	213.09 ± 123.49	.174
BMI, kg/m^2	[n_w=532210]	[n_w=160675]	[n_w=371535]	
Underweight (<18.5)	28848 (5.42)	7982 (4.97)	20866 (5.62)	.696
Normal (<23)	143652 (26.99)	39560 (24.62)	104093 (28.02)	.315
Overweight (<25)	86408 (16.24)	23219 (14.45)	63189 (17.01)	.257
Obese I (<30)	192223 (36.12)	53953 (33.58)	138270 (37.22)	.089
Obese II (≥30)	81079 (15.23)	35961 (22.38)	45118 (12.14)	.002
Waist–hip ratio				
Male	[n_w=256604]	[n_w=90220]	[n_w=166384]	
	0.94 ± 0.07	0.93 ± 0.08	0.95 ± 0.07	.059
Male ratio >0.90	187269 (72.98)	57997 (64.28)	129272 (77.69)	.005
Female	[n_w= 270338]	[n_w=65538]	[n_w=204799]	
	0.92 ± 0.07	0.92 ± 0.06	0.92 ± 0.07	.825
Female ratio >0.80	261993 (96.91)	63167 (96.38)	198826 (97.08)	.731
Waist–height ratio				
Waist–height ratio >0.5	402334 (76.35)	110422 (70.89)	291912 (78.64)	.023
Male	[n_w=256604]	[n_w=90220]	[n_w=166384]	
	0.53 ± 0.07	0.52 ± 0.08	0.54 ± 0.07	.095
Male ratio >0.50	170336 (66.38)	53104 (58.86)	117232 (70.46)	.023
Female	[n_w= 270338]	[n_w=65538]	[n_w=204799]	
	0.58 ± 0.07	0.59 ± 0.08	0.57 ± 0.07	.236
Female ratio >0.50	231998 (85.82)	57318 (87.46)	174681 (85.29)	.570
Blood pressure				
Normal (SBP<120 AND DBP<80)	125979 (23.35)	57907 (35.73)	68071 (18.03)	-
Elevated (SBP 120-129 AND DBP <80)	37378 (6.93)	9353 (5.77)	28025 (7.42)	<.001
HTN stage 1 (SBP 130-139 OR DBP 80-89)	152312 (28.23)	51768 (31.94)	100544 (26.63)	<.001
HTN stage II (SBP≥140 OR DBP≥90)	223966 (41.5)	43034 (26.55)	180932 (47.92)	.004
Behavior				
Current drinker [n_w = 511436]	218456 (42.71)	83686 (56.5)	134770 (37.09)	<.001
Alcohol intake in the last 30 days among current drinkers (14.0g alcohol/ standard drink)	[n_w= 204827]	[n_w=77790]	[n_w=127037]	
	4.40 ± 7.48	3.7 ± 5.49	4.82 ± 8.46	.138
Current smoker [n_w = 511436]	105570 (20.64)	41869 (28.27)	63701 (17.53)	.002
Low physical activity [n_w = 501646]	253269 (50.49)	81819 (55.55)	171451 (48.38)	.077
Unhealthy diet (<400g of fruits and vegetables per day) [n_w = 277580]	227334 (81.9)	68209 (86.67)	159125 (80.01)	.066

Table 5. Risk factors associated with Metabolic Syndrome (MetS) among young adults with diabetes mellitus

