Artículo original

High prevalence of overweight, obesity, and biochemical risk factors for cardiovascular disease among young nurses: importance of metabolic syndrome

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Abstract

Objective: *Although the information on metabolic syndrome is overwhelming, reports regarding workers are scarce, especially those evaluating cardiovascular disease. Using biochemical markers, we investigated the prevalence of metabolic syndrome and cardiovascular risk in nurses at University Hospital, Mexico City.* ***Methods:*** *This was a cross-sectional study; 78% (n = 479) of nurses from our hospital participated. Anthropometric, diet, lipid and lipoprotein data, and ultrasensitive measures of C-reactive protein were obtained. Metabolic syndrome was assessed according to the ATP III criteria. Risk of cardiovascular disease was determined by C-reactive protein levels and low-density lipoprotein/high-density lipoprotein and cholesterol/high-density lipoprotein ratios.* ***Results:*** *Among 370 participating nurses, the prevalence of metabolic syndrome was 12.4%. The prevalence of BMI ≥ 27 was 82.6% in those with metabolic syndrome, and 28.1% in those without metabolic syndrome (P < 0.05), and the prevalence of BMI ≥ 30 was 69.6% in those with metabolic syndrome and 13.3% in those without metabolic syndrome (P < 0.05). High levels of C-reactive protein (> 3 mg/L) were observed in 61% of nurses with metabolic syndrome and 27% of those without metabolic syndrome (P < 0.05). Subjects with metabolic syndrome more commonly had a moderate or high risk of cardiovascular disease, according to cholesterol/lipids ratios.* ***Conclusions:*** *The prevalence of metabolic syndrome was similar to that in the general population. However, a high prevalence of overweight and obesity among nurses with metabolic syndrome could be a determinant of a future cardiovascular disease.*

Key words: *Metabolic syndrome, cardiovascular diseases, risk factor, nurses, female.*

Resumen

Objetivo: Actualmente existe una enorme cantidad de información sobre el síndrome metabólico, sin embargo, los estudios sobre trabajadores son escasos, especialmente los que evalúan enfermedades cardiovasculares. El objetivo del presente estudio es determinar la prevalencia de síndrome metabólico, obesidad y enfermedad cardiovascular así como su relación entre sí, en el personal de enfermería del Hospital Médica Sur.
Métodos: Se realizó un estudio transversal donde se determinaron antropometría, concentraciones sanguíneas de glucosa, insulina, perfil de lípidos, pruebas de función hepática y proteína C ultrasensible (PCRu) en el 78% (n=479) de las enfermeras de nuestro Hospital. El síndrome metabólico fue diagnosticado de acuerdo a los criterios ATP III. El riesgo de enfermedad cardiovascular fue determinado mediante los niveles de proteína C reactiva y los índices LDL/HDL y colesterol/HDL.
Resultados: Se incluyeron 370 pacientes, de los cuales 97.8% son mujeres, con una edad promedio de 30.9 años. La prevalencia de síndrome metabólico fué de 12.4%, sobrepeso (IMC >27 m/kg^2) 34.9% y obesidad (IMC >30 m/kg^2) de 20%. En aquellos que presentaron síndrome metabólico se observó un incremento en el riesgo de enfermedades cardiovasculares (concentraciones de PCRu >3 mg/L). En el análisis mutivariado, se observó que la mayor probabilidad presentar síndrome metabólico se encuentra en aquellos con aumento en la relación colesterol total/HDL (OR 4.8; IC95% 2.9-7.9).
Conclusiones: La prevalencia de síndrome metabólico es similar a la reportada en la población general. Observamos una fuerte asociación entre la prevalencia de obesidad y riesgo cardiovascular. Este tipo de análisis no se ha reportado previamente en el personal de salud, por lo que instaurar programas de intervención eficientes es de primordial importancia.

Palabras clave: Síndrome metabólico, enfermedades cardiovasculares, factores de riesgo, enfermeras.

