

Metabolic syndrome in the Philippine general population: prevalence and risk for atherosclerotic cardiovascular disease and diabetes mellitus

DANTE D MORALES, FELIX EDUARDO R PUNZALAN, ELIZABETH PAZ-PACHECO, RODY G SY, CHARMINE A DUANTE FOR THE NATIONAL NUTRITION AND HEALTH SURVEY (NNHES): 2003 GROUP

Abstract

The objectives of this study were to determine the prevalence of metabolic syndrome (MS) and its component risk factors among Filipinos using three sets of criteria and to evaluate the association between MS and atherosclerotic cardiovascular disease and diabetes mellitus. The study utilised a multi-staged cluster sampling design.

The prevalence of MS was found to be 11.9% by National Cholesterol Education Program/Adult Treatment Panel (NCEP/ATP III) criteria, 14.5% by International Diabetes Federation (IDF) criteria and 18.5% by NCEP/ATP III criteria modified by the American Heart Association/National Heart, Lung and Blood Institute (NCEP/ATP III-AHA/NHLBI) criteria. Low levels of high-density lipoprotein cholesterol (HDL-C) occurred in 60.2% of men and 80.9% of women. Abdominal obesity was noted in 17.7% of men and 35.1% of women. Blood pressure (BP) $\geq 130/85$ mmHg was seen in 33.3%, hypertriglyceridaemia in 20.6% and fasting blood sugar ≥ 100 mg/dL (5.55 mmol/L) in 7.1%. Age-adjusted odds ratios showed that MS, by all three definitions, predisposed an individual to diabetes mellitus (DM) and stroke while MS by the IDF definition predis-

posed an individual to myocardial infarction (MI). Individuals with MS did not have a significant predisposition to angina and peripheral artery disease (PAD).

Thus, the metabolic syndrome is common in Filipinos, with low HDL-C as the most prevalent component. The metabolic syndrome predisposes to diabetes mellitus and stroke, with a tendency to MI using the IDF criteria.

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Introduction

Metabolic syndrome (MS) is a clustering of several metabolic factors that increases the risk for atherosclerotic cardiovascular disease (ASCVD) and diabetes mellitus (DM).¹ Its prevalence and predisposition to ASCVD and DM have been well reported but both vary according to the various definitions of MS used and the population's ethnicity, age group and co-morbidities.^{2,9} The occurrence and the predisposition of MS to diseases in the general population have not been well established. Because of its importance and implications for health care, we report here the prevalence and disease predisposition of MS in the general and non-institutionalised adult population in the Philippines.

The National Nutrition and Health Survey (NNHeS): 2003–2004, also called the 6th National Nutrition Survey (NNS): Clinical Phase, was conducted as a collaborative effort of the private sector's 14 medical specialty associations and the Philippine government's Department of Health and the Food and Nutrition Research Institute of the Department of Science and Technology (FNRI-DOST).

The survey used a multi-staged, stratified cluster sampling design and a protocol similar to that of the Philippines' 5th National Nutrition Survey (NNS): Clinical Phase conducted in 1998¹⁰ and that of the United States' National Health and Nutrition Examination Survey (NHANES).^{11,12} The Philippine surveys studied different populations. The NNHeS 2003–2004 determined, for the first time, the national prevalence of 24 diseases and 11 risk factors. For

Section of Cardiology, Department of Medicine, University of the Philippines College of Medicine, Pedro Gil, Manila, Philippines.

Dante D Morales, Cardiologist-Internist

Felix Eduardo R Punzalan, Cardiologist-Internist

Rody G Sy, Cardiologist-Internist

Section of Endocrinology, Diabetes, and Metabolism, Department of Medicine, University of the Philippines College of Medicine, Pedro Gil, Manila, Philippines.

Elizabeth Paz-Pacheco, Endocrinologist-Internist

Food and Nutrition Research Institute, Department of Science and Technology, Taguig City, Philippines.

Charmaine A Duante, Biostatistician

Correspondence to: Dr Dante D Morales

Medical Director's Office, Manila Doctors Hospital, 667 United Nations Avenue, Ermita, Manila, Philippines.