	Total (n_w=162675)	With Metabolic Syndrome (n_w=131983)	No Metabolic Syndrome (n_w=30692)	Crude Odds Ratio (95% CI)	*p*
	Frequency (%); Mean ± SD; Median (Range)				
Age, y	36.79 ± 6.4	37.22 ± 6.26	34.94 ± 6.75	1.054 (1.01–1.1)	.029
Sex					
Male	91027 (55.96)	70183 (53.18)	20845 (67.92)	1.0 (Reference)	-
Female	71648 (44.04)	61800 (46.82)	9847 (32.08)	1.864 (0.92–3.76)	.082
Total fat intake, g					
	34.27 ± 26.9	36.07 ± 28.98	26.94 ± 14.11	1.016 (1.0004–1.03)	.044
	26.26 (1.27–162.98)	26.7 (1.27–162.98)	23.95 (6.8–57.12)		
General physical activity					
Low	65458 (44.45)	57365 (47.36)	8093 (30.94)	2.009 (0.93–4.32)	.074
High	81819 (55.55)	63752 (52.64)	18067 (69.06)	1.0 (Reference)	-
Current drinker [n_w = 148113]	83686 (56.5)	69862 (58.03)	13824 (49.88)	1.389 (0.7–2.78)	.351
Alcohol intake in the last 30 days among current drinkers (14.0 g alcohol per standard drink)	n_w = 77790	n_w = 64422	n_w = 13370		
	3.70 ± 5.49	3.35 ± 5.25	5.40 ± 6.37	0.942 (0.87–1.01)	.114
	0.84 (0 to 20)	0.84 (0 to 20)	3.30 (0 to 20)		
Current smoker [n_w = 148113]	41869 (28.27)	32803 (27.25)	9065 (32.71)	0.77 (0.37–1.62)	.489
Civil status					
Single	39844 (24.49)	29887 (22.64)	9957 (32.44)	1.0 (Reference)	-
Married	106697 (65.59)	88300 (66.9)	18397 (59.94)	1.599 (0.76–3.36)	.215
Live-in	12459 (7.66)	11399 (8.64)	1060 (3.45)	3.582 (0.72–17.84)	.119
Widowed	1285 (0.79)	1285 (0.97)	0	-	-
Separated	2390 (1.47)	1112 (0.84)	1278 (4.17)	0.29 (0.04–2.39)	.249
Highest educational attainment					
No or incomplete primary education	13478 (8.29)	9508 (7.2)	3969 (12.93)	-	-
Elementary graduate	19040 (11.7)	14845 (11.25)	4195 (13.67)	1.913 (0.72–5.09)	0.193
Some high school education	22763 (13.99)	16042 (12.15)	6721 (21.9)	1.602 (0.76–3.36)	0.212
High school graduate	46601 (28.65)	35985 (27.26)	10616 (34.59)	2.135 (1.09 to 4.18)	0.027
Vocational or technological course	11134 (6.84)	11134 (8.44)	0	3.576 (1.59 to 8.05)	0.002
Some college education	18702 (11.5)	16239 (12.3)	2463 (8.02)	2.462 (1.09 to 5.57)	0.031
College graduate	30148 (18.53)	27420 (20.78)	2728 (8.89)	2.738 (0.98 to 7.65)	0.055
Postgraduate	406 (0.25)	406 (0.31)	0	-	-
Wealth quintile	n_w=159846	n_w=129154	n_w=30692		
Poorest	24791 (15.51)	18599 (14.4)	6191 (20.17)	1.0 (Reference)	-
Poor	23003 (14.39)	18329 (14.19)	4674 (15.23)	1.305 (0.44–3.88)	.631
Middle	31221 (19.53)	23700 (18.35)	7521 (24.5)	1.049 (0.38–2.92)	.927
Rich	36838 (23.05)	30333 (23.49)	6506 (21.2)	1.552 (0.55–4.34)	.401
Richest	43993 (27.52)	38193 (29.57)	5800 (18.9)	2.192 (0.75–6.44)	.152
Total energy, kcal	n_w = 78697	n_w = 63123	n_w = 15574		
	1776.78 ± 758.38	1810.67 ± 787.07	1639.38 ± 624.54	1.0003 (0.9997–1.0009)	.298
	1654.34 (573.27 to 3824.62)	1748.45 (573.27 to 3824.62)	1406.08 (906.64 to 3047.99)		
Total carbohydrates, g	n_w = 78697	n_w = 63123	n_w = 15574		
	306.13 ± 142.16	309.07 ± 145.34	294.19 ± 130.64	1.0008 (0.997–1.004)	.653
	271.53 (87.47 to 685.38)	271.53 (87.47 to 685.38)	248.54 (98.99 to 582.84)		
Total protein, g	n_w = 78697	n_w = 63123	n_w = 15574		
	58.35 ± 26.34	59.23 ± 27.41	54.76 ± 21.58	1.007 (0.99–1.02)	.407
	52.82 (13.57 to 156.28)	52.82 (13.57 to 156.28)	52.89 (25.63 to 118.17)		

Statistical test used: Logistic regression

current smokers (28% vs 18%); but better risk profiles in terms of hypertension stage 1 (15% vs 28%), hypertension stage 2 (11% vs 19%), total cholesterol (215.46±51.15 mg/dL vs 228.77±54.91 mg/dL, LDL-C (136.24±44.89 mg/dL vs 228.77±54.91 mg/dL), and BP ≥130/85 mmHg (38% vs 63%). When using WHR and WHtR for obese classification, male older adults have greater proportions with central obesity than young adults (77% vs 64%).

Among the young adults with diabetes, age and total fat intake were shown to be factors predictive of metabolic syndrome (Table 5). With every unit increase in age and total fat intake, the odds of having metabolic syndrome were raised by 5.4% (95% CI 1%–10%) and 1.6% (95% CI 0.04%–3%), respectively. Being at least a high school graduate has increased odds of having metabolic syndrome (cOR 2.135, 95% CI 1.09 to 4.18).

DISCUSSION

This study shows that young-onset diabetes in Filipinos have some differences in cardiometabolic risk factors compared to late-onset diabetes. However, these two age categories have similarly high percentages of the metabolic syndrome. In this national cross-sectional survey from 2013, one in five Filipino adults with diabetes was diagnosed before age 45 years, with prevalence of 2.64% which is low compared to published literature in other countries. The 2013 national survey in China, determined the prevalence of diabetes in the 20- to 39-year age-group to be 5.9%,[6–8] in

Hong Kong, it is at 21.3% of the DM cohort,[9] while the Joint Asia Diabetes Association (JADE) program which looked into Asian population reported around 18% young onset DM prevalence. Filipino young-onset diabetes had mean age of 37 years, mostly males, married, and employed. Similar to what was published in Asian YOD, mean age at diagnosis is 33 years, comprising mostly of men, and are obese.[3] In the US, YOD was diagnosed at 36 years old, with 7.7 years duration of diabetes, mostly in non-Hispanic Black population, and twice likely to be more obese than their young non-diabetic counterparts.[4] In Indians, the onset of YOD is nearly 10 years earlier than what was observed in other Asian countries, and 20 years earlier than what is usually observed in the Caucasian population, with T1DM and T2DM occurring with equal frequency at 40%.[10]

