Metabolic Syndrome among Type-2 Diabetic Patients in Benghazi-Libya: A pilot study

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Abstract

Background: Metabolic syndrome is a cluster of three out of five conditions that are due to hyperinsulinemia: abdominal obesity, atherogenic dyslipidemia (high triglycerides and/or low HDL), elevated blood pressure, and elevated plasma glucose. The syndrome is highly prevalent in patients with type-2 diabetes mellitus and often precedes the onset of hyperglycemia. It has been shown that metabolic syndrome is an independent clinical indicator of macro- and microvascular complications in diabetics. Aim and objectives: the aim of this pilot study was to estimate the frequency and characteristics of metabolic syndrome among type-2 diabetic patients in Benghazi. Patients and methods: This cross-sectional study involved 99 randomly selected adult patients with type-2 diabetes mellitus. The patients were interviewed and examined, and their lipid profiles were checked 9-12 hours after overnight fasting. Metabolic syndrome was defined according to the criteria of the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III) and of the International Diabetes Federation (IDF).

Results: About 92% of the patients had the metabolic syndrome according to ATP III criteria and 80.8% according to IDF criteria. Females were more affected, males with metabolic syndrome were significantly older, and females were significantly more obese. No significant difference was observed between males and females regarding waist circumference, HDL level and triglyceride level. The commonest and most important component of metabolic syndrome in the study group was low HDL.

Conclusion: Metabolic syndrome is common among Libyans with type-2 diabetes mellitus, and it is significantly more common in females than males. The most significant predictor of metabolic syndrome in type-2 diabetic patients in Benghazi is low HDL.

Key words: Metabolic, diabetes, hypertension, dyslipidemia, obesity, Benghazi, Libya.

Introduction

Metabolic syndrome (MS) is a cluster of multiple cardiovascular risk factors. It is defined as the presence of two out of four conditions that result from insulin resistance: abdominal obesity, atherogenic dyslipidemia, elevated blood pressure, and elevated plasma glucose. In 2001, the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III) proposed a set of easily applicable criteria to diagnose metabolic syndrome [1]. The criteria were modified in 2005 by the American Heart Association (AHA) and the National Heart, Lung and Blood Institute (NHBI) [2]. Other similar criteria were proposed in 2005 by the International Diabetes Federation (IDF) [3]. Compared to ATP III, IDF criteria seem to overestimate the prevalence of MS without improving prognostic value [4,5,6]. Patients with type-2 diabetes mellitus (DM) already fulfill one of the NCEP-ATP III or IDF diagnostic criteria, and two more are required for an MS diagnosis. From an epidemiological point of view, the syndrome is highly prevalent in patients with type-2 DM, and it often precedes the onset of hyperglycemia [7,8,9]. However, much controversy surrounds the importance of MS in diabetics as a separate biological entity over each of its components as a cardiovascular risk factor [10,11,12]. On the other hand, many studies have shown that MS, irrespective of its definition, is an independent clinical indicator of macrovascular and microvascular complications in diabetics [10,11]. The objectives of this pilot study were as follows:

- estimate the frequency and characteristics of MS among male and female type-2 diabetic patients in Benghazi
- compare the two commonly used sets of criteria, ATP III and IDF.

Patients and method

This cross-sectional study involved 99 randomly selected adult patients with type-2 DM attending Benghazi Diabetes Center during 2007. Each day, nine patients were indiscriminately selected (unsystematic randomization). The patients were interviewed and examined by the authors, and their lipid profiles were checked 9-12 hours after overnight fasting. Obesity was defined according to WHO criteria as body mass index (BMI) ≥ 30 kg/m2. Hypertension was defined as blood pressure ≥ 140/80 mmHg. MS was diagnosed, according to the AHA/NHLBI modified ATP III criteria [2], as the presence of two out of the following three criteria:

- waist circumference (WC) ≥ 102 cm in males or ≥ 88 cm in females;
- blood pressure (BP) ≥ 130/85 mmHg or on treatment;
- triglycerides (TG) ≥ 150 mg/dl or on treatment;
- high density lipoproteins (HDL) < 40 mg/dl in males or < 50 mg/dl or on treatment in females.