The earliest description of the phenotypic characteristics of metabolic syndrome (MS), in association with polycystic ovary syndrome, was published in 1921 by Archard et al.[1] In 1956, Vague[2] systematically described the features of MS. Much information has since become available. Today, the worldwide prevalence of MS, its relationship with other chronic diseases,[3] and high-risk populations have been well described.

The importance of MS is increasing, especially considering its associated comorbidities. Its reported prevalence depends on the diagnostic criteria selected, with a general prevalence of 23.7%. This prevalence varies widely within

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the populations analyzed. MS was ascertained to occur in 58.3% of Mexican-American women between 40 and 74 years old,[4] although the prevalence of MS in the general Mexican population was recently estimated to be 26.6%.[5]

Despite the overwhelming number of publications about MS in different populations, few reports suggest the importance of this entity in specific occupations. We consider this issue a priority, particularly when the role of cardiovascular disease in MS is assessed.[6] Few articles, and those mainly from Japan, have evaluated MS in specific groups of workers.[7,8]

Because of the importance of evaluating cardiovascular risk in health workers, we investigated the prevalence of MS and cardiovascular risk using biochemical markers in nurses of the University Hospital in Mexico City.

Research design and methods

Population and sample

We conducted a cross-sectional study at the Medica Sur Clinic and Foundation. This hospital mainly provides care for middle- and high-income individuals from Mexico City and other metropolitan areas. The study was approved by the Human Subjects Committee at the Medica Sur Clinic and Foundation as conforming to the ethical guidelines of the 1975 Declaration of Helsinki, and written informed consent was obtained from all participants before entry. All information obtained was analyzed by the researchers; all data were confidential, and were not available to the subjects' employers. All nurses (n = 485) were invited to participate in the study. Our sample population comprised a series of consecutive asymptomatic nurses who voluntarily agreed to participate in the study (n = 379; acceptance rate of 78%).

Diet history questionnaire

Participants completed a food frequency questionnaire, with commonly used portion measures specified. The questionnaire included questions on the frequency and brands of multivitamin and individual vitamin supplements used. The answers were subsequently electronically scanned and the daily intake of various nutrients was determined using SNUT software, a program developed by the Instituto Nacional de Salud Pública, Mexico City,[9] and appropriate to the Mexican population. We thus estimated dietary energy, protein, carbohydrate, total, saturated, polyunsaturated, and monounsaturated fat, vitamin, mineral, and antioxidant intake.

Physical examination

Body weight was measured, in light clothing and without shoes, to the nearest 0.1 kg. Height was measured to the nearest 0.5 cm. Body mass index (BMI) was calculated as weight (kilograms) divided by height (meters) squared. Waist circumference to the nearest 0.1 cm was measured at the midpoint between the lower border of the rib cage and the iliac crest, and hip circumference was similarly measured at the widest point between the hip and buttock. Percentage body fat was measured by bioelectrical impedance (Tanita BC-418 Segmental Body Composition Analyzer).

Metabolic syndrome

Participants with three or more of the following criteria were deemed to have MS.[10] The criteria were defined in accordance with the Executive Summary of the Third Report of the National Cholesterol Education Program.[10]

- Abdominal obesity: waist circumference > 102 cm in men and > 88 cm in women
- Hypertriglyceridemia: triglycerides ≥ 150 mg/dL
- Low high-density lipoprotein cholesterol (HDL): < 40 mg/dL in men and < 50 mg/dL in women
- High blood pressure: ≥ 130/85 mmHg
- High fasting glucose: ≥ 110 mg/dL.

Analytical procedures

Insulin levels were measured using an immunoenzymometric assay (MEIA; Abbott Diagnostics, Illinois, IL, USA), with inter- and intra-assay coefficients of variation of less than 3%.