Filipino YODs were noted to be heavier, with higher BMIs and classify as being Obese II. This result was similar in a survey enrolling 41,029 patients with T2D across Asia.[3] A predominance of overweight and obese class was also seen among individuals with type 1, youth-onset type 2 and monogenic diabetes in the US, Germany and Austria making it difficult to make clinical distinctions.[11] Since we see that obesity is a consistent feature, it is interesting to note that there is a similar proportion of diabetics being physically active among the young and the old (55% vs 48%, p=0.078), yet there are more obese persons among the YOD (56% vs 49%, p=0.01). Although not significantly different, both the YOD and LOD are more than 80% unhealthy eaters. The mix between the nonmodifiable— genetics, race/ethnic background, family history of diabetes, being the offspring of a pregnancy complicated by gestational diabetes mellitus (GDM); and modifiable—poor diet, disordered eating behaviors, stress, and depression are identified contributors to this growing problem of obesity.[12,13]

When using the WHR and WHtR criteria to diagnose obesity, more male older adults with diabetes were classified as obese. This represents the population which may have a normal BMI but with central obesity. Central obesity means increased visceral adipose tissue (VAT) which has been associated with a range of metabolic abnormalities, including insulin resistance and adverse lipid profiles— the known risk factors for T2D and CVD.[14] VAT has been shown to be involved in activating pro-inflammatory cytokines, oxidative stress and the renin–angiotensin–aldosterone system (RAAS). Cut-off values used for WHR were 0.90 for men and 0.80 for women based on WHO Asian cutoffs also served as the basis in multiple Asian studies showing Asians to have an increased metabolic risk at lower waist circumference, and lower waist–hip ratio than Europeans. Waist-height ratio as a measure of abdominal obesity was also shown to be better than BMI in predicting CV risks.[15-16] In a study done among Filipinos living in rural areas, cardiometabolic diseases occurred at lower BMI, waist circumference, and WHR cut-offs compared to WHO recommendations. Obesity cut-offs in rural Filipino males and females are BMI of 24 and 23 kg/m^2, WC of 84 and 77 cm, and WHR 0.91 and 0.85, respectively. Countries in the Western Pacific and Southeast Asia also exhibited lower cut-offs for at least one cardiometabolic disease to occur.[17] Studies in Filipino-American women showed that those of the same age and sex with the same BMI have a higher fat percentage; thus, at higher risk for diabetes, high blood pressure, and heart disease compared to Caucasians.[18] It is important to screen for obesity using these more sensitive indices as the risk of T2D and diabetic complications increases continuously with increasing obesity.[19]

More Filipino YOD are current smokers. Smoking has been identified as a risk factor for diabetes in the young, increasing the odds by 1.6 fold. The exact mechanism on how smoking causes diabetes is still under study, however the theory involves directly damaged β-cell function, increased inflammation and oxidative stress, and impaired endothelial function.[20] Epidemiologic studies such as the European Investigation into Cancer (EPIC-Norfolk) showed cigarette smoking was independently associated with higher hemoglobin A1c (HbA1c) concentrations, with both male and female smokers exhibiting similar changes in HbA1c values.[21] The Health Professionals' Follow-Up Study showed men who smoked 25 or more cigarettes per day had a relative risk of incident diabetes of 1.94 (95%CI 1.25, 3.03) compared to non-smokers.[22] Furthermore, smoking was associated with an increased risk for diabetes treatment, hospitalization, and mortality among both men and women, and risk increased in a dose-response dependent manner with the number of cigarettes smoked per day, with men being affected more than women.[23] A cause-effect relationship between smoking and diabetes cannot be solidly established as it is multifactorial. Stress, diet, levels of physical activity and distribution of body fat are confounders in the analysis from various studies. Active smoking was seen as a risk factor for progression of diabetic nephropathy, retinopathy and neuropathy with a dose-dependent risk increase among smokers with T1D, while significantly decreased incidence of retinopathy in smokers with T2D.[24] It has also been shown that smoking is one of the key risk factors for cardiovascular disease and the strongest predictor of death.[25] Unfortunately for the NNHeS, no data on health seeking behaviors were sought and no inclusion of measures of kidney function nor micro/macroalbuminuria, retinopathy, neuropathy, and no hard cardiovascular endpoints were noted.

Alcohol consumption is also a relevant lifestyle factor in the development of T2D. Significantly more YOD are current drinkers at 40% vs 31% in older adults, and alcohol use has been found to be a risk factor to develop DM at an early age. Various trials have shown that moderate alcohol consumption improved insulin sensitivity by increasing an anti-inflammatory plasma protein—adiponectin, while some studies showed an opposite effect.[26,27] The difference in results might be a variable of quantity, the type of alcoholic beverage, and drinking patterns. Twenty prospective cohort studies included in a meta-analysis showed that compared with non-alcohol beverage drinkers, the relative risk (RR) for T2D among men was most protective when consuming 22 g/day alcohol (RR 0.87 [95% CI 0.76–1.00]) and became deleterious at just over 60 g/day alcohol (1.01 [0.71–1.44]), and among women, consumption of 24 g/day alcohol was most protective (0.60 [0.52–0.69]) and became deleterious at about 50 g/day alcohol (1.02 [0.83–1.26]).[28] Among 70,551 Danish subjects, the lowest risk of diabetes was observed at 14 drinks/week in men (HR 0.57 [95% CI 0.47, 0.70]) and at 9 drinks/week in women (HR 0.42 [95% CI 0.35, 0.51]), relative to no alcohol intake, and consumption of alcohol on 3–4 days weekly was associated with significantly lower risk for diabetes in men (HR 0.73 [95% CI 0.59, 0.94]) and women (HR 0.68 [95% CI 0.53, 0.88]), compared to binge drinking at once a week.[29] Alcohol consumption in this study composed of 3-4 standard drinks per day (40-60 g alcohol) for the young and old cohorts, which is above the recommended amount of alcohol intake per day. Binge drinking status comprised 12% of the population with diabetes with similar frequencies between groups. However, no correlation was established between binge drinking and having early onset DM.