Metabolic syndrome was also diagnosed according to IDF criteria [3] when waist circumference was ≥ 94 cm in males and ≥ 80 cm in females and at least one of the following three criteria was present: blood pressure ≥ 130/85 mmHg, triglycerides ≥ 150 mg/dl, and high density lipoproteins < 40 mg/dl in males and < 50 mg/dl in females. Values above the cut-off points for each parameter were regarded as abnormal. The results were expressed as mean ± standard deviation (SD). Statistical analyses were performed using the Statistical Package for the Social Sciences (Windows version 11.0; SPSS Inc, Chicago, IL, USA).

Differences between groups were tested statistically using the Chi Square test or the independent-sample t-
Results
Out of 99 patients, 61 were females and 38 were males. The mean age of all patients was 56 years (SD 9.5 years), males were slightly older, and had slightly longer duration of diabetes. Of all patients, 74.4% were obese, and obesity was significantly more frequent among females (P < 0.001). Mean BMI was 33.6 kg/m² (SD 5.6 kg/m²). There was no significant difference between males and females regarding WC, HDL and TG, but systolic and diastolic BP were slightly higher in males. The prevalence of hypertension (HTN) among the study group was 64% (Table 1). The frequency of MS was 92% according to ATPIII criteria and 80.8% according to IDF criteria, and females were significantly more affected in both cases (Fig. 1). Low HDL was the most significantly frequent abnormality according to ATPIII criteria (83.5%) while both low HDL and high TG were the most significantly frequent abnormalities according to IDF criteria (86.3% and 55% respectively) (Table 2). According to ATPIII, the mean HDL was significantly lower in both males (36 mg/dl) and females (37.1mg/dl) with MS than those without MS (54.1 mg/dl and 59 mg/dl respectively, P < 0.05) but according to IDF criteria it was significantly lower only in females. TG level was significantly higher in MS patients according to IDF criteria (191.8 vs. 115.7 mg/dl, P=0.007) (Table 3). According to ATPIII criteria, males with MS were significantly older and had a higher mean systolic and diastolic BP than females (136.1 vs. 126.7mmHg, P=0.05) while females were significantly more overweight with higher mean BMI than males (35.8 vs. 30.4 kg/m², P=0.000) (Table 4).

Discussion
We show that MS is quite prevalent among Libyan type-2 diabetic patients. In fact, this prevalence is among the highest in the world [5,9,13,14] (Table 5). In view of the small sample size, larger studies would be needed to confirm this finding. This high frequency could be due to both genetic predisposition and environmental factors, such as high caloric diet and lack of exercise. Roaied and Kablan reported that only 20% of males and 58% of females with diabetes in Benghazi practice regular exercise [15]. Females were significantly more affected by MS than males, probably because of the higher frequency of obesity among females. The high rate of general and central obesity in our patients, particularly in females, endorses the importance of exercise for diabetic patients.

Atherogenic dyslipidemia (high TG and/or low HDL) appears to be the most frequent and the most significant component of MS in Libyan diabetic patients, as has been reported in other parts of the world [16]. Thus, TG and HDL require particular attention in the diagnosis of MS in diabetic patients, unlike WC, which showed no significant difference between MS and non-MS Libyan diabetic patients, as has been reported elsewhere. For example, one Japanese study concluded that neither the presence of MS, as defined by the IDF guideline, nor the WC was associated with the presence of either microvascular nor macrovascular complications in Japanese type 2 diabetic patients [4].