Tel: +632 524 6302; Fax: +632 52331 81

E-mail: dantedmorales@yahoo.com

Table 1. Definitions and criteria for the clinical diagnosis of the metabolic syndrome (MS)

Clinical measure	NCEP/ATP III (2001)	IDF (2005)	NCEP/ATP III-AHA/NHLBI (2005)
Waist circumference	Any 3 of the following 5 features: WC \geq 102 cm (men) or \geq 88 cm in women	Increased WC (population-specific) Plus any 2 of the following:	Any 3 of the following 5 features: WC: EU/NA \geq 94 cm (men) or \geq 80 cm (women); Chinese/Southeast Asians/South Asians \geq 90 cm (men) or \geq 80 cm (women); Japanese $>$ 85 cm (men) or \geq 90 cm (women)
Triglyceride	TG \geq 150 mg/dL	TG \geq 150 mg/dL or on treatment	TG \geq 150 mg/dL or on treatment
HDL-C	HDL-C $<$ 40 mg/dL (men) or $<$ 50 mg/dL (women)	HDL-C $<$ 40 mg/dL (men) or $<$ 50 mg/dL (women) or on treatment	HDL-C $<$ 40 mg/dL (men) or $<$ 50 mg/dL (women) or on treatment
Blood pressure	\geq 130/ \geq 85 mmHg	\geq 130 mmHg systolic or \geq 85 mmHg diastolic or on hypertension treatment	BP \geq 130/ \geq 85 mmHg or on treatment
Fasting glucose*	$>$ 110 mg/dL (includes type 2 DM)	\geq 100 mg/dL (includes type 2 DM)	\geq 100 mg/dL (includes type 2 DM)

Key: WC = waist circumference; EU/NA = Europe/North America; TG = triglyceride; NCEP = National Cholesterol Education Program; ATP = Adult Treatment Panel; IDF = International Diabetes Federation; AHA = American Heart Association; NHLBI = National Heart, Lung and Blood Institute; HDL-C = high-density lipoprotein cholesterol; DM = diabetes mellitus; * The 2001 definition identified fasting plasma glucose of \geq 110 mg/dL (6.1 mmol/L) as elevated. This was modified in 2003 to be \geq 100 mg/dL, in accordance with the American Diabetes Association's definition of IFG.

Conversion factors for TG, mg/dL \times 0.01129 = mmol/L; HDL-C, mg/dL \times 0.0259 = mmol/L; FPG, mg/dL \times 0.055 = mmol/L

Table 2. Prevalence of MS based on NCEP/ATP III, IDF and NCEP/ATP III modified by AHA/NHLBI definitions: NNHeS: 2003–2004