The diets of YOD are characterized by higher cereal and rice intake, lower intake of starchy roots and tubers, lower intake of milk and derivatives and whole milk, higher total carbohydrate intake, and higher total energy intake compared with their older counterpart. The average total caloric and carbohydrate intakes were higher in the young adult group than in the older adult group. Carbohydrate intake for both groups were above the suggested intake of 60% total caloric requirement. This pattern of eating behavior, dietary abundance, coupled with sedentary lifestyle may affect weight. Chronic excess caloric intake leads to excessive weight gain then obesity, which has been shown as the driver of insulin resistance fueling early onset diabetes. Those with unhealthy dietary habits, including intake of simple sugars, low dietary quality, skipping meals, and binge eating predispose to glucose spikes and hyperinsulinemia.[30] Sustained hyperinsulinemia increases risk for early β cell exhaustion and cardiometabolic diseases.[31] Glucose dysregulation seen in both young adult and pediatric populations shows changes in the distribution of fat. A combination of high intramyocellular lipid content, increased VAT, decreased subcutaneous and ectopic liver fat deposition and increased epicardial adipose tissue was noted.[14,32] Mechanisms from disorders in lipid metabolism and inflammation also support the development of diabetes mellitus in the young. Obese individuals have chronically increased levels of circulating free fatty acids, and might contribute to increased reactive oxygen species and impaired insulin secretion. Pro-inflammatory factors namely tumor necrosis factor-α, interleukin 1β, and high-sensitivity C-reactive protein are noted to be increased in hyperglycemic states.[33] Physiologic changes that occur with aging may be contributory to the observed decreased caloric intake among the LOD. Swallowing problems, satiety issues, indigestion and mechanical problems as a result of a more advanced age may hinder food intake.[34] Thus, issues of malnutrition and hypoglycemia may be more encountered in the older cohort than in YOD.

Urinary iodine excretion and hemoglobin were significantly greater in the YOD than in LOD. Majority of iodine absorbed by the body is excreted in the urine, so urinary iodine excretion is considered as a sensitive indicator of iodine intake and changes in iodine status.[35] A high UIE rate may indicate sufficient iodine intake, or in excessively high levels, hyperthyroidism. Higher UIE rates were observed in the young adults, indicating higher iodine intake in this group. It is interesting to note, however, that when the dietary sources of each age group is considered, the older adults had more intake of iodine-rich foods, such as seafood and dairy products. In addition, young adults were noted to have a lower prevalence of diabetes. In a study conducted in Saudi Arabia which is an iodine-sufficient country, patients with diabetes have lower iodine concentration,[36] which may implicate that UIE levels can be an indicator of insulin resistance or glucose control. Consequently, persons with diabetes may also benefit from routine urinary iodine determination to screen for thyroid dysfunction.[37] Hemoglobin, meanwhile, was significantly greater in the younger adult bracket. This is consistent with age-related decrease in hemoglobin levels, affected by physiologic causes, chronic diseases, nutritional deficiencies, or changes in diet. In contrast, levels of vitamin A were comparable between the two. Vitamin A, an antioxidant vitamin, is present in animal products such as organ meats, fish, egg yolks, and fortified milk. Although comparable between the two age groups, vitamin A ranks among the nutrients with the highest level of inadequacy in Filipino adults. The prevalence of inadequacy of vitamin A also increases significantly with age.[38] The importance of vitamin A in pancreatic β cell development is highlighted by decreased β cell mass and impaired glucose tolerance in vitamin A-deficient adult mice. Reduced β cell mass increased α cell mass, with hyperglycemia and altered serum insulin and glucagon profiles.[39] Furthermore, micronutrient deficiency may also be related to developing macro and microvascular complications of diabetes, as diabetic patients with vitamin A deficiency are also seen to develop nonhealing foot ulcers.[40] The continued high prevalence of diabetes in both young and older age groups in the Philippines suggests a complex interplay of many different factors leading to its development. The different common nutrients found inadequate in the typical Filipino diet may be contributing to this burden.

The prevalence of hypertension is lower in YOD. Hypertension was also not found to be a cardiometabolic risk factor in the Filipino YOD cohort. Although this may reflect a subclinical disease activity because of a younger age of subjects, this study is limited by a one-point sampling, and no follow-ups. This result is in contrast to those seen in some studies that at diagnosis, 26% of adolescents with diabetes have hypertension, increasing to 50% by the fourth decade.[41] The Treatment Options for Type 2 Diabetes in Adolescents and Youth (TODAY) clinical trial involving 699 adolescents from 10-17 years old with newly diagnosed T2D showed 11.6% were hypertensive at baseline and 33.8% by end of study with average follow-up of 3.9 years, with male sex and higher BMI significantly increasing the risk for hypertension and eventually nephropathy.[42] Analysis from the Framingham study showed that patients with coexisting T2D and hypertension had higher rates of mortality from all causes (32 vs 20 per 1000 person-years; $p<0.001$) and cardiovascular events (52 vs 31 per 1000 person-years; $p<0.001$) compared with normotensive subjects with DM.[43] Among the young, it is safe to infer that prolonged disease exposure of the YOD with hypertension can significantly lead to earlier and poorer cardiovascular and metabolic profiles. Implications of this would entail early aggressive glycemic, cardiometabolic and BP control for the young patients with diabetes.