Plasma glucose in the fasting state was measured in duplicate with an automated analyzer. The coefficient of variation for a single determination was 1.5%. Total cholesterol (TC), HDL, and triglyceride concentrations were measured by enzymatic colorimetric methods, using CHOL, HDL-C plus (second generation), and TG assays (Roche Diagnostics Co., Indianapolis, IN, USA), respectively. Low-density lipoprotein cholesterol (LDL) concentrations were calculated using the Friedewald formula.[11]

Insulin resistance was assessed using the homeostasis model assessment for insulin resistance (HOMA-IR), originally described by Matthews et al.[12] HOMA-IR was calculated using the following formula:

$$\text{HOMA-IR} = (\text{fasting insulin } [\mu\text{U/mL}] \times \text{fasting glucose [mmol/L]}) \times 22.5^{-1}.$$

A high index of insulin resistance has a value of > 2.5.

C-reactive protein (uCRP) was measured with an ultrasensitive assay in 1 mL of blood following overnight fasting. The serum was frozen at –73 °C and processed within 30 days using a chemiluminescent immunoassay system (IMMULITE 2000; Diagnostic Products Corp., Los Angeles, CA, USA) with a dynamic range of 0.02–250 mg/L and a coefficient of variation of less than 15%.[13]

Statistical analysis

We established a comparison of continuous variables between cases and controls by means of the nonparametric Mann–Whitney *U* test, because of a lack of normality in some variables. Categorical variables compared between cases and controls were evaluated with Fisher's exact test (two-tailed). The statistical analysis was performed using SPSS/PC v. 12.0 software (SPSS, Chicago, IL, USA).

Results

In this study, 379 nurses agreed to participate. Six nurses were excluded because of incomplete information and three because their serum samples were not adequately processed. Of the 370 nurses analyzed, most were female (8 men; 362 women; $P < 0.05$), with a mean (± SD) age of 30.91 ± 7.3 years *(Table I)*. The

Table I. Anthropometric and biochemical characteristics of nurses analyzed.

	All (N = 370)	Without metabolic syndrome (N = 324)	With metabolic syndrome (N = 46)
Age (mean ± SD)	30.91 ± 7.3	30.6 ± 7.2	32.9 ± 7.5*
Female (*n* [%])	362 (97.8)	317 (97.8)	45 (97.8)
Weight (kg) (mean ± SD)	62.7 ± 11.3	61.0 ± 10.5	74.7 ± 10.3*
Height (m) (mean ± SD)	1.5 ± 0.05	1.5 ± 0.05	1.5 ± 0.05
BMI (mean ± SD)	26.0 ± 4.4	25.4 ± 4.0	30.8 ± 3.8*
BMI > 27 m/kg^2 (*n* [%])	129 (34.9)	91 (28.1)	38 (82.6)*
BMI > 30 m/kg^2 (*n* [%])	75 (20.3)	43 (13.3)	32 (69.6)*
Waist circumference (cm) (mean ± SD)	82.5 ± 9.6	80.9 ± 8.9	93.45 ± 7.2*
% Body fat (mean ± SD)	33.7 ± 6.6	32.9 ± 6.4	40.2 ± 4.5*
SBP (mmHg) (mean ± SD)	110.4 ± 11.5	109.6 ± 11.2	115.6 ± 12.5*
DBP (mmHg) (mean ± SD)	74.7 ± 8.7	73.9 ± 8.3	80.0 ± 9.4*
Glucose (mg/dL) (mean ± SD)	89.1 ± 14.2	87.8 ± 11.7	97.7 ± 24.0*
Triglycerides (mg/dL) (mean ± SD)	126.1 ± 79.6	116.8 ± 63.9	191.5 ± 132.8*
HDL (mg/dL) (mean ± SD)	45.2 ± 12.1	46.3 ± 12.0	36.6 ± 8.6*
LDL (mg/dL) (mean ± SD)	111.5 ± 25.6	110.9 ± 25.2	115.5 ± 28.3
HOMA > 2.5 (*n* [%])	64 (17.4)	45 (14)	19 (41)*
uCRP (mg/L) (mean ± SD)	3.2 ± 4.3	2.9 ± 3.9	5.3 ± 6.2*
uCRP > 3 mg/L (*n* [%])	116 (31.4)	88 (27)	28 (61)*
ALT (U/L) (mean ± SD)	14.6 ± 7.9	14.2 ± 7.5	17.4 ± 9.7*
AST (U/L) (mean ± SD)	22.6 ± 7.7	22.2 ± 7.6	24.9 ± 8.1*
Total calorie intake (mean ± SD)	2.089 ± 1.266	2.101 ± 1293	2.003 ± 1.058