Age (y)	NCEP/ATP III			IDF			NCEP/ATP III-AHA/NHLBI		
	Males and females % (95% CI)	Males % (95% CI)	Females % (95% CI)	Males and females % (95% CI)	Males % (95% CI)	Females % (95% CI)	Males and females % (95% CI)	Males % (95% CI)	Females % (95% CI)
20–29	4.9 (3.2–6.6)	5.3 (2.9–7.7)	4.3 (1.8–6.9)	4.9 (2.9–6.9)	4.7 (2.6–6.9)	5.1 (2.3–7.9)	6.8 (4.6–9.0)	8.2 (5.3–11.2)	5.1 (2.3–7.9)
30–39	9.3 (6.9–11.7)	11.3 (8.0–14.7)	6.8 (3.7–9.8)	11.6 (9.0–14.2)	12.1 (8.8–15.5)	11.0 (7.3–14.7)	15.8 (12.8–18.8)	18.6 (14.5–22.6)	12.4 (8.5–16.2)
40–49	14.8 (11.3–18.2)	14.2 (10.1–18.3)	15.3 (9.8–20.8)	21.0 (17.2–24.7)	18.5 (13.7–23.3)	23.4 (17.4–29.5)	25.3 (21.4–29.1)	24.9 (19.6–30.2)	25.6 (19.4–31.9)
50–59	25.3 (20.2–30.3)	17.7 (11.7–23.8)	31.5 (24.2–38.8)	30.4 (24.8–35.5)	22.5 (15.0–30.0)	36.8 (29.7–45.1)	37.4 (31.5–43.3)	31.2 (23.1–39.3)	42.4 (35.0–49.8)
60–69	21.0 (18.7–23.2)	13.9 (11.1–16.6)	26.6 (23.3–29.8)	23.0 (20.7–25.3)	14.4 (11.6–17.3)	29.7 (26.2–33.2)	29.3 (26.8–31.8)	21.1 (18.0–24.3)	35.7 (32.1–39.3)
\geq 70	17.8 (15.1–20.4)	7.2 (4.4–10.0)	24.7 (20.9–28.5)	20.3 (17.2–23.1)	7.6 (4.9–10.3)	28.3 (24.0–32.7)	25.5 (22.4–28.6)	11.9 (8.4–14.3)	34.4 (29.9–38.8)
All	11.9 (10.6–13.2)	10.5 (8.8–12.2)	13.4 (11.6–15.2)	14.5 (13.1–16.0)	11.8 (10.1–13.6)	17.4 (15.3–19.5)	18.6 (17.0–20.2)	17.5 (15.4–19.6)	19.7 (17.6–21.8)

Key: NCEP = National Cholesterol Education Program; ATP = Adult Treatment Panel; IDF = International Diabetes Federation; AHA = American Heart Association; NHLBI = National Heart, Lung and Blood Institute

this report, the focus will be two-fold: one is on four ASCVD-related risk factors included in the MS definitions, which are obesity, hypertension, dyslipidaemia and DM,

and the other is on four atherosclerotic diseases, namely angina pectoris, myocardial infarction (MI), peripheral artery disease (PAD) and stroke.¹³

Table 3. Prevalence (%) of individual component risk factors of MS in the general population based on the NCEP/ATP III modified by the AHA/NHLBI criteria: NNHeS: 2003–2004

Gender	HDL-C (Male: < 40 mg/dL) (Female: < 50 mg/dL)	Blood pressure* ≥ 130/≥ 85	Waist circumference (Male: ≥ 90 cm) (Female: ≥ 80 cm)	Triglycerides† ≥ 150 mg/dL	FBS† ≥ 100 mg/dL
Male	60.2 (1.0)	37.5 (1.3)	17.7 (1.1)	26.5 (0.6)	6.9 (0.6)
Female	80.9 (1.5)	28.8 (1.1)	35.1 (1.3)	14.3 (0.6)	7.3 (0.3)
Total	70.2 (1.0)	33.3 (1.0)	26.1 (0.96)	20.6 (0.6)	7.1 (0.4)

Key: MS = metabolic syndrome; NCEP = National Cholesterol Education Program; ATP = Adult Treatment Panel; AHA = American Heart Association; NHLBI = National Heart, Lung and Blood Institute; HDL-C = high-density lipoprotein cholesterol; FBS = fasting blood sugar; * Based on single visit blood pressure reading; † Based on laboratory result alone

Conversion factors for TG, mg/dL x 0.01129 = mmol/L; HDL-C, mg/dL x 0.0259 = mmol/L; FPG, mg/dL x 0.055 = mmol/L

Table 4. Mean values of the individual component risk factors of the MS based on NCEP/ATP III modified by the AHA/NHLBI criteria: NNHeS: 2003–2004

Gender	HDL-C	Waist circumference	Blood pressure Mean (95% CI)		Triglyceride	FBS
	Mean (95% CI) (mg/dL)	Mean (95% CI) (cm)	Systolic (mmHg)	Diastolic (mmHg)	Mean (95% CI) (mg/dL)	Mean (95% CI) (mg/dL)
Male	40.2 (39.8–40.7)	79.3 (78.7–79.9)	123.1 (122.1–124.1)	78.4 (77.7–79.0)	130.5 (126.1–134.9)	77.8 (76.2–79.5)
Female	42.6 (42.1–43.0)	76.8 (76.2–77.5)	119.7 (118.6–120.9)	75.2 (74.6–75.9)	104.6 (101.8–107.5)	79.2 (77.5–81.0)
All	41.3 (41.0–41.8)	78.1 (77.6–78.6)	121.5 (120.7–122.3)	76.8 (76.3–77.4)	118.0 (115.2–120.7)	78.5 (77.1–79.9)