Table 1 Characteristics of the entire study group (Biochemical parameters are given in mg/dl. DM= diabetes mellitus, BMI=body mass index, HDL= high density lipoproteins, WC= waist circumference, TG=triglyceride, SBP= systolic blood pressure, DBP=diastolic blood pressure, BP=Blood pressure, HTN= hypertension, MS= metabolic syndrome, ATPII=adult treatment panel III, IDF= international diabetes federation. P-values refer to differences between males and females)

|                          | Males       | Females     | P-value | All patients |
|--------------------------|-------------|-------------|---------|--------------|
| Number                   | 38          | 61          |         | 99           |
| Age: mean±SD (range)     | 58.2±11.5   | 54.6±7.8    | 0.073   | 56±9.5       |
|                          | (37-76)     | (39-75)     |         |              |
| DM duration: mean±SD     | 10.7±9.6    | 8.7±6.5     | 0.22    | 9.4±7.8      |
|                          |             |             |         |              |
| Obesity                  | 47.3%       | 91.8%       | <0.001  | 74.4%        |
|                          |             |             |         |              |
| BMI:mean±SD (range)      | 30±5.3      | 35.9±4.5    | <0.001  | 33.6±5.6     |
|                          | (16-42)     | (16-42)     |         |              |
| WC: mean±SD (range)      | 102.9±11.6  | 104.2±10.5  | 0.57    | 103.6±10.9   |
|                          | (67-125)    | (52-121)    |         |              |
| Abnormal WC              | 55.2%       | 78.6%       | 0.014   | 69.6%        |
|                          |             |             |         |              |
| Abnormal HDL             | 65.7%       | 88.5%       | 0.006   | 79.7%        |
|                          |             |             |         |              |
| TG: mean±SD (range)      | 178.2±111   | 176.6±113   | 0.94    | 177.2±112    |
|                          | (57-486)    | (34-675)    |         |              |
| Abnormal TG              | 47.3%       | 47.5%       | 0.98    | 47.4%        |
|                          |             |             |         |              |
| SBP: mean±SD             | 134±17.1    | 126±18.2    | 0.08    | 129.8±18     |
|                          |             |             |         |              |
| DBP: mean±SD             | 83.1±8.5    | 74.8±8.4    | 0.07    | 81.1±8.5     |
|                          |             |             |         |              |
| Abnormal BP              | 78.9%       | 73.8%       | 0.55    | 75.8%        |
|                          |             |             |         |              |
| HTN                      | 65.8%       | 63.9%       | 0.85    | 64.6%        |
|                          |             |             |         |              |
| MS (ATPIII): n/n (%)      | 32/38       | 59/61       | 0.026   | (91.9%)      |
|                          | (84.2%)     | (96.7%)     |         |              |
| MS (IDF): n/n (%)         | 26/38       | 54/61       | 0.014   | 80.8%        |
|                          | (68.4%)     | (88.5%)     |         |              |
Figure 1 Percent frequency of MS among males and females with type-2 DM according to IDF and modified ATPIII criteria.

Table 2 Comparison between MS and non-MS diabetic patients according to IDF and modified ATPIII criteria (HDL= high density lipoproteins, WC= waist circumference, TG=triglyceride, BP=Blood pressure, HTN= hypertension, MS= metabolic syndrome).

|                | According to ATPIII | According to IDF |
|----------------|---------------------|------------------|
|                | With MS             | Without MS       | P    | With MS      | Without MS | P     |
| Raised WC      | 71.4% 50%           | 0.2              | 100% | 52.6%        | 68.4%       | 0.00 1|
| Raised BP      | 78% 50%             | 0.07             | 77.5%| 65%          | 0.4         |       |
| Raised TG      | 49.4% 25%           | 0.18             | 55%  | 15.8%        | 0.00        | 2     |
| Low HDL        | 83.5% 37.5%         | 0.00             | 86.3%| 52.6%        | 0.00        | 1     |
| Obesity        | 76.9% 50%           | 0.09             | 78.8%| 57.9%        | 0.06        |       |
| HTN            | 68.1% 25%           | 0.01             | 65%  | 63.2%        | 0.8         |       |