* *versus* nurses without metabolic syndrome, $P < 0.05$. BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL, high-density lipoprotein cholesterol; LDL, low-density lipoprotein cholesterol; HOMA, homeostatic model assessment; uCRP, C-reactive protein measured with an ultrasensitive assay; ALT, alanine aminotransferase; AST, aspartate aminotransferase.

Table II. Prevalence of metabolic syndrome criteria in nurses (N = 370).

Elements of metabolic syndrome	*n*	%
Waist circumference: > 102 cm (men) or > 88 cm (women)	90	24.3
Triglycerides: ≥ 150 mg/dL	95	25.6
High-density lipoprotein cholesterol: < 40 mg/dL (men) or < 50 mg/dL (women)	265	71.6
Blood pressure: ≥ 130 mmHg (systolic) and/or ≥ 85 mmHg (diastolic)	83	10.0
Fasting glucose or insulin resistance: ≥ 110 mg/dL or HOMA index > 2.5	69	18.6

HOMA, homeostatic model assessment.

Table III. Relationship between cardiovascular risk and LDL/HDL and TC/HDL ratios according to metabolic syndrome.

	Metabolic syndrome		
	With (N = 46) n (%)	Without (N = 324) n (%)	P*
LDL/HDL ratio			< 0.001
low risk (0.5–2.9)	16 (34.7)	248 (76.5)	
moderate risk (3.0–6.0)	29 (63.0)	76 (23.4)	
high risk (> 6.0)	1 (2.1)	0 (0)	
TC/HDL ratio			< 0.001
low risk (3.3–4.3)	8 (17.3)	231 (71.3)	
average risk (4.4–7.0)	34 (73.9)	92 (28.4)	
moderate risk (7.1–11.0)	4 (8.6)	1 (0.3)	
high risk (> 11.0)	0 (0.0)	0 (0.0)	

* Pearson χ^2. LDL, low-density lipoprotein cholesterol; HDL, high-density lipoprotein cholesterol; TC, total cholesterol.

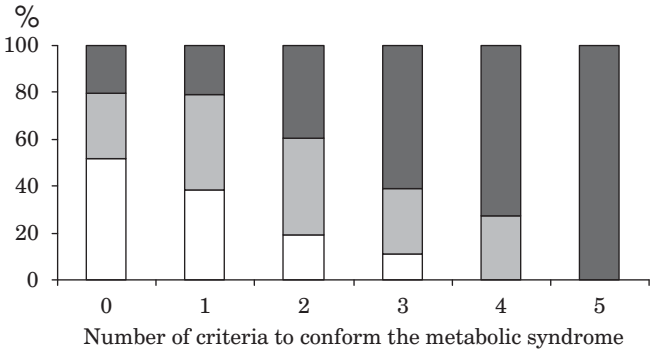

Figure 1. *Prevalence of different cut-off values for C-reactive protein measured with an ultrasensitive assay (uCRP), according to the number of components of metabolic syndrome. White bars, uCRP < 1 mg/L; gray bars, uCRP 1–3 mg/L; black bars, uCRP > 3 mg/L.*

prevalence of MS was 12.4% (n = 46). The most common component of MS in the sample was low HDL levels (Table 2); 17.3% of subjects had no criterion for MS, and 7.1% had four or five criteria (data not shown). A significantly higher prevalence of overweight (BMI ≥ 27 kg/m^2) and obesity (BMI ≥ 30 kg/m^2) was observed in subjects with MS (P < 0.05) *(Table I)*. No differences were observed in the intake of total calories or other macronutrients (data not shown).