Key: HDL-C = high-density lipoprotein cholesterol; FBS = fasting blood sugar; NCEP = National Cholesterol Education Program; ATP = Adult Treatment Panel; AHA = American Heart Association; NHLBI = National Heart, Lung and Blood Institute

Conversion factors for TG, mg/dL x 0.01129 = mmol/L; HDL-C, mg/dL x 0.0259 = mmol/L; FPG, mg/dL x 0.055 = mmol/L

The primary objective was to determine the prevalence of metabolic syndrome among the Filipino adult population aged 20 years and above, based on the criteria of the National Cholesterol Education Program-Adult Treatment Panel III (NCEP/ATP III), the International Diabetes Federation (IDF) and the NCEP/ATP III modified by the American Heart Association and the National Heart, Lung and Blood Institute (AHA/NHLBI). The secondary objectives were to determine the national prevalence of each of the component risk factors of MS, based on various definitions and criteria, and to evaluate whether there is an association between MS and ASCVD and DM in the sampled population.

Methods

Subjects

The NNHeS was conducted with two components, a clinical survey with broad and extensive coverage of diseases and risk factors and the 2003 6th NNS of the FNRI-DOST. It used a sampling design that covered the whole Philippines with its 17 regions and 79 provinces except Batanes, a tiny island in the country's northern tip. It adopted, for the first

time, the master sampling frame of the Family Income and Expenditures Survey (FIES) of the Philippine National Statistics Office. Sampling units were family units called barangay or contiguous barangays with at least 500 households each. From these, Enumeration Areas (EAs) were randomly sampled, from which households were selected. The population that represented the whole country was generated by sampling 25% of those households. All members of the sampled households were visited by teams of field workers and were included in the survey.

Data collection

Data were collected through anthropometric, biochemical and clinical strategies which included validated questionnaires, physical examination and performance of an electrocardiogram. Glucose levels were measured in serum samples separated at the site of extraction and sent on dry ice to a central laboratory, with the time of extraction and time of centrifugation recorded for adjustment if needed. These strategies, criteria for various diagnoses, data encoding, validation and analyses were described in an

Table 5. Prevalence (%) of the individual component risk factors in subjects with the MS based on NCEP/ATP III modified by AHA/NHLBI criteria: NNHeS: 2003–2004

Gender	HDL-C (Male: < 40 mg/dL) (Female: < 50 mg/dL)	Waist circumference (Male: ≥ 90 cm) (Female: ≥ 80 cm)	Blood pressure ≥ 130/≥ 85 mmHg	Triglycerides ≥ 150 mg/dL	FBS ≥ 100 mg/dL
Male	87.2 (2.3)	67.6 (3.0)	78.4 (2.6)	80.6 (2.6)	19.1 (2.4)
Female	95.6 (1.4)	89.3 (1.6)	72.3 (2.8)	55.1 (2.9)	27.6 (2.6)
Total	91.5 (1.4)	78.8 (1.7)	75.3 (2.0)	67.5 (2.0)	23.5 (1.9)

Key: HDL-C = high-density lipoprotein cholesterol; FBS = fasting blood sugar; NCEP = National Cholesterol Education Program; AHA = American Heart Association; NHLBI = National Heart, Lung and Blood Institute

Conversion factors for TG, mg/dL x 0.01129 = mmol/L; HDL-C, mg/dL x 0.0259 = mmol/L; FPG, mg/dL x 0.055 = mmol/L

earlier report.¹³ The blood and urine determinations performed in the laboratory used were documented to be valid and reliable.