Table 3 Comparison between mean values of different MS components among MS and non-MS diabetics according to IDF and modified ATPIII criteria (M=male, F=female, WC= waist circumference, BMI=body mass index, HDL= high density lipoproteins, TG=triglyceride, SBP= systolic blood pressure, DBP= diastolic blood pressure, MS= metabolic syndrome).

|                | According to ATPIII | According to IDF |
|----------------|---------------------|------------------|
|                | With MS             | Without MS       | P    | With MS      | Without MS | P     |
| WC/M           | 104±11.4            | 96.8±11.5        | 0.16 | 106±7.5      | 96.2±15.8  | 0.014 |
| WC/F           | 104±10.7            | 105.5±7.7        | 0.85 | 104.8±8.1    | 99.2±22.1 | 0.19  |
| TG             | 183±114             | 108±41           | 0.06 | 191.8±118    | 115.7±38   | 0.007 |
| HDL/M          | 36 ±16.2            | 54.1±18.5        | 0.01 | 37.1±19      | 42.5±13.6  | 0.3   |
| HDL/F          | 37.1±9.2            | 59±8.4           | 0.002| 35.8±8.3     | 53.5±7.3   | 0.000 |
| BMI            | 33.9±5.6            | 30.3±5           | 0.08 | 34.2±5.1     | 31.3±6.9   | 0.027 |
| SBP            | 130.3±19            | 120±8.9          | 0.16 | 129.8±18.4   | 130±16.8   | 0.9   |
| DBP            | 81.3±8.47           | 76.6±5.1         | 0.18 | 81.2±8.8     | 80.7±7.5   | 0.8   |

Study limitations
Our study sample was large enough to fulfill our aims, but a larger sample would be more suitable for detecting small differences between means. Unfortunately, because of the high prevalence of MS in the study population, the number of patients without MS was too few to make a reliable comparison between patients with and without MS. Moreover, we did not measure HbA1c in this study, and this may affect the frequency of MS as well as the frequency of each parameter because the degree of glycemic control might affect the lipid profile as well as the weight of the patient. Despite these limitations, this pilot study was able to reveal important aspects of this clinical syndrome among diabetic patients in Libya, perhaps most notable of which is its very high prevalence.

Conclusions
Metabolic syndrome is not only highly prevalent among the study population; it is more prevalent than reported worldwide. It is more common among females than males. Males with MS were significantly older and had a higher blood pressure and females were significantly more obese. The most significant indicator of MS in type-2 diabetics in Benghazi is atherogenic dyslipidemia, particularly low HDL, but there is no significant difference between MS and non MS patients regarding age, disease duration, blood pressure or waist circumference.

Although the need to diagnose MS in diabetics is controversial, we believe that it is worth considering because diabetic patients with MS need a more aggressive approach in management in order to achieve glucose control, which necessitates the use of insulin sensitizers and more emphasis on exercise.
The impact of MS on long-term complications of DM.

Own local reference measures should be defined.

and non-diabetic subjects.

syndrome and its different components among diabetics define more precisely the frequency of metabolic resistance and thus it has positive effects on patients' weight, lipid profile and glycemic control.

is a specific contraindication. Metformin targets insulin diabetic patients, particularly those with MS, unless there is a more positive impact on patients' weight, HDL and TG levels as well as on BP and glycemic control.

- Metformin should be prescribed to most type-2 diabetic patients, particularly those with MS, unless there is a specific contraindication. Metformin targets insulin resistance and thus it has positive effects on patients' weight, lipid profile and glycemic control.

Studies of larger samples should be conducted to define more precisely the frequency of metabolic syndrome and its different components among diabetics and non-diabetic subjects.

- The standard WC used in this study as defined by the IDF guideline nor an increased waist circumference increased the risk of microvascular or macrovascular complications in Japanese patients with type 2 diabetes. Diabetes Res Clin Pract. 2008; 79(3): 350-353.