The lipid profiles of Filipino YOD were similar to LOD with high TC, high LDL, high Tg, and low HDL. However, YOD had significantly lower TC and LDL compared to older adults with diabetes. Mean LDL between YOD and LOD population is high at 136 and 150 mg/dl, with mean TC at 215 and 228 mg/dl, respectively, which is above the recommended treatment targets. Only 6% and 4% had desirable LDL of <70 mg/dl among the YOD and LOD. This is in contrast to the published Asian YOD data where mean LDL was lower at 107 vs 106 mg/dl, and also mean TC was lower at 184 vs 181 mg/dl, respectively.[3] With the presence of obesity in the YOD, we expect a proportional increase of TC and LDL. The mechanism for this has not been truly established but the hypothesis is still related to insulin resistance. HbA1c was significantly directly related to TC and non-HDL (calculated as the TC minus HDL).[44] In this study, more than 90% of females and 70% of males had low HDL, with mean of 34 mg/dl in the YOD, and 35 mg/dl in LOD. This is consistent with previously published data on Filipinos having lower HDL (40.8±0.2 mg/dL) compared in NHANES (60.7±0.7 mg/dL), although there is a phenomenon of isolated low HDL-c phenotype.[45] Triglyceride values were also elevated to more than 200 mg/dl for both groups. The lipid profile picture of young diabetics are typical and comparable to those with LOD. What is alarming is that if this picture gives us a glimpse of glycemic control which suggests poorly controlled diabetes, and foreseen cardiovascular effects of dyslipidemia. However we cannot commit to the relation of blood sugar control in our Filipino young DM cohort as no HbA1c was taken for the patients included in the national survey.

More than 80% of the YOD and LOD have metabolic syndrome. The absence of significant differences in the proportion of metabolic syndrome between the YOD and LOD has important implications. Early onset presence of MetS predispose to around 2.5 fold increased atherosclerotic cardiovascular disease, and five-fold increased diabetic complications which are major contributors to morbidity and mortality all over the world.[46] Metabolic syndrome also affects early cognitive decline and early onset dementia.[47] Several studies have shown that MetS prevalence increases with age. Clustering of the metabolic syndrome regardless of components, happened at 45-65 years of age, and decreased by >65 year old.[48] However, in the Filipino population MetS starts early on. Both YOD and LOD had increased prevalence for metabolic syndrome, with individual components not significantly different in proportion between the young and the old except for higher hypertension prevalence in the old. The overall MetS prevalence in the general population according to the 2013 Philippine NNHeS is 27%, and ranged from 12-19% in an earlier local study.[49] Having diabetes increases MetS prevalence as what was shown in this study, obesity in the young is another factor contributing to MetS to a greater extent than in the elderly, and may account for the observed increase in prevalence of MetS in recent years that is disproportionately highest in the young.[50] Similarly, it is demonstrated in this study that increasing age and fat intake were identified to be predictors for the occurrence of MetS among Filipino YOD. Thus, for prevention, we need to institute targeting a healthy diet and achieving a desirable weight in the young.

Type 2 diabetes mellitus has been previously known as a disease of older adults but the overall burden for young-onset diabetes continues to increase as declines in mortality rates among people with diabetes have been seen during the past two decades in every age-group except young adults aged 20–44 years.[4] A better understanding of the cardiometabolic characteristics of this population is important, to render effective service delivery and timely preventive mechanisms to halt development of chronic diabetic complications. Interventions should be multifaceted to address multiple barriers in diabetes care.

Limitations

These are some of the limitations of this study: (1) there was no distinction as to the type of diabetes; (2) young-onset diabetes diagnosis was based on age alone at the time of the survey rather than based on the onset of the diabetes with no way to verify if these are undiagnosed DM rather than already with ongoing treatment; (3) diabetic complication end points were not investigated i.e. retinopathy, neuropathy, nephropathy, macrovascular complications- stroke, myocardial infarction; (4) diabetes control was not reported, and (5) no follow-up studies were conducted.

Strengths of this study include that it is a nationally representative data from the Philippines, and cardio-metabolic risk factors were obtained through standardized measurement and laboratory procedures.

CONCLUSIONS

Early-onset diabetes mellitus appears to be driven by obesity, MetS and social behaviors. More YOD were obese despite being more physically active. YOD are also unhealthy eaters. Young Filipino adults were more likely to have diabetes when they are obese, smokers, and alcoholic beverage drinkers, while the occurrence of MetS is affected by increasing age, excess fat intake and advanced educational attainment. The similarly high prevalence of metabolic syndrome in both the YOD and LOD has important implications on the early development of atherosclerotic cardiovascular diseases and diabetic complications. These findings suggest a need for more precise screening, management, and prevention strategies to decrease diabetes and MetS risk. Future directions of this work include the need for a prospective study to further investigate the relationship between the risk factors, as this can lead to an increased disease prevalence and mortality rate among YOD as they age.