Definitions and criteria for metabolic syndrome (MS)

At present, there are several accepted definitions and sets of criteria utilised for MS. In this study, we used three: the original NCEP/ATP III from 2001,¹⁴ the IDF from April 2005¹⁵ and the NCEP/ATP III modified by the AHA/NHLBI in September 2005.¹⁶ Although there are many similarities in components and criteria, there are also multiple differences. Table 1 shows the criteria for each of these three definitions.

Statistical analysis

The prevalence of the MS was computed based on the different criteria and definitions used. Single prevalence of each risk factor comprising each definition was also computed. We determined the contribution of each risk factor to the MS based on NCEP/ATP III-AHA/NHLBI modification.

We also determined the association between MS, defined by the different criteria, and the four atherosclerosis-related diseases of angina, Q wave MI, stroke and PAD and DM using the nested case-control approach. We included as cases those who were found to possess the outcome of interest for the different diseases and we selected the matched controls for these cases according to age and gender. The ratio was one case to two controls. The association was determined by estimating the odds ratio using the different definitions of MS as risk factors for ASCVD and DM.

Results

From a total of 790 enumeration areas, 2,636 households were surveyed comprising 4,753 adults aged 20 years and above, representing 42.6 million Filipinos.

Prevalence of MS

The prevalence of MS by the three principal definitions is shown in table 2. Based on the NCEP/ATP III definition, the prevalence was 11.9% while using the IDF, it was 14.5%. The NCEP/ATP III definition was modified by the

Table 6. Prevalence of atherosclerotic cardiovascular diseases and diabetes mellitus in the general population: NNHeS: 2003–2004

Gender	Angina* % (SE)	Peripheral arterial disease* % (SE)	Stroke* % (SE)	MI % (SE)	DM† % (SE)
Male	10.9 (0.7)	4.5 (1.0)	1.3 (0.0)	0.7 (0.2)	4.1 (1.0)
Female	14.1 (0.7)	3.9 (1.0)	1.5 (0.0)	0.4 (0.1)	5.0 (1.0)
Total	12.5 (0.5)	4.2 (0.0)	1.4 (0.0)	0.6 (0.1)	4.6 (0.0)

Key: MI = myocardial infarction; DM = diabetes mellitus; * Based on questionnaire alone; † Based on questionnaire and FBS > 125

AHA/NHLBI by using the waist circumference specific to different ethnic regions in the diagnosis of abdominal obesity and fasting blood sugar (FBS) of equal to or greater than 100 mg/dL (5.5 mmol/L). This showed an MS prevalence of 18.6% for Filipinos. According to all three definitions, the prevalence rate of MS was higher in female than male subjects and in the older than the younger age groups. However, in the two younger age categories, namely 20–29 years and 30–39 years, MS was actually more prevalent in males than in females. There is also a drop in prevalence in the oldest age group (> 70 years).

Prevalence of individual component risk factors of MS in the general population

Table 3 shows the national prevalence in percentage of the individual risk factors included in the MS based on the three definitions and criteria. In the general population, low HDL-C < 40 mg/dL (1.036 mmol/L) occurred in 60.2% of men and low HDL-C < 50 mg/dL (1.295 mmol/L) in 80.9% of women, giving a mean for both genders of 70.2% with low levels of HDL-C. The prevalence of BP ≥ 130/85 mmHg was 33.3%. Abdominal obesity, defined as waist circumference (WC) of ≥ 90 cm in men, was noted in 17.7% of subjects and, defined as ≥ 80 cm for women, in 35.1% of subjects. The overall prevalence of hypertriglyceridaemia of

Table 7. Unadjusted odds ratios using the different definitions of MS as risk factors for angina, stroke, PAD, MI and DM