- Physicians treating type-2 diabetic patients, particularly those with MS, unless there is a specific contraindication. Metformin targets insulin resistance and thus it has positive effects on patients' weight, lipid profile and glycemic control.

A new worldwide definition. Lancet. 2005; 366:1059–1062.

Neither the presence of metabolic syndrome as defined by the IDF guideline nor an increased waist circumference increased the risk of microvascular or macrovascular complications in Japanese patients with type 2 diabetes. Diabetes Res Clin Pract. 2008; 79(3): 427-432.

- Metformin should be prescribed to most type-2 diabetic patients, particularly those with MS, unless there is a specific contraindication. Metformin targets insulin resistance and thus it has positive effects on patients' weight, lipid profile and glycemic control.

- Studies of larger samples should be conducted to define more precisely the frequency of metabolic syndrome and its different components among diabetics and non-diabetic subjects.

- The standard WC used in this study as defined by ATPIII/IDF needs to be validated for our patients, and our own local reference measures should be defined.

- Prospective follow up studies are needed to identify the impact of MS on long-term complications of DM.

Table 4: Comparison between males and females with MS according to IDF and modified ATPIII criteria (Biochemical parameters are given in mg/dl. Means are given ± SD. Abn.=abnormal, BMI=body mass index, HDL= high density lipoproteins, WC=waist circumference, TG=triglyceride, HTN=hypertension, BP=blood pressure, SBP=systolic blood pressure, DBP=diastolic blood pressure, MS=metabolic syndrome).

| ATPIII     | Males | Females | P   | Males | Females | P    |
|------------|-------|---------|-----|-------|---------|------|
| Number     | 32    | 59      |     | 26    | 54      |      |
| Age        | 58.5±10.7 | 54.5±7.7 | 0.04 | 59.4±9.7 | 53.8±7.4 | 0.006 |
| Duration   | 11.5±10 | 8.6±6.5 | 0.1  | 12.2±10.2 | 8.4±6.3 | 0.04 |
| Mean WC    | 104±11.4 | 104±10.7 | 0.98 | 106±7.5 | 104.8±8.1 | 0.5  |
| Raised WC  | 55.3%  | 78.7%   | 0.06 | 100%   | 100%    |      |
| Obesity    | 50%    | 91.5%   | 0.000 | 53.8%  | 90.7%   | 0.000 |
| Mean BMI   | 30.4±5.5 | 35.8±4.6 | 0.000 | 31.3±4.7 | 35.6±4.7 | 0.000 |
| Mean TG    | 190±115 | 179±114 | 0.66 | 202.8±124 | 186.5±117 | 0.5  |
| Raised TG  | 47.4%  | 47.5%   | 0.9  | 57.6%  | 53.7%   | 0.7   |
| Mean HDL   | 36±16.2 | 37±9    | 0.16 | 37.1±19.2 | 35.8±8.3 | 0.6   |
| Low HDL    | 65.8%  | 88.5%   | 0.028 | 73%    | 92.5%   | 0.01  |
| HTN        | 71.9%  | 66.1%   | 0.57 | 58.6%  | 64.8%   | 0.9   |
| Raised BP  | 84.4%  | 74.6%   | 0.28 | 84.6%  | 74%     | 0.29  |
| Mean SBP   | 136.1±17.2 | 126.7±18.5 | 0.05 | 135.4±17.9 | 125.8±18 | 0.06  |
| Mean DBP   | 84±8.7 | 79.7±8.3 | 0.055 | 83.4±9.8 | 79.6±8.3 | 0.1   |

Table 5 Prevalence of metabolic syndrome among type-2 diabetics in different countries

| Country | ATPIII | IDF |
|---------|--------|-----|
| Libya   | 92%    | 80.8% |
| USA[9]  | 70%    | /    |
| Italy[5]| 68.4%  | 73.7% |
| UK[13]  | 61%    | 54%  |
| China[14]| 55.7% | 50%  |

Recommendations

- Physicians treating type-2 diabetics should place greater emphasis on weight reduction and exercise, which together should have a positive impact on patients' weight, HDL and TG levels as well as on BP and glycemic control.