Acknowledgments

This project was made possible by the data provided by the Department of Science and Technology – Food and Nutrition Institute through Mr. Eldridge Ferrer. The authors would like to thank Dr. Venus Oliva Cloma- Rosales and Ms. Kerry Ong for their invaluable support in analyzing the results of this research.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

Dr. Uy declares no conflict of interest. Dr. Jimeno is the Vice Editor-in-Chief of JAFES.

Funding Source

The Philippine Lipid and Atherosclerosis Society through the PLAS-Pfizer research grant funded this study.

References

1. Cho NH. IDF Diabetes Atlas, 9th ed. Brussels, Belgium; 2019. International Diabetes Federation. 2020. Available from http://www.diabetesatlas.org.
2. Dayrit MM, Lagrada MLP, Picazo OF, Pons MC, Villaverde MC. The Philippines Health System Review. Asia Pacific Observatory on Health Systems and Policies; 2018. Available from https://apps.

who.int/iris/bitstream/handle/10665/274579/9789290226734-eng.pdf?sequence=1&isAllowed=y.
3. Yeung RO, Zhang Y, Luk A, et al. Metabolic profiles and treatment gaps in young-onset type 2 diabetes in Asia (the JADE programme): A cross-sectional study of a prospective cohort. Lancet Diabetes Endocrinol. 2014;2(12):935–43. PMID: 25081582. https://doi.org/10.1016/S2213-8587(14)70137-8.
4. Saydah SH, Siegel KR, Imperatore G, Mercado C, Gregg EW. The cardiometabolic risk profile of young adults with diabetes in the U.S. Diabetes Care. 2019;42(10):1895–902. PMID: 31221678. https://doi.org/10.2337/dc19-0707.
5. FNRI. Philippine Nutrition Facts and Figures 2013: 8th National Nutrition Survey Overview [Internet]. 2015. Available from http://enutrition.fnri.dost.gov.ph/site/publications/8th-national-nutrition-survey-overview/.
6. Hu C, Jia W. Diabetes in China: Epidemiology and genetic risk factors and their clinical utility in personalized medication. Diabetes. 2018;67(1):3–11. PMID: 29263166. https://doi.org/10.2337/dbi17-0013.
7. Wu Y, Wang L, Cai Z, Bao L, Ai P, Ai Z. Prevalence and risk factors of low health literacy: A community-based study in Shanghai, China. Int J Environ Res Public Health. 2017;14(6). PMID: 28604645. PMCID: PMC5486314. https://doi.org/10.3390/ijerph14060628.
8. Ong YH, Koh WCA, Ng ML, et al. Glutamic acid decarboxylase and islet antigen 2 antibody profiles in people with adult-onset diabetes mellitus: A comparison between mixed ethnic populations in Singapore and Germany. Diabet Med. 2017;34(8):1145–53. PMID: 28370329. PMCID: PMC5575487. https://doi.org/10.1111/dme.13358.
9. Chan JCN, Lau ESH, Luk AOY, et al. Premature mortality and comorbidities in young-onset diabetes: A 7-year prospective analysis. Am J Med. 2014;127(7):616–24. PMID: 24680795. https://doi.org/10.1016/j.amjmed.2014.03.018.
10. Sahoo S, Zaidi G, Vipin V, et al. Heterogeneity in the aetiology of diabetes mellitus in young adults: A prospective study from north India. Indian J Med Res. 2019;149(4):479–88. PMID: 31411171. PMCID: PMC6676834. https://doi.org/10.4103/ijmr.IJMR_1004_17.
11. Dubose SN, Hermann JM, Tamborlane WV, et al. Obesity in youth with type 1 diabetes in Germany, Austria, and the United States. J Pediatr. 2015;167(3):627–32.e1-4. PMID: 26164381. https://doi.org/10.1016/j.jpeds.2015.05.046.
12. Arslanian S, Bacha F, Grey M, Marcus MD, White NH, Zeitler P. Evaluation and management of youth-onset type 2 diabetes: A position statement by the American Diabetes Association. Diabetes Care. 2018;41(12):2648-68. PMID: 30425094. PMCID: PMC7732108. https://doi.org/10.2337/dci18-0052.
13. Nip ASY, Reboussin BA, Dabelea D, et al. Disordered eating behaviors in youth and young adults with type 1 or type 2 diabetes receiving insulin therapy: The SEARCH for diabetes in youth study. Diabetes Care. 2019;42(5):859-866. PMID: 30862656. PMCID: PMC6489106. https://doi.org/10.2337/dc18-2420.
14. Ormazabal V, Nair S, Elfeky O, Aguayo C, Salomon C, Zuñiga FA. Association between insulin resistance and the development of cardiovascular disease. Cardiovasc Diabetol. 2018;17(1):122. PMID: 30170598. PMCID: PMC6119242. https://doi.org/10.1186/s12933-018-0762-4.
15. World Health Organization. Waist circumference and waist–hip ratio: Report of a WHO Expert Consultation; 2008. Available from https://www.who.int/publications/i/item/9789241501491.
16. Huxley R, Mendis S, Zheleznyakov E, Reddy S, Chan J. Body mass index, waist circumference and waist: Hip ratio as predictors of cardiovascular risk--a review of the literature. Eur J Clin Nutr. 2010;64(1):16–22. PMID: 19654593. https://doi.org/10.1038/ejcn.2009.68.
17. Pagsisihan DA, Sandoval MA, Paz-Pacheco E, Jimeno C. Low indices of overweight and obesity are associated with cardiometabolic diseases among adult filipinos in a rural community. J ASEAN Fed Endocr Soc. 2016;31(2):97-105. https://doi.org/10.15605/jafes.031.02.04.
18. Araneta MRG, Wingard DL, Barrett-Connor E. Type 2 diabetes and metabolic syndrome in Filipina-American women: A high-risk nonobese population. Diabetes Care. 2002;25(3):494–9. PMID: 11874936. https://doi.org/10.2337/diacare.25.3.494.
19. Luk AOY, Lau ESH, So WY, et al. Prospective study on the incidences of cardiovascular-renal complications in chinese patients with young-onset type 1 and type 2 diabetes. Diabetes Care. 2014;37(1):149–57. PMID: 24356598. https://doi.org/10.2337/dc13-1336.
20. Chang SA. Smoking and type 2 diabetes mellitus. Diabetes Metab J. 2012;36(6):399–403. PMID: 23275932. PMCID: PMC3530709. https://doi.org/10.4093/dmj.2012.36.6.399.