As shown in *Table I*, nurses with MS had higher levels of uCRP than those without MS (P < 0.05) and a higher prevalence of uCRP levels ≥ 3 mg/L (P < 0.05), which is considered to confer a higher cardiovascular risk *(Figure 1)*. Furthermore, in nurses with MS, cardiovascular risk was moderate and/or high according LDL/HDL and TC/HDL ratios (Table 3). The prevalence of MS in nurses with uCRP levels of ≥ 3 mg/L was 24% vs. 7% in those with uCRP levels of < 3 mg/dL (P < 0.05).

Conclusions

We determined the prevalence of MS and biochemical cardiovascular risk factors in a sample of nurses. To our knowledge, this is the first study to examine these characteristics in healthcare workers. We observed a high prevalence of biochemical risk factors for cardiovascular disease (high uCRP, and high LDL/HDL and TC/HDL ratios) in subjects with MS. Recently, Nakanishi et al[7] showed in a prospective study that, among male office workers, MS predicts ST-T abnormalities and type 2 diabetes, even after adjustments were made for confounding factors. This result suggests the importance of MS in cardiovascular disease among workers. In another study by Alegria et al,[14] the overall prevalence of MS among workers was similar to that in our population. They demonstrated that there were important differences according to work type, with a higher prevalence of MS in manual workers (11.8%), and a lower prevalence in office workers (9.3%) and managers (7.7%), suggesting a role for social class in the prevalence of MS. The relationship between noninvasive imaging diagnosis, biochemical markers of cardiovascular disease, and socioeconomic position is unclear, but could be dependent on adiposity.[15]

Although the prevalence of MS according to age was similar in our study to that reported in the general population, one aspect demanding special attention is the high prevalence of overweight, obesity, and increased biochemical risk factors for cardiovascular disease in a group of predominately young women. Even if female sex is a low risk factor for MS and cardiovascular disease[16] in young adults, the dramatically high prevalence of overweight and obesity in our study sample suggests a strong susceptibility to the development of cardiovascular disease. This assumption is based on an interesting study by Lo et al,[17] who

demonstrated that obesity is associated with greater intima–media thickness in young and middle-aged women, an effect that could be mediated by adipokines and other cytokines.[18] In fact, Turhan et al[19] have shown that, among young women with newly diagnosed premature coronary artery disease, the presence of MS is high (73% *vs* 31% in the control group; $P < 0.001$). Analysis of our sample demonstrated a similar tendency. Even more importantly, the presence of MS at a young age is considered the most important predictor of future cardiovascular disease. If we consider that the multiple mechanisms involved in the pathogenesis of MS may have their roots early in life, early intervention in high-risk subjects should be beneficial.[20] We found no differences in the intake of total energy or other macronutrients among nurses with or without MS, despite the association between insulin resistance (a hallmark of MS) and diet. An interesting finding of the Nurses' Health Study suggests that some elements of diet can influence insulin resistance syndrome in women.[21]

Finally, the limitations of this study should be mentioned. We did not evaluate other important risk factors for MS and cardiovascular disease, such as physical activity, smoking, or the use of oral contraceptives or hormonal replacement. Another issue not adequately evaluated was the role of the work schedule in MS and cardiovascular disease, an important topic that has recently been discussed.[22] However, our nurses are at high risk of developing cardiovascular disease in the near future and effective strategies are necessary to avoid this.

In conclusion, this is the first study describing the characteristics of MS and biochemical risk factors for cardiovascular disease in young nurses. Although the prevalence of MS was similar to that of the general population, the high prevalence of overweight and obesity among nurses with MS could be a determinant of future risk of cardiovascular disease. This emphasizes the importance of effective strategies to prevent overweight and obesity and thus cardiovascular disease.

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