Diseases	NCEP/ATP III		Metabolic syndrome definition NCEP/ATP III-AHA/NHLBI		IDF	
	OR	95% CI	OR	95% CI	OR	95% CI
Angina (case=906; control=1,812)	0.98	0.79–1.22	0.94	0.78–1.14	0.92	0.75–1.14
Stroke (case=192; control=384)	1.28	0.81–2.02	1.32	0.89–1.98	1.59	1.03–2.47
PAD (case=322; control=644)	0.82	0.54–1.23	0.82	0.59–1.15	0.85	0.59–1.22
MI (case=50; control=100)	1.47	0.66–3.28	2.05	0.96–4.36	1.93	0.85–4.36
DM (case=187; control=374)	16.15	10.47–24.92	18.55	11.82–29.13	9.2	6.08–13.79

Key: NCEP = National Cholesterol Education Program; ATP = Adult Treatment Panel; AHA = American Heart Association; NHLBI = National Heart, Lung and Blood Institute; IDF = International Diabetes Federation; MI = myocardial infarction; DM = diabetes mellitus; PAD = peripheral arterial disease

Table 8. Age-adjusted odds ratios using the different definitions of MS as risk factors for angina, stroke, PAD, MI and DM: NNHeS: 2003–2004

Diseases	NCEP/ATP III		Metabolic syndrome definition NCEP/ATP III-AHA/NHLBI		IDF	
	OR	95% CI	OR	95% CI	OR	95% CI
Angina (case=906; control=1,812)	0.18	0.14–0.24	0.24	0.19–0.30	0.86	0.65–1.15
Stroke (case=192; control=384)	2.99	1.41–6.33	2.38	1.26–4.52	2.62	1.28–5.33
PAD (case=322; control=644)	0.07	0.04–0.14	0.22	0.13–0.38	0.15	0.08–0.26
MI (case=50; control=100)	0.03	0.01–0.12	0.09	0.03–0.28	21.6	4.25–110.12
DM (case=187; control=374)	1.90	1.10–3.29	2.59	1.44–4.66	27.4	14.63–51.16

Key: OR = odds ratio; CI = confidence interval; PAD = peripheral arterial disease; MI = myocardial infarction; DM = diabetes mellitus; NCEP = National Cholesterol Education Program; ATP = Adult Treatment Panel; AHA = American Heart Association; NHLBI = National Heart, Lung and Blood Institute; IDF = International Diabetes Federation

≥ 150 mg/dL (1.6935 mmol/L) has been reported previously at 20.6%.¹³ FBS of 100 mg/dL (1.129 mmol/L) and above occurred at the rate of 7.1%.

Mean values of the individual component risk factors of MS

Mean levels and 95% confidence intervals of the risk factors of MS, based on the NCEP/ATP III modified by the AHA/NHLBI, are shown in table 4. The mean HDL-C level was low for women, at 42.6 mg/dL.

Prevalence of individual component risk factors of MS in subjects with MS

The prevalence of the individual components of MS in subjects with MS, as defined by the NCEP-ATP III modified by the AHA/NHLBI, is shown in table 5. Overall, the five components, arranged in the order of contribution, were low HDL-C, increased WC, blood pressure of $\geq 130/\geq 85$ mmHg, high triglyceride and elevated FBS. For both genders, the highest contribution came from low HDL-C, at 91.5%.

Prevalence of atherosclerotic cardiovascular diseases and DM in the general population

Table 6 shows the national prevalence of four atherosclerotic cardiovascular diseases and DM. Four of these have been previously reported, namely 12.5%, 4.2%, 1.4% and 4.6% for angina pectoris, PAD, stroke and DM, respectively.¹³ The diagnoses were all based on validated questionnaires, while the prevalence of MI based on ECG interpretation was 0.6%.

Association of MS with ASCVD and DM

Table 7 demonstrates that, based on unadjusted odds ratios, there was a highly significant predisposition of MS to DM based on all three definitions. It was only MS defined by the IDF that predisposed to stroke. However, table 8 shows that when adjusted for age, MS predisposed to DM with age-adjusted odds ratios of 1.9, 2.59, 27.4; that it predisposed to stroke with odds ratios of 2.99, 2.38, 2.62, based on the three different MS definitions; and to MI but based only on the IDF definition. There was no positive association between MS and angina or between MS and PAD.