21. Sargeant L a, Khaw KT, Bingham S, Day NE, Luben RN, Oakes S, et al. Cigarette smoking and glycaemia: The EPIC-Norfolk Study. European Prospective Investigation into Cancer. Int J Epidemiol. 2001;30(3):547–54. PMID: 11416081. https://doi.org/10.1093/ije/30.3.547.
22. Rimm EB, Chan J, Stampfer MJ, Colditz GA, Willett WC. Prospective study of cigarette smoking, alcohol use, and the risk of diabetes in men. BMJ. 1995;310(6979):555–9. PMID: 7888928. PMCID: PMC2548937. https://doi.org/10.1136/bmj.310.6979.555.
23. Campagna D, Alamo A, Di Pino A, Russo C, Calogero AE, Purrello F, et al. Smoking and diabetes: Dangerous liaisons and confusing relationships. Diabetol Metab Syndr. 2019;11(85). PMID: 31666811. PMCID: PMC6813988. https://doi.org/10.1186/s13098-019-0482-2.
24. Cai X, Chen Y, Yang W, Gao X, Han X, Ji L. The association of smoking and risk of diabetic retinopathy in patients with type 1 and type 2 diabetes: A meta-analysis. Endocrine. 2018;62(2):299–306. PMID: 30128962. https://doi.org/10.1007/s12020-018-1697-y.
25. Rawshani A, Rawshani A, Franzén S, et al. Risk factors, mortality, and cardiovascular outcomes in patients with type 2 diabetes. N Engl J Med. 2018;379(7):633–44. PMID: 30110583. https://doi.org/10.1056/NEJMoa1800256.
26. Cordain L, Melby CL, Hamamoto AE, et al. Influence of moderate chronic wine consumption on insulin sensitivity and other correlates of syndrome X in moderately obese women. Metabolism. 2000;49(11):1473–8. PMID: 11092514. https://doi.org/10.1053/meta.2000.17672.
27. Ögge LE, Gerhard Brohall MD, Carl Johan Behre MD, Schmidt C, Fagerberg B. Alcohol consumption in relation to metabolic regulation, inflammation, and adiponectin in 64-year-old caucasian women: A population-based study with a focus on impaired glucose regulation. Diabetes Care. 2006;29(4):908–13. PMID: 16567836. https://doi.org/10.2337/diacare.29.04.06.dc05-1782.
28. Baliunas DO, Taylor BJ, Irving H, et al. Alcohol as a risk factor for type 2 diabetes: A systematic review and meta-analysis. Diabetes Care. 2009;32(11):2123–32. PMID: 19875607. PMCID: PMC2768203. https://doi.org/10.2337/dc09-0227.
29. Holst C, Becker U, Jørgensen ME, Grønbæk M, Tolstrup JS. Alcohol drinking patterns and risk of diabetes: a cohort study of 70,551 men and women from the general Danish population. Diabetologia. 2017;60(10):1941–50. PMID: 28748324. https://doi.org/10.1007/s00125-017-4359-3.
30. Hu T, Jacobs DR, Larson NI, Cutler GJ, Laska MN, Neumark-Sztainer D. Higher diet quality in adolescence and dietary improvements are related to less weight gain during the transition from adolescence to adulthood. J Pediatr. 2016;178:188-193.e3. PMID: 27640354. PMCID: PMC5085861. https://doi.org/10.1016/j.jpeds.2016.08.026.
31. Cha ES, Paul S, Braxter BJ, Umpierrez G, Faulkner MS. Dietary Behaviors and glucose metabolism in young adults at risk for type 2 diabetes. Diabetes Educ. 2018;44(2):158–67. PMID: 29495910. PMCID: PMC6431295. https://doi.org/10.1177/0145721718756057.
32. Wilmot E, Idris I. Early onset type 2 diabetes: Risk factors, clinical impact and management. Ther Adv Chronic Dis. 2014;5(6): 234–44. PMID: 25364491. PMCID: PMC4205573. https://doi.org/10.1177/2040622314548679.
33. Lascar N, Brown J, Pattison H, Barnett AH, Bailey CJ, Bellary S. Type 2 diabetes in adolescents and young adults. Lancet Diabetes Endocrinol. 2018;6(1):69–80. PMID: 28847479. https://doi.org/10.1016/S2213-8587(17)30186-9.
34. Stanley K. Nutrition considerations for the growing population of older adults with diabetes. Diabetes Spectr. 2014;27(1):29–36. PMID: 26246753. PMCID: PMC4522893. https://doi.org/10.2337/diaspect.27.1.29.
35. World Health Organization. Urinary iodine concentrations for determining iodine status in populations [Internet]. World Health Organization; 2013. Available from https://apps.who.int/iris/bitstream/handle/10665/85972/WHO_NMH_NHD_EPG_13.1_eng.pdf?ua=1.
36. Al-Attas OS, Al-Daghri NM, Alkharfy KM, et al. Urinary iodine is associated with insulin resistance in subjects with diabetes mellitus type 2. Exp Clin Endocrinol Diabetes. 2012;120(10):618–22. PMID: 23203253. https://doi.org/10.1055/s-0032-1323816
37. Sun Z, Wang X, Chen J, et al. [Effects of iodine excess on islet β cells (β-TC-6) function and the mechanism]. Wei Sheng Yan Jiu. 2017;46(4):610–4. PMID: 29903184.
38. Angeles-Agdeppa I, Sun Y, Denney L, et al. Food sources, energy and nutrient intakes of adults: 2013 Philippines National Nutrition Survey. Nutr J. 2019;18(59). PMID: 31601200. PMCID: PMC6785859. https://doi.org/10.1186/s12937-019-0481-z.
39. Zhou Y, Zhou J, Sun B, et al. Vitamin A deficiency causes islet dysfunction by inducing islet stellate cell activation via cellular retinol binding protein 1. Int J Biol Sci. 2020;16(6):947–57. PMID: 32140064. PMCID: PMC7053333. https://doi.org/10.7150/ijbs.37861.
40. Pena G, Kuang B, Cowled P, et al. Micronutrient status in diabetic patients with foot ulcers. Adv Wound Care (New Rochelle). 2020;9(1):9–15. PMID: 31871826. PMCID: PMC6918841. https://doi.org/10.1089/wound.2019.0973.
41. Narasimhan S, Weinstock RS. Youth-onset type 2 diabetes mellitus: Lessons learned from the TODAY study. Mayo Clin Proc. 2014; 89(6):806–16. PMID: 24702733. PMCID: PMC4319667. https://doi.org/10.1016/j.mayocp.2014.01.009
42. TODAY Study Group. Rapid rise in hypertension and nephropathy in youth with type 2 diabetes: The TODAY clinical trial. Diabetes