References

1. National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III): Executive summary of the third report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). JAMA. 2001; 285:2486–2497.

2. Grundy SM, Cleeman JI, Daniels SR, et al. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. Circulation. 2005; 112:2735–2752.

3. Alberti KG, Zimmet P, Shaw J: The metabolic syndrome: a new worldwide definition. Lancet. 2005; 366:1059–1062.

4. Iwasaki T, Togashi Y, Ohshima K, et al. Neither the presence of metabolic syndrome as defined by the IDF guideline nor an increased waist circumference increased the risk of microvascular or macrovascular complications in Japanese patients with type 2 diabetes. Diabetes Res Clin Pract. 2008; 79(3): 427-432.

5. Monami M, Marchionni N, Masotti G, Mannucci E. IDF and ATP-III definitions of metabolic syndrome in the prediction of all-cause mortality in type 2 diabetic patients. Diabetes Obes Metab. 2007; 9(3): 350-353.

6. Saely CH, Koch L, Schmid F, et al. Adult Treatment Panel III 2001 but Not International Diabetes Federation 2005 Criteria of the Metabolic Syndrome Predict Clinical Cardiovascular Events in Subjects Who Underwent Coronary Angiography. Diabetes Care 2006; 29:901–907.

7. Bonora E, Targher G, Formentini G, et al. The metabolic syndrome is an independent predictor of cardiovascular disease in type 2 diabetic subjects: prospective data from the Verona Diabetes Complications Study. Diabet Med. 2004; 21:52–58.

8. Alexander CM, L Lansman PB, Teutsch SM, Haffner SM. NCEP-defined metabolic syndrome, diabetes, and prevalence of coronary heart disease among NHANES III participants age 50 years and older. Diabetes. 2003; 52:1210–1214.

9. Lin SX, Pi-Sunyer EX. Prevalence of the metabolic syndrome among US middle-aged and older adults with and without diabetes: a preliminary analysis of the NHANES 1999-2002 data. Ethn Dis. 2007; 17(1):35-39.

10. The Metascreen Writing Committee. The Metabolic Syndrome Is a Risk Indicator of Microvascular and Macrovascular Complications in Diabetes. Diabetes Care 2006; 29:2701-2707.

11. Wong J, Molyneaux L, Constantin MI, Twigg SM, Yue DK. The metabolic syndrome in type 2 diabetes: When does it matter? Diabetes Obes Metab. 2006; 8(6):690-697.

12. Kahn R, Buse J, Ferrannini E, Stern M. The metabolic syndrome: time for a critical appraisal: joint statement from the American Diabetes Association and the European Association for the Study of Diabetes. Diabetes Care. 2005; 28:2289-2304.

13. Cull CA, Jensen CC,Retnakaran R, Holman RR. Impact of the metabolic syndrome on macrovascular and microvascular outcomes in type 2 diabetes mellitus: United Kingdom Prospective Diabetes Study 78. Circulation. 2007; 6,116(19):2119-2126.

14. Liu B, Yang Y, Song X, Dong X, et al. An evaluation of the International Diabetes Federation definition of metabolic syndrome in Chinese patients older than 30 years and diagnosed with type 2 diabetes mellitus. Metabolism. 2006; 55(8):1088-1096.

15. Roaied R.B and Kablan AA. Profile of diabetes health care at Benghazi Diabetes Centre, Libyan Arab Jamahiriya. East Mediterr Health J. 2007; 13(1):168-176.

16. Kompoti M, Mariolis A, Alevizos A, et al. Elevated serum triglycerides is the strongest single indicator for the presence of metabolic syndrome in patients with type 2 diabetes. Cardiovasc Diabetol 2006; 5:21 doi:10.1186/1475-2840-5-21.