Care. 2013;36(6):1735–41. PMID: 23704672. PMCID: PMC3661847. https://doi.org/10.2337/dc12-2420.
43. Chen G, McAlister FA, Walker RL, Hemmelgarn BR, Campbell NRC. Cardiovascular outcomes in Framingham participants with diabetes: The importance of blood pressure. Hypertension. 2011;57(5):891–7. PMID: 21403089. PMCID: PMC3785072. https://doi.org/10.1161/HYPERTENSIONAHA.110.162446.
44. Maahs DM, Wadwa RP, Bishop F, Daniels SR, Rewers M, Klingensmith GJ. Dyslipidemia in Youth with Diabetes: To Treat or Not to Treat? J Pediatr. 2008;153(4):458–65. PMID: 18847618. PMCID: PMC2585025. NIHMSID: NIHMS71611. https://doi.org/10.1016/j.jpeds.2008.05.062.
45. Rutherford JN, McDade TW, Feranil AB, Adair LS, Kuzawa CW. High prevalence of low HDL-c in the Philippines compared to the US: Population differences in associations with diet and BMI. Asia Pac J Clin Nutr. 2010;19(1):57–67. PMID: 20199988. PMCID: PMC3152979. NIHMSID: NIHMS308702.
46. Jiang B, Zheng Y, Chen Y, et al. Age and gender-specific distribution of metabolic syndrome components in East China: Role of hypertriglyceridemia in the SPECT-China study. Lipids Health Dis. 2018;17(1):92. PMID: 29678174. PMCID: PMC5910574. https://doi.org/10.1186/s12944-018-0747-z.
47. Feinkohl I, Janke J, Hadzidiakos D, et al. Associations of the metabolic syndrome and its components with cognitive impairment in older adults. BMC Geriatr. 2019;19(1):77. PMID: 30845934. PMCID: PMC6407250. https://doi.org/10.1186/s12877-019-1073-7.
48. Devers MC, Campbell S, Simmons D. Influence of age on the prevalence and components of the metabolic syndrome and the association with cardiovascular disease. BMJ Open Diabetes Res Care. 2016;4(1):e000195. PMID: 27158519. PMCID: PMC4853802. https://doi.org/10.1136/bmjdrc-2016-000195.
49. Paz-Pacheco E, Jimeno C. Diabetes Care in the Philippines. J ASEAN Fed Endocr Soc. 2015;30(2):118–24. https://doi.org/10.15605/jafes.030.02.17.
50. Goodman E, Dolan LM, Morrison JA, Daniels SR. Factor analysis of clustered cardiovascular risks in adolescence: Obesity is the predominant correlate of risk among youth. Circulation. 2005;111(15):1970–7. PMID: 15837951. https://doi.org/10.1161/01.CIR.0000161957.34198.2